



Queensland Centre for Advanced Technologies

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A world-class facility

The Queensland Centre for Advanced Technologies is a world class research and development facility for the mining, energy and manufacturing industries. It delivers innovative, industry directed research and technology to the Australian exploration, mining, minerals processing and manufacturing industries.

QCAT is an outstanding example of collaboration between CSIRO, the Queensland State Government, Cooperative Research Centres and universities.

QCAT is home to five CSIRO divisions: Energy Technology, Exploration and Mining, ICT Centre, Manufacturing and Infrastructure Technology, Minerals.

QCAT also hosts the Centre for Low Emission Technology (cLET), CRC for Cast Metals Manufacturing (CAST) and the CRC for Coal in Sustainable Development (CCSD).



Geosciences

Efficient mining activities rely on a comprehensive understanding of geology. Mining geoscience aims to reduce uncertainty related to the minescale geological environment.

QCAT's focus is to improve technologies and systems for understanding geological inputs across the life of mine process to improve safety, reliability and cost effectiveness.

Data analysis

As a global leader in new technologies we have developed both borehole and hand-held

logging instruments and are developing new ways to extract additional data from conventional logging methods. This will enhance predictive abilities, speed up drilling and improve geophysical data.

3D imaging and data processing is allowing fast and accurate mapping and monitoring of mine operations. This can be applied to open pit and underground mining, structural modelling, blast optimisation, drill core profiling and real time input to mining operations.

Sirovision[®] is a high precision imaging technology that supports fast, accurate geotechnical and geological mapping of rock and terrain surfaces in 3D.

A data-mining tool, Self Organising Maps, has been developed aimed at creating new ways to determine relationships between disparate data sets including geological, geochemical, geophysical and airborne.

Mine design and monitoring

Capabilities in rock mass and geotechnical characterisation are being used to assess and predict ground conditions and material behaviour during mining.

Pioneering work in microseismic monitoring for the coal industry is developing a real-time microseismic monitoring system to warn of imminent roof fall.

Ore quality

Prediction of material behaviour during mining, processing and transport is leading to improved liberation and recovery. Although there is a current focus on the coal industry, our knowledge of petrology, fragmentation analysis and handleability is applicable to all commodities.

Industry collaboration

The Rangal Structure Supermodel Project has been completed with the building of a three dimensional visualisation model of the Rangal Coal Measures in Queensland, using information from seam correlations and structure mapping and characterisation. Research continues to improve 2D and 3D seismic data analysis techniques.





The model will radically improve the ability of explorers to target potential deposits and will improve mine planning capabilities.

Coal and Metalliferous Mining

Researchers at QCAT are working to provide applied technology solutions to major issues confronting the coal and metalliferous mining industries in rock cutting, geomechanics, automation, mining systems, mine safety and mine equipment and technology.

Mine systems

Innovative new mining systems are being developed which meet the challenges of more efficient, economic and safer recovery of ores.

Research into Underground Coal Gasification (UCG) is continuing. The process provides the ability to extract hard to reach or low quality coal cheaply and with less environmental impact than other coal mining or utilisation techniques. Coal is burnt underground, generating a gas which is captured at the surface and can be used for synthesis of liquid fuels at costs competitive with current world oil supply.

A non-entry method for hard rock mining called ROES™ is being developed to use a new generation of remote controlled equipment to drill, load explosives and initiate blasts. ROES™ only requires access at the top and base of the mining area which dramatically reduces mine development costs.

Longwall automation

Our world-first system works with existing face equipment to deliver accurate automatic longwall face alignment and horizon control. The system uses an inertial navigation unit to measure the 3D position of the longwall shearer as it moves across the face. Specially developed software provides a realistic 3D visualisation of face equipment conditions that allows control and monitoring of the automated face.

Virtual mine

Our capabilities in visualisation, spatial data integration and web-enabled 3D graphics have delivered a range of technologies. One of these is Virtual Mine. It transforms multi-dimensional data into interactive, web-accessible 3D models. This allows real-time data streams to be monitored and managed using a mine's own intranet to improve access to information and facilitate remote mining.

