MAY 2025

CURRENT PROJECTS REPORT

This report is a summary of current and completed projects for the months February, March and April 2025

ACARP

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UNDERGROUND

Reports Published This Quarter

C27020
Management of Coal Bursts and Pillar Burst in Deep Mines
University of Adelaide
Murat Karakus
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C27020

C28020
Optimising Cable Bolt Pre-tensioning Practice to Control Roadway Roof Failure Using Advanced Combined Axial and Shear Testing Facility
Monash University
Hossein Masoumi
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C28020

C29010
In-situ Stress Measurements using Cored Coal/Rocks for Coal Burst Management
University of Adelaide
Murat Karakus
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C29010

C34007
Evaluating Toxicity of Different Types of Respirable Crystalline Silica Particles to Lung Cells and Tissues
University of Queensland
Gordon Xu
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C34007

Coal Burst

C28012
Microfracture Analysis as a Trigger for Coal Bursts

SCT Operations
Winton Gale
Yvette Heritage

Value:	$498,000
Report Expected:	May 2025
Industry Monitor/s:	Brad Elvy Frank Fulham Ian Stone Patrycja Sheffield Paul O'Grady Peter Corbett Roger Byrnes Russell Thomas Sharif Burra
ACARP Contact:	Peter Bergin

The draft final report has been submitted to the Industry Monitors for review.

C33014
Coal Burst Research Findings

SCT Operations
Winton Gale
Yvette Heritage

Value:	$388,000
Report Expected:	May 2025
Industry Monitor/s:	Frank Fulham Ian Stone Patrycja Sheffield Paul O'Grady Peter Corbett Roger Byrnes Russell Thomas Sharif Burra
ACARP Contact:	Peter Bergin

The draft final report has been submitted to the Industry Monitors for review.

C35014
Investigation of Pre-Installation of Optic Fibre Cable in Exploration Holes for Longwall Weighting and Coal Burst Monitoring

CSIRO
Joey Duan
Matt van de Werken

Value:	$258,473
Report Expected:	June 2025
Industry Monitor/s:	Ian Stone Marc Henderson Tim Dean
ACARP Contact:	Peter Bergin

The project goal is to provide a new and more cost-effective approach for assessing the longwall caving progress and coal burst risk. It has two objectives:

- To trial optic fibre cables pre-installed in geo-exploration holes for high accurate and cost efficiency longwall weighting and coal burst monitoring; and
- To conduct a field demonstration using both distributed acoustic sensing (DAS) and geophones and investigate the optimal monitoring configuration, data processing and interpretation methods for the DAS system.

During the past three months, the DAS data collected from this project was analysed. The distribution of seismic events clearly demonstrated the height of fractures. Three fracturing zones, namely immediate caving zone, intermediate fracturing zone and strata delamination zone, can be identified to characterise the fracturing behaviour of the overburden. The borehole lithology correlated well with the fracturing profile and the discontinuities observed in the DAS wavefields, illustrating that borehole deployment of optical fibre cables can be used for characterisation of longwall caving mechanisms and subsurface properties during mining-induced seismicity monitoring. More data processing and interpretation is in progress. The final report is being drafted, and we aim to submit it in the next three months.

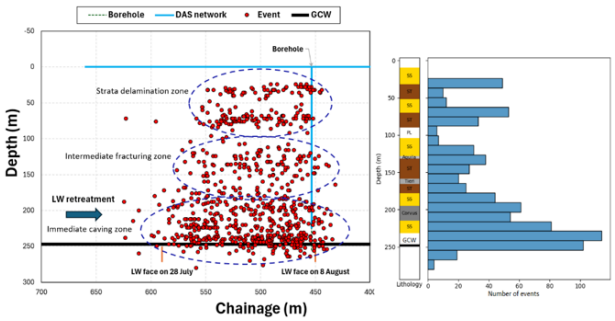


Figure 1. Three fracturing zones identified with the distribution of seismic events in cross-section

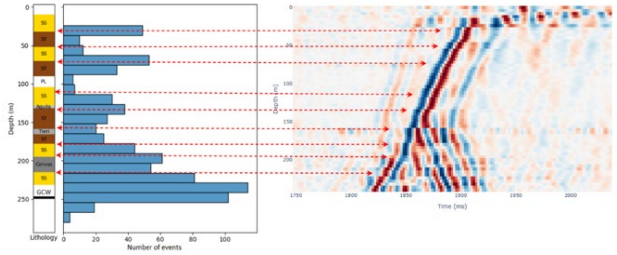


Figure 2. Correlation between the borehole lithology, fracturing profile and discontinuities observed in the DAS wavefield associated with a seismic event located below the bottom of the borehole.

Detection and Prevention of Fires and Explosions

C28013
Use of Compressed Air Foams (CAFs) to Alter Goaf Air Circuits and Mitigate Spontaneous Combustion Events

Mines Rescue
Alaster Wylie
Clive Hanrahan
Dave McLean

Value:	$392,500
Report Expected:	May 2025
Industry Monitor/s:	David Webb Martin Mackinnon Paul Wild Peter Baker Sharif Burra
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C29026
Investigation into the Thermal Ignition Caused by IS Power Supplies

Simtars
Sean Muller

Value:	$153,700
Report Expected:	June 2025
Industry Monitor/s:	Brad Lucke Jarod Chadwick
ACARP Contact:	Patrick Tyrrell

The objectives of the project are to:

- Determine the fault conditions arising in an intrinsically safe electrical circuit that could ignite combustible material on a mining machine;
- Determine the role and extent that combustible material accumulation can cause or contribute to the risk of equipment fires, when ignited by intrinsically safe power supplies; and
- Determine the parameters to be considered in installing an intrinsically safe circuit in an area where

they could be an accumulation of flammable materials.

During the quarter the project progressed as follows:
- Concept design of testing procedure was completed;
- Manufacturing of testing equipment commenced;
- Testing materials is being obtained (oils, greases, coal dust).

The following steps will be addressed in the next quarter:
- Manufacturing of test equipment;
- Evaluation of PSU to determine safe parameters and output terminals that could provide uncontrolled electrical energy;
- Complete validation testing of test setup;
- Start of full-scale testing; and
- Conduct T-rating tests for test samples.

Environment - Subsidence and Mine Water

C28004
Monitoring Hydrological Status of Complex Upland Heath Communities Using Canopy Conductance and Thermal Imaging

Queensland University of Technology
Andrew Fletcher

Value:	$230,964
Report Expected:	June 2025
Industry Monitor/s:	Gary Brassington Peter Corbett
ACARP Contact:	Patrick Tyrrell

No report received. The final report is being prepared.

C33021
Pilot Scale Membrane Distillation Crystalliser (MDC) with Renewable Heat Source for Mine Water Brine Management

CSIRO
Ramesh Thiruvenkatachari

Value:	$969,195
Report Expected:	December 2025
Industry Monitor/s:	Paul O'Grady Tim Kendrick
ACARP Contact:	Patrick Tyrrell

This project aims to undertake a mine site demonstration of the MDC system for treating saline and acid mine drainage mine impacted water under actual mine site conditions. The main objectives are to develop a modular MDC water treatment plant to mine site specifications, install at the mine site by integrating with onsite infrastructure and to demonstrate the mine impacted water treatment performance. Through this study optimum operating process parameters for AMD treatment will be obtained in maximising reusable water recovery with reduced volume of saturated concentrate.

Mechanical works of the pilot construction has been completed. Electrical work is in progress and expected to be completed next quarter. Site works infrastructure such as ground compaction at mine site location where the pilot unit is to be installed, power supply facilities and control room setup are also to be carried out in the next quarter.

C35016
Rehabilitation Options for Ponded Areas Due to Longwall Coal Mining

University of Queensland
Louisa Rochford

Value:	$397,200
Report Expected:	May 2026
Industry Monitor/s:	Callum Gawne Jason Fittler Michael Moore Ned Stephenson
ACARP Contact:	Patrick Tyrrell

There has been limited research on the most appropriate options for rehabilitating land subsided by longwall mining in Australia. This project is investigating the implications of retaining ponded areas from longwall mining, including their contribution to environmental values. The approach is to select a study site and conduct the research at that location over a three-year period, providing a template for the assessments that are required to make decisions on rehabilitation options for ponded areas at other mines.

Three rounds of fieldwork have been completed, with the final round scheduled for 20 to 23 May. The final round of fieldwork will involve bird surveys and camera trapping around the ponds. A machine learning algorithm will subsequently be developed to assist with post-processing of the fauna data from the camera trapping. Mine site representatives continue to record pond water levels using staff gauges in three ponds.

Preparation of the Site Characterisation Report to be delivered at the end of quarter 3 is underway. The report will provide details of the field and analytical work undertaken for the project. Reporting on the vegetation surveys and soil sampling and analysis is complete, with the remaining sections under development.

The Impact Assessment is underway. Soil hydrological modelling to predict how the ponded areas will affect soil moisture (and therefore potential post-mining land uses) has been completed. Refinement of the water balance model to include soil physical properties from the field program is underway.

Maintenance and Equipment

C28010
Towards Better, Safer Mines - Optical Technologies for Software Defined Instrumentation

University of New South Wales
Francois Ladouceur

Value:	$704,974
Report Expected:	July 2025
Industry Monitor/s:	Ben McCamley Brad Lucke Dave Young Ernest Baafi Jonathan Harris
ACARP Contact:	Patrick Tyrrell

The first stage of this project completed the design of an optically powered, intrinsically safe gas monitoring station (CH4, CO, CO2, O2). This certified system has been successfully deployed in situ and reliably collected data over a period of two months (17/12/2020 to 15/02/2021). Stage 2 now seeks to fix identified technical issues with the current system and proceed with its testing, develop an improved system design, focussing on design for manufacture and providing the resources needed for its deployment and testing.

UNSW and ACARP are negotiating a path to completion for this project.

C33009
Ceramic Wall Flow Filter Commercialisation

PPK Mining Equipment
Bradley Drury
Greg Briggs

Value:	$888,778
Report Expected:	June 2024
Industry Monitor/s:	Andrew Esdaile Steve Coffee Trevor Hartley
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C33017
Specialised Instrumentation and Data Processing for Real Time FEA Condition Monitoring of AFC Chain

Vayeron
Ryan Norris

Value:	$185,000
Report Expected:	June 2025
Industry Monitor/s:	Brad Lucke Jarrod Sampson
ACARP Contact:	Patrick Tyrrell

No report received.

C33026
Prototype Battery Electric Load Haul Dump

3ME Technology
Justin Bain
Lewis Grainger
Martin Kime

Value:	$1,431,295
Report Expected:	August 2025
Industry Monitor/s:	Brad Lucke Dave Young Matt Wang Sharif Burra
ACARP Contact:	Patrick Tyrrell

The objective of this project is to design, build, and certify a high-performance battery for use in an Electric Vehicle (EV) system that meets Australian Hazardous Area requirements. Achieve Hazardous Area certification of an Ex battery and then integrate into an underground rubber tyred vehicle to operate in a hazardous area of an underground coal mine.

Key activities conducted to date are:
- Certifying Body continued assessment against relevant standards;
- Testing continued with several assessments passed;
- Charger prototype construction complete;
- Charge function test completed; and
- Scaled enclosures completed.

Key tasks to be conducted next quarter include:
- Complete testing with certifying body;
- Complete large scale battery construction; and
- Commence full battery system testing.

C35013
Ex.P Enclosure Designs

CSIRO
Peter Reid

Value:	$248,500
Report Expected:	February 2026
Industry Monitor/s:	Brad Lucke Colin Hoyle Dave Young
ACARP Contact:	Patrick Tyrrell

Negotiations ongoing with commercialisation partners to finalise a path forward, after which detailed redesign work will commence.

Mining Technology and Production

C20033
Development of a Safer Underground Explosive

University of New South Wales
Andres Castro
Duncan Chalmers

Value:	$468,000
Report Expected:	July 2025
Industry Monitor/s:	Brad Elvy Paul Wild Rob Nowell Russell Thomas
ACARP Contact:	Patrick Tyrrell

Underground mines resort to the use of explosives to break extremely hard materials that intrude into coal seams. Since there is no longer P5 explosive available for delay firing, mines resort to using type 1 explosive. Confusion arises as to how these explosives can be safely used. Currently permitted explosives are being used outside the recommended guidelines as published by the Buxton Testing Authority in the UK. In order that they can be used safely, mines are conducting risk assessments to manage the incendive hazard that possibly could be created by a cut off shot and additionally managing the deflagration hazard with the same risk assessment when using P1 explosives. This project developed an alternate test regime that adequately assesses the deflagration risk of an explosive. The information gained from this testing provides additional data to change the testing regime for permitted explosives.

The report writing is close to being finalised with a draft report to be distributed to the monitors as soon as possible.

C28018
Longwall Floor Horizon Sensing

CSIRO
Andrew Strange

Value:	$269,680
Report Expected:	June 2025
Industry Monitor/s:	Jarod Chadwick
ACARP Contact:	Patrick Tyrrell

Effective horizon control is essential for both safety and productivity in underground longwall mining. The key to achieving this outcome is a reliable means of actively sensing the geological strata of the seam floor. This project will develop a ground penetrating radar (GPR) sensor for installation on a production longwall and long-term trial as a floor horizon sensor.

As previously reported, the high-density polyethylene (HDPE) skid base was successfully trialled but the flexible insertion rubber sheet that connects the skid base to the bracket attached to the longwall pan failed after 10 weeks of production operation. Furthermore, the bracket used in the recent trial became corroded as it was fabricated from mild steel. The corrosion made the bracket difficult to remove. Based upon recommendations from the operators at the host site, the original flexible insertion rubber sheet has been replaced with 6mm thick conveyor belt rubber and a new bracket fabricated from stainless steel. The conveyor belt rubber has significantly more tensile strength over the original insertion rubber and should be more suited to this application.

The replacement rubber sheet and bracket have just been assembled and are about to be shipped to the host mine site for subsequent installation so that the longwall floor horizon sensing system can be trialled in production conditions.

C29033
Alternative Flameproof Enclosure Protection Techniques

CSIRO
Peter Reid

Value:	$272,000
Report Expected:	May 2025
Industry Monitor/s:	Brad Lucke Colin Hoyle
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C34003
Self-Drilling Bolt Automation: Finalisation of Development

OKA Rock Bolt Technologies
Mark Levey

Value:	$2357744
Report Expected:	June 2025
Industry Monitor/s:	Roadway Development Task Group
ACARP Contact:	Patrick Tyrrell

The project objectives are as follow:

- Complete development of the Chemicals, Capsule and Self Drill Bolt;
- Complete the development of the Adaptor, headplate and software such that an underground trial can take place; and to
- Carry out an underground trial.

The underground trial preparation began early March, and the trial was conducted late March, early April. The trial duration was shortened due to mine site priorities, however there was sufficient time to test the semi-automatic technology in a mining environment. Overall, the trial was successful with no insurmountable issues found.

The chemical cure time, (post chemical injection through to torquing the nut) was excessive at around 45 seconds. This part of the process can be expedited by adopting the spin-to-stall chemical. Obviously, the spin-to-stall chemical formula and process needs to be tested within the technology.

The final report is currently being drafted.

C34015
Assistive Shuttle Car: Development of an Industry Ready Guidance System: Stage 3

CSIRO
Andrew Strange
Mark Dunn

Value:	$205,395
Report Expected:	May 2025
Industry Monitor/s:	Roadway Development Task Group
ACARP Contact:	Patrick Tyrrell

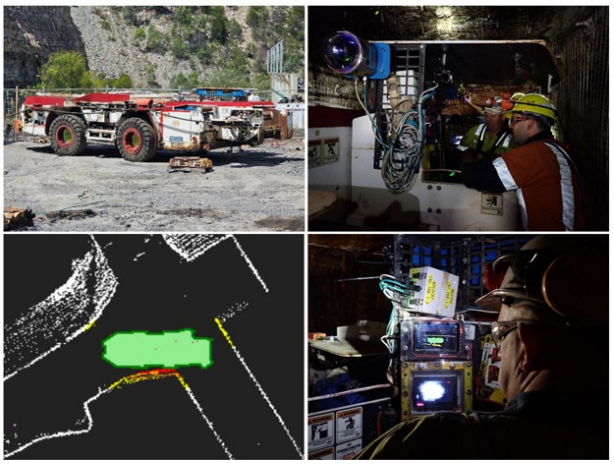
Most development operations in Australia utilise manual line-of-sight radio-controlled miners to cut roadways, and operator driven shuttle cars to transfer coal from the working face. These levels of technology are not able to achieve the goal of safe remote operation of roadway development. Two issues have been identified that inhibit progress in the domain of remote development:

- Continuous miner self-steering technology to maintain desired roadway headings has not yet reached the required level of performance required for sustained remote operation.
- No automated options currently exist to guide shuttle cars while tramming through roadway systems and whilst avoiding ribs, cut-through corners and other infrastructure.

An assistive guidance system based on CSIRO's ExScan technology and simultaneous localisation, and mapping (SLAM) techniques has been developed to address these issues.

The assistive guidance system was taken to the host mine site and temporarily mounted onto a shuttle car located in an underground roadway dedicated for evaluating equipment which is close to the box cut on the surface. The ExScans were mounted to the operator cab and the guidance system output was displayed on an IS tablet, giving feedback to the operator to aid in collision avoidance.

During the two day trial, two operators evaluated the guidance system and both when driving manually accidentally took a corner too tightly and drove into the wall. On the following run, the operators used the guidance system and successfully navigated the corner without impacting the wall. The feedback from the shuttle car operators involved in the trial was very positive. The figure shows results from the production trial. The project report is currently being prepared.



Clockwise from top left: The shuttle car with the system installed; the project team instructing an operator how to use the system; the operator looking at the guidance display; a screenshot of the guidance display showing point of impact with the roadway wall.

C34024
Effects of Rock Weathering on Life-of-mine Roadway Stability

University of Queensland
Zhongwei Chen

Value:	$312,534
Report Expected:	June 2025
Industry Monitor/s:	Brian Vorster Matt Tsang
ACARP Contact:	Patrick Tyrrell

The main project objectives are to:
- Identify the relevant weathering testing standards for assessing the process of rock degradation;
- Experimentally characterise and quantify the responses of rock properties to the weathering; and to
- Apply the laboratory results to assess the weathering impact on CMRR de-rating and its implications to support design practices.

The project report is currently being drafted and is expected to be submitted by the end of May.

C35004
Advancing Remote and Automated Capability for Longwall and Roadway Development

CSIRO
Andrew Strange
Jonathon Ralston

Value:	$2,517,000
Report Expected:	July 2025
Industry Monitor/s:	Roadway Development Task Group
ACARP Contact:	Patrick Tyrrell

This project responds to the industry need to accelerate remote and automated longwall and roadway development capability. The project utilises the flexible industry-directed project model to deliver research impacts to industry through well-scoped work packages.

The topic for work package #4 (WP4) was "Offline Drivage Monitoring Stage 2" and built on the outcomes from work package #1 where real-time offline drivage capability was incorporated into the CM navigation system previously developed by CSIRO.

The technical activities of WP4 have been completed and results presented to the industry working group. The highlights have been summarised as follows:
- Stationary detection algorithms using miner data captured over EIP were successfully developed for both Komatsu 12CM30 and Sandvik MB650 miner bolters;
- The offline drivage system with the new stationary algorithms was trialled on both miners in production conditions with significantly improved results achieved compared with previous trials. The performance on the Sandvik miner was greater than the Komatsu miner, however the goal of 100mm error after 100m of advance was not achieved on either due to position drift causing cross-track and along-track error;
- Lab-based experiments were conducted which quantified performance limitations of the navigation system (cross-track error) due to the inertial sensor;
- Lab-based investigations determined that the along-track error was caused by detecting miner motion after motion had commenced (i.e. clearing the stationary flag too late). This can be resolved by triggering motion from an alarm that sounds prior to the miner moving; and
- An approach to reduce cross-track error with and Komatsu miners was identified and demonstrated with CSIRO's Tuglet mobility platform.

The recommendations from WP4 are:
- Update the new stationary algorithms to trigger motion from an alarm that sounds prior to motion;
- Update CM navigation system procedures to conduct gyro-compass aligns more frequently such as during maintenance shifts or shift changeovers;
- Industry to decide if the existing performance limitations are suitable for future remote and autonomous RWD operations.

Several topics for work packages #5 and #6 were raised. The two of most interest by industry was to identify and resolve the edge cases with the Gate End Face Alignment system and progress the Offline Drivage Monitoring system. Scope for these topics as WP5 and WP6 is underway and will be reported to the project monitors shortly to seek formal approval.

C35009
Longwall Remote Operations – Face Mapping Robot – Phase 1

Quantum Engineering and Consulting Group
Luke Dyer

Value:	$170,000
Report Expected:	May 2025
Industry Monitor/s:	Duane Witkowski Jarod Chadwick
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C36013
Planar Reflecting Radio Antenna (PRRA) for Underground Coal Mines

Roobuck
Dane Zielinski-Nicolson
Naing Ba
Tommy Chaung

Value:	$360,000
Report Expected:	February 2026
Industry Monitor/s:	Dave Young Jarod Chadwick Jonathan Harris
ACARP Contact:	Patrick Tyrrell

The aim of this project is to simulate, manufacture, validate and test single/multi-band planar reflecting radio antenna (PRRA) in underground coal mines to extend network coverage with minimal cost/infrastructure.

Work completed over the quarter includes:

- Designing the first functional prototype of the angle adjustment mechanism, including torque calculations for critical elements -
  - ordering and assembling a fabricated prototype of the mechanism to validate its design,
  - researching materials that meet transmissivity requirements as well as satisfying IECEx compliant surface resistance properties, for the front face of the antenna enclosure,
  - continuing the design of the antenna enclosure for the PRRA module;

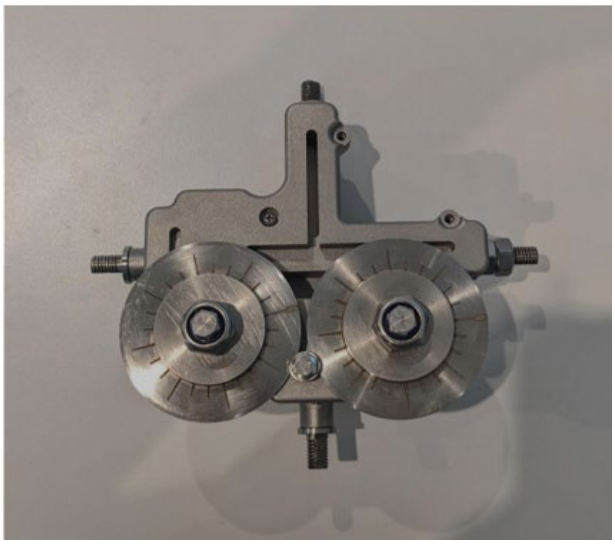
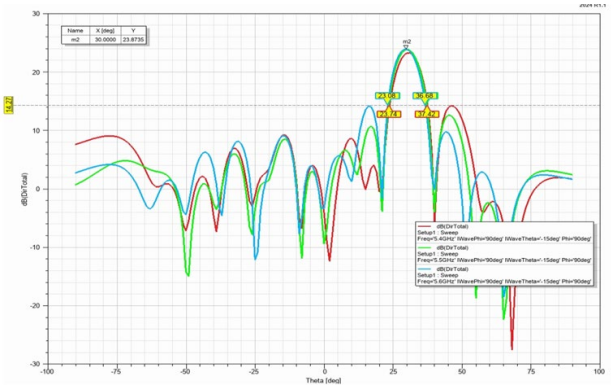


Figure: First fabricated and functional prototype of the rotation mechanism.