Mine equipment and technology

From concept development to testing and commercialisation, new and emerging technologies developed at QCAT are solving mining industry problems.

COSFLOW is an integrated simulation software package that couples fluid (gas and water) flow through a porous medium with rock deformation and stress. It is the only product of its kind in the world to simulate ground deformation and water/gas flow. The software was developed by CSIRO in collaboration with the Japan Coal Energy Centre (JCOAL) and the Japanese Department of the New Energy and Industrial Technology Development Organization (NEDO).

Major achievements in opencut coal mining include the development of a laser-based system that will optimise performance by allowing draglines to dig to plan. Automation of rope shovels using a scale model is also well advanced.

In rock cutting we are developing new and more efficient drilling systems and drill monitoring technology to optimise equipment operation.

Initially developed for mine methane drainage, the Microtunneller prototype is being further developed for mineral as well as coal mining. It is based on conventional bore drills but is only 100mm in diameter.

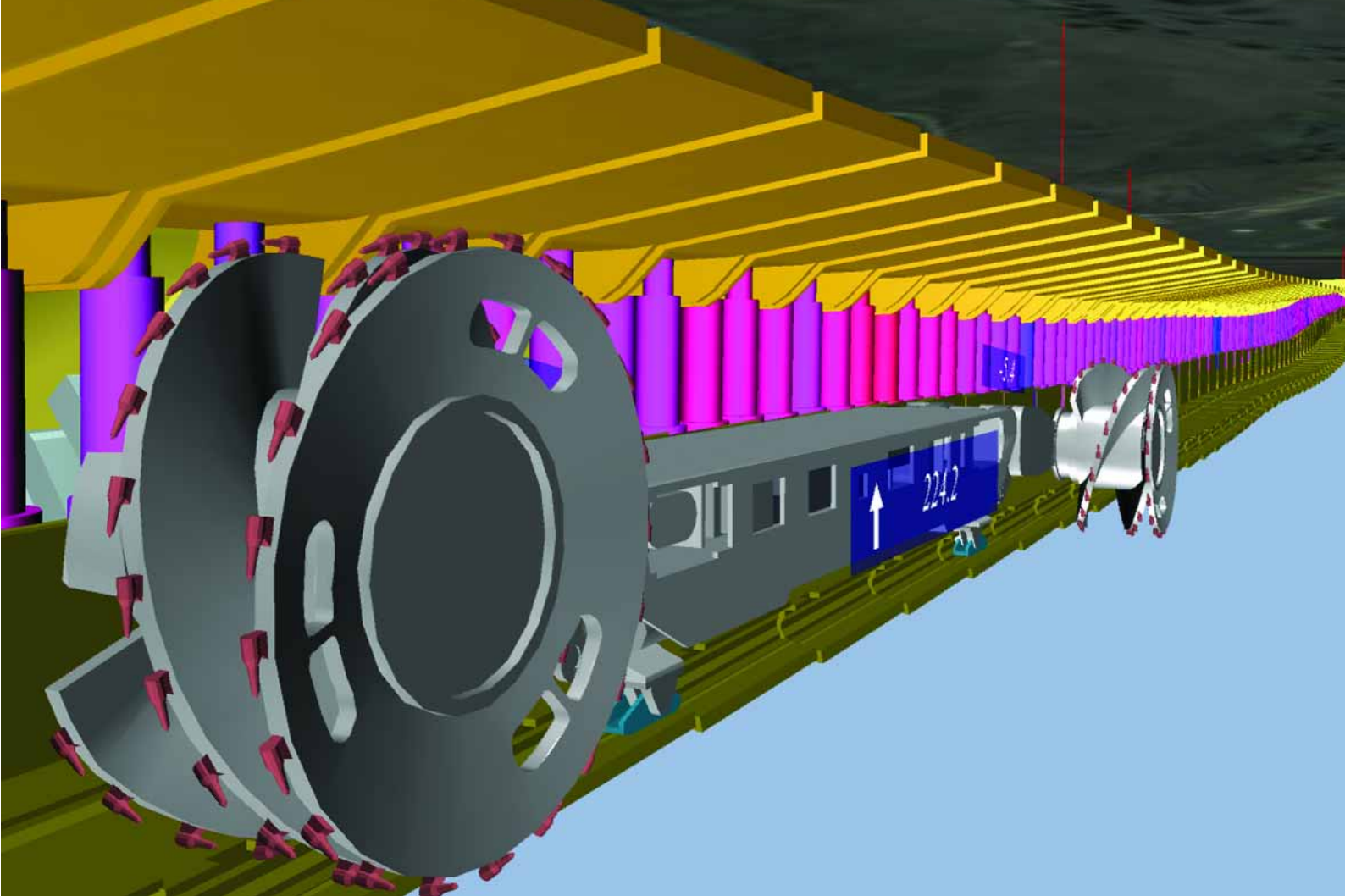
The use of laser scanners is improving the measurement of in-situ volume of a haul truck load with other projects under investigation including scanning coal train wagons and coal bins.