- Designing the first prototype of 5GHz PRRA -
  - extensive research and simulations have been carried out for the 5GHz Wi-Fi reflective antenna design and results have been analysed to determine optimal parameters such as array element, size, centre frequency and bandwidth,
  - design files have been sent to the manufacturer and fabrication is underway;



Planned next steps:

- Finalise the antenna enclosure design in preparation for a first prototype;
- Seek guidance on applicable and accessible fabrication methods for, and then procure the antenna enclosure prototype;
- Test the function and ergonomics of the angle adjustment mechanism with the antenna enclosure mounted;
- Optimise the design of the angle adjustment mechanism and the antenna enclosure based on testing;
- Research both site specific and generalisable methods to mount the combined antenna and rotation mechanism; and
- Field test the 5GHz PRRA at mine site 1.

C36014
Roof Support Location using Wireless Ranging

CSIRO
Matt van de Werken

Value:	$212,543
Report Expected:	September 2025
Industry Monitor/s:	Brad Elvy Tom Hudson
ACARP Contact:	Patrick Tyrrell

This project aims to develop a prototype system capable of real-time localisation of longwall roof supports using wireless ranging technology. The core objective is to alleviate the roof support left behind problem, thereby improving operational efficiency and safety.

During the past quarter, substantial progress was made towards the prototype system. The longwall simulator and visualisation engine underwent several enhancements, including continued development and integration into the visualisation environment of the messaging system. Work on the localisation algorithm also progressed steadily.

On the hardware front, the design of the localisation Tag advanced significantly, with the prototype now nearing production readiness. In parallel, development of the embedded firmware for the tag-anchor pairs continued, focusing particularly on implementing and refining two-

way ranging functionality, which is essential for accurate positioning.

Looking ahead to the next quarter, efforts will be directed towards finalising the localisation algorithm and producing the first batch of tag prototypes. Embedded software development will continue, with an emphasis on ensuring reliable communication between tags and anchors. Additionally, commercialisation activities will be ramped up to prepare the system for industry deployment.

Health and Safety

C24010
Proximity Detection Systems Specification for Underground Coal Mining Machines

Simtars
Sean Muller

Value:	$565,988
Report Expected:	May 2025
Industry Monitor/s:	Brad Lucke Frank Fulham Michael Barker
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C28029
Personal Real Time Dust/Particulate Monitor (Direct Mass Based Measurement)

Lear Siegler Australasia
Peter Phaedonos

Value:	$1,521,730
Report Expected:	July 2025
Industry Monitor/s:	Brad Lucke Glenn Owens Ian Marshall
ACARP Contact:	Patrick Tyrrell

The PDM Real time dust monitor is a safety tool and a safety companion to the miner. At any point in the miner's working shift the PDM will display the exposure levels you will have and allow the operator to make decisions and withdraw to a safe area. Standards exist for limiting exposure to the respirable fraction of coal dust in most industrial settings, the PDM will provide the miner with the means to monitor and manage such exposer. It will have a very low detection limit that will meet or exceed current and anticipated exposure limits, and AS2985-2009 requirements for such continuous testing.

Status of project with latest updates are following:

- Prototype assembly has begun - tolerance and fit tests currently underway;
- Drafting of assembly instructions for all assemblies has begun in preparation for the commercial production of units;
- Auxiliary boards returned to be re-worked due to supplier not manufacturing to expected standard. Re-worked boards to arrive end of May.

The PDM3800 has now reached a big milestone in its development – that of the first prototype PDM3800 being assembled, which is currently underway.

C33001
Silica Analysis of Dust on PDM filters: Phase 2 Optimisation and Field Demonstration of the Developed Methodology

CSIRO
Hsin Wei Wu
Yonggang Jin

Value:	$516,700
Report Expected:	April 2026
Industry Monitor/s:	Andrew Lau Sharif Burra
ACARP Contact:	Patrick Tyrrell

A methodology was developed to enable respirable crystalline silica (RCS) analysis of PDM-collected coal dust in phase 1 of this project. This current phase aims to progress the developed methodology towards industry implementation through optimisation of the methodology by analysis of a variety of laboratory-generated and mine-collected dust samples, setup of dust detachment-redeposition apparatus and compact FTIR spectrometer at the mine site, and field trials and demonstration of the methodology for RCS analysis of PDM3700 samples at the end of the shift.

A series of parallel dust sampling experiments were conducted in the laboratory to collect respirable coal dust samples with varying silica contents. The samples were then examined using XRD and FTIR techniques to develop a correction model to eliminate interferences from other silicate minerals in the coal dust. Kaolinite, a major interfering component, was analysed and quantified using the newly developed calibration curves. A strong correlation between the XRD and IR analysis results of kaolinite quantification was observed. Further XRD analysis of the coal powdery sample and its generated respirable dust sample will identify other silicate mineral components that can interfere with IR analysis of RCS.

C33012
Respirable Dust Reference Testing Method and Dust Chamber Facility

Simtars
Sean Muller

Value:	$215,950
Report Expected:	January 2026
Industry Monitor/s:	Andrew Lau Sharif Burra Tony Egan
ACARP Contact:	Patrick Tyrrell

The aim of this project is to establish the methodology for the respirable dust chamber as a reference tool for cyclones and devices used in the industry. This will be achieved through three objectives:

- Establish that the respirable dust chamber conforms to international testing methodology and accuracy;
- Verify the methodology utilising a selection of respirable dust cyclones and impactor plate devices currently used underground;
- Compare the accuracy of the devices when using a different dust types and dust mixtures (stone dust, coal dust, silica).

During the quarter the project progressed as follows:

- Fabrication and installation of control system was completed; and
- Design of a system for running air through the samplers was completed.

The following steps will be addressed in the next quarter:

- Completion of the pneumatic system for introducing air into the system;
- Testing of the control system;
- Integration of the chiller unit;
- Fabrication of a system for running air through the samplers;
- Integration of the test instruments; and
- Commissioning of individual instruments and subsystems.

C34006
Resilience and Mental Health in Mining Pilot Program

Macquarie University
Rebecca Mitchell

Value:	$476,099
Report Expected:	April 2026
Industry Monitor/s:	Sharif Burra
ACARP Contact:	Patrick Tyrrell

The primary objective of this project is to investigate the work-related factors that influence the resilience of coal mining employees. This endeavour aims to design interventions that bolster the resilience of these individuals, thereby improving work practices and experiences that directly contribute to employee resilience and mental well-being in the Australian coal mining sector. Concurrently, we identify and address any practices that might adversely impact resilience and mental health.

Over the quarter, we have successfully held workshops with key stakeholders in the partner mine to define a desirable, viable and feasible set of activities that form a "resilience building program". This is effectively the implementation phase.

We have completed multiple site visits in the preparation of the pilot, and we work with the Safety Manager and COO on a regular basis now. However, since last quarter we have not put together the team to help us implement our pilot plan – in addition to continued CEO support we now have held on-site workshops with the HR Team, Corporate Services, CHPP Superintendent, Shift Supervisors and Operatives. This phase of our work is a "bottom up" approach with these key stakeholders co-creating ideas for our resilience building program. This is a critical part of our project as we are in the translation phase with people "at the coal face".

C34023
Advanced Breathing Apparatus with Gas Membrane Modules

Monash University
Victor Chang

Value:	$298,436
Report Expected:	June 2025
Industry Monitor/s:	Lee Earnshaw Paul Wild
ACARP Contact:	Peter Bergin

The main objective of the project is to develop a prototype for breathing apparatus which will replace the CO2 adsorption module with a light weight gas separation module.

Researchers have finished the planed trials and now preparing the final report which will be submitted in due course.

C36006
Advanced Lung Function Assessments for Diagnosis of Coal Mine Dust Lung Disease (CMDLD): The Next Step Towards a Better Health Surveillance Program

I-MED Radiology Network

Value:	$186,832
Report Expected:	August 2025
Industry Monitor/s:	Andrew Lau Shane Apps Sharif Burra
ACARP Contact:	Patrick Tyrrell

This study will investigate whether a new advanced lung function test - Lung Ventilation Analysis Software (LVAS) - can improve the diagnosis of Coal Mine Dust Lung Disease (CMDLD), compared to the current mainstay test of spirometry. Previous projects showed most individuals subsequently diagnosed with CMDLD had no lung function impairments on their spirometry and that spirometry incorrectly identified lung function abnormalities in otherwise healthy individuals. LVAS could enable the earlier detection of lung diseases and reduce the need for additional tests. If confirmed by this project, introduction of LVAS testing could lead to a more effective health surveillance program for CMDLD and minimise harm to affected individuals.

This project is currently on hold while a new project leader is approved by the Industry Monitors.

Roadway Development

C27076
Underground Coal Mine Gateroad Development Continuous Haulage System

Premron CHS
Mick Whelan

Value:	$9,773,528
Report Expected:	May 2025
Industry Monitor/s:	Roadway Development Task Group
ACARP Contact:	Patrick Tyrrell

This project aims to develop a Continuous Haulage System for mine gateroad development, utilising the closed conveyor system of the "Premron CHS" ©. The project is a continuation of projects C22009, C23017 and C24023. Premron awaits a suitable host mine to complete the project objective, namely the performance in an underground trial. Work in this space is continuing in a positive path, with several potential host mines showing real interest.

The project encompass the following key objectives:

- Build and install a suitable Premron CHS Testing Track;
- Install Premron CHS Minibuild machine (nom 55m);
- Commission Premron CHS machine along with Sizer Feeder; and to
- Trial test Premron CHS and Sizer Feeder including several open days for industry.

Premron have completed all four objectives, with the commissioning of the Premron CHS (mini build) and the Sizer Feeder machines on their Mine Monorail Test Track, in Gladstone. The demonstration showed the capabilities of both machines, with the Premron CHS negotiating a 6m radius cut thru, before being loaded with rock, delivered by the Sizer Feeder machine.

The highly successful open days were held during November 2024, with a broad range of mining companies in attendance. Several of these companies are now in discussion with Premron, to see how this new technology may help their operation. At this stage we have signed CA's with all companies and are sharing information, to allow their due diligence on our technology.

C33013
Light Weight Composite Conveyor Support Structures

University of New South Wales
Ganga Prusty
Serkan Saydam

Value:	$499,804
Report Expected:	May 2025
Industry Monitor/s:	Roadway Development Task Group
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C33020
Floor Horizon Control for Roadway Development

CSIRO
Andrew Strange

Value:	$80,000
Report Expected:	May 2025
Industry Monitor/s:	Roadway Development Task Group
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

Strata Control and Windblasts

C29014
Definition and Quantification of Long Term Stability of Coal Pillar Systems

University of New South Wales
Ismet Canbulat
John Watson

Value:	$230,000
Report Expected:	May 2025
Industry Monitor/s:	Matt Tsang Peter Corbett Russell Thomas
ACARP Contact:	Peter Bergin

The draft final report has been submitted to the Industry Monitors for review.

C29019
Mechanical Assessment of Time Dependent (Creep) Behaviour of Coal and Coal Measure Rocks Under Uniaxial and Triaxial Conditions Based on Experimental and Analytical Methodologies

Monash University
Amin Heidarpour
Hossein Masoumi

Value:	$205,000
Report Expected:	May 2025
Industry Monitor/s:	Brian Vorster
ACARP Contact:	Peter Bergin

The draft final report has been submitted to the Industry Monitors for review.

C29022
Mechanical Investigation of Two Critical Standing Support Systems (Timber Chock and Pumpable Crib) in Underground Coal Mines

Monash University
Hossein Masoumi
Javad Hashemi

Value:	$295,000
Report Expected:	June 2025
Industry Monitor/s:	Bob Coutts Brian Vorster Dan Payne Patrycja Sheffield
ACARP Contact:	Peter Bergin

The main objective of the project is to characterise the mechanical behaviour of two standing support systems including timber chock and pumpable crib which are commonly utilised in underground coal mines in Australia.

Outcomes will be published as two volumes with the draft of first volume on Timber Standing Support System under review.

To examine the mechanical behaviour of pumpable cribs, the first round of trip has been initiated with the preparation of three large-scale samples, each with a height of 3,250mm and a diameter of 914mm. These samples were produced with cuttable bags and a water-to-cement ratio of 1:1.75 in Newcastle. At this stage three compression tests will be conducted using the Multi-axis Substructure Testing (MAST) device at Swinburne University of Technology. These tests will assess the samples behaviour under compression, both as a service load and a reserve load, to determine their compression capacity. This data is essential for the subsequent stage, where the samples will undergo combined actions.

The three large-scale samples were transported to the Smart Structures Laboratory at Swinburne University. The setup for testing has already been completed and testing and disposal of the samples are now planned.

In addition to the large-scale samples, 15 cylindrical samples with a diameter of 100mm and a height of 200mm were prepared for material testing. These samples are critical for the numerical modelling process required in the next stages of the project.

C33024
Improved Model Upscaling of Overburden Hydraulic Conductivity for Input into Groundwater Models

SCT Operations
Yvette Heritage

Value:	$230,000
Report Expected:	June 2025
Industry Monitor/s:	Bob Coutts Gary Brassington Peter Corbett
ACARP Contact:	Peter Bergin

The key objective for the project is to determine an upscaling method that bridges the gap of geotechnical model fracture conductivity at longwall panel detail, to groundwater model bulk conductivity input requirements.

Investigations into upscaling methodologies have provided changes to mining induced hydraulic conductivity of only about 1 order of magnitude. Not the minimum 3-5 orders of magnitude hydraulic conductivity reduction that the groundwater modellers need to use.

The outcome of this project is a proposed hypothesis that desaturation is responsible for the significant reduction in relative conductivity. Understanding that running unsaturated groundwater models with current computing power is not currently practicable for timely

and cost appropriate solutions to the client, this project provides a method for determining the site specific relative conductivity to use in groundwater models, based on the limiting conductivity layer at the top of the desaturated zone.

This proposed methodology is supported by two site specific models comparing the hydraulic conductivity from the rock failure model with the groundwater model inputs and site groundwater data. Reporting is near completion.

C34018
Carbolt – Pre Commercial Fixed Length Carbolt Prototype

Mining3
David John

Value:	$360,088
Report Expected:	May 2025
Industry Monitor/s:	Alex Wright
	Bob Coutts
	Peter Quinn
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C34021
Roof Beam Support Assessment Tool

Resource Geotechnical
Terry Medhurst

Value:	$230,000
Report Expected:	June 2025
Industry Monitor/s:	Brian Vorster
	Roger Byrnes
ACARP Contact:	Patrick Tyrrell

Previous projects C22008 and C24015 funded the development of a roof support design approach that takes account of differing roof conditions, effect of support type and stiffness that can be used for mine design and in the strata management process. An analytical framework was developed for roadway development that provides a measure of both support load and roof convergence which can be matched and updated against roof monitoring data. It is based on beam-column principles and incorporates bending, immediate roof failure and shear. The model relies upon inputs from the Geophysical Strata Rating, roof bolt characteristics including pull-out stiffness/load, in-situ stress ratio and unconfined compressive strength.

A windows based version has been developed that can be used to assess both development and longwall abutment loads. The initial version and user guide has been developed and completed. An extension has been granted to introduce additional options into the program following evaluation from the industry monitors that includes:

- Use of both bolts and cables installed on first pass development;
- Inclusion of the use of multiple TARP triggers for support upgrades, in relation to changing strata conditions on development, for secondary support and impact of stress notches;
- Implementation of the inclusion to install centreline cables.

Coding for these extensions is complete, and a process of testing with project monitors has commenced.

C34022
Risk Based Model for Forecasting Longwall Face Cavity Development

University of New South Wales
Chengguo Zhang
Ismet Canbulat

Value:	$173,200
Report Expected:	June 2025
Industry Monitor/s:	Matt Martin
	Matt Tsang
ACARP Contact:	Peter Bergin

Cavity development across the longwall face can cause substantial production losses and pose significant safety risks to mine workers during recovery operations. Previous research into longwall roof cavities has primarily focused on individual causes, such as equipment, shield pressures, geology, in situ stresses and geotechnical setting. In this project, researchers will adopt a holistic assessment of all causes that, in combination, can result in the formation of a roof cavity. The project aims to produce a risk-based approach for assessing the likelihood of cavity development; a set of predetermined controls to mitigate the risk of cavity development; and a proposed hierarchy of longwall fall of ground severity linked to these controls, based on the escalating level of risk.

The main progress in the quarter includes the following.

- More experiments have been conducted for cavity location forecasting with shield groupings. We observed that finer spatial resolution can cause lower absolute probability metrics yet still demonstrated feasibility for comparative risk assessment. Geological domain classification information can only result in marginal improvements. Analysis of the newly processed Mine B dataset indicated that 3-shield group zonal prediction achieved commendable performances with some challenges with panel LW104a and finer 5-group resolutions. This can be issue with panel-specific generalisation.
- Numerical modelling has been completed, with a UDEC model successfully calibrated to investigate the sensitivity of rock behaviour to geological factors with the verified model.
- We are currently finalising the report writing.

C35008
Optimum Design of Pillars with Various Sizes and Shapes at Increasing Stress Environment

University of Queensland
Mehdi Serati
Paul Buddery

Value:	$172,000
Report Expected:	May 2025
Industry Monitor/s:	Brian Vorster John Grieves Peter Corbett
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C35010
Causes for Swelling and/or Bearing Capacity Floor Failures in a Pillar System Under Varying Geological and Geotechnical Environments

University of New South Wales
Serkan Saydam

Value:	$298,300
Report Expected:	November 2025
Industry Monitor/s:	Brian Vorster Peter Corbett
ACARP Contact:	Peter Bergin

This project aims to investigate the conditions of swelling and bearing capacity floor failures through an experimental program, in-situ monitoring program, and analytical and numerical approaches and determine the timing of failure. Based on the learning from projects C26064 and C29041, an analytical model will be developed to evaluate the bearing capacity of soft floor strata in underground coal mines. The cutting-edge numerical modelling framework will be developed that will enable us to better understand the swelling failure mechanisms. The research team will develop a framework for the assessment and prediction of floor heave. This approach will provide comprehensive guidelines to assess and predict floor heave failures.

Numerical modelling work is ongoing based on oedometer tests on tuff samples collected from the site. The purpose of modelling is to assess and predict rock swelling under different vertical loadings over an extended period. New experiments are conducted to study the one-dimensional swelling behaviour of compacted clays. Experimental design aims to study and interpret the swelling behaviour affected by chemical factors such as the type and concentration of cations in salt solution and different treatment methods. The clay materials are mixed to obtain a mineral composition similar to the core sample and then compacted to reach the target density. In addition to deionised (DI) water, salt solutions of sodium chloride (NaCl) and potassium chloride (KCl) are used for swelling tests on mixed clays. Fig. 1 indicates that both NaCl and KCl have apparent mitigation effects on clay swelling. The KCl solution shows good potential as a cation exchange method for swelling control. In the following months, more experiments on the permeability control method (CaCl2) and tests on different solution concentrations will be conducted.

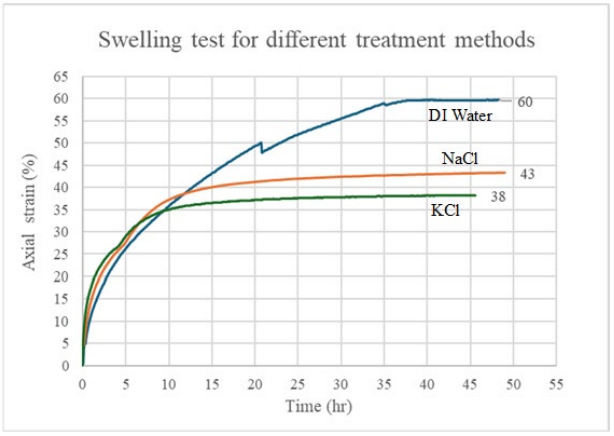


Fig.1 Comparison of clay swelling in deionised water and salt solution.

C35011
Revolutionising the In-Situ Stress Measurement Using a New Generation of Downhole Tools: DilaStress

University of New South Wales
Hamid Roshan
Ismet Canbulat

Value:	$184,500
Report Expected:	June 2025
Industry Monitor/s:	Brian Vorster Patrycja Sheffield
ACARP Contact:	Peter Bergin

Understanding in-situ stress conditions is paramount for the safety, efficiency, and productivity of coal mining operations. Currently, overcoring is the preferred technique to measure-situ stress in underground mining. However, it is often hindered by the considerable time, investment, operational complexities, and high costs. This challenge was tackled in a previous stage of this project by developing DilaStress to create an efficient downhole stress measurement technique and associated Tool. This study will field test the DilaStress tool for insitu stress estimation.

The design, development, and components testing of the DilaStress tool and its software have been completed and the final report is being prepared for submission.

C36010
Next Generation Fibre Glass (FG) Rock Bolts with Robust Shear Strength Properties to Replace Steel Rock Bolts

University of Southern Queensland
Ali Mirzaghorbanali

Value:	$147,998
Report Expected:	June 2025
Industry Monitor/s:	Dennis Black Peter Corbett
ACARP Contact:	Patrick Tyrrell

This research focuses on the development of novel Glass Fibre Reinforced Polymer (GFRP) dowels with improved shear-bearing capacity for the Australian coal mining industry. Three Reinforcing Element configurations (RE1, RE2, and RE3) will be combined with three Resin matrices, epoxy (R1), vinyl ester (R2), and unsaturated polyester (R3), including formulations with optimised concentration of graphene additives, to manufacture a range of GFRP dowel prototypes. These dowels will be manufactured in different diameters to investigate the influence of cross-sectional area on shear performance. Guillotine shear box testing will be used to identify the most optimum design configuration offering the highest shear strength. The optimal prototype will then undergo large-scale double-shear testing within concrete blocks that simulate medium- and high-strength rock strata, with uniaxial compressive strengths of 40 MPa and 60 MPa, respectively, to evaluate its performance under realistic field condition.

Initially, a detailed review of composite rock bolt manufacturing methods—including pultrusion, braidtrusion, and hybrid approaches—was conducted. Three Resin systems R1, R2, and R3, were selected and evaluated for their mechanical, thermal, and chemical properties. Testing included tensile, V-notch shear (for R1 and R2), and compression tests, as well as DSC for thermal degradation and FTIR for functional group analysis. These evaluations were performed on samples cured for 14 and 28 days under both ambient and elevated (post-cured) temperatures. To manufacture a range of GFRP dowel prototypes, E6-grade glass direct roving, was selected as the reinforcement fibre. The first three prototypes, labelled RE1, RE2, and RE3, each 1.2 metres in length with average diameters of 35 mm were manufactured using a combination of pultrusion and three layers of braiding process with 26° braid angle. Each core was subsequently infused with one of the three resins and moulded within PVC tubes. These initial prototypes were cured under both room temperature and elevated thermal conditions. Out of the three prototypes, the RE1 prototype demonstrated the highest shear resistance in single-shear guillotine box testing, reaching a maximum load capacity of 18 tonnes. Based on this performance, R1 was selected as the optimum resin system for subsequent analysis. To investigate the optimum RE architecture regarding effect of braiding angle on shear capacity of the prototypes, two additional prototypes, RE4 and RE5, were manufactured using 19° and 40° braiding angles, respectively. Testing results showed that the 26° braiding angle offered the greatest shear capacity, as illustrated in Figure 1.