SMART*CUT technology utilising thermally stable diamond composites is being trialed in tools suitable for mechanical excavation, rock cutting, drilling and sawing. These new tools offer greatly extended operating lives and increased productivity and efficiency.

In collaboration with several other bodies CSIRO is developing projects to exploit emerging Galileo technologies. Galileo is a second generation Global Navigation Satellite System (GNSS) which is expected to improve productivity and safety at surface mines.

Emerging technological breakthroughs in ground penetrating radar (GPR), Ultra Wideband (UWB) radar systems, acoustics,





and image analysis are being used to “see” through the rock wall to the unmined resource.

QCAT expertise in the field of slope stability and open pit mining geomechanics will expand minable reserves and dramatically improve mine design, mine safety and risk management.

Mine safety

We are developing practical solutions for issues in all areas of the mine environment. Our researchers are utilising knowledge from areas as far removed as radar proximity detection, materials manufacturing and testing and dust behaviour and control to solve problems faced by mines day-to-day.

Under development are a range of solutions such as collision avoidance systems for vehicles, transparent flame proof covers for electrical fault finding in coal mines and shearer scrubber systems to decrease health problems arising from dust inhalation on the longwall face.

The real-time risk management project has developed a system that can integrate over 20,000 sources of data and present it in a

mine control room in a clear, easily understood format. Operators can see conditions in the mine such as the location of miners, vehicles and equipment, environmental and gas conditions, and strata movements.

CSIRO has developed tools and techniques that have resulted in a fundamental understanding of goaf gases flow mechanics. This understanding has challenged traditional beliefs and strategies and resulted in far more effective goaf gas drainage and inertisation procedures. Our optimum strategies and technologies for the prevention and control of spontaneous combustion and fires in underground coal mines are returning significant benefits to the industry.

Research strengths in the field are in mine ventilation planning, optimisation and design; spontaneous combustion control and mine methane management.

Mining Solutions

CSIRO has developed high level capabilities in a number of specialised areas. CSIRO Mining Services now allows you to tap into this expertise to generate solutions and increase

efficiency and safety in your mining operation. This consulting service offers timely technical solutions tailored to your specific issues.

Our key capabilities include:

- Coal characterisation
- Dust, gas and spontaneous combustion assessment
- Geological hazard assessment
- Geotechnical assessment
- Longwall automation support
- Longwall geomechanics
- Longwall top coal caving

Industry collaboration

The industry-sponsored Landmark project has achieved major automation advances for longwall coal mining over the last five years. The development and application of new inertial navigation technologies provides accurate three dimensional position measurement of the longwall shearer throughout the mining process.

This position information is central to the automation system which results in improved production consistency, productivity and safety.

The significance of the Landmark automation system has been acknowledged internationally by the industry and longwall equipment manufacturers. The project is now moving into the commercialisation phase.

In addition, CSIRO has played an important role with the first Longwall Top Coal Caving technique to be introduced in Australian coal mines. We have assessed the Chinese-developed approach and researched its application in Australian conditions, resulting in the development of new tools to enable the characterisation of caving conditions. Ventilation, gas, dust and spontaneous combustion issues have also been addressed.





Processing

Innovative and cost effective processing of Australia's mineral wealth is essential to the minerals industry. CSIRO's unique range of expertise extends from detailed mineralogical, beneficiation and agglomeration evaluations to predicting and optimising processing performance in iron ore, non-ferrous and coal processing.