In the next stage of this research, the shear capacity measured in the RE1 prototype will be further enhanced through the incorporation of graphene additives, known for their mechanical reinforcement properties. An optimal graphene concentration will be determined and integrated into the epoxy resin matrix to produce a new prototype with braiding angle 26 degree, designated as RE6. This formulation aims to further improve the shear strength of the GFRP composite system. To assess the influence of dowel diameter on shear-bearing capacity, RE6 dowels will be manufactured in various additional diameters ranging from 20mm to 25mm, following the same manufacturing parameters established in earlier stages. These prototypes will undergo single and double-shear testing, with the double-shear tests specifically designed to simulate field conditions. For this purpose, the dowels will be encapsulated in concrete specimens of varying compressive strengths and subjected to different levels of pretension to reflect practical installation scenarios. The outcomes will provide insight into shear load transfer mechanisms and the interaction between GFRP dowels and surrounding media. Finally, the performance of the optimised GFRP dowels will be benchmarked against both commercially available GFRP rock bolts and conventional steel rock bolt (M24 coal bolt) to evaluate their potential for broader application in strata reinforcement systems in Australian underground coal mines.

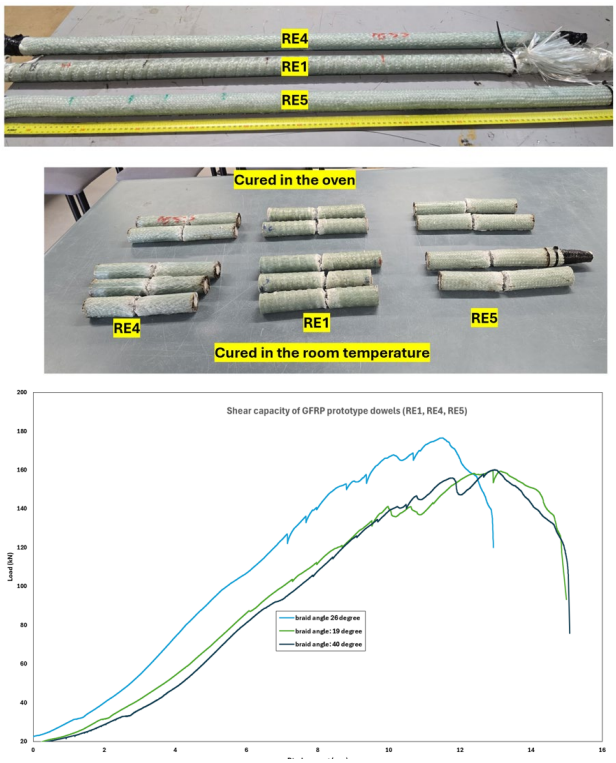


Figure 1. (top) a view of RE1, RE4, and RE5 prototypes with three different braiding angles, including 19, 26, and 40 degrees, respectively; (middle) RE1, RE4, and RE5 after testing; (bottom) shear load versus shear displacement of GFRP rock bolts tested using single shear testing method of RE1, RE4, and RE5.

Ventilation, Gas Drainage and Monitoring

C25072
New Approaches to Mine Gas Analysis and Ratios

Simtars
Sean Muller

Value:	$416,192
Report Expected:	June 2025
Industry Monitor/s:	John Grieves
ACARP Contact:	Peter Bergin

The project aim is to identify additional gases for the detection and monitoring of spontaneous combustion. This will be achieved through three objectives:

- Using a medium scale reactor, profile the gases evolved from the heating of a Queensland coking coal with a methane/ethane seam gas composition and a New South Wales coal with a carbon dioxide seam gas;
- Compare these gas profiles to the normal carbon dioxide seam gas and methane/ethane seam mine fingerprints identified in the first stage of this project and project C10015;
- Expand the current "Fire Ladder" to include additional alkanes below the ethylene point which can be used to give earlier warning of a developing heating / spontaneous combustion and incorporated into TARPs.

The work status is as follows:

- Testing with coal is continuing. Coal is being step-heated up to the point where it will start self-heating, at which point the system will be made to follow the coal's heating and will be allowed to reach the maximum cut off temperature. As of 8 May, the coal has been step heated to 70ºC;
- Gas samples are being taken at 5°C temperature intervals, and they are being processed through the laboratory as they are made available. Collation of the data from this run is in progress;
- Data gathered from the previous run has been processed and graphed;
- X-pid has been repaired; data is being collected from each of the temperature set-points collected to-date from the step-heating phase of the current coal.

The following steps will be addressed in the next reporting period:

- Step-heating of the coal will continue till the coal takes over and reaches the maximum allowable temperature;
- Gas samples will be taken regularly and processed;
- Processing of data gathered from the current run of coal will continue;
- Validating the X-Pid particularly for targeted aldehydes will continue;
- Comparison of X-Pid data with results generated from micro-GC, GC-MS and HPLC analytical techniques will be undertaken.

C27035
Automatic Leak Detection for Tube Bundle Systems

Simtars
Sean Muller

Value:	$220,000
Report Expected:	May 2025
Industry Monitor/s:	John Grieves
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C28027
Effect of Occlusions by Coal and Stone Dust on the Sensitivity and Time Response of Methane Gas Detectors in Underground Coal Mines

Ampcontrol
Ian Webster
Sean Muller

Value:	$90,000
Report Expected:	June 2025
Industry Monitor/s:	John Grieves Patrick Tyrrell
ACARP Contact:	Peter Bergin

The project objectives are to:

1. Establish the existing degrees of occlusion of real time methane sensors in service in underground coal mines by qualitative survey, and hence determine the potential compromise in performance; and
2. Verify and quantify the susceptibility of real time methane detectors to occlusion by coal and stone dust by controlled laboratory testing of typical methane sensing devices.

During the quarter the following tasks were undertaken or completed in relation to Objective 2.

Testing of gas detectors:

- Testing and data analysis completed for effect of occlusion for four gas detectors under dust conditions within the purpose-built test chamber;
- Results of testing correlated and aligned with established terminology and methodology.

Reports:

- Draft report on comparison of calibration masks, effects of blockages and occlusion by dust on the gas detectors has been completed;
- Draft report has been peer reviewed, with comments received for consideration;
- Abstracts and presentation proposals for several conferences have been prepared and submitted.

The next steps of the project schedule for the coming quarter are as follows:

- Consider comments from peer reviewers;

- Revise draft report as and where needed;
- Continue to explore opportunities to submit abstracts and presentation proposals; and
- Submit the draft final report to ACARP.

C29018
Evaluation of Explosion Resistant Ventilation Control Devices and Determining Explosion Risk Exclusion Zones

University of Wollongong
Alex Remennikov
Sean Muller
Timothy Jackson

Value:	$534,484
Report Expected:	June 2025
Industry Monitor/s:	David Webb John Grieves Paul Wild Russell Thomas Tim Huston
ACARP Contact:	Peter Bergin

Stage 2 of this project aims to characterise the threat of projectiles from mine entrances through a systematic experimental and numerical approach.

During the quarter:

- Experimental Program for Shaft Simulation: Experimental testing for shafts has been completed. The experimental program comprised of small-scale shaft simulations with projectiles and plates placed at the exit. Following feedback obtained from the progress meeting with the monitors, the experimental program has been expanded to include full-scale borehole simulations with objects placed at the exit, and small-scale shaft simulations with projectiles placed within the horizontal test section.
- Motion Analysis for Shaft Simulation: Motion analysis of flight trajectories has commenced for shaft simulations. Professional motion analysis software will be used to track projectiles in mid-flight and extract their initial launch conditions (i.e., initial velocity, launch angle and azimuth angle). The software has been calibrated to accurately track projectiles emanating out of the shaft following best practices from the developer. Figure 1 presents an illustration of this process. These initial launch conditions will then be extrapolated to obtain their final striking points using Python programming.

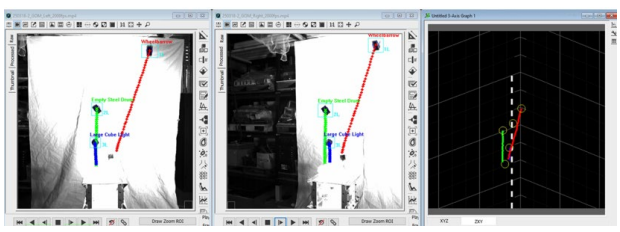


Figure 1: Motion tracking of projectiles emanating out of shafts/boreholes.

- Development of Guideline for Defining Exclusion Zone for Drifts (Validation Phase): An empirical approach was successfully implemented to predict the initial velocities of projectiles, and worst-case projectile ranges were determined iteratively using Python programming. This methodology is currently undergoing validation against experimental drift simulations and will be expanded to include exclusion zones for shafts/boreholes.
- Latest project updates have been shared with the industry monitors. Following feedback obtained from the monitors, the additional tests has been performed to include full-scale borehole simulations with objects placed at the exit, and small-scale shaft simulations with projectiles placed within the horizontal test section. Validation checks on linking total impulse with projectile motion has also been initiated.

C34011
Appraisal of Gas Indicators from Goaf Drainage Holes for Spontaneous Combustion and Explosion Risk Management: Stage 2

University of New South Wales
Guangyao Si

Value:	$223,254
Report Expected:	May 2025
Industry Monitor/s:	David Webb John Grieves Paul Wild
ACARP Contact:	Peter Bergin

The draft final report has been submitted to the Industry Monitors for review.

C34014
Borehole Tools to Deal with Outbursting, Coal Bursting and Gas Drainage

Sigra
Ian Gray

Value:	$2,176,576
Report Expected:	December 2025
Industry Monitor/s:	Ventilation Task Group
ACARP Contact:	Patrick Tyrrell

This project is to produce a survey system for drilling, including a rock recognition system and a packer system to enable coal seam permeability and pressures to be determined. The project is multi-facetted as it involves drilling hardware, sensing equipment, downhole and at the drill rig sensing and electronics. This is in both IS and flameproof form and it also involves a lot of software development. The drill rig sensing has been substantially limited by the limitations placed on modifying OEM drilling equipment.

The work in this quarter has been principally associated with getting IS approval. This has proven to be quite

difficult with a consulting IS group providing different advice to the certifier. These problems have now been overcome and the nest stage is delivering a fully assembled tool for examination.

Drilling software has been completed to a trial stage.

C35015
Studies of Coal Toughness and Gas Sorption Dynamics for Outburst Risk Management

University of Wollongong
Ting Ren

Value:	$275,000
Report Expected:	June 2025
Industry Monitor/s:	David Webb
	Dennis Black
	Gerard Potgieter
	John Grieves
	Russell Thomas
	Sharif Burra
	Steve Winter
	Van Oppel
ACARP Contact:	Patrick Tyrrell

The objective of this project is to improve industry knowledge and management of potential outburst risks by conducting systematic studies of coal toughness, geo-mechanical properties and gas sorption dynamics with different coals sourced from underground coal mines in New South Wales and Queensland.

The project has completed the following tasks:

- Rapid desorption experiments for CH4 and CO2 were conducted on coal samples from various seam sections of Mine D at fixed gas pressures of 1000 KPa and 2000 KPa, with results presented in Figure 1;
- Gas expansion energy analyses for both CH4 and CO2 at fixed pressures, including rapid desorption energy, free gas expansion energy, and total initial gas expansion energy (Figure 2), with comparative results of gas-induced energy accumulation and its potential role in triggering coal and gas outburst events;
- Additional coal toughness tests of samples from various mine sites to establish a comprehensive database of toughness indices, with the relationship between these indices and other physical parameters currently under analysis;
- Triaxial compression tests on coal cores from two seam sections of Mine D showed a clear decline in permeability with increasing pore pressure (Figure 3), along with a comparative analysis showing a strong inverse correlation between coal permeability and triaxial strength;
- Completion of a hybrid outburst threshold limit incorporating gas content, gas composition, gas pressure, and coal toughness index (f), alongside the formulation of a comprehensive risk assessment method that integrates gas content, coal strength, toughness, sorption hysteresis, and rapid desorption test results;
- Commencement of final report drafting.

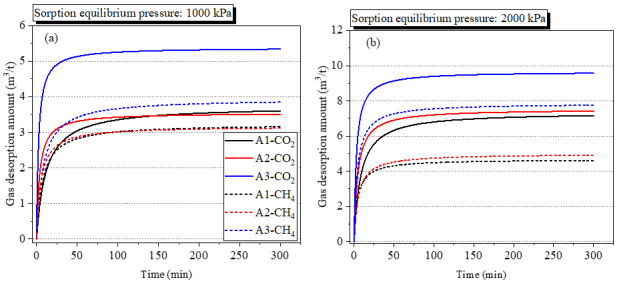


Figure 1 Rapid desorption curves of CH_4 and CO_2 at fixed gas pressures: (a) 1000 kPa and (b) 2000 kPa

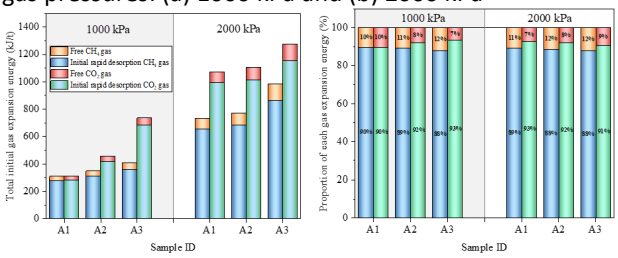


Figure 2 Comparison of total initial gas expansion energy for CH_4 and CO_2 under fixed gas pressures

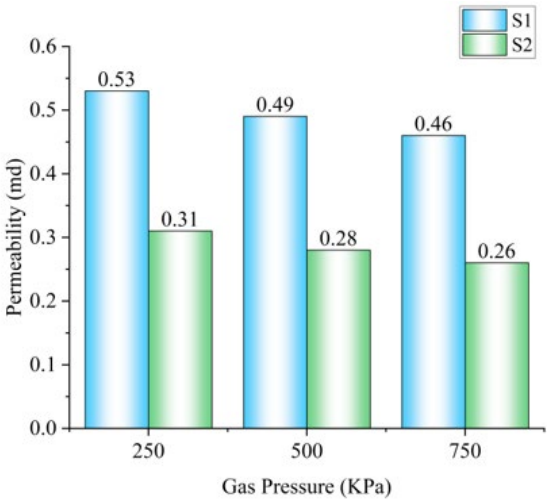


Figure 3 Permeability of coal cores at different gas pressures

C36003
Practical Implications of Oxygen Deficiency on the Determination of Graham's Ratio in Longwall Goafs

Simtars
Sean Muller

Value:	$64,350
Report Expected:	March 2026
Industry Monitor/s:	David Webb
	John Grieves
ACARP Contact:	Patrick Tyrrell

Graham's ratio is a commonly used indicator for measuring the intensity of the oxidation of coal in underground mine atmospheres. The basis of Graham's ratio is the conversion efficiency of oxygen to carbon monoxide. Graham's ratio uses the nitrogen from a sample for the calculation of oxygen deficiency. This allows for dilution by methane and carbon dioxide seam

gases. This calculation is made on the basis that nitrogen is an inert gas which is not consumed or created.

This project will investigate the practical implications for the interpretation of Graham's ratio and other indicators in the presence of an oxygen deficient atmosphere (due to natural processes and both added nitrogen or exhaust gases via inertisation).

Mine data is continuously being acquired for data review.

C36005
Optimisation of Goaf Management Strategies

CSIRO
Krishna Tanguturi
Qingdong Qu
Rao Balusu

Value:	$1,443,557
Report Expected:	February 2028
Industry Monitor/s:	Ventilation Task Group
ACARP Contact:	Patrick Tyrrell

The objective of this project is to develop optimum goaf management strategies to maximise goaf gas drainage, reduce oxygen ingress into the longwall goaf, and minimise fugitive emissions. The main focus of the project studies is to: obtain a fundamental understanding of goaf gas distribution; obtain an understanding of the impact of various geological, mining and operations parameters; investigate the feasibility of various goaf gas drainage designs and strategies to maximise gas drainage and minimise oxygen ingress; develop optimum inertisation strategies to minimise oxygen ingress on both maingate and tailgate sides of the longwall goaf; examine the impact of various additional goaf management strategies; and develop optimum adjacent goaf gas drainage strategies to minimise greenhouse gas emissions into the main return airways.

In the last quarter, extensive goaf gas drainage studies have been carried out to investigate the impact of various goaf gas drainage strategies on goaf gas drainage efficiency and goaf gas distribution, including oxygen ingress patterns. These goaf gas drainage studies include changes in number of goaf holes, total drainage rates, ventilation layouts, face airflow rates and perimeter goaf wells. In the current quarter, goaf gas drainage studies are continuing with changes in location of goaf holes, increased/decreased drainage rates in nearby holes, and different drainage rates in individual goaf holes. A new CFD model with only 500m of the longwall goaf has also been developed to investigate the effectiveness of various goaf drainage strategies in the startup area of the longwall panel. Results of all modelling studies are being analysed in detail to assist in the development of optimum goaf management strategies.

C36011
Borehole Tools – Caliper Log

Sigra
Ian Gray

Value:	$424,160
Report Expected:	January 2026
Industry Monitor/s:	Ventilation Task Group
ACARP Contact:	Patrick Tyrrell

This project's objective is to produce a caliper log to permit the logging of boreholes. The reason for building this is to detect overbreak such as may occur due to the washout of gouge material, indicative of outburst conditions and breakout which is indicative of high stress. The latter being important from a rockburst and general stability viewpoint. In non-intrinsically safe near vertical holes these measurements would be made using an acoustic televiewer. This is not an option in gassy horizontal boreholes.

Work this quarter has been principally related to dealing with intrinsically safe issues that have caused a delay to project C34014. This involves the electronics that will be used with the caliper log. The mechanical design was put on hold until these complications have been dealt with. These problems now appear to be overcome and the mechanical design may now progress again.

C36012
Rotary Steering System Field Trial and Developments

Sigra
Ian Gray

Value:	$449,600
Report Expected:	June 2025
Industry Monitor/s:	Ventilation Task Group
ACARP Contact:	Patrick Tyrrell

This project is to enable field trials and necessary modifications to be made to the Sigra rotary steering system (RSS) tool that was developed as part of project C28022 and was completed in 2020 without an underground field trial. During this period a drilling trial was conducted using a civil engineering horizontal directional drilling rig and many changes have been implemented as a result of this.

The Sigra RSS is designed to replace down hole motors in underground in seam drilling and in particular to overcome problems faced with 'boggy ground'. The latter is caused by cuttings bed build up around the drill string. The rotary steering system involves the use of a rotating drill string with a non-rotating sleeve fitted with pads that deflect the drill bit. The rotating drill string has been shown, in oilfield use, to prevent cuttings buildup. The RSS should also permit greater power at the bit compared to downhole motors that are currently used underground. It is hoped that this will enable faster penetration rates when drilling through stone. The tool is being totally redesigned for the next field trial.

C36015
Intelligent Integrated Distributed Fibre Optic Sensing Technologies

CSIRO
Wayne Stasinowsky
Yi Duan

Value:	$568,317
Report Expected:	May 2026
Industry Monitor/s:	Ben Yang Dennis Black Peter Corbett
ACARP Contact:	Patrick Tyrrell

Temperature, strain and seismicity monitoring are crucial for geotechnical hazards (e.g., spontaneous combustion, pillar failure, strata instability) management in underground coal mines. This project aims to advance remote underground mining operation capabilities by targeting specific technology developments in areas of high strategic need and opportunity for industry. The key components of this project are:

1. Continuous temperature profiling using distributed temperature sensing (DTS);
2. Combined continuous pillar strain and microseismic measurement using optic fibre; and
3. Real-time distributed acoustic sensing (DAS) data processing based on deep learning pipelines.

During the quarter, the main activity for each key component include:

1. Continuous temperature profiling using distributed temperature sensing: a mine site has agreed to support the experiment of using DTS for continuous monitoring the temperature along the underground roadway for ventilation management. Logistics of the field trial are being planned with the mine ventilation superintendent. The installation of the fibre cables will be coordinated with the installation of the bundle hole over the next three months.
2. Combined continuous pillar strain and microseismic measurement using optic fibre: the initial mathematics of the system was too simplified. A more comprehensive model of the system is now being developed so that numerical modelling can be conducted and correct calibration can be derived.
3. Real-time distributed acoustic sensing (DAS) data processing based on deep learning pipelines: a workflow incorporating smoothing, edge detection and cross correlation has been developed for seismic phase detection. The results show that the developed methodology can reliably obtain the curvature of seismic phases and the associated apex for source location. Meanwhile, machine learning algorithms including recurrent neural network and U-net are also being investigated for seismic phase detection as additional methods for enhancing the robustness of the results.

C37006
Frictional Ignition – Water Spray Standards, their Basis and Effectiveness with Modern Mining Environment

CSIRO
Craig Harbers
Xing Li
Yong Sun

Value:	$89,814
Report Expected:	June 2025
Industry Monitor/s:	David Webb Steve Winter
ACARP Contact:	Patrick Tyrrell

This project aims to identify the requirements for which drums/sprays should be designed to optimise the use of water sprays to minimise the FI risk, highlighting situations where the operating parameters of modern mining equipment will reduce the effectiveness of nominally compliant water spray systems.

Progress over the quarter:

- We continued to review the literature to identify critical factors, with a focus on rock cutting with picks and water sprays in longwall mining. Our attention has also been paid on the water spray standards.
- A key research member of the project travelled to the UK in April with a delegation from an Australian coal mining company. In the UK, this research member attended the Midlands Institute of Mining Engineers annual Health and Safety seminar and met with the health and safety executive and other counterparts to investigate the basis of the British Coal codes and rules. He also had a face-to-face exchange with a member of the committee who drafted the British Coal codes and rules and visited the water spray certification testing facility run by this committee member. Furthermore, this key research member visited the IOM3 library, the National Coal Mining Museum library, and the National Archives to search for further information on frictional ignition from British Coal/NCB. More information has been collected. We are currently reviewing the information collected from the UK.
- Based on our preliminary research so far, we have identified some research activities that could be included in the Stage 2 work program.

OPEN CUT

Reports Published This Quarter

C35029
Renewable Energy as Post Mining Land Use

University of Queensland
Claire Cote
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C35029

Geology

C34020
Guideline for Standardising Structure Interpretation in ATV/OTV Logs

University of Queensland
Mojtaba Rajabi

Value:	$163,415
Report Expected:	June 2025
Industry Monitor/s:	Brian Vorster Matt Tsang
ACARP Contact:	Anne Mabardi

The draft final report has been submitted to the Industry Monitors for review.

C35023
Recovery of Critical Minerals from Coal and Coal Production Waste

CSIRO
Clint McNally
Nerrida Scott

Value:	$154,000
Report Expected:	June 2025
Industry Monitor/s:	Andrew Lau Caroline Lang Shaun Booth
ACARP Contact:	Patrick Tyrrell

This project investigated potential rare earth sources in a coal mine waste and then identified possible techniques for beneficiation.

Samples of mine waste were provided from a mine based on data researched from geological logs which indicated possible section of slightly elevated rare earth concentrations. These samples were then analysed and it was found that some dilution existed in the samples, leading to lower than expected concentrations. Techniques were considered for physical separation and a range of options tried. The resulting wet gravity separations of the samples provided were found to be inefficient due to significant breakdown of the sample in water to a sub-optimal size range. Leaching trials are ongoing but it has been identified that ionic leaching is not feasible. Flotation results will be available in the next two weeks.

The project is now in the final stage of writing up and a report will be provided shortly.

C35025
CSR Predictions and Correlations Definition

McMahon Coal Quality Resources
Chris McMahon

Value:	$35,880
Report Expected:	August 2025
Industry Monitor/s:	Alison Burke Maurizio Tonelli Tomoaki Nagata
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C35047
Real Time Prediction of Coal Top Through Guided Borehole Radar Wave Imaging for Open Cut Blast Hole Drilling

CSIRO
Matt van de Werken
Wayne Stasinowsky

Value:	$496,730
Report Expected:	June 2026
Industry Monitor/s:	Jack Woollett Troy O'Reilly
ACARP Contact:	David Drakeley

The project objectives are to:

- Develop a fully functional real-time coal top guidance system prototype suitable for field demonstration trials where it is fitted to a blast rig drilling production holes;
- Extend and mature the technology and engineering developed in phase 2;
- Develop a prototype to the stage that the technology is ready to engage a commercial partner.

Progress during the quarter:

- The phase 3 project has been extended with the awarding of phase 4. This will enable further testing in different geology at a second mine site. This additional testing will enable initial commercialisation to start if the trials are successful.
- Problems with antenna configuration and the various electronics components have continued. Investigation of the reasons for this have excluded many possibilities but the cause of the issues remains elusive. Further testing is continuing.
- Due to these problems and delays, the TRL 7 test at a mine site has been further delayed.

C36022
Validation of LIBS Technology for Downhole Resource Evaluation

CSIRO
Joe Perkins

Value:	$276,020
Report Expected:	April 2026
Industry Monitor/s:	Jason Schumacher Mark Laycock Sudipta Nag
ACARP Contact:	David Drakeley

This project aims to further validate Laser-Induced Breakdown Spectroscopy (LIBS) as a rapidly deployable technology through expanded lab testing and field trials and is a follow-on from project C34029.

The project aims to:
- Using state-of-the-art laboratory LIBS hardware and multivariate analytical methods, build upon the preliminary findings of project C34029 to develop a comprehensive coal core derived calibration model;
- Integrate LIBS spectral information into washability models using processed core samples;
- Conduct field testing using a prototype/pre-commercial LIBS downhole tool to determine the potential and challenges of optimising LIBS technology specifically for the evaluation of coal resources.

This quarter approximately eight metres of coal core donated by ACARP partners has been scanned, with results now undergoing processing. This marks the first dataset of its kind in a coal context on this scale and is being analysed in parallel with traditional laboratory testing. Preliminary results are expected to be available in time for presentation at the Bowen Basin Symposium in September.

In parallel with laboratory work, efforts to secure a site for the planned field trial are ongoing. While a potential site has been identified, access to the necessary electrical schematics from the hardware provider has been delayed due to the company's recent acquisition and associated changes in funding oversight.

Drilling and Blasting

C35018
Reactive Ground Testing

Queensland Magnetic Research
Alastair Torrance
Gary Cavanough

Value:	$340,000
Report Expected:	July 2025
Industry Monitor/s:	Andrew Micallef Mark Laycock
ACARP Contact:	David Drakeley

The draft final report has been submitted to the Industry Monitors for review.

C37010
Segregation Testing of Category 2 Explosive Transport Boxes

Blast Ability International
Lee Julian
Ryan Brogden

Value:	$155,750
Report Expected:	October 2025
Industry Monitor/s:	Tim Gray
ACARP Contact:	Patrick Tyrrell

The objectives of this project are to demonstrate the effectiveness of the segregation gap between the explosive carry boxes on mixed loads. AEC3, The Australian Code for the Transport of Explosives by Road and Rail, 3rd Edition, requires that the segregation gap is proven to be effective. Testing is planned on carry boxes that are representative of those used in industry to demonstrate that the segregation gap is effective.

The following outcomes have been achieved to date:
- A representative carry box design, gap and manufacturers have been determined;
- A draft test regime has been developed;
- Free issue of the carry boxes has been negotiated with the suppliers;
- The testing range has been book for testing for the week commencing Monday, 7 July;
- Project planning and preparations for testing have commenced.

The coming quarter will focus on the safe and successful completion of detonation testing. Ongoing work to satisfactorily achieve the project aims will be determined after the test results have been analysed.

Environment

C29049
Saline Pit Lakes as Aquatic Ecosystems: A Design Manual for Closure

Edith Cowan University
Mark Lund

Value:	$1,089,226
Report Expected:	June 2025
Industry Monitor/s:	Andrew Lau John Watson
ACARP Contact:	David Drakeley

In Australia, many community members and regulators expect that final voids will be backfilled. However, a lack of backfill materials combined with prohibitive costs ensures that pit lakes will be a permanent feature of most post mining landscapes. Pit lakes are considered the 'greatest legacy of open cut mining' due to the potential for safety issues, ground and surface water contamination, and in-lake toxicity. Additionally, pit lake science has struggled to find a foothold in mainstream literature, limiting wider scientific exposure to the issue of pit lakes and holding back advancement of the development of remediation and closure approaches. Therefore, the broad objective of our proposed research is to understand the biophysical processes in unrehabilitated saline pit lakes and investigate options for enhancing ecosystem services in the Hunter Valley and Bowen Basin.

Salinity is a key water quality issue with many Australian pit lakes. Many natural lakes are saline and have valuable ecosystem values. Understanding the role of catchments and nutrient inflows in maintaining salinity within useful ranges and driving ecosystem processes is therefore important to determine the range of future uses for these pit lakes. These future uses may include as aquatic ecosystems, recreational areas, and for aquaculture.

The overall project approach has two main components:

1) In situ component. Continuing the monitoring of four saline pit lakes (Hunter Valley and Bowen Basin) for a broad range of water chemistry, physical and biological parameters from C27043. We have added an additional four pit lakes in the Bowen Basin to the monitoring program in 2021. Based on findings from the C27043 monitoring program, we have introduced some refinements for 2021 that include improved replication of water quality data, and consistent numbers of macroinvertebrate and diatom samples between sites. We will sample each lake twice yearly. Using instrument chains, installed in all lakes we collect hourly data on stratification and salinity levels.
2) Experimental component to examine rehabilitation options -
   - Carbon (in the form of terrestrial organic matter) determines the nature of the aquatic food web and creates important habitat. In C27043, using tank mesocosms (1000 L) on site, we tested the effects of adding coarse, low-cost organic matter on lake water and sediments on biophysical and chemical endpoints (as measured in the lake). Based on the positive improvements recorded, in this project we will reset the mesocosms and test both organic matter phosphorus additions. Low phosphorus concentrations were recorded in all the pit lakes studies in C27043, and additions should stimulate primary production, creating more food for macroinvertebrates.
   - Littoral areas are well-established as the most important areas for biodiversity in lakes and yet also represent the most expensive component of pit lake rehabilitation (due to the earthmoving requirements to create these areas). We will conduct detailed sampling at a small rehabilitated saline pit lake to investigate the influence of water depth on biodiversity to determine the littoral area requirements of pit lakes for creating productive aquatic environments.
   - As shown in C27043, organic matter additions can enhance biodiversity in saline pit lakes. Experimentally we will move from mesocosms to a pit lake to test organic matter additions in situ.
   - Artificial floating islands of vegetation will be tested as a source of carbon and propagules that could assist in pit lake development during filling.

We are currently in the process of writing up the results from the study and preparing the Design Guidelines.

C34025
New Landscape Evolution Model for Assessing Rehabilitation Designs

University of Newcastle
Greg Hancock

Value:	$875,391
Report Expected:	June 2025
Industry Monitor/s:	Chris Quinn Jason Fittler
ACARP Contact:	Patrick Tyrrell

The objective of this project is to test and develop the newly developed SSSPAM landscape evolution model and SIBERIA (LEM) so that they can be used easily to evaluate both constructed and proposed post-mining landforms. The models will be tested across a range of sites in Queensland and New South Wales.

The testing and evaluation of both models continues with case studies in both states. A laboratory weathering assessment of waste materials has developed material specific weathering parameters that can be used in the SSSPAM model to predict erosion reduction and pedogenesis. A paper has been published in the journal Geomorphology. Further weathering work is now being undertaken using fresh waste material. For the coal mine materials examined weathering is rapid and is not a major influence on landscape evolution. It also confirms the robustness of the weathering model in SSSPAM.

Further weathering work is now being undertaken for coal mine waste rock. Recent work quantifying the effectiveness of vegetation in reducing erosion has been published. An examination of diffusive erosion model in SSSPAM has been completed and work published.

The development of model input parameters has continued with more sites in Queensland and the Hunter Valley with validated sets of parameters available. Continued testing and development of the SSSPAM model continues for a range of both mining and pasture sites. A recent issue with the SSSPAM model has been the updating of the Python code and compatibility when compiling on new computers particularly with Windows 11. This is currently being addressed. A new interface for SIBERIA has been developed and is undergoing testing. A focus at present is on the Hunter Valley where high quality LiDAR data has allowed the identification of erosion features such as rills and gullies. This data is being used to parameterise and evaluate both the SIBERIA and SSSPAM models. Recent outputs include an assessment of DEM grid spacing needed to reliably capture erosion features as well as above ground features such as contour drains. This work has recently been published.

A new capability in the SSSPAM model has been the inclusion of a landscape uplift capacity. This now allows SSSPAM and SIBERIA to be used as a landscape design tool. This work is currently being prepared as a peer reviewed journal paper.

C34027
Microalgae Cultivation as a Low Cost Method for Desalinating Void Water and Generator of Post Mining Bioeconomic Activity from Final Voids

University of Queensland
Ben Hankamer
Leigh Trevaskis

Value:	$3,155,904
Report Expected:	April 2026
Industry Monitor/s:	Andrew Lau Jason Fittler John Watson Trudy Mazucco
ACARP Contact:	Patrick Tyrrell

The Stage 3 objectives of this project include:

- Pilot scale production of microalgae using void water.
- Development and confirmation of downstream processing methods to deliver quality target products.
- Target product testing to confirm product quality, market prices and demand.
- Advance business modelling for the proposed void PMLU.

In the quarter, the project has conducted the following work.

Biomass production for downstream processing: The project has commenced scaling cultivation of multiple microalgae strains to 20 L under laboratory conditions. Cultivation will soon be scaled to:

- 200 L in greenhouse-housed systems to boost winter production;
- A 4000 L photobioreactor.

Development of downstream processing methods of quality products: In-house biochemical analyses have been established for total protein, carbohydrate and lipid content, omega-3, and carotenoids. All necessary standards for targeted high-value biomass fractions obtained. Characterisation of extracellular polymeric substances (EPS), demonstrated as significant for desalination in Stage 2, is underway.

Target product testing is underway for pet food and biochar: strain screening for EPA/DHA content and biomass production for activated carbon trials.

Advance business modelling is clarifying downstream market expectations.

C34035
High Interest Native Plant Pittosporum Angustifolium for Mine Rehabilitation: Key Strain Identification and Germplasm Propagation Investigation

RNA Environmental Services
Ryan Anderson

Value:	$197,401
Report Expected:	June 2025
Industry Monitor/s:	Andrew Lau Andrew Micallef
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C35021
Delineating Water Tables and Flow Pathways Inside Spoil Piles to Support Water Quality Predictions

University of Queensland
Mansour Edraki
Neil McIntyre
Thierry Bore

Value:	$297,420
Report Expected:	August 2025
Industry Monitor/s:	Andrew Lau
ACARP Contact:	David Drakeley

The project aim is to detect the spatial and temporal distribution of major flow pathways and water table(s) inside spoil piles with the level of confidence required for the progressive rehabilitation of spoil piles and

prediction of water balance and water quality of final voids, in particular predictions of spoil seepage quality.

The case study site located in the Gloucester Basin is preparing to finish coal extraction and will transition to closure upon completion of mining operations.

This quarter, focus has been on the following activities:

- The numerical model has been updated to reflect the actual field profile, incorporating the effects of surface compaction and compacted layers resulting from truck and dozer operations on-site. Realistic boundary conditions (e.g., monthly rainfall recharge) and the spatial distribution of hydraulic properties (i.e., K values) have also been integrated into the model.
- Physical characterisation of spoil materials was conducted, including maximum and minimum porosity, specific gravity, and particle size distribution, following ASTM standard methods. These results provide a robust foundation for defining parameters in the numerical model.
- Mathematical analysis of the geophysics survey data has been completed, establishing a relationship between conductivity and normalised chargeability for 3 survey lines. A relatively linear trend is observed, with zones exhibiting high normalised chargeability and conductivity identified as geophysically significant.
- Appropriate cell dimensions (i.e., diameter and length) were selected, and suitable packing conditions were established. Following successful experimental setup and rigorous calibration, petrophysical tests on spoil materials using the SIP method has been progressing smoothly.

C35026
Management Strategies for Invasive Leucaena on Coal Mine Sites

University of Queensland
Shane Campbell

Value:	$531,528
Report Expected:	January 2027
Industry Monitor/s:	Andrew Lau Cian Morgan Craig Bushell Hardy Wincen Melissa Brunner Morné van Zyl
ACARP Contact:	Patrick Tyrrell

The primary objective of this project is to develop strategies to effectively manage the invasive species leucaena (Leucaena leucocephala) in rehabilitation on coal mine sites in Queensland. Leucaena is a leguminous tree introduced to Australia for use as a forage for livestock production, but it has also become an environmental weed in sub-tropical and tropical regions.

A foliar herbicide experiment was established to evaluate 11 herbicides for their effectiveness in controlling Leucaena (Figure 1). A rate response trial of the most effective herbicides is currently in preparation and scheduled for application in the last week of May. Field marking and plant tagging have already begun, and pre-treatment monitoring will be conducted in the coming weeks. The same preparations are underway for a seasonality trial, in which selected treatments will be applied across different seasons to investigate whether herbicide effectiveness can be improved depending on the timing of application. A simulated aerial application trial to be undertaken at the Tropical Weeds Research Centre in Charters Towers aims to assess the feasibility of aerial herbicide application for Leucaena control. Due to uneven seedling growth, the trial has been postponed to September. Monitoring of a residual herbicide trial has now been concluded after a 14 month period where ten herbicides were evaluated for their ability to prevent seedling recruitment of leucaena from the soil seed bank on three different mine collected soils.

Fire research on leucaena is continuing near Rockhampton in collaboration with the Department of Environment and Science. This includes determining the effect of fire on leucaena plants and soil seed reserves. The pre fire field treatments (i.e. no treatment, mulching or basal bark spraying) have been completed setting up for a dry season burn (Figure 2). To compliment this a simulated fire has been conducted on the seedbank samples from this site collected in autumn 2024. These samples were then allowed to germinate in the greenhouse to identify seedbank composition and response to fire conditions.

Figure 3 Foliar herbicide trial implemented on leucaena.

Figure 2: (Left) Pre fire mulching conducted in March. (Right) Pre fire basal bark spraying of leucaena.

C35030
Erosion and Sediment Control Framework for Queensland Mines – Calibration and Validation

University of Queensland
Robynne Chrystal

Value:	$347,196
Report Expected:	April 2026
Industry Monitor/s:	Andrew Lau Jason Fittler Tim Kendrick
ACARP Contact:	Patrick Tyrrell

A framework for Erosion and Sediment Control Plans (ESCP) for Queensland coal mine sites was developed during project C29046. The ESCP Framework uses a GIS-based RUSLE tool that was developed to quantify soil loss on site, assist with identifying erosion risks and with selecting, designing, and implementing controls on site. This work also provided guidance on the key steps for sediment basin design. This project aims to verify that the soil loss rates calculated using the GIS-based RUSLE tool accurately represent site conditions at different catchment scales and land uses and that the guidance provided in project C29046 is applicable and reflects approaches that ensure compliance.

The experimental design for field trials and flume erosion experiments has been developed in consultation with site 1 personnel and plans are currently underway to transport soil and spoil material to UQ's erosion lab facility to carry out erosion experiments. A field trip to site 2 was undertaken in April to collect disturbed and undisturbed soil samples and inspect the sediment traps. Overall, the sediment traps have worked effectively, holding large volumes of sediment following several heavy rainfall events experienced over the past few months. Methods to quantify these loads using LiDAR data are currently being investigated.

C36018
Predicting the Long Term Erosional Behaviour of High Walls

University of Newcastle
Greg Hancock
Sue Henderson

Value:	$443,980
Report Expected:	March 2026
Industry Monitor/s:	Andrew Lau Chris Quinn Jason Fittler
ACARP Contact:	Patrick Tyrrell

The project objective are to:

- Better understand the process and rates of mine highwall erosional failure;
- Develop parameters for input into numerical models for high wall erosional failure; and to
- Calibrate and validate a predictive model (SIBERIA) for the erosion of highwalls.

Discussions with mines are ongoing and permission given for use of existing DEMs that the team has. Several provided DEMs have found not to be suitable.

Some sites for high wall analysis have been identified and model input files prepared for both the Hunter Valley and Queensland. Initial modelling for a site in Queensland has been conducted with positive outcomes in terms of model application. A site in New South Wales has been found to be suitable and the highwall examined. Results demonstrate that a highwall can be subject to erosion from external runoff as well as developing gullies internally. The need to manage external runoff is an initial key finding. The methodology using a LEM provides plausible outcomes and from this a work flow has been developed

Several sites have committed to providing materials and landscape data for analysis. The data is now being processed with needs for additional data being prepared. Additional field and GIS data needs are now being determined.

C36020
Semi Autonomous Bulldozers for Mine Site Rehabilitation

University of Queensland
Ross McAree

Value:	$498,218
Report Expected:	January 2026
Industry Monitor/s:	Andrew Lau Brian Neilsen Jonathan Miln Ned Stephenson Simon Zillman Teo Di Pasquale
ACARP Contact:	Patrick Tyrrell

Challenges facing industry regarding the user of dozer operation for rehabilitation are the financial cost of rehabilitation, availability of skilled people and environmental issues. These challenges could be significantly alleviated through the development and deployment of semi-automated bulldozers. Recent research found that human operated bulldozers achieved 56% of the maximum productivity potential, compared with productivity rates of up to 92% when missions for semi-autonomous bulldozers were autonomously planned. This project will develop, demonstrate, and evaluate the capability to undertake a substantial proportion of the bulk earthwork for mine-land rehabilitation using semi-autonomous bulldozers with enhanced mission planning to optimise performance.

An update for the quarter:

- Completed knowledge capture phase with comprehensive use case documentation, systems analysis, and gap assessment of existing Caterpillar SATS technology;
- Successfully developed two key technologies: BUMP-R (terrain-based work-block planning) - handles specific rehabilitation scenarios effectively but has limitations in addressing all potential scenarios and STAMP-R (mission guidance and sequencing for dozers) done;
- Final evaluation phase scheduled at Caterpillar's Tucson Proving Ground (May 5-15) followed by Queensland site trials in June/July to measure productivity improvements, fuel savings, and emissions reduction.

C36042
Validation of a Landform Design and Management System for Sloped Grazing PMLU

Valarion
Leigh Trevaskis

Value:	$688,080
Report Expected:	February 2028
Industry Monitor/s:	Andrew Lau Hardy Wincen Melissa Brunner Morné van Zyl
ACARP Contact:	Patrick Tyrrell

The project's primary objectives are to:

- Characterise the impact livestock behaviour has on stability indicators for sloped grazing PMLU in the Bowen Basin;
- Provide statistical confirmation of an adaptive grazing management system for maintaining the stability of sloped grazing PMLU;
- Obtain evidence that justifies the use of stability indicators for the approval of grazing PMLU rather than a slope gradient ceiling per se;
- Assess the feasibility of using integrated behavioural, landform elevation, and sustainability indicator data for developing a grazing PMLU landform evolution model;
- Use stability indicator data from replicated treatments to evaluate recommendations from previous grazing PLMU studies;
- Publish a best-practice guide for managing livestock on sloped grazing PMLU.

Project work during this quarter:

- Confirmed a host site;
- Undertaken a site visit to confirm the area's suitability for the trial;
- Confirmed the type of livestock to be used and the anticipated stocking rate;
- Engaged in planning for the reconfiguration of selected on-animal sensors for deployment on livestock at the site; and
- A May/June visit will be undertaken to confirm livestock management protocols with the collaborating farmer.

C36043
Using Large Floating Islands to Promote Aquatic and Terrestrial Biodiversity in Pit Lakes

Edith Cowan University
Mark Lund

Value:	$697,290
Report Expected:	March 2027
Industry Monitor/s:	Andrew Lau John Watson Ned Stephenson
ACARP Contact:	David Drakeley

Previous projects C27043 and C29049 demonstrated that closure of pit lakes as aquatic ecosystems is likely a viable, sustainable, and economically responsible option for post-mining land use. Riparian vegetation and littoral areas are critical ecosystem components that cannot be established before the lake is full.

Artificial floating islands (AFIs) can provide habitat for waterbirds and other fauna. Therefore, AFIs may be used to encourage waterbird usage, create habitat for fauna (including turtles, fish, frogs, macroinvertebrates, and terrestrial organisms) and as a source of plant propagules, and general habitat for fauna (aquatic and terrestrial) in pit lakes. Waterbirds are particularly important to aquatic biodiversity because they are vectors of plants, invertebrates, bacteria, fish eggs, and major sources of nutrients (N and P) through excreta. Propagules from AFIs can continually seed the pit lake during filling, potentially removing the need for companies to return after the lake fills to plant a riparian zone, especially as the upland vegetation is normally well-established by then limiting access to the shore.

The broad goal of this research is to develop the use of large-scale AFIs as a tool that can deployed by miners to develop or improve biodiversity in their pit lakes making them suitable for closure as aquatic ecosystems or demonstrating improvement for NUMAs.

We will investigate the effectiveness of AFIs by testing pairs of pit lakes across WA, NSW and Qld. In each pair, one lake will be treated with an AFI and the other left as a control. Using previous data collected at the sites in C27043 and C29049 and extending this monitoring in this project we can test the effectiveness of AFIs using a Before/After/Control/Impact (BACI) study design.

Islands have been installed at all three sites in WA, Qld and NSW. We have also completed the first two rounds of monitoring of all pit lakes and by the end of June will have completed the third round of sampling. At the moment we are seeing strong growth of plants on all three islands, accompanied by extensive use of the islands by waterbirds.

Rock Mechanics

C29005
System for Rock Fall Analysis Field Trial

CSIRO
Marc Elmouttie
Peter Dean

Value:	$321,268
Report Expected:	July 2025
Industry Monitor/s:	Matt Tsang
ACARP Contact:	Patrick Tyrrell

Systems to detect, monitor and analyse rock-falls in open pit mining operations have the potential to improve operational safety, improve calibration of rock fall simulators (restitution coefficients), and importantly provide quantitative data to justify current standoff designs. A monitoring system that can accumulate a large database of rock fall events across the full strike length of highwalls is required. The use of existing monitoring systems (radar, vision, lidar) as well as knowledge of the wall geometry, geology (rock mass types) and structural characteristics (defect orientations and intensities) has potential to support detection of events (potentially in real-time) and detect rock fall movements accurately enough for determination of trajectories (bounce kinematics), impact locations and final resting positions.

This project will field trial a prototype system which, in response to industry monitor feedback, now consists of a trailer-based solution for housing the sensitive electronics, software and computing hardware to integrate data from microseismic monitoring and vision systems. Ideally, third party radar when available is fused with this seismic and vision data.

Modifications to the system to support more robust environmental control for the sensitive electronics system have now been implemented. Due to logistics issues with undertaking the long duration field trial at site A, a site trial has been commenced at CSIRO. The images below show the trailer, fibre-optics setup and accompanying geophone system. The field trial will continue over the coming weeks to determine the sensitivity and performance of the system. A second site is currently being investigated and time permitting, trials will be undertaken. The plan is to complete all field work, analysis and final reporting by June.