Iron ore and non ferrous metals

Cost and productivity benefits can be realised through accurately predicting an ore's properties and processing potential. This is being achieved by linking ore mineralogy and petrology to metallurgical performance to allow more rapid assessment of processing options as well as the viability of new deposits.

More effective iron ore beneficiation strategies are being developed to accommodate increasing exploitation of alternative iron ore sources.

Research is also continuing on beneficiation of magnetite resources, including tailings.

Capabilities in designing, modelling and optimising hydrocyclones allows us to compare different designs on new ore types.

Agglomeration research is proving instrumental in helping companies throughout the world prove up new resources. Together with industry, researchers are optimising existing practices and conducting trials ranging from laboratory to pilot-scale on new ores and ore blends.

A key facility is CSIRO's state-of-the-art pilot-scale sinter rig. This world class rig also monitors gas and particulate emissions. Other research, in response to environmental pressure, is investigating reducing these emissions from sinter plants at the outset using alternative fuels.

Coal

Researchers are working with the coal industry to improve the quality and competitiveness of Australian coal in international markets.

Continuing improvements in sensing, information processing and communication

technologies are providing many opportunities for better managements of coal cleaning systems. The Intelligent Plant concept is investigating the employment of this new capability. It will allow coal processing plant operators know current operational performance in real time, and how it compares with optimal standards. This will improve efficiencies and long-term operating costs in coal production plants.

Industry collaboration

CSIRO scientists have developed a new technique to help reduce internal damage to the AG and SAG mills used in iron ore processing. In collaboration with an Australian mine the first continuously powered on-line vibration monitoring system has been installed. It is able to locate the points where tumbling material has

a direct impact on the mill's lifters and liners. The new CSIRO vibration monitoring system has the potential to help tune the mill's operation to minimise occurrences of direct liner impacts, saving millions of dollars in costs.

Manufacturing – light metals engineering

The light metals engineering group at QCAT has received international recognition for their work in magnesium handling and fatigue performance research.

Working with the CAST CRC the focus is on the production of light metals, such as the development of magnesium alloys that are significantly reducing greenhouse gas emissions.

Light Metals

On-going research on the fatigue properties of castings has continued for a number of magnesium and aluminium casting applications. Improving fatigue life will improve the reliability of safety-critical components for the automotive industry.

Hot-tearing is a major limitation in the aluminium casting industry, limiting both productivity and quality. QCAT researchers, in collaboration with the University of Queensland, Monash University and Comalco are studying the cause of hot-tearing in an effort to reduce its incidence.

QCAT researchers played a supporting role in the development of a magnesium engine block alloy for Volkswagen within the CAST CRC by confirming the fatigue performance of the engine block alloy, particularly at operating engine temperatures. The 1.2 litre magnesium engine, used in the Volkswagen Lupo, is 70% lighter than the previous cast iron engine.

Magnesium Melt Protection

Researchers at QCAT developed a new system for stopping molten magnesium from burning. The new system replaces sulphur hexafluoride, the world's most potent greenhouse gas with a refrigerant gas, resulting in a 98 per cent savings in emissions. At one US die caster switching eight die casting machines to the new



gas system saved greenhouse gas emissions of over 170,000 tonnes of CO₂-equivalent.

Industry collaboration

Through the US-Australia Climate Action Partnership a project is underway to reduce high global warming synthetic greenhouse gases. QCAT expertise is assisting research programs in the United States to replace the very potent greenhouse gas sulphur hexafluoride used in magnesium production. American-based trials on alternative gas technologies developed by the CAST CRC showed greenhouse gas reductions of 98 per cent compared to standard technologies, resulting in potential greenhouse gas savings for the USA of around four millions tonnes of CO₂ equivalent.

Coal utilisation

The goal of QCAT's energy research is to improve power generation efficiencies, reduce emissions and develop new low emissions power generation systems.

In partnership with industry and government CSIRO is developing new clean coal technologies to dramatically reduce greenhouse gas emissions in combination with techniques to clean carbon from emissions and store it safely.