C33040
Machine Learning for Rockfall Analysis

University of Newcastle
Anna Giacomini
Klaus Thoeni
Marc Elmouttie

Value:	$342,240
Report Expected:	November 2025
Industry Monitor/s:	Matt Tsang
ACARP Contact:	Patrick Tyrrell

The project proposes using machine learning (ML) for rockfall analysis. The objective is to identify a rapid and reliable method for estimating the location and energy of rockfall events at the base of a highwall, effectively mitigating the associated risks without the need to run specific rockfall simulations. The main outcome for the industry will be an ML-based tool to manage rockfall hazards at the base of highwalls.

It was identified that the number of simulated blocks used per seeder was insufficient to accurately capture the natural variability of rockfall outcomes. Specifically, the use of only 100 blocks per seeder was found to be too limited to provide stable and representative predictions, particularly when incorporating complex geological layering. To address this, a comprehensive sensitivity analysis was conducted (Figure 1), and it was determined that a minimum of 1,000 blocks per seeder is required to robustly capture the statistical behaviour of key output variables such as first impact distance and run-out extent. Running such large-scale simulations, however, presented a significant computational challenge. To overcome this, the research team re-developed the simulation code using a novel and highly efficient programming technique, which allows for operations to be executed simultaneously rather than sequentially. This innovative approach — referred to as a vectorised implementation — resulted in simulations running approximately 25 times faster, enabling the complete dataset to be regenerated using 1,000 blocks per seeder. The outcome is a more reliable and precise basis for quantifying rockfall risk and calculating critical thresholds such as 90th-percentile distances.

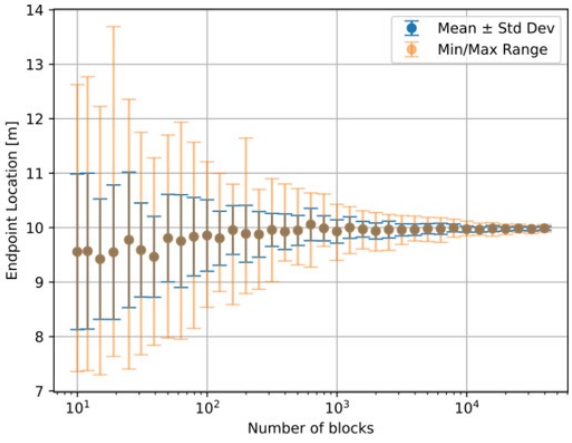


Figure 1. Variation of total runout (endpoint location) for 50 different simulations varying the number of blocks per seeder.

In parallel, the team explored new ML methods to improve the accuracy of rockfall prediction models. Previously, Principal Component Analysis (PCA) was used to reduce the dimensionality of input data. While effective, PCA is a linear method that does not always capture the complexity of high-dimensional datasets such as those derived from 2D slope profiles. This quarter, PCA was replaced with a more powerful technique known as autoencoder. An autoencoder is a type of artificial neural network that learns to compress complex input data into a compact set of key features — called a latent representation — and then reconstruct the original data from this compressed form. Unlike PCA, autoencoders can model non-linear relationships, which makes them particularly well-suited for capturing the intricate variations in slope geometry and material properties. The latent features extracted by the autoencoder were then used as input to various regression models, including Linear Regression, Random Forest, K-Nearest Neighbours (KNN), and Extreme Gradient Boosting (XGB). This new approach significantly improved the prediction of critical output quantiles, especially for the distance to the first impact and final run-out location. The models showed better generalisation and reduced underprediction rates compared to those using manually defined features or PCA-based inputs. Overall, compared to the linear regression using only geometrical features, it was observed an improvement of 20.5% on the prediction of the energy at first impact, 32.8% on the prediction of the position of first impact, and 23.7% on the prediction of the total runout. An example of the old linear regression results with geometrical features versus the new improved results with XGB and latent features is shown in Figure 2.

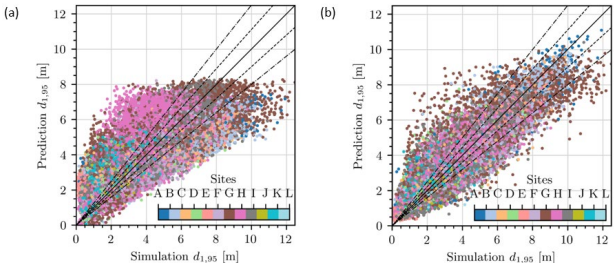


Figure 2. Simulation vs. prediction plot for first impact $d_{1,95}$ coloured by site for: (a) linear regression with geometrical features and (b) XGB with latent features.

C35022
Quantifying Hoek-Brown Disturbance Factor (D) for Coal Measures Through an Integrated Laboratory and Numerical Modelling Approach

University of Queensland
Italo Onederra
Zhongwei Chen

Value:	$672,162
Report Expected:	October 2026
Industry Monitor/s:	Matt Tsang Peter Chern
ACARP Contact:	Patrick Tyrrell

The main objective of the project is to construct a comprehensive and generalised estimation method for the Disturbance factor (D) in coal measure strata. This mainly includes the quantification of the variation of D in response to blast-induced damage and scale effects to establish an effective guide for the definition of D in slope stability analysis.

During this quarter, analysis and results were consolidated into a draft final report for stage 1. Key achievements include the successful evaluation of the Hybrid Stress Blast Model (HSBM) to generate more realistic representations of blast-induced damage envelopes via peak particle velocity (PPV) mapping. This work supported the development of a 2D PPV mapping tool that enables rapid visualisation of PPV contours while significantly reducing computational costs. The objective was to deliver a more practical approach for defining damage extents and determining corresponding D factors.

The study also introduced a working hypothesis linking PPV damage thresholds to D factors, which was explored through both physical and numerical experiments. A preliminary correlation between PPV thresholds and reductions in P-wave velocity was also established and demonstrated.

The next phase which has recently commenced will focus on field validation of the proposed methodology.

C36017
From Open Pit to Pumped Hydro Energy Storage, a Focus on Low Wall Stability

University of Newcastle
Anna Giacomini
Jubert Pineda
Olivier Buzzi

Value:	$405,500
Report Expected:	October 2026
Industry Monitor/s:	Andrew Lau Shaun Booth Troy O'Reilly Tyron Domenici
ACARP Contact:	David Drakeley

The project objectives are to identify the fundamental failure mechanisms of a low wall in the context of pumped hydro energy storage (PHES) and provide guidance to mitigate the geotechnical failure risks.

In the quarter, we have:

- Finished processing the crushed material (coarse material) from Mine A (see Figure 1).
- Obtained approximately 1m^3 of suitable cat 2 spoil material from Mine B. The material is being dried (see Figure 2). When homogenisation is complete, we will start the series of direct shear tests and repeat the erosion experiment to confirm that erosion is indeed an issue even for low batter angles and assess the influence of compaction.
- Identified new data on Mine A for the desktop study. We have processed some of the data, comparing cross sections at different dates (see Figure 3). However, the dates of the surveys provided do not match the dates at which water levels in the pit where taken. We have requested more spoil pile surveys, at corresponding dates.

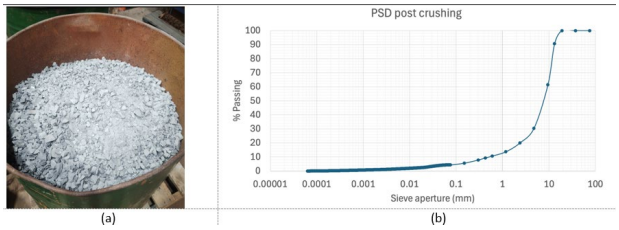


Figure 1: (a) Crushed sandstone from Mine A. (b) Particle size distribution of crushed sandstone.

Figure 2: Material from Mine B being dried with a fan

Figure 3: comparison of cross sections of low wall and high wall at Mine A at different dates. (a) shows no change in profile, (b) shows that about 20m of fill was added between 13/11/2023 and 04/04/2024 (see red arrow), which hides any possible settlement, if any.

C36021
Measuring the Tensile Strength of Thin Units in Coal Measure Rocks using a Comminution Approach

University of Queensland
Dion Weatherley
Joan Esterle
Katerina Savinova

Value:	$214,100
Report Expected:	July 2025
Industry Monitor/s:	Andrew Lau Jianping Li Matt Tsang
ACARP Contact:	David Drakeley

Traditional strength testing of rocks relies heavily on compressive methods; however, there is a growing need to determine intact tensile strength to support site-specific geotechnical assessments. This project explores an innovative approach by adapting techniques from comminution, aiming to derive rock tensile strength from small-diameter mini-cores (<20 mm, with a 1:1 aspect ratio). The focus is on evaluating the potential of the Short Impact Load Cell (SILC) instrument for testing overburden rock types common in coal measures, such as sandstone, siltstone, and claystone. Additionally, the

project seeks to refine a methodology specific to coal measure rocks, improving the reliability of tensile strength estimates by incorporating geological variability, texture, and mineral composition.

Work completed during this quarter:

- Continued regular consultation meetings with industry monitors to align project goals and expectations.
- Collected spectral reflectance measurements using a hand-held spectrometer on 15mm diameter cylinders across various lithologies. These measurements are restricted to larger-diameter samples due to the instrument's spot size and sensitivity to ambient light. These results indicate the consistent presence of smectite-white mica mixture on surface of all cylinders.
- Completed approximately 60 SILC breakage tests on sandstone cylinders (a complete experimental set includes a minimum of 30 tests).
- Conducted preliminary data analysis using in-house software, generating initial models of apparent stiffness and cumulative tensile strength distributions.
- Ongoing literature review.

Work planned for the next quarter:

- Complete SILC breakage tests and data collection for siltstone and claystone samples, including tests at various orientations to bedding planes.
- Perform Brazilian Tests (splitting tensile strength) on 10–15 disc-shaped samples of sandstone and siltstone. Efforts will be made to access UQ's mini-Brazilian Test setup to enable direct testing of 15mm diameter cylinders for comparative analysis.
- Continue engagement with industry monitors for feedback and alignment.
- Begin drafting and work toward completion of the final project report.

C36023
"SCANDY" - A handheld Imaging System for Real Time Spoil Categorisation

University of New South Wales
Simit Raval

Value:	$178,050
Report Expected:	June 2025
Industry Monitor/s:	Jacques Strydom Ned Stephenson Tim Vangsness
ACARP Contact:	Patrick Tyrrell

This project aims at developing an intuitive, mobile AI application for real-time spoil characterisation, leveraging advanced computer vision and deep learning techniques. The app is trained on smartphone images, captured at waste dump sites across New South Wales and Queensland, and is specifically designed for offline functionality in remote mining environments. A major focus has been on improving data preprocessing, enhancing user-driven annotations, and integrating Explainable AI (XAI) methods to ensure transparency and boost trust in the model's predictions.

During the last quarter, the beta version of the app was actively deployed across three additional mine sites for extensive field testing and real-world validations. Over 2,000 new spoil images were collected using the beta app under diverse environmental and geological conditions. Onsite geotechnical engineers annotated spoil features such as particle size, relative density, and plasticity directly within the app, enabling high-quality inputs for future retraining cycles. Initial trials demonstrated partial success in offline spoil categorisation, though model accuracy varied significantly. Analysis revealed that prediction inconsistencies stemmed from several field-related factors: improper zoom levels skewing perceived texture and particle size, non-standard image angles distorting spatial cues, and frames containing mixed spoil categories introducing ambiguity. These factors led to reduced classification reliability in uncontrolled environments. Field users provided valuable feedback, highlighting the practical usability of the app and suggesting improvements in guided image capture. All collected data is now being integrated into the retraining pipeline, with efforts underway to benchmark field-based annotations against cloud-trained predictions, supporting ongoing development of sensible AI-integration for mine site deployment

Maintenance and Equipment

C33034
Dozer Suspension Seat to Reduce Body Vibration

University of Queensland
Danellie Lynas

Value:	$83,107
Report Expected:	May 2025
Industry Monitor/s:	Shane Apps Tim Gray Troy O'Reilly
ACARP Contact:	Anne Mabardi

The draft final report has been submitted to the Industry Monitors for review.

C36019
In-situ Slew Bearing Scanner for Shovels

Ascribe Engineering
Matthew Robinson

Value:	$190,300
Report Expected:	June 2025
Industry Monitor/s:	Brendan Wilkins Tim Gray Tyson Burkitt
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C37007
People and Process: Case Review on Human Systems Integration and OTR Tyre Handling Mobile Plant in Mining Operations

ViVA! Health at Work
Sara Pazell

Value:	$150,162
Report Expected:	September 2025
Industry Monitor/s:	Brendan Wilkins Rob Fraser Tim Gray Tony Egan
ACARP Contact:	Patrick Tyrrell

This project aims to understand the organisational decision making processes when selecting, using, and integrating OTR tyre handling equipment (prime movers and attachments) in mining maintenance work systems.

The project objectives are:
- To examine decision making and role accountabilities in participating mine sites for their OTR tyre handling work systems, including:
  - work bay design,
  - mobile plant equipment and attachment selection,
  - technician team selection,
  - operational risk assessments,
  - and the alignment with leading practice frameworks;
- To develop recommendations on improving these processes if gaps exist.

The researchers facilitated workshop sponsored by the Earth Moving Industry Safety Round Table (EMESRT), a global initiative led by major mining companies to improve safety by design. The in-person, attendance-style workshop involved fifteen domain experts and guests (suppliers, human factors educators, a transport representative, a project manager, and an organisational strategist), and three of the ViVA research project team members. This workshop was structured to validate the industry problem statement, the tyre maintenance life cycle stages, and the task requirements in four domains of tyre handling equipment management: environmental design, governance and operations, equipment selection and risk assessment, and technician team selection and operations.

The industry group confirmed a minor revision to the problem statement. The research team led the domain experts through small focus group exercises involving recalling work scenarios and classifying job functions, pain points, and effective operational requirements. The research team used these findings to refine their digital list of tyre handling work functions.

Additionally, two researchers attended two mine sites on 18/19 March, to examine the integration of tyre handling work functions that impact on operational effectiveness. They reported on these findings to the Industry Monitors who advised the researchers on administering a focussed survey to a sample of industry tyre asset management managers. The research team is developing mid-way report for submission to the Industry Monitors.

Health and Safety

C36033
Live Monitoring of Workplace Exposures In Surface Mobile Equipment

SafeOperate
Andrew Westaway

Value:	$152,000
Report Expected:	November 2025
Industry Monitor/s:	Shane Apps
ACARP Contact:	Patrick Tyrrell

This project primarily aims to establish real-time whole body vibration monitoring of operators in mining equipment, with secondary objectives of real-time seat suspension and haul road health monitoring. This achieved through the creation of seat covers containing embedded accelerometers fitted to equipment, accelerometers mounted to the cab of equipment, and all collected data to be GPS tagged.

Progress during the quarter:
- 12 Accelerometer embedded seat covers have been manufactured;
- Seat covers to be delivered to mine site mid-May;
- Meeting with mine site management in mid-May to plan for installation of seat covers, the display of data collected from these systems and to plan the delivery and installation of additional SafeOperate systems for fitment; and
- Redesign of SafeOperate systems to incorporate more robust aspects for mine site environments ongoing.

General

C37013
Thermally Enhanced Floating Solar Still System for Reducing a Mine's Reliance on Raw Water Allocations and Achieving a Drought Resilient Post Mining Land Use for Final Voids

Valarion
Leigh Trevaskis

Value:	$83,000
Report Expected:	February 2027
Industry Monitor/s:	Andrew Lau Angus Ball Shaun Booth
ACARP Contact:	Patrick Tyrrell

The objective of this project is to design and performance test a modular and potentially thermally enhanced floating solar still prototype that:

- Has capacity to scale for application on voids of varying water surface areas and water quality;
- Produces commercially relevant volumes of water (i.e. > 12ML/ha) to supplement mine operational requirements and PMLU agricultural applications;
- Requires minimal maintenance;
- Provides ease of access and functionality for safe system maintenance; and
- Delivers a cost-effective means for avoiding expensive backfilling of final voids.

In this first quarter, the following work was conducted:

- Research on materials, manufacturing, and concept design;
- Completed a review of peer-reviewed research, technology, and materials;
- Collaborated with an industrial designer to develop a list of materials and coatings (e.g. hydrophobic; antifouling) for testing in mini-still designs;
- Material and coatings samples will be procured and subjected to void water conditions in the Bowen Basin prior to final prototype manufacturing;
- Mini-still design, testing and evaluation; and
- The project is progressing mini-still designs to support the iterative development of a final prototype.

COAL PREPARATION

Reports Published This Quarter

C28061
Quantitative Based Structural Integrity Evaluations Using Modal Parameters Estimation

Mincka Engineering
Fidel Gonzalez
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C28061

C33049
An Emerging Pulsed Power Technology for Dewatering Mineral Tailings

University of Queensland
Mansour Edraki
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C33049

C33050
Dewatering Efficiency of Fine Flotation Concentrates by De-Aerating Froth Products - Plant Demonstration

University of Queensland
Yongjun Peng
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C33050

C34039
Soft Sensor for Predicting Dense Medium Cyclones Performance

University of Queensland
Gordon Forbes
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C34039

C34046
Clay Type Effect on Magnetite Medium Properties in Dense Medium Cyclones

CSIRO
Clint McNally
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C34046

Maintenance and Equipment

C35036
Autonomous Stockpile Dozing: Quantifying Viability

University of Queensland
Ross McAree

Value:	$352,797
Report Expected:	May 2025
Industry Monitor/s:	Chris Huth Chris Jackson Frank Mercuri Jimmy Pollack Peter Shumack
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C36028
Continuous Stockpile Cavity Warning System - Feasibility Assessment

CSIRO
Wayne Stasinowsky

Value:	$191,600
Report Expected:	June 2025
Industry Monitor/s:	Michael Booth Tom Buckby
ACARP Contact:	Ben Gill

The project objectives are to:

- Conduct a feasibility assessment for a system that will allow the mine to monitor the stockpile continuously in real time and give real-time warning of a developing void to the dozer operator;
- Model the responses numerically to determine that there is sufficient resolution to detect dangerous voids; and to
- Test the technique using scale models.

Progress during the quarter:

- Focus on scale model tests;
- Results to date have continued to be positive indicating that this technique is feasible;
- Testing of ground probing radar with suitable different frequencies is to be conducted over a full-size stockpile to test signal penetration. This is in addition to the originally specified project scope but will add to the feasibility assessment. We are currently waiting on a mine site to both approve the trial and to let us know a suitable time to conduct the test;
- The report has been delayed due to the volume of data to be reported and finalising the last tests.

Dewatering

C29060
Tailings Management - Dewatering Flume Site Trials

University of Newcastle
Craig Wheeler

Value:	$278,500
Report Expected:	May 2025
Industry Monitor/s:	Jenny Park Peter Shumack
ACARP Contact:	Patrick Tyrrell

The objective of this project is to further refine and conduct site trails of a dewatering flume developed in project C27067. The aim of the flume is to increase the solids content of the tailings entering the tailings dam and recover water before it is deposited in the tailings dam. The recovered water would be recycled back to the CHPP as process water, thus limiting the volume of water stored in the tailings dam and reduce, or eliminate, the use of secondary flocculant in the tailings dam.

Original onsite testing is complete and further testing at a new site is progressing under a project extension. New feed material has been tested over a range of concentrations and flowrates to optimise solids recovery. Further testing with various flocculant dosage levels is planned.

C33051
Hybrid Microwave Technology for Dry Stacked Tailings Applications

University of Queensland
Christian Antonio

Value:	$121,335
Report Expected:	June 2025
Industry Monitor/s:	Frank Mercuri Naresh Racha
ACARP Contact:	Ben Gill

One of the most pressing challenges facing the mining industry today is the increasing frequency of catastrophic tailings dam collapses. Such events are known to cause significant environmental damage as well as loss of life. There is a strong industry push to move away from wet tailings dams to drier and safer options. A viable alternative to tailings storage in dams is Dry Stack Tailings (DTS) technology.

This project proposes a new approach that could reduce tailings moisture contents to levels required for dry stacking – the use of Hybrid Microwave (MW) Technology. This approach combines microwave treatment with conventional dewatering techniques. This method could bridge the moisture content gap between conventionally dewatered material and Dry Stack Tailing requirements.

The project aims to evaluate the feasibility of a continuous process and measure the energy requirements to achieve different product moisture content. Finally, it will provide a concept for a microwave-assisted dewatering process for future research studies.

Progress during this quarter include:
- Conducted meetings with a practicing microwave expert (collaborator) to obtain feedback on the project, focusing on the design, energy requirements, and scale-up of the microwave process aimed at producing tailings suitable for dry stacking.
- Received a draft report from the collaborator outlining the current state of industrial microwave processing, along with an evaluation of the design, energy demands, and CAPEX/OPEX considerations for achieving dry stacked tailings and process scale-up. This report will be incorporated into the final report.
- Final report preparation is currently in progress.

C34051
Cost Effective Approach for Coal Tailings Dewatering using Semi Inverted (SIV) Hydrocyclones

University of Queensland
Christian Antonio

Value:	$174,500
Report Expected:	July 2025
Industry Monitor/s:	Jenny Goh Tom Wilson
ACARP Contact:	Ben Gill

The application of coagulation, flocculation, and mechanical dewatering units such as belt press filters (BPF), centrifuges, and horizontal belt filters (HBF) is currently used by industry as a practical approach for dewatering coal tailings. However, there are still challenges that limit dewatering of coal tailings which affects the performance of these dewatering processes. These include the presence of clay materials, elevated fines and ineffective coagulation and flocculation methods, amongst others.

This project aims to develop a technologically and economically viable approach to reduce moisture content and capture fine clay particles in tailings to improve tailings dewatering outcomes, by using Semi-Inverted (SIV) Hydrocyclone Technology, followed by coagulation, and flocculation. The study aims to use the SIV to split a tailings sample into a coarse stream (underflow product), with reduced moisture content, and a clay-rich fines stream (overflow product). This will enable targeted processing of the two streams that could consequently improve the efficiency of downstream dewatering units. A potential tailings sample has been received for evaluation for use in this project.

Progress during this quarter focussed on:

- Analysis of the coagulation and flocculation tests conducted on the feed, overflow, and underflow products generated from the SIV testing has been completed.
- Final report preparation is currently in progress.

C35032
Improving the Dewatering of Fine Coal Tailings by Minimising Micro-Nano Bubbles

University of Queensland
Yongjun Peng

Value:	$238,470
Report Expected:	June 2025
Industry Monitor/s:	Han Hooi Tom Henshaw
ACARP Contact:	Ben Gill

The draft final report has been submitted to the Industry Monitors for review.

C36025
Green and Effective Reagents for Centrifugal Dewatering

University of Queensland
Liguang Wang

Value:	$198,982
Report Expected:	January 2026
Industry Monitor/s:	Chris Denyer Jenny Park
ACARP Contact:	Ben Gill

The objectives of this project are to:

- Screen and develop green reagents for dewatering of coals and tailings over a broad size range to achieve low product moisture level and high solids recovery; and to
- Provide a guide for reagent selection in dewatering of Australian black coals and tailings.

During this quarter, we improved the repeatability of settling tests by introducing a waiting period after reagent addition and using a mixing tool. Eight reagents were selected for settling tests. Among them, three representative flocculants were further evaluated at lower dosages in both sedimentation tests and filtration tests. Turbidity measurements were conducted for each flocculant to further evaluate dewatering efficiency.

In the following quarter, more individual and combined reagents will be tested. Some green reagents will also be tested to identify the optimal reagent type and dosage for improving the efficiency of dewatering by sedimentation, filtration, and centrifugal dewatering.

Environmental Improvement

C29042
Tailings to Topsoil

University of Newcastle
Ken Williams

Value:	$765,300
Report Expected:	September 2026
Industry Monitor/s:	Bill Baxter Paul O'Loughlin
ACARP Contact:	Patrick Tyrrell

The objective of this staged project is to develop a co-utilisation and soil improvement program that addresses the environmental challenge of tailings management for mining operations. This transformational alternative for tailings management research optimises existing technologies for dewatering, delivery, and soil remediation processes into an integrated "pit to paddock" mobile plant emplacement and cultivation system.

Field trials: Current photos of Mine Site 2 are shown below (Fig 1). The photos show the pasture mix plots. Weed control has just been undertaken at the site.
Figure 4: Mine Site 2 Pasture Mix Plots at 0:100, 5:95, 10:90, and 25:75 Tailings: Soil

Ex-situ Trials – Glasshouse: The coal tailings that were collected for the ex-situ glasshouse trials (which will include a pyrolysis treatment) were tested by thermogravimetric analysis (TGA) to determine target pyrolysis temperatures. The process used a heating rate of 5°C / min to a maximum temperature of 1000°C. The figure below (Fig 2) shows three stages in the TGA and DTG curve (1) loss of moisture occurring below 100°C, (2) the primary stage of devolatilisation which peaked at 443°C, and (3) tertiary reactions at around 600 °C. For the pyrolysis trials, the temperatures that will be targeted are 300, 500, and 700°C.

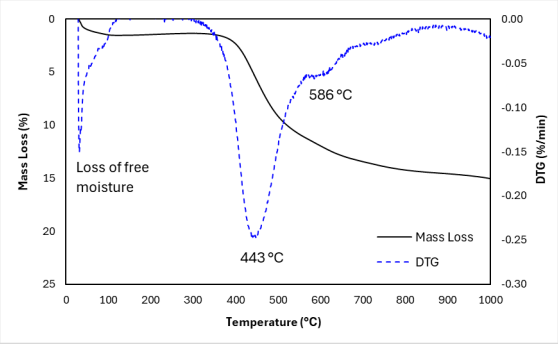


Figure 5: TGA and DTG of Coal Tailings

The coal tailings were also analysed using Scanning Electron Microscopy (SEM) to assess initial surface morphology prior to pyrolysis (Fig 3). This will be compared to post pyrolysis coal tailings.

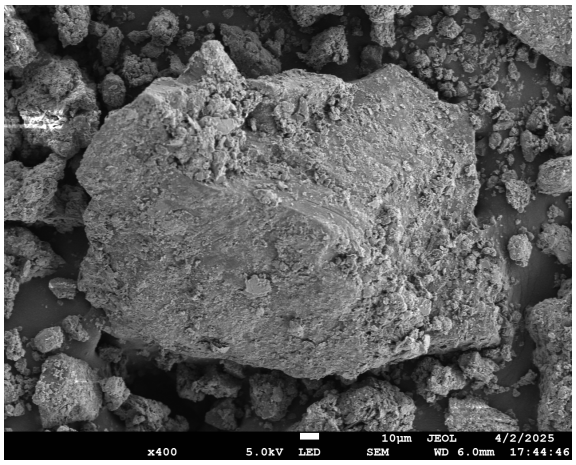


Figure 3: SEM of Coal Tailings

Brunauer–Emmett–Teller (BET) surface area analysis was also conducted, and again the results will be compared to the tailings post pyrolysis to see changes to pores and surface area. X-Ray Diffraction has also been conducted for the coal tailings. Finally, the tailings, soil, and waste rock have been tested for pH, EC, exchangeable cations, acid neutralising capacity, carbon, nitrogen, phosphorus, potassium, sulphur, and trace elements.

Ex-Situ Trials – Column Leaching: Planning and set-up for the column leaching trials have also commenced at the University of Queensland.

C35033

Non-invasive and Real Time Monitoring of Slurry Tailings Density and Velocity in the Transmission Pipeline using Electrical Resistance Tomography Method

University of Queensland
Chenming Zhang
David Williams

Value:	$259,000
Report Expected:	June 2025
Industry Monitor/s:	Peter Shumack
ACARP Contact:	Patrick Tyrrell

The objectives of the project are to:

- Develop a resistivity inverse model that converts the longitudinal and cross-sectional resistivity tomography of coal slurry to its density and velocity, accounting for the effects of temperature, EC, air content and coal tailings mineralogy;
- Test the system at a coal transmission pipeline for in situ and real-time monitoring of the slurry transport conditions;
- Verify the monitored results with those obtained using concurrent technologies.

During the quarter:

- Laboratory experiments were conducted to evaluate how clay content and pore water conductivity influence the bulk electrical conductivity of coal tailings slurry;
- The bulk conductivity was measured across a range of solids concentrations (15% to 35%) and pore water conductivities (0.001 to 10 S/m), as shown in Figure 1;

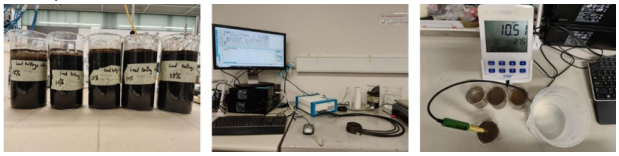


Figure 1 Electrical conductivity experiments in laboratory

- XRD analysis confirmed that the solid material contains approximately 32% clay minerals.
- As illustrated in Figure 2, within the solids concentration range typically used in pipeline transport at mine sites, the bulk conductivity of the slurry increases linearly with pore water conductivity. This relationship appears to be largely unaffected by the clay content. This finding demonstrates that, at typical operating solids concentrations, the effect of clay surface conductivity on ERT-based measurements is negligible.

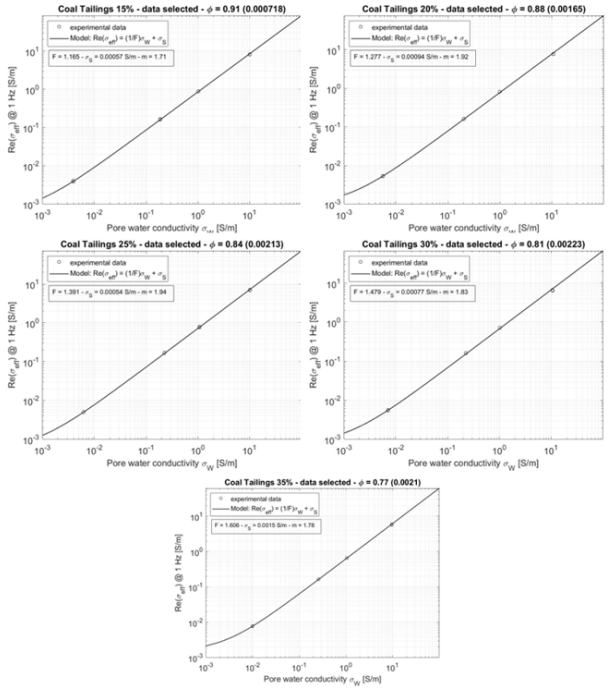
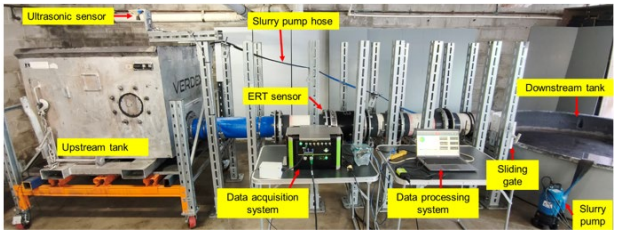


Figure 2 Relationship between bulk electrical conductivity and pore water conductivity under different solids concentration

- Dam break tests were successfully carried out using coal tailings slurry to assess the performance of ERT under dynamic flow conditions (Figure 3).



- The slurry samples had solids concentrations ranging from 25% to 35%, adjusted by dilution with process water;
- A temperature calibration test was also performed (Figure 4) to ensure measurement accuracy across different operating temperatures;

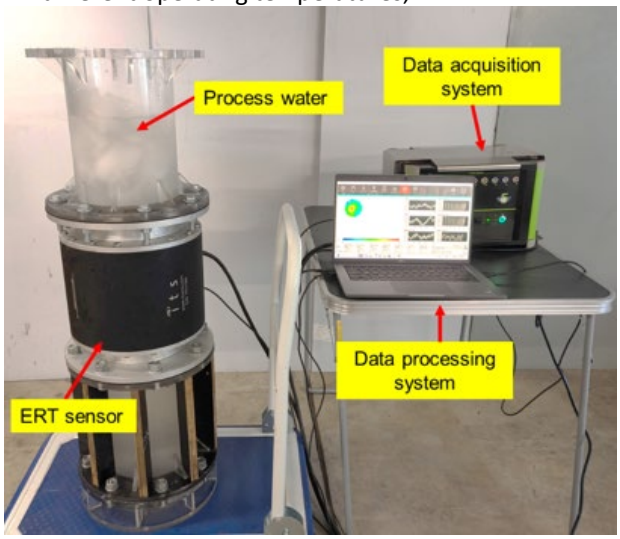


Figure 4 Temperature calibration test

- The relationship between the temperature-compensated mean resistance values (obtained from ERT) and solids concentration is shown in Figure 5. The results indicate that the ERT system can effectively differentiate slurry density, with an accuracy of ±0.5%.

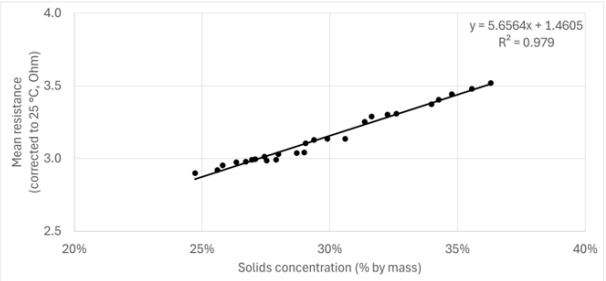


Figure 5 Established linear correlations between the mean resistance corrected to 25˚C and the solids density obtained from the dam break tests

C35048
Cost Effective Rehabilitation of Tailings Dams

CSER Research
Mike Cole
Carmen Castor

Value:	$973,580
Report Expected:	March 2027
Industry Monitor/s:	Andrew Lau
	Brooke York
	Shaun Booth
ACARP Contact:	Patrick Tyrrell

This project builds on the research conducted in projects C27009, C29041, and C34030, focusing on the cost-effective rehabilitation and closure of tailings dams. It aims to support the development of final land use plans in collaboration with each mine and further tailings amelioration techniques to optimise outcomes for native vegetation. Additionally, the project aims to maximise plant and soil biodiversity of the dams and their surrounds.

During the quarter, efforts have focused on data collection at the mine site tailings dam used in C27009, prior to its final capping. This included the harvesting of trees to contribute towards the ongoing modelling of functional components and biomass. These activities will improve understanding of mass distribution throughout the plant and allow estimation of leaf area and carbon content of components.

Additionally, we have observed that storing plants in a nursery environment can reduce their physiological capacity. Namely, leaves lose their capacity for uncontrolled transpiration, indicating that the plants' water-loss is now only under stomatal control. As these plants are returned to full function via new growth, it will be necessary to differentiate transpiration components between leaves under stomatal control and those that also have uncontrolled transpiration when estimating total transpiration rate for the plant.

Experimental plants, between one to seven years of age since planting on tailings, were resurveyed for survival, with minimal deaths observed in these later stages of dam development. This suggests that conditions on the dam are evolving similar to primary succession on disturbed land. Recent surveys provided anecdotal evidence of ecological development including plant dispersal into the site and the presence of fauna, including insects and birds. These findings have contributed to furthering our understanding of ecosystem network development.

Fine Coal

C34002
Full Scale Beneficiation of Coal Fines by Novel Agglomeration

University of Newcastle
Kevin Galvin

Value:	$4,568,256
Report Expected:	July 2025
Industry Monitor/s:	Ben Gill Jack Lauder Jason Schumacher Jenny Goh Luke Dimech Paul Sainsbury
ACARP Contact:	Patrick Tyrrell

The objective of this project is to investigate the scale-up of a novel fine coal agglomeration technology through a study at full-scale. The project involves the design, commissioning and operation of the novel agglomeration technology. The feed source is expected to be a fine coal tailings stream suitable for the thermal market. The study will quantify the scale-up at 500m^3/h in terms of yield, ash, moisture and economic benefits. The novel agglomeration technology offers the prospects of a low capital investment for processing the fine coal tailings stream normally sent to the thickener.

This project involved a substantial scale-up from a 25mm diameter pipe configuration to a 350mm diameter pipe system requiring the flow of the slurry and binder through a single hole in an orifice plate to produce agglomerates. The early results suggested that the system does not scale directly, and that the collision efficiency with the emulsion binder is impacted negatively. Additional funding was secured to develop further understanding of the scale-up of the technology. The current standard pipe configuration, with a diameter of 350mm, was replaced by a new design standard based on a 100mm diameter pipe configuration.

The new pipework was installed, other standard hire items secured, site approvals were obtained, and commissioning completed. The experimental work was undertaken based on a systematic plan. The new set up offered key levers for generating a more effective binder. The experimental work was driven firstly towards successful agglomeration, and then towards more economic conditions, keeping the operation as simple and well controlled as possible. The main part of the study was based on an orifice plate with a single hole, designed to achieve a specific pressure drop. The results from the program of work showed the technology could readily generate product ashes of approximately 10% ash. The combustible recoveries were variable and satisfactory, increasing as the oil dose increased.

Towards the end of the experimental study the orifice plate was replaced with a new plate containing seven holes. Some air was also introduced with the feed. The results from this experiment were impressive with very high combustible recovery and low product ash. The work was also replicated. The oil dose was significantly lower than that achieved in the larger scale study. The work strongly indicates the potential for separation at an even lower oil dose. Therefore, this program of work has been successful in reducing the project risk, and for understanding the likely conditions needed to secure a strong separation.

Findings from the recent phase of work were reviewed. It was agreed the work should be extended to a final phase by inserting a simple pipe-bundle arrangement within the main 350mm pipe configuration. This means a much higher processing rate, up to 350m^3/h will be used via multiple 100mm pipes within the bundle. The feed, product and reject pipe connections will need to be reinstalled. Other changes to the main feed pipe will be needed. The emulsion binder will need to be produced at a rate sufficient to support the larger scale of work. There have been multiple preliminary reviews of the proposed work to ensure the site meets safety requirements. A further formal safety review will follow before proceeding to the final phase of the study.

C34040
Optimising the Diesel Droplet Size in Coal Preparation Plants

University of Queensland
Yongjun Peng

Value:	$231,157
Report Expected:	July 2025
Industry Monitor/s:	Chris Denyer Han Hooi Jason Schumacher
ACARP Contact:	Ben Gill

The objectives of this project are to:

- Develop full-scale emulsification systems incorporating the online droplet size measurement;
- Determine the optimal diesel droplet sizes in representative coal preparation plants varying with coal type, water salinity and diesel dosing through statistically designed ON/OFF trials;
- Identify the most efficient and economic diesel dispersion system to achieve each optimal droplet size; and to

- Develop the most suitable diesel dispersion strategy for each representative plant through an assessment of flotation improvement, reduction of diesel consumption, hurdles to implementation (e.g. safety, ease of installation and conversion, ease of operation) and capital and operating costs.

During this quarter, the research team successfully completed the analysis of samples collected from the trials at Mine Site 1. Results demonstrate that ultrasound-assisted diesel emulsification increased combustible recovery by approximately 1–2%, without requiring additional diesel input. This enhancement is attributed to the formation of finer diesel droplets, which promote improved dispersion and interaction during flotation. Importantly, the trials also revealed that a 20% reduction in diesel dosage had no significant impact on combustible recovery when emulsification was applied. This finding underscores a key operational advantage—emulsification technology offers a clear pathway to reduce diesel consumption while maintaining flotation efficiency, with potential cost and sustainability benefits for large-scale operations.

Preparations are underway for the next phase of testing at Mine Site 2, which features contrasting process conditions including low-rank coal, low-salinity process water, and higher baseline diesel usage. These plant-scale trials are designed to evaluate the interactive effects of coal properties, water chemistry, and diesel dosing on emulsification performance, with the goal of refining site-specific implementation strategies. Site compliance for the ultrasound equipment has been completed, and the trial campaign will commence following delivery and installation. These upcoming trials are expected to provide critical data to support broader industrial adoption of physically emulsified diesel in flotation circuits.

C34043
In Plant Demonstration of the Next Generation Flotation System

University of Queensland
Liguang Wang

Value:	$258,347
Report Expected:	July 2025
Industry Monitor/s:	Elie Bassil Nic Roberts
ACARP Contact:	Ben Gill

The objectives of this project are to:
- Build a prototype of the next-generation flotation system with low energy and maintenance requirements for coal preparation;
- Demonstrate the prototype in a coal prep plant.

The prototype system comprising a 40cm diameter column and auxiliary parts is now ready for the site trial. In the following quarter, the site work is expected to commence at the participating site.

C34045
Real Time Automatic Measurement of Frother Distribution in a Coal Preparation Plant

University of Queensland
Liguang Wang

Value:	$124,560
Report Expected:	July 2025
Industry Monitor/s:	Chris Denyer Peter Shumack
ACARP Contact:	Ben Gill

The objectives of this project are to:
- Build a prototype for real-time automatic measurement of frother concentration; and to
- Evaluate and demonstrate the prototype at a participating site to maximise coal recovery and prevent the overfrothing ('froth out') problem.

During this quarter, the formulation was further refined by adjusting the concentration of key ingredients, resulting in a significantly improved flash point of 93 °C (from the original 46 °C). As liquids with a flash point of 93 °C or below are classified as flammable, further adjustments were made to the blending ratio to ensure the updated formulation is not classified as flammable, without compromising MIBC detection sensitivity. The updated formulation and the cleaning solution have been sent to a specialist laboratory for precise flash point measurements to confirm the prototype unit does not hold any flammable liquids, thereby enhancing operational safety.

Fine-tuning of the prototype unit was still in progress. While several minor issues have been resolved and the current system can automatically detect MIBC concentration in the sample, it achieves a lower MIBC concentration detection sensitivity than that of a manual procedure.

In the next quarter, we will finalise testing of the prototype unit and complete all required preparations in accordance with the recommendations from the participating site. This includes developing a pre-start checklist and standard operating procedures to support smooth deployment and operation during the site trial. We anticipate that the trial will commence by the end of the next quarter.

C35024
Froth Flotation Predicted v Actual Definition

McMahon Coal Quality Resources
Chris McMahon

Value:	$41,360
Report Expected:	May 2025
Industry Monitor/s:	Jason Schumacher Jenny Goh Mel Robbins
ACARP Contact:	Patrick Tyrrell

The draft final report has been submitted to the Industry Monitors for review.

C35031
Demonstrating Better Classifying Cyclones

Elsa Consulting Group
Andrew Swanson
Andrew Vince

Value:	$377,475
Report Expected:	April 2026
Industry Monitor/s:	Clinton Vanderkruk Jack Lauder Jenny Park Jimmy Pollack
ACARP Contact:	Ben Gill

The overall objective of this project is to leverage off the significant past ACARP research on better classifying cyclones, to build and demonstrate the industrial benefits of the new Flat bottomed Classifying Cyclone Concept (FBCCC) at an appropriate scale, namely 380mm diameter cyclone. Specifically, coal-independent performance efficiencies will be determined using: 1) Size separation partition curves and related characteristic parameters α, d50 and Rf; 2) Size-by-size Tromp curves and related characteristic parameters d50 and Ep. These will then be used as benchmarks to compare against such curves generated by existing technologies.

The first stage was to determine how small-detail FBCCC design adjustments impact on capacity/pressure/metallurgical performance characteristics prior to unit construction and testing. Western Sydney University (Centre for Infrastructure Engineering, School of Engineering) has developed a discrete element model (DEM), and the results of using said model suggest that unexpectedly high alpha values may be expected. These simulations were used to identify dimensions for a 380mm unit that was designed and built, as well as its capacity.

Initially it was thought there would be a need for extensive, and expensive, fine coal float/sink work to be included in the project. However, given the surprisingly good alpha values from simulation work, it has been concluded that more modest testing will satisfactorily demonstrate the new design of 380mm unit. If the alpha values are confirmed to be high, supported by sizing and some conventional float/sink work, then the demonstration is complete. The simulations also indicated that low Rf values are possible.

The nature of the demonstration trials and the resultant sample testing have been extensively discussed with our project monitors and the originally proposed and budgeted analytical procedures are being followed. The initial pilot run was aborted because of an equipment malfunction. The second set of trials commenced on 13 November 2024 with the Industry Monitors and other interested parties in attendance.

Some laboratory analyses results of the samples collected from that test campaign have been received, with more expected later in the year. The project is on schedule and budget.

C35034
Working Effectively with Swelling Clays in Fine Coal Flotation to Improve Product Quality and Recovery

University of Queensland
Anh Nguyen
Ngoc Nguyen

Value:	$200,304
Report Expected:	June 2025
Industry Monitor/s:	Ed Provan Jack Lauder Jason Schumacher Luke Dimech
ACARP Contact:	Ben Gill

The project objective is to investigate effective measures (clay suppressants and wash water) to reduce ash (clay) content and increase recovery of fine coal flotation. Specific aims include:

- Characterise clay types and compositions in coal flotation feed, clay-coal liberation, and surface properties;
- Screen (design) and test clay suppressants to remove clay slime coatings;
- Design and conduct experiments to evaluate the effect of wash water hydrodynamics on reducing clay entrainment; and
- Conduct experiments using mechanical cell, Microcel, and Jameson cell for evaluating and benchmarking effective of clay and ash removals.

The ultimate goal is to deliver higher-quality products and opportunities to increase overall plant recovery by avoiding high ash/clay entrainment.

In this quarter we have completed all flotation tests to evaluate the effectiveness of different clay depressants for coal flotation feed samples from agreed (three) mines. The results were discussed at a review meeting in February this year. The Industry Monitors appreciated

the results and agreed that the test work had been adequate to conclude the project. We are developing the final report and will submit it in the next quarter.

C35035
3D Particle Surface Composition Analysis for Flotation Using Micro-CT

University of Newcastle
Rohan Stanger

Value:	$81,730
Report Expected:	July 2025
Industry Monitor/s:	Araz Ejtemaei
ACARP Contact:	Ben Gill

This project aims to characterise a suite of plant flotation samples using micro-CT surface analysis. The technique involves determining the composition (vitrinite, inertinite, mineral content) at each particles surface interface. The project will focus on +38um material for this technique development to suit this micro-CT instrument resolution.

Work in the last quarter has revolved around resolving instrument issues with the Micro-CT software. Specific to this project is sudden loss of communications with the instrument, which appears to result in a shift to the greyscale intensity in the next couple of scans. We believe this impacts the measurement of vitrinite and inertinite.

The manufacturer has provided an updated software version and a communication checklist to work through. Realistically, this delay has shifted the final report back to the next quarter.