Coal Gasification

QCAT's advanced coal gasification facility, in collaboration with the Cooperative Research Centre for Coal in Sustainable Development, is used to gather information about the use of coal in clean energy technologies. These technologies will form the basis of future coal-based power generation systems capable of operating with low, and ultimately zero, emissions.

The Ultra-Clean coal (UCC) process, developed at QCAT, produces coal that has had virtually all its mineral impurities chemically removed. It has been designed as a replacement for oil and gas in power generation.

Next Generation Low Emission technologies

CSIRO is the major research contributor to the Centre for Low Emission Technology (cLET), a joint venture with industry and the state government. The primary focus of cLET is on development of next generation low-emissions technologies with an emphasis on large-scale CO₂ capture and energy systems based on the use of hydrogen.

Industry collaboration

Audits at Queensland coal mines have identified that coal flotation during processing can be significantly improved to allow recovery of very fine coal currently lost to tailings. Collaborative CSIRO research has developed a way to significantly improve fine coal recovery using a new coal grain analysis method. Sponsored by ACARP, the work has developed detailed flotation performance analysis and modelling approaches. These methods present opportunities for individual mines to increase overall recovery by several per cent and their bottom line by several to many millions of dollars per annum.

Sustainability

Research at QCAT provides the Australian minerals industry with strategies and technologies to develop sound sustainability practices that enhance the social, environmental and economic potential of the resources sector. The focus is on issues which assist mineral and energy companies protect their licence-to-operate in exploration and environmental management and social integration.

Greenhouse gas and waste mitigation

QCAT researchers are developing new technologies for the desalination of worked water and for generating energy as a by-product of methane management. We aim to develop Integrated Waste Management systems for Australian mines which will utilise or mitigate two or more waste streams in one process.

In the methane management field CSIRO and Chinese researchers are building the first ever pilot-scale demonstration Ventilation Air Methane Catalytic Turbine unit at a Chinese mine. VAMCAT will reduce methane emissions from underground coal mines and will be powered by about 1% methane in ventilation air.

Research into the use of solar heat to power an engine seeks to improve greenhouse efficiencies by providing an alternative power source for remote mine sites. The heat storage device being developed for this application allows stable operation despite sunlight fluctuation.

Social Acceptance

Considerable effort is being directed into growing research looking at the effects of the uptake and/or acceptance of technology and the institutions that constrain science.

QCAT is leading an initiative on Minerals and Energy in Society that hopes to provide a

practical route to achieving sustainability that does not undermine commercial advantages in the minerals industry.

Industry collaboration

Industry-wide collaboration has resulted in a scientifically-based gasification research program which has expertise for the measurement and assessment of coal gasification behaviour in complex, high temperature, high pressure systems. This program has facilitated industry support for the development of options for the capture, storage and ultimate reduction of CO₂ emissions through new generation, low-emission power technologies. Work is being progressed through the Centre for Low Emission Technology (cLET), a joint venture between the Queensland Government, CSIRO, Stanwell and Tarong power corporations, ACARP and the University of Queensland.





Information and Communication Technology

Information and Communication Technology (ICT) is a core enabling technology that flows through all new developments in mining.

QCAT researchers are recognised experts in the field of mine automation and industry leaders in the linking of control systems and mechanical automation for the mining industry.

Automation

The development of sensors, dynamic system modelling and control, distributed real-time software and embedded systems has allowed QCAT researchers to focus on automation applications for outdoor, underground, aerial and underwater use.

Several autonomous vehicle projects are underway, each demonstrating a particular technological solution. These include the Robust Outdoor Vision-based Experimental Robots (ROVER), the automation of Hot Metal Carriers (HMCs) for the aluminium processing industry, the Unmanned Aerial Vehicle (UAV) and the Autonomous Underwater Vehicle.

The ROVER project is demonstrating how vision can be used to localise a vehicle, detect potential obstacles and identify free space to drive along.

A HMC donated to CSIRO by Comalco has been retrofitted with automation components to allow it to be driven by an on-board computer as well as the traditional driver.

Our Unmanned Aerial Vehicle (UAV) project is working towards an autonomous helicopter that can complete tasks such as powerline inspections, reducing the need to operate costly, full-sized piloted aircraft.