C36026
Side-by-Side Analysis of Coal by Automated Micro-CT and Commercial Laboratory Testing

University of Newcastle
Rohan Stanger

Value:	$167,432
Report Expected:	June 2025
Industry Monitor/s:	Mel Robbins Michael Saxby Tom Wilson
ACARP Contact:	Ben Gill

This project aims to trial an automated sample carousel for a laboratory micro-CT instrument and compare data with standard testing for float/sink and petrographic analysis. The intention is to determine the speed and accuracy of micro-CT derived coal tests. If successful, it will provide an automated 3D analytical test method with faster turn-around times and potentially lower costs. This automation trial will develop the workflows needed to test the automated scanning, image reconstruction, particle recognition and analysis.

In this quarter, we have observed communication issues with the micro-CT that have affected this project. We have resolved issues in the automation process (carousel and robot arm). The current communications issues appears to be software related. Specific to this project is sudden inability to conduct “stitched” scans comprising of multiple overlapping scans. This was the current focus of the project and is related to taking larger scan volumes for 1-2mm particle sizes.

The manufacturer has provided an updated software version and a communication checklist to work through. Realistically, this delay has shifted the final report back to the next quarter.

C36029
Testing a Novel Flotation Concept for Coal

CSIRO
Nerrida Scott

Value:	$88,204
Report Expected:	September 2025
Industry Monitor/s:	Frank Mercuri Jenny Goh Michael Saxby
ACARP Contact:	Ben Gill

This project has involved the testing of a new prototype flotation rig as a proof of concept. A number of samples have been trialled so far and early indications are that the samples tested so far are floating some inertinites and some coarse coal, with acceptable ash quality for a concentrate stream, however further work on more samples, and including Denver Tree Flotation tests need to be done in order to provide a direct comparison.

The next stage of work will involve looking at some additional samples from mine sites in a range of sizes and running side-by-side Denver and novel flotation rig tests followed by a Denver Tree test. Previous results have indicated via Coal Grain Analysis, that the cell is able to recover reasonable concentrate ash quality with some retention of inertinites and coarse material in the concentrate. The next phase of research will trial the unit as a second stage cell for comparison to the original single stage configuration. We are hoping to obtain additional samples to run more extensive tests in the near future.

The outcomes of this project will be a test report on the prototype in relation to its performance relative to a laboratory Denver cell. The report will assess the viability of this experimental design with a view to eventually scaling up. Consideration will be given to the ability to recover more inertinites and coarser particles as well as assessing general flotation recovery.

Gravity Separation

C34048
Using Clay Stabilised Medium for the Separation of Small Coal in a Dense Medium Cyclone

CSIRO
Andrew Taylor
Nerrida Scott

Value:	$204,432
Report Expected:	June 2025
Industry Monitor/s:	Chris Denyer Frank Mercuri
ACARP Contact:	Ben Gill

This project involved establishing a comparison between small coal run through a DMC, spiral and a hydrocyclone for the same coal type. Care was taken to ensure that the relative % non-magnetics in the sample was held consistent in the samples.

The objective was to demonstrate to industry the option of processing small coal, (-2.0mm +0.1mm) in a Dense Medium Cyclone with good cut point control, magnetite recovery and comparative efficiency when compared to spirals and hydrocyclone.

We are now in the final stage of the work program. All test runs have now been completed and processing of samples is underway.

A report is being prepared concurrently and will be issued once final results are received.

C36024
DMC Efficiency Improvement Using an Applied Magnetic Field

University of Queensland
Quentin Campbell

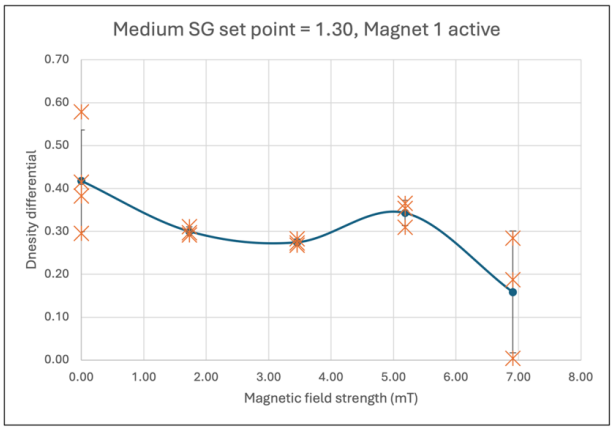
Value:	$205,050
Report Expected:	November 2025
Industry Monitor/s:	Araz Ejtemaei Frank Mercuri Jack Lauder
ACARP Contact:	Ben Gill

Prior research has demonstrated that the application of a magnetic field to a Dense Medium Cyclone (DMC) system can effectively reduce the density cut-point, enhance separation sharpness, and increase product yield—all key objectives for Australian coal producers. The current project is designed to evaluate the economic and performance advantages of incorporating a magnetic field into a pilot-scale DMC process utilising a magnetite medium.

Expected benefits:

- Lower Density Cut-Points: The project aims to achieve lower ash content in the final product while maintaining or improving the overall yield;
- Improved Separation Sharpness: The integration of a magnetic field is expected to provide enhanced control over the separation process, leading to improved yield;
- Cost Efficiency: The potential utilisation of coarser magnetite is anticipated to result in reduced magnetite losses and a lower viscosity medium, thereby offsetting the stability challenges typically associated with coarser media.

Progress during the quarter:
Following the completion of water and magnetite commissioning, baseline testing commenced on the small Multotec (South Africa) pilot rig. Initial results obtained at a low medium feed specific gravity of approximately 1.28 have been very encouraging (see figure). Evaluation of the effect of the applied magnetic field on the density differential (as an indicator of cyclone efficiency), demonstrates that the magnetic field significantly stabilises an inherently unstable cyclone operation. The density differential exhibited a decrease with increasing magnetic field strength up to a certain threshold, beyond which more instability was observed, likely attributed to the collapse of the air core.



The findings to date indicate the following:

- The application of a magnetic field can stabilise the operation of an otherwise unstable Dense Medium Separation cyclone;
- An optimal magnetic field strength exists for achieving the highest performance.

Future work will involve investigating cyclone performance at higher medium specific gravities. Subsequently, the identified optimal operating conditions will be employed in a series of radiometric tracer tests to quantitatively determine the density cut-points and Ep values.

The manufacturing of the large, redesigned Multotec DMC plant has been completed, and the unit is currently being shipped to Australia. Upon arrival, the rig will be assembled, installed at the Julius Kruttschnitt Mineral Research Centre, and commissioned.

C36030
Measurement of DMC Wear using 3D Laser Technology

CSIRO
Andrew Taylor
Nerrida Scott

Value:	$175,422
Report Expected:	December 2025
Industry Monitor/s:	Dan Perkins Luke Winkelman
ACARP Contact:	Ben Gill

This project aims to scan the internal dimensions of a dense medium cyclone over its wear life. In the previous project, numerous scanners were trialled, proving the concept. Technology has moved forward from the original work and new scanners have been sourced. The intention of this project is to measure the internal wear of DMCs in a real plant situation over the course of their entire service and to link this information to the DMC operational performance as measured by the plant. The combination of off-the-shelf laser technology with CSIRO software enhancements will be used to digitally map DMC internal wear in a plant situation.

The researchers have engaged with a DMC supplier to support this work and a trip is planned to their manufacturing facility in early June to trial the scanner in a DMC. Once satisfied that this technique is successful, the mine site trials will be able to commence. A record of the measured wear of a DMC over the life of a cyclone will be mapped and linked to the performance of that DMC over time. Use of this new instrument will remove the need to enter the confined space of the DMC to take measurements.

C37008
Banana Screen Capacity and Efficiency

CTE Coal
Chris Thornton

Value:	$199,830
Report Expected:	July 2025
Industry Monitor/s:	Dan Delahunty Jenny Park
ACARP Contact:	Ben Gill

The objectives of this project are to:
- Develop accurate drainage rates for static screen panels for different apertures and material characteristics; and to
- Develop an accurate operating window for banana screens.

The screen test rig at QCAT was inspected by the team to ensure the test rig was still fit for purpose. After reviewing the test rig the testing program was defined and discussions were held with the various vendors to prepare for the testing program that is locked in for the week of the 12th of May. The current schedule has 12 May locked in to determine the drainage rates for water only across the screen. Solids testing (i.e. bed depth and particle diameter) is planned to be tested in mid-June.

Process Control

C34044
Real Time Monitoring and Control of Froth Flotation

University of Queensland
Liguang Wang

Value:	$262,437
Report Expected:	August 2025
Industry Monitor/s:	Chris Denyer Chris Huth Josh Kowalczuk Rick Jeuken
ACARP Contact:	Ben Gill

The objectives of this project are to:
- Further evaluate and demonstrate a simple, cheap and fast sensor for monitoring the efficiency of multiple flotation cells; and to
- Develop remote control strategies corresponding to the sub-optimal operation identified by the sensor.

During this quarter, we started building four units of the upgraded drag sensor and their holders. The new design features a new set of transducers and a redesigned paddle to improve measurement robustness and sensitivity while minimising signal drift. In parallel, we are upgrading the associated electronic cabinet to ensure reliable operation under harsh weather conditions with minimal supervision.

We conducted a site visit to discuss the upcoming site trial and finalised the experimental plan. Potential installation locations were identified, and the experimental plans was shared with site personnel. We also reviewed the previously identified issues related to the machine vision system installed on-site to ensure proper integration and data collection during the trial.

The site trial is expected to commence in the next quarter, pending the completion of the construction of the drag sensor units.

C34052
Simulation Enabled Digital Twin for the Control, Design and Optimisation of a Teeter Bed Separator

University of Queensland
Kym Runge

Value:	$232,531
Report Expected:	July 2025
Industry Monitor/s:	Chris Denyer Chris Jackson
ACARP Contact:	Ben Gill

Up to a fifth of in-plant material in Queensland metallurgical coal preparation plants is too fine to be efficiently upgraded using a dense medium cyclone and too coarse to be separated using froth flotation. This middling fraction (typically -2+0.35mm) is processed using hydraulic classifiers, such as teeter bed separators. In this project, researchers will use a combined experimental and simulation-based approach to develop a computational model that can be used as the basis of a performance-maximising advanced control strategy for the teeter bed separator (TBS).

The scope of work included site surveys of full-scale TBS units, laboratory fluidisation test work, regression modelling of site survey data and development and validation of a CFD model.

All the site work for this project has been completed, involving 80 surveys of industrial TBS units at two coal processing plants. These surveys were performed of three different designs of TBS fed six different feed types at two different coal processing plants operated under different operating conditions. Feed samples were also collected during the campaign and transported to the JKMRC where they were subjected to fluidisation and washability analysis. As previously reported, all CFD models have been developed and are ready for validation using survey data.

During the last quarter, data from the survey work was received and mass balancing and regression analysis is underway to determine drivers of TBS performance. CFD simulations have been commenced using the feed washability data, with the results to be compared to the full-scale TBS data and laboratory fluidisation tests to validate the CFD methodology.

Final reporting is planned to be completed by July 2025.

TECHNICAL MARKET SUPPORT

Reports Published This Quarter

C34063
International Round Robin for Coke Reactivity Index, Coke Strength after Reaction and I600
CSIRO
Lauren Williamson
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C34063

C35039
Impact of Coal Grain Composition and Macerals Association on Fluidity Development in the Plastic Layer of Australian Coals
University of Newcastle
Arash Tahmasebi
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C35039

C35045
Impacts of Chemical Structure Transformation in the Plastic Layer on the Microtexture Development during Coking
Royal Melbourne Institute of Technology
Soonho Lee
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C35045

C36004
Physical and Chemical Structure Characterisation of Biomass for Biocoke Production
University of Newcastle
Arash Tahmasebi
Link to download the final report:
https://www.acarp.com.au/abstracts.aspx?repId=C36004

Metallurgical Coal

C35038
Microalgae Blending for Low Carbon Metallurgical Coke Production

University of Newcastle
Arash Tahmasebi

Value:	$172,000
Report Expected:	May 2025
Industry Monitor/s:	Nick Andriopoulos Stephen Brant
ACARP Contact:	Ashley Conroy

This project aims to evaluate the impact of microalgae blending on the coking behaviour, coke properties, and coke gasification performance of selected Australian coals to determine the tolerable microalgae addition level and carrying capacity of Australian coals. Specific objectives are to:

- Analyse the influence of microalgae on the thermoplastic and thermal decomposition behaviour of Australian coals;
- Evaluate the coking behaviour and pressure generation of coal/microalgae blends at different addition levels;
- Determine the optimal microalgae addition rate and study the carrying capacity of Australian coals in blend with microalgae from coke property analysis;
- Evaluate the impact of microalgae on coke microstructure and microtexture and coke quality indices;
- Explore the fate of alkali species during the coking process; and to
- Evaluate high-temperature reactivity of bio-cokes.

Progress in the quarter:

- All experimental and analysis work in the project is complete; and
- Drafting of the final report is underway for submission to the project monitors in May.

C35040
Changes in Combustibility of Coal when Co-Combusted with Hydrogen Rich Fuels in PCI

University of Newcastle
Liza Elliott

Value:	$218,367
Report Expected:	December 2025
Industry Monitor/s:	Cameron Tasker Caroline Lang James Bottle Oliver Scholes
ACARP Contact:	Ashley Conroy

With the steel industry under pressure to reduce CO_2 emissions, there are several possible changes to the steelmaking process that could be adopted. The first and easiest step in improving sustainability is the introduction of a material with high hydrogen content via tuyere injection. This injectant could be coke oven gas, waste plastics, biomass materials or hydrogen and hydrogen containing gases. However, as most of these materials have lower coke replacement ratios, most steelmakers will be looking to introduce these fuels along with coal. It is unclear, however, what the impact of co-combustion has on the possible injection rate.

This project aims to determine the impact on coal reactivity of co-combustion of hydrogen rich fuels: biomass, plastics, coke ovens gas, ammonia, and hydrogen. Two techniques will be used: the combustibility of solid fuels will be assessed using the Drop Tube Furnace technique developed in project C19049, that compares the combustion behaviour of coals in a set standard condition. Then a TGA (Thermo-Gravimetric Analyser) will be used to measure the reactivity of these materials individually and when co-

combusted with coal. This will show changes in behaviour expected due to reduction of oxygen concentrations caused by the consumption of the hydrogen rich fuel.

Drop Tube Furnace tests and TGA analysis are all underway. Significant issues with the drop tube furnace are ongoing and rectification has been difficult. A new furnace has been ordered to replace the existing Drop Tube Furnace, with delivery expected soon.

The TGA was found to be unsuitable for reactions containing H2 as the reaction is expected to occur away from the sample pan. An alternate methodology has been developed, safety approvals have been obtained, and initial experiments are underway.

The TGA to be used for ammonia containing reactions has had a catastrophic failure of the furnace. A replacement has been obtained and safety approvals are complete. One of the requirements of the safety approval is a replacement mass flow controller, which has been ordered.

C35041
Effect from the Co-Combustion of Coal and Biomass on Production of Fine Particles (<PM10)

University of Newcastle
Liza Elliott

Value:	$228,531
Report Expected:	August 2025
Industry Monitor/s:	Cameron Tasker Caroline Lang Oliver Scholes
ACARP Contact:	Ashley Conroy

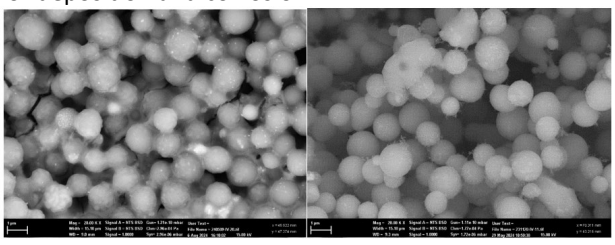
Many power stations are looking to reduce their CO_2 emissions with the addition of biomass to the feed coal for combustion. Biomass is an overarching term to describe organic material derived from plants and is considered CO_2 neutral as the CO_2 emitted during combustion is equivalent to the CO_2 absorbed during the plant's growth. However, biomass generally has much higher contents of Na and K than coal, and these elements are associated with the organic structure of the plant. In bituminous coals these elements are generally associated with minerals that may be liberated during milling. The proximity of the alkalis to carbon increases the chance of vaporisation during combustion.

A recent project, C29075, has shown that the proportion of PM10 particles produced during combustion of relatively refractory ashes is much higher than expected. When co-combusted with biomass, the PM10 produced would be expected to increase dramatically as the alkalis associated with the biomass would be expected to report predominantly to the fine particle fraction of the particle size distribution, though a high ash load associated with the coal ash may limit this. It is unresolved where other species within the biomass would report. The source of PM10 from co-combustion materials must be understood if the value of coal is not to be undermined.

This project aims to assess the scope of fine particle emissions produced during combustion of biomass and the interactions expected between biomass and coal when these fine particles are forming during co-combustion.

TIMA analysis of the coal is complete, as is chemical fractionation of the biomass samples. All combustion test work and SEM EDS analysis for chemistry of the resulting particles is complete. The presence of a significant proportion of carbon in ash in many of the samples has made it difficult to obtain an accurate particle size distribution of the particles. These samples will need to be ashed in a low temperature asher to ensure accuracy of the resulting particle size distributions.

Some of the collected particles during the co-combustion of coal and biomass, particularly samples collected on tray IV of the cascade impactor are covered in a coating that appears to have glued the collected particles together. Figure 1 show SEM micrographs of the particles collected on tray IV when coal and hardwood are co-combusted, compared to the particle collected during coal only combustion. This sticky coating has implications for deposition and corrosion.



A) B)

Figure 1: The particles collected on Tray IV of A, coal and hardwood and of B, coal only.

Figure 2 shows the particle size distribution from the cascade impactor trays for co-combustion of coal and hardwood. While these particles are all below 10 μm, as the proportion of hardwood increases, the ultrafine particles increase in size. This is a reflection of the coatings observed during co-combustion.

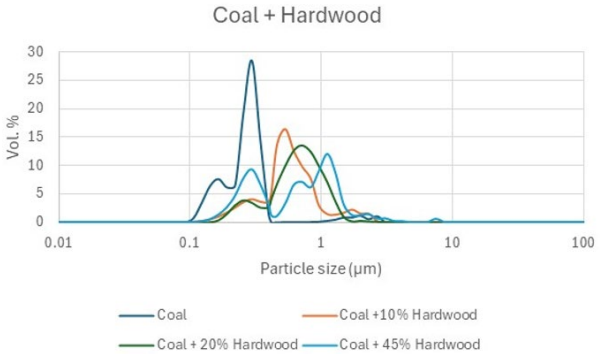


Figure 2: The particle size of particles collected in the cascade impactor for combustion of coal and coal + hardwood blends.

C35042
Physical and Chemical Interactions Between Charcoal and Coal During Coking

University of Queensland
Karen Steel

Value:	$135,694
Report Expected:	June 2025
Industry Monitor/s:	Graeme Harris Morgan Blake
ACARP Contact:	Ashley Conroy

This project addresses the demand from cokemakers to add high proportions of biomass to cokemaking blends whilst not compromising on coke strength. It has been recognised for some time that addition of biomass decreases coke performance in terms of both CSR and CRI. One of the major adverse effects is reduced fluidity. It has been established that converting biomass to charcoal at high temperature (800°C) in the first instance reduces the adverse effect. Given that oxygen content decreases as charring temperature increases, it is strongly suspected that high temperatures are preferred due to the loss of oxygen from the char; oxygen is already well known to decrease fluidity through condensation reactions.

This project investigates the blending of biomass with high fluidity coals to deliberately interact with biomass at low temperature, thereby mitigating the adverse effects caused by biomass and preserving the function of the prime coking coal. The project involves studying three high fluidity coals, three biomass types (sugar cane bagasse, bamboo, and Jarrah), and two coking coals.

Work within this review period focused on completing the second round of larger scale test work and finalising the final report. We have prepared the cokes and are carrying out the CSR and CRI test work.

The final report is complete except for the final CSR and CRI results. The final report is due by end of June however we expect to deliver it before then.

C35043
Abrasion Resistance of Coke Under Hydrogen Reduction Blast Furnace Conditions

University of Newcastle
Hannah Lomas

Value:	$159,416
Report Expected:	May 2025
Industry Monitor/s:	Nick Andriopoulos Oliver Scholes Stephen Brant
ACARP Contact:	Ashley Conroy

The draft final report has been submitted to the Industry Monitors for review.

C35044
What We Now Know about Coking Coals and Coke

CSIRO
Lauren Williamson

Value:	$96,284
Report Expected:	June 2025
Industry Monitor/s:	Lauren North Morgan Blake
ACARP Contact:	Ashley Conroy

The main objectives of this project are to:

- Integrate the findings from projects completed since 2014, with other, primarily Australian, research into an overall picture of what makes a coke “good” and what is a good coke;
- List new findings that research has established that are useful to industry; and
- Review the effects of adding biomass and hydrogen into the iron making process.

Work on reviewing 56 reports under the metallurgical coal category is complete. The project team is currently finalising the draft project report.

C35046
Gasification Reactivity and Degradation of Coke Lumps Under Simulated Conventional and Oxygen Rich Blast Furnace Processes

University of Newcastle
Apsara Jayasekara

Value:	$98,500
Report Expected:	May 2025
Industry Monitor/s:	Lauren North Nick Andriopoulos
ACARP Contact:	Ashley Conroy

The draft final report has been submitted to the Industry Monitors for review.

C36031
Structural Optimisation and Reactivity Evaluation of Ferro Coke Produced using Australian Coals

University of Newcastle
Arash Tahmasebi

Value:	$167,000
Report Expected:	November 2025
Industry Monitor/s:	Cameron Tasker Graeme Harris Nick Andriopoulos Stephen Brant
ACARP Contact:	Ashley Conroy

The project aims to examine the suitability of Australian coals for ferro-coke production and to develop a new

understanding of the mechanism of microstructure formation and reactivity of ferro-coke. Specific objectives are to:

- Evaluate the coal properties and blend strategies suitable for ferro-coke production;
- Explore the use of high-fluidity Australian coal as a binder during ferro-coke decarbonisation;
- Analyse the impact of iron ore addition level on thermal decomposition behaviour and thermoplasticity development in coal blends;
- Evaluate the impact of iron ore on microstructure development during the carbonisation of ferro-coke;
- Improve the understanding of factors underpinning the reactivity of ferro-coke under simulated blast furnace reaction conditions;
- Identify the governing factors driving the strength and reactivity of ferro-coke.

Progress in the quarter:

- A total of 25 ferro-coke samples (each with four repeats) were prepared with varying ferrous (iron ore and DRI) and binder (coal tar pitch and high fluidity coal) contents;
- The 3D microstructure of the ferro-coke samples was analysed using CT images obtained in the Synchrotron, and the results were correlated with tensile strength;
- TGA tests on pelletised blends were also conducted to study the reduction behaviour of iron ore during carbonisation;
- Results showed that DRI outperformed iron ore as the ferrous feed in ferro-coke due to lower adverse impact on blend fluidity and bonding mechanism; and
- Current progress was presented to project monitors in March.

Next quarter will involve microtexture characterisation and TGA gasification testing of ferro-coke samples.

C36032
Impact of Biomass on Coke Microstructure Evolution and Gas Diffusion During CO2 Gasification

University of Newcastle
Arash Tahmasebi

Value:	$169,000
Report Expected:	April 2026
Industry Monitor/s:	Graeme Harris Lauren North Morgan Blake Nick Andriopoulos Sean Flanagan Shaun Booth
ACARP Contact:	Ashley Conroy

The proposed project investigates the impact of biomass on coke reactivity and microstructure evolution during CO_2 gasification. Specific objectives are to:

- Study the impact of biomass species and pre-treatment method on the mechanism of reactivity of biochar;
- Compare gas diffusion in biocoke microstructure with the progression of gasification using a developed reaction-diffusion mode;
- Investigate the changes in biocoke microstructural evolution and structural degradation during gasification;
- Develop new mechanistic understanding of biocoke gasification, i.e., volumetric vs. diffusion-controlled gasification;
- Determine the degree to which biomass pretreatment influences biocoke degradation;
- Investigate the Onset as a means of benchmarking biocoke reactivity with conventional coke.