We are also developing a unique underwater vehicle called Starbug. The vehicle has been field tested with impressive demonstrations of autonomous terrain following and environmental monitoring in highly unstructured reef environments using vision as the primary sensor.

Wireless Sensor and Actuator Networks

Based on recent advances with low-cost wireless sensors researchers are aiming to create versatile ICT systems which comprise networked robots and sensors. The system would comprise thousands of small low-cost sensors embedded in the environment, mobile sensors, robots, and humans, all interacting to cooperatively achieve tasks.

On site at QCAT the Fleck-Net, made up of a small number of wireless sensor network (WSN) devices, is providing a medium scale ad hoc wireless sensor network test bed. This exhibits many of the challenges that need to be addressed to make sensor networks work. We are also working to create remote environmental systems and underwater sensor networks.

Working with CSIRO

CSIRO actively seeks partnerships and joint ventures with research organisations, governments and a wide range of industries. We can offer world-class people and facilities, leading edge technology, product development and project management to meet the needs of industrial, research and commercial partners.

CSIRO's attributes include:

- world-class expertise in cutting-edge approaches using new technologies
- ongoing fundamental research programs designed to meet changing market needs; and
- breadth and depth of multi-disciplinary expertise.

CSIRO, the Australian Government's premier research organisation, has a broad reach across technical, economic, social and environmental issues, which impact on all sectors of the resources and energy industries.

Partnering with CSIRO provides access to these resources, allowing partners to develop and share critical intellectual property and commercialisation opportunities.

Partnering arrangements

When working with CSIRO, partners can expect access to a multi-disciplinary pool of talent and facilities that are at the forefront of international research. Partnership arrangements are tailored to suit the needs of individual customers – we work with industry and other potential research users to maximise the opportunities that research and development create. Types of partnerships include:

- collaborative research;
- contract research;
- commercial licensing agreements; and
- consulting and technical services.

Research services

The opportunity for Australian companies to gain tax advantages from government R&D concession schemes also makes investing with CSIRO attractive. We have extensive contacts within Australia and overseas and undertake collaborative projects with industry, government and research partners around the world.

We are extremely flexible in our commercial arrangements with industry. The most common arrangements are:

Information exchange – CSIRO regularly works with industry groups to identify where R&D can have the most impact on its business.

Joint developments – many of our projects are collaborations with one or more clients, with costs, risks, knowledge and benefits shared.

License agreements – to commercialise outcomes of CSIRO's research.

Consultancies – technical assistance with specific problems not directly covered by commercial laboratories or consultants.

Lease of facilities and equipment – access to CSIRO's specialised equipment and facilities.

Commercial research – many projects are undertaken on a commercial and confidential basis with costs and benefits, including any intellectual property, going to the client.

Staff exchanges – postdoctoral, professional and industry training secondments.

Contacts

QCAT Acting Executive Manager

Tim McLennan
+61 7 3327 4480
Tim.McLennan@csiro.au

CSIRO Exploration & Mining

Greg Rowan
+61 7 3327 4179
Greg.Rowan@csiro.au

CSIRO Energy Technology

Dr David Harris
+61 7 3327 4617
David.Harris@csiro.au

CSIRO Manufacturing & Infrastructure Technology

Dr Nigel Ricketts
+61 7 3327 4638
Nigel.Ricketts@csiro.au

CSIRO ICT Centre

Dr Peter Corke
+61 7 3327 4584
Peter.Corke@csiro.au

CSIRO Minerals

Dr Ralph Holmes
+61 7 3327 4452
Ralph.Holmes@csiro.au

Communication Manager

Bob Chamberlain
+61 7 3327 4469
bob.chamberlain@csiro.au

Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.



Contact Us

Phone 1300 363 400
+61 3 9545 2176
Email Enquiries@csiro.au
Web www.csiro.au

For further information about CSIRO at QCAT

Tim McLennan
Acting Executive Manager
tim.mclennan@csiro.au
+61 7 3327 4444

Bob Chamberlain
Communication Manager
bob.chamberlain@csiro.au
+61 7 3327 4469