Progress during the quarter:

- Three RCO coke samples, one base coke and two biocokes incorporating 10% biochar, were received;
- Samples were cored into cylinder lumps;
- Micro-CT imaging of the unreacted samples is currently underway.

Next quarter involved image analysis of unreacted samples and preparation of partially gasified cokes in TGA. This will be followed by CT imaging of the reacted cokes and image registration analysis.

C36034
Sugar Coated Coal: Determining if Glucose Addition Can Improve Coke Quality of Coal-Biomass Blends

ACIRL
Callum Mainstone

Value:	$111,622
Report Expected:	June 2025
Industry Monitor/s:	Caroline Lang Graeme Harris Lauren North Morgan Blake Nick Andriopoulos Sean Flanagan Shaun Booth
ACARP Contact:	Ashley Conroy

Including biomass in coal blends for coke production is a preferred method to achieve reduced carbon emissions, as changes to key metallurgical infrastructure are not required. However, adding plant dry matter biomass to coke reduces its quality, even in low concentrations. Adding glucose to other forms of biomass such as lignin prior to blending with coal may result in improved coke strength. Glucose can be sourced from agricultural, textile and forestry waste that does not compete with food production for land or water. This project will conduct a series of coking trials to determine the effectiveness of using glucose to contribute bio-carbon to coking coal blends and the potential to enable higher ash coals to be utilised.

A draft final report is being prepared for submission to the Industry Monitors for review.

C36035
Microstructure Characterisation and Simulation of Bio-additives in Coke

University of Newcastle
David Jenkins
Edward Bissaker

Value:	$114,200
Report Expected:	April 2026
Industry Monitor/s:	Graeme Harris Lauren North Morgan Blake Nick Andriopoulos Sean Flanagan Shaun Booth
ACARP Contact:	Ashley Conroy

Project objectives are to:
- Develop a capability, based on statistical characterisation of coke microstructures, to relate the properties of bio-additives in coke to the mechanical properties of coke (i.e. coke strength);
- Use the capability to identify the specific properties of bio-additives that affect coke strength; and to
- Investigate the range of possible microstructures that could be created using bio-additives to optimise the coke strength, for specified bio-additive demand (e.g. mass fraction added).

Project progress during the quarter:
- A subset of bio-coke samples for analysis has been received, and the remaining samples will be available in the next quarter;
- Testing of coke core sizes for analysis and suitable micro-CT reconstruction parameters has commenced;
- Previously developed microstructure analysis algorithms are being re-configured for biocoke sample analysis;
- Literature review underway;
- Imaging of samples scheduled for the next quarter.

C36036
Biochar-Coke Integration for Improved Coke Strength and Performance

University of New South Wales
Pramod Koshy

Value:	$244,400
Report Expected:	January 2026
Industry Monitor/s:	Graeme Harris Lauren North Morgan Blake Nick Andriopoulos Sean Flanagan Shaun Booth
ACARP Contact:	Ashley Conroy

This project is focussed on understanding the impact of higher biochar addition levels and coal type on the quality of the resultant cokes for ironmaking. This project is part of a suite of concurrent projects which investigate different key aspects related to the addition of biochar to coals. The aims of the project are as follows:
- Understand the impact of biomass addition (5-20 wt%, possibly 25-30 wt%) to coals (with varying vitrinite contents) on the resultant macrostructural, microstructural, and microtextural features of the cokes;
- Analyse the physical, microstructural, and interfacial features of the biochar-coal components in blended cokes through fractography and microtextural analysis after mechanical testing; and
- Develop associations between biomass addition levels with coal type and coke performance under potential blast furnace conditions using standard coke quality indicators.

Two base cokes were fabricated and sent to UNSW. These have been cored and gasified. Discussions on blend compositions and biomass additions are still to take place as the start meeting for the project has not been organised.

C36037
Exploring the Effects of Bio-char and Torrefied Biomass Addition on the Microtexture of Bio-coke

Royal Melbourne Institute of Technology
Soonho Lee

Value:	$155,000
Report Expected:	April 2026
Industry Monitor/s:	Graeme Harris Lauren North Morgan Blake Nick Andriopoulos Sean Flanagan Shaun Booth
ACARP Contact:	Ashley Conroy

This project aims to investigate the chemical interactions between bio-char/torrefied biomass and coal macerals

within bio-coke microstructures using Pearson's anisotropy quotient (AQ) colour-coded bireflectance mapping technique. A secondary objective is to develop a code-based image analysis method to quantify the microtexture compositions surrounding biomass particles and assess their microtextural interactions.

During this quarter, two coals, premium coking coal and semi-hard coal, with different vitrinite contents (~60% and ~75%) and fluidity, but similar coal rank (~1.2% MMVR), were blended with bamboo and acacia char at a 10% ratio. These single coals and blends were carbonised in a 400 kg pilot-scale recovery coke oven (RCO) at QCAT, CSIRO. CSR-sized lump coke samples were produced for each bio-coke and sent to Pearson Coal Petrography for AQ mapping. Two coke-sized lumps per sample were embedded in resin, cross-sectioned, and polished for bireflectance scanning. A total of four CSR lumps (two resin blocks per sample) were prepared: base cokes for premium and semi-hard coals, and bio-cokes from blends of bamboo char–premium coal and acacia char–premium coal.

A MATLAB code was successfully developed to quantitatively analyse the microtexture compositions at the interfaces between bio-char particles and reactive maceral-derived components (RMDC). A separate code was also developed to examine the interfaces between inertinite particles and RMDC in the base coke samples.

In the upcoming quarter, remaining samples will be sent for AQ mapping. Multiple regions per CSR lump, including bio-char particles surrounded by RMDC, will be analysed using the developed codes. Through comparative analysis of base cokes and bio-cokes, the effects of biomass type, pre-processing methods and coal properties on microtextural interactions will be examined.

C36038
Effects of Ash Minerals on Coke Reactivity under Hydrogen Injection, Low CO2 Blast Furnace Conditions

University of Wollongong
Ray Longbottom

Value:	$51,290
Report Expected:	July 2025
Industry Monitor/s:	Cameron Tasker Nick Andriopoulos
ACARP Contact:	Ashley Conroy

The primary objective of this project is to quantify the impact of mineralogy on the reactivity of metallurgical coke using a coke analogue at temperatures of 1100°C and higher using H_2 containing gas mixtures.

To assess the mineral effects on coke reactivity with H_2-containing gases, selected cokes and coke analogues containing targeted minerals will be reacted at temperatures from 1100-1600°C under blast furnace conditions representing H_2 injection, low CO_2 operation. These results will then be compared against the reactivity of coke with CO-CO_2 gas mixtures, helping to evaluate the effect of changing from traditional to H_2 injection blast furnace operation on coke performance.

The outcomes from the proposed project will directly improve the understanding of the impacts of hydrogen on coke quality requirements and coke performance in the BF in H_2 injection, low CO_2 operation.

Much of the reactivity testing has been completed. The testing at 1600°C in a 26% CO, 14% H_2, 60% Ar atmosphere showed that Si-rich samples had higher mass losses than Fe-rich samples, in both coke and coke analogue samples. Characterisation of the samples after reaction should give insights into whether this was due to reaction between the gases and carbon, or due to reduction of the Si-rich minerals in the cokes and coke analogue. The final 4-5 reactivity tests at 1350°C and 1100°C will be completed in the next two weeks, and the focus will shift to the characterisation of the samples.

C36039
Alternative Thermal Processing of Coal Pilot Extruded Coke and Supercapacitor Demonstration

University of Newcastle
Rohan Stanger

Value:	$157,178
Report Expected:	July 2025
Industry Monitor/s:	Graeme Harris Lauren North Morgan Blake Nick Andriopoulos Peter Austin Sean Flanagan Shaun Booth
ACARP Contact:	Ashley Conroy

This project aims to conduct pilot trials on our extrusion system to produce a final "annealed" coke product; suitable for CSR evaluation. The project will also continue development of our coal-based supercapacitor to produce a larger proto-type system for energy storage. Specific to the pilot extrusion system, the test work will involve an evaluation of final annealing temperature and the addition of "bio-fluids" to the feed mixtures (as opposed to biomass derived solids like biochar).

This quarter has been focussed on trials with a modified extrusion die. We have also had to wait for alumina tubes to be ordered. During this time, we were granted access to the Australian Synchrotron MCT beam line and conducted high pixel resolution scans (0.325um/px) of the different bio-based carbon feedstocks and extruded products. Our early findings suggest that the biochar retains its internal porosity even through thermal extrusion. This supports our hypothesis that other biomass pretreatment technologies (producing liquid

phases) are likely to provide denser carbons for sustainable coke production.

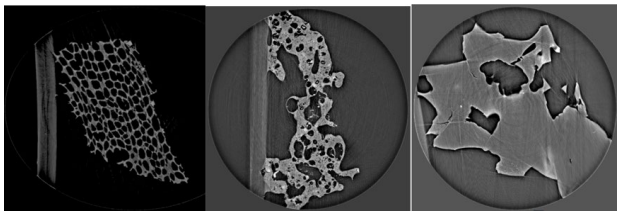


Figure 1. High resolution Synchrotron scans of bio-based carbon feedstocks indicating significant differences in porosity. From left to right samples are biochar, carbonised molasses and carbonised biopitch.

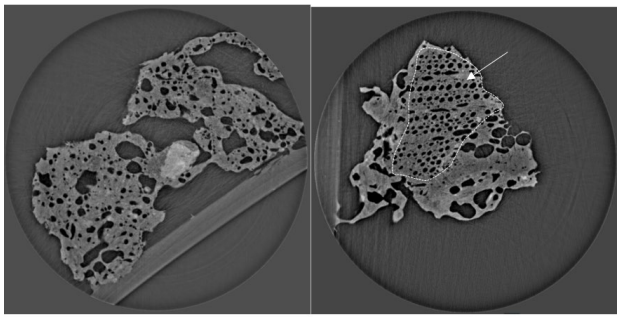


Figure 2. High resolution Synchrotron scans of extruded coke with 100% coal (left) and 80% coal:20% biochar. The biochar segment is clearly identifiable from its structured internal porosity.

C36040
Tracking the Carbonisation Performance of Vitrinite Macerals

University of Queensland
Karen Steel

Value:	$108,664
Report Expected:	June 2025
Industry Monitor/s:	Lauren North
	Oliver Scholes
ACARP Contact:	Ashley Conroy

This project builds on previous research where different vitrinite maceral subgroups were examined before and after pyrolysis/carbonisation using optical microscopy. While the pyrolysis product of collotelinite bands comprised large spherical pores with thin pore walls, the pyrolysis product of collodetrinite was markedly different, comprising smaller pores and thicker pore walls. Given that pore structure influences coke quality indices, knowledge on the specific vitrinite properties that give rise to the best quality coke would be beneficial for cokemakers developing blend formulations.

The objective of this project is to apply the 'before vs after' technique developed by Tara Congo to examine coals of different rank and from different Australian coal measures. Additionally, we aim to characterise molecular structure using XPS and 13C NMR and relate this to the observations made. This work addresses the research priority to relate coke performance to coal property information.

During this quarter we have been studying the behaviour of coals having a higher rank than the first three samples. We have found the expansion behaviour to be different as the rank has increased, and we are also seeing different behaviour between coals of similar rank but from different basins. It appears the differences can't be explained by maceral analysis alone. There is consistency with observations made in previous projects for these coals and we are currently writing up the findings to help set direction. In particular, we plan to see if the molecular characterisation work can help provide new knowledge to explain the observations.

We have had a setback with the project as our rheometer has ceased to operate, and we have needed to replace it with a new instrument. In addition, it has proved difficult to acquire samples from one of the basins that is important for the study. We will continue trying to obtain samples from it; however, we may need to include samples from a different location that is of equal interest.

C36041
Quantifying Biochar Interactions with Coal for Coke Making

CSIRO
Lauren Williamson

Value:	$141,683
Report Expected:	July 2025
Industry Monitor/s:	Graeme Harris
	Lauren North
	Morgan Blake
	Nick Andriopoulos
	Sean Flanagan
	Shaun Booth
ACARP Contact:	Ashley Conroy

The objectives of this project are to:

- Prepare cokes for consistent analysis of different aspects of biomass addition (including coke standard coke quality determinations) for use across a suite of biomass related projects commencing in 2024 and retain material for future projects in the Coal Bank.
- Quantifying the relationship between biomass char surface area, size distribution and their impact on coke properties.

Further biomass is required to complete coke making on a further ten cokes. The most recent advice is that this material will be sent for crushing at ALS prior to being delivered to CSIRO in May. Once this material is available testing of biomass addition of >20 % will be conducted at small scale prior to testing at pilot scale to ensure that coke will be formed and that personnel and equipment will be managed safely.

Thermal Coal

C35005
Feasibility Study, Upgrade and Commissioning of ALS-ACIRL Pilot Scale Combustion Test Facility

ALS Coal
Luke Beattie

Value:	$591,250
Report Expected:	June 2025
Industry Monitor/s:	Caroline Lang Greg Wickman Jane Lawson Oliver Scholes
ACARP Contact:	Ashley Conroy

The overall objective of the project is to upgrade ALS-ACIRL's existing pilot scale coal combustion test facility so that it can more accurately simulate current and emerging coal fired combustion technology.

Stage 1 – Feasibility – Complete
Stage 2 – Upgrade – Complete
Stage 3 – Commissioning – Draft Report expected May.

During February, March and April trial burns of 2 Australian thermal coals were completed under both subcritical and supercritical HELE (High Efficiency, Low Emissions) conditions. Co-firing of a biochar under supercritical HELE conditions was also completed as part of the commissioning.

The draft final report is expected to be delivered soon.

General

C25053
Coal Sample Bank

CSIRO
Aedita Crouch
Lauren Williamson

Value:	$708,271
Report Expected:	February 2028
Industry Monitor/s:	Technical Market Support Committee
ACARP Contact:	Ashley Conroy

The objective of this project is to operate the ACARP Sample Bank to make coal, coke and biomass samples available to researchers and to enhance the systematic provision of the samples for projects funded by ACARP.

To date, 89 coal samples have been delivered, stored at -18°C and their details recorded in a database, there are also 39 cokes, 7 biomasses and 1 fly ash stored. Of the coal samples stored coal quality data has been provided by coal producers for 79 of the samples.

In the quarter three coal samples were provided to project C36040. During 2025 to date 28 samples (coal/coke/biomass) have been provided to projects.

C26003
Management of SA and ISO Coal Technical Committees Work Programs

Carbon Connections Consulting
Barry Isherwood

Value:	$497,750
Report Expected:	December 2026
Industry Monitor/s:	Graeme Harris Lauren North
ACARP Contact:	Anne Mabardi

This project is a continuation of support for the management and input into Australian and ISO Coal Sampling, Coal Preparation and Analysis Standards.

SA Committee MN/1/1 Coal Analysis (mirror to ISO TC27/SC5) held its four monthly hybrid meeting in March, reviewing additional newly released 2025 Systematic Reviews. Many of these have been brought forward so that ballots will be closed and comments may be discussed at the TC27 meeting in November. At the ISO meeting, comments returned on all ballots and SR's over the past two years will be discussed.

A meeting was held with ISO CS and heads of other TC's to discuss progress with implementation of their London Protocol.

The Derogation Request to outlaw certain phrases in Test Reports, such as "unusual observations" and "deviations from the test method" has now been resolved with ISO CS and this exception rule can be applied to all TC 27 Standards.

Most work in the quarter was around the forthcoming TC27 meeting in New Orleans in November, which included:

- Drafting NOM, requirements and discussions with US organisers;
- Assembling previous meeting logistics to assist USA in meeting preparation;
- Researching entry requirements and visas for all countries into the USA, including China;
- Preparation of draft meeting schedule;
- Review of ballot inputs from each P Member country and if meeting ISO obligations;
- Briefing to Australian delegates regarding meeting requirements and funding access; and
- Options for the following TC meeting in 2027 should India not co-operate.

C26037
Australian Participation in Development of ISO Methods for Sampling, Analysis and Coal Preparation and National Technical Committee Support

Standards Australia
Ben Russell

Value:	$448,624
Report Expected:	December 2026
Industry Monitor/s:	Graeme Harris Lauren North
ACARP Contact:	Anne Mabardi

SA support for Australian Mirror Committee—Schedule of meetings.

MN-001 (Coal and Coke)—Mirror Committee for ISO/TC27
Chairman: Barry Isherwood
Last meeting: 8 August 2024 (Online meeting)
Next meeting: 24 July 2025 (Venue: SA Office, Sydney)

MN-001-01 (Coal analysis) —Mirror Committee for ISO/TC27/SC3 and SC5
Chairman: Barry Isherwood
Last meeting: 20 March 2025 (ACPS Office, Newcastle)
Next meeting: 24 July 2025 (SA Office, Sydney)
Meeting objective: Review ISO/TC27/SC5 and SC3 documents including systematic reviews and finalise Australian mirror Committee position on ISO ballot (and comments).

MN-001-02 (Coal Preparation) —Mirror Committee for ISO/TC27/SC1 and SC4
Chairman: Darren Mathewson
Last meeting: 11 March 2025 (ACPS Office, Newcastle)
Next meeting: 12 June 2025 (ACPS Office, Newcastle).
Meeting objective: Review of ISO/TC27/SC1 and SC4 documents including systematic reviews and finalise Australian mirror Committee position on ISO ballot (and comments). Review update on national Standards and projects.

C33065
Digital Petrographic Atlas of Australian Coals - Maintaining the Knowledge

University of Queensland
Joan Esterle

Value:	$197537
Report Expected:	July 2025
Industry Monitor/s:	Graeme Harris Sean Flanagan
ACARP Contact:	Ashley Conroy

This project will create a Digital Petrographic Atlas of Australian Coals, their maceral and mineral composition at different ranks, linked into our current understanding of basin scale variation in rank, type and grade, highlighting case studies that assist with conceptual minescale models for understanding and predicting coal quality variation. In addition to the atlas, a library of scanned petrographic images of product coals from different basins and formations, illustrating the variation in rank, grade and type will be developed. This can be used for reference, training and round robins.

Writing and editing of the final report is in progress and during the quarter we've been working hard on the project outcomes.

MINE SITE GREENHOUSE GAS MITIGATION

C28078
Technical Development Unit (TDU) for Catalytic Conversion of VAM

University of Newcastle
Michael Stockenhuber

Value:	$1,040,592
Report Expected:	July 2025
Industry Monitor/s:	Jim Sandford Russell Thomas
ACARP Contact:	Patrick Tyrrell

No report received.

C33068
Airbag Inspired Explosion Suppression System for Mitigation of VAM Explosions

University of Newcastle
Behdad Moghtaderi

Value:	$583,073
Report Expected:	June 2025
Industry Monitor/s:	David Webb Jim Sandford Russell Thomas
ACARP Contact:	Patrick Tyrrell

No report received.

C35049
Optimisation of Operational Parameters of Catalytic Reactor for the Oxidation of Ventilation Air Methane

University of Newcastle
Michael Stockenhuber

Value:	$238,464
Report Expected:	August 2025
Industry Monitor/s:	Jim Sandford Russell Thomas
ACARP Contact:	Patrick Tyrrell

No report received.

C36007
Assessment of Sensors and Airflow Modelling for their Suitability to Quantify Methane Emissions in Open Cut mines

University of New South Wales
Simit Raval

Value:	$534,880
Report Expected:	March 2026
Industry Monitor/s:	Ben Klaassen Iain Hornshaw Jim Sandford John Grieves Ned Stephenson Sandy Tickell
ACARP Contact:	Patrick Tyrrell

The project aims to establish evidence-based guidelines for the coal industry, covering the selection of sensors, strategies for data capture, and the influence of airflow modelling, leading to the utilisation of machine-learning-based mathematical models to estimate total methane emissions. The project consists of five work packages (WP).

Following a comprehensive review of available sensors and methodologies for methane observation (WP1), a gas-sensing LiDAR system, integrating LiDAR and gas absorption spectroscopy, was selected in WP2 for methane quantification at a controlled release facility.

During the last quarter, under WP3, we have started conducting controlled release experiments across a range of emission rates and variable meteorological conditions (including pressure, temperature, and relative humidity). Quantification results from these experiments are currently being processed.

In parallel, we are developing gas plume simulations using airmass flow models. The outcomes from both the modelling and controlled release experiments will be compared for validation.

Additionally, we are in a process of procuring low-cost metal oxides (MOx) sensors. Future experiments will involve simultaneous measurements using both MOx sensors and the LiDAR-based system. These efforts aim to enhance the model development and calibrations.

C36008
Low Cost Precious Metal Free Honeycomb Monolithic VAM Catalysts and their Catalytic Activity and Stability Under Water and Dust Bearing Conditions

CSIRO
Yonggang Jin

Value:	$352,820
Report Expected:	October 2026
Industry Monitor/s:	Jim Sandford Paul Wild Russell Thomas Victoria Longley
ACARP Contact:	Patrick Tyrrell

The objective of this project is to develop low-cost honeycomb monolithic catalysts (HMCs) based on the high-performance precious-metal-free catalyst material newly developed by CSIRO in project C29069 and evaluate HMCs' catalytic activity and stability with a simulated VAM stream containing water vapour and simulated ventilation air dust. Success of the proposed project is a stepping-stone to progressing the development of low-cost high-performance VAM catalysts for the structured catalytic VAM mitigator.

In the quarter, the project team conducted a ventilation air (VA) shaft dust survey at a coal mine in Queensland. The field study aimed to understand the concentration of VA dust and collect dust samples for further laboratory characterisation. They also optimised the catalyst washcoating process to determine the optimal secondary support and their amounts to enhance mass transfer and catalytic activity of the HMCs. Meanwhile, they investigated the preparation method of the low-cost catalyst to scale up production. Large amounts of low-cost catalyst powder samples will be prepared for studying the washcoating of the low-cost catalyst onto large-size honeycomb monolithic substrates.

C37002
Methane Matters: Updates on Relevant Advances for Coal Mine Emissions

University of New South Wales
Simit Raval

Value:	$161,890
Report Expected:	June 2026
Industry Monitor/s:	Mine Site GHG Mitigation Committee
ACARP Contact:	Patrick Tyrrell

The aim of this project is to monitor advancements in methane emission estimations across three broad categories:

- Sensors for detection, including ground-based, airborne, and satellite-based systems.
- Models for emission estimations, focusing on efforts to reduce associated uncertainties.
- Policy frameworks that influence monitoring protocols.

In the quarter, a system has been developed to methodologically search various relevant sources. Using the available tool and other literature survey methods, we are in advance stages to compile a report on the evaluation of the satellite observations in the context of coal mine emissions.

The project leader has attended and delivered following two presentations in Xuzhou, China.

- Coal Mine Methane Emission Estimates: Bridging Data Gaps to Drive Decarbonisation (2025 China-Australia Summit on Decarbonising the Energy and Resources);
- Comparative Analysis of Satellite-Based Coal Mine Methane Monitoring Techniques, (2025 International Workshop on Methane Observation and Quantification).

The team also (online) attended the EGU 2025 session for methane emissions held in Vienna, Austria.