CSIRO

QCAT Annual Report

QUEENSLAND CENTRE FOR ADVANCED TECHNOLOGIES

2002/03

Mission

The Queensland Centre for Advanced Technologies (QCAT) will be recognised for the excellence of its contribution to the mining, energy and manufacturing industries.

Our mission is to generate products and processes of high value to Australia's mineral and energy resources and manufacturing industries with particular focus on those resources and industries located in Queensland.

The Queensland Centre for Advanced Technologies (QCAT) is a world class facility for research and development in all aspects of the mining, energy and manufacturing industries. Our goal is to increase the international competitiveness and efficiency of Queensland's and Australia's resource based and related industries.

QCAT is a partnership between the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the State Government of Queensland. The establishment of the Centre flows from an agreement between the Commonwealth and Queensland Governments to expand and diversify the research and development activities undertaken by CSIRO in Queensland.

Government Occupants

CSIRO
Exploration and Mining
Minerals
Energy Technology
Manufacturing and Infrastructure Technology
Light Metals Flagship

Cooperative Research Centres
CRC for Coal in Sustainable Development
CRC for Cast Metals Manufacturing (CAST)

Commercial Occupants

Advanced Mining Technologies Pty Ltd
Alcan Queensland R&D Centre
Applied Mining Technologies Pty Ltd
Australian Centre for Mining Environmental Research Limited (ACMER)
Coal Recovery Australia
ComEnergy
Cutting Edge Technology Pty Ltd
Geotek Solutions
Instinct Television
Jenkins–Kwan Technology Pty Ltd

front cover image: Australia's Mining Monthly/Darryl Peroni

QCAT Annual Report 2002/03

CSIRO

Queensland Government

The mining industry is a star performer for the Australian economy. It contributes roughly five per cent of Gross Domestic Product.

Foreword

In 2000/01, export earnings from Australian mineral resources rose to $55.6 billion. Coal exports added $8.8 billion to that figure, making coal the single biggest component.

However, nothing can be taken for granted. The long-term viability of Australian mining depends on innovative research, new technologies, services and equipment. There is also a need for safer, more efficient and cost-effective mining strategies. In addition, a number of challenges loom on the horizon.

The Queensland Centre for Advanced Technologies (QCAT) underpins Australia's leadership in the global resources sector. Exciting new developments this year include an agreement to establish the Centre for Low Emission Technologies, and Alcan agreeing to co-locate with QCAT.

QCAT is a partnership between the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Queensland State Government. It delivers world-class research and engineering to the Australian exploration, mining, minerals processing and manufacturing industries.

By establishing a critical mass of expertise, QCAT delivers a regular flow of leading edge technologies, high value products and processes to the resources industry.

QCAT represents an outstanding example of collaboration between CSIRO, the Queensland Government and industrial partners. Its support for the resource industry is helping Australia maintain its international competitiveness.

As Queensland Minister for State Development I am delighted with the performance of our investment in QCAT.

Tom Barton MP
Minister for State Development

QCAT continues to thrive as a centre of excellence. Across 2002/03 QCAT attracted 49 projects, each with a value of more than $100,000. The total value of the projects was $31.4 million. In June 2003, 250 people worked at the Centre.

Executive Manager's report

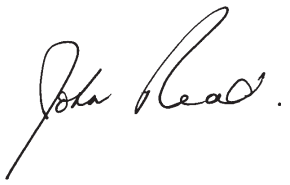
CSIRO continues to consolidate its leadership role as the hub of science and industry, attracting an impressive group of research and industry organisations to the QCAT site.

The past year has seen some exciting developments. In particular, the decision by the global aluminium and packaging giant Alcan to relocate a major part of its alumina and bauxite research and development capability to QCAT represents a perfect fit for us. Also of note is the agreement with the Queensland Government (Innovation and Information Technology) to establish the Centre for Low Emission Technologies at QCAT. The decision to establish the headquarters of the Light Metals Flagship at QCAT recognises the site's unique mix of research capability in light metals processing, products, technology and related services, especially energy. Our charter is to be recognised for excellence in our contribution to the mining, energy and manufacturing industries, and these initiatives represent a strong synergy of people, products, technology and potential.

During the year QCAT continued work on a range of innovative and challenging projects in collaboration with industry partners, from co-operating in the commercialisation of CSIRO technologies for power generation from waste coal and fugitive gases through to procedures to make mining cheaper and safer, and ensuring the continued improvement in environmental performance of the industry.

Although QCAT research focuses strongly on the needs of Queensland industry, it is increasingly the subject of considerable international interest. The site continues to be visited regularly by government delegations, trade missions, diplomats and Australian business leaders.

The model of QCAT as a multi-disciplinary enterprise combining industry and science is working. QCAT continues to expand the research undertaken in Queensland by CSIRO, the federal and state governments, The University of Queensland and related organisations in the exploration, mining, minerals and related manufacturing industries. QCAT facilities are being developed to meet new demands from joint venture partners and industry collaborators to continue the addition of value to the relevant industry sectors.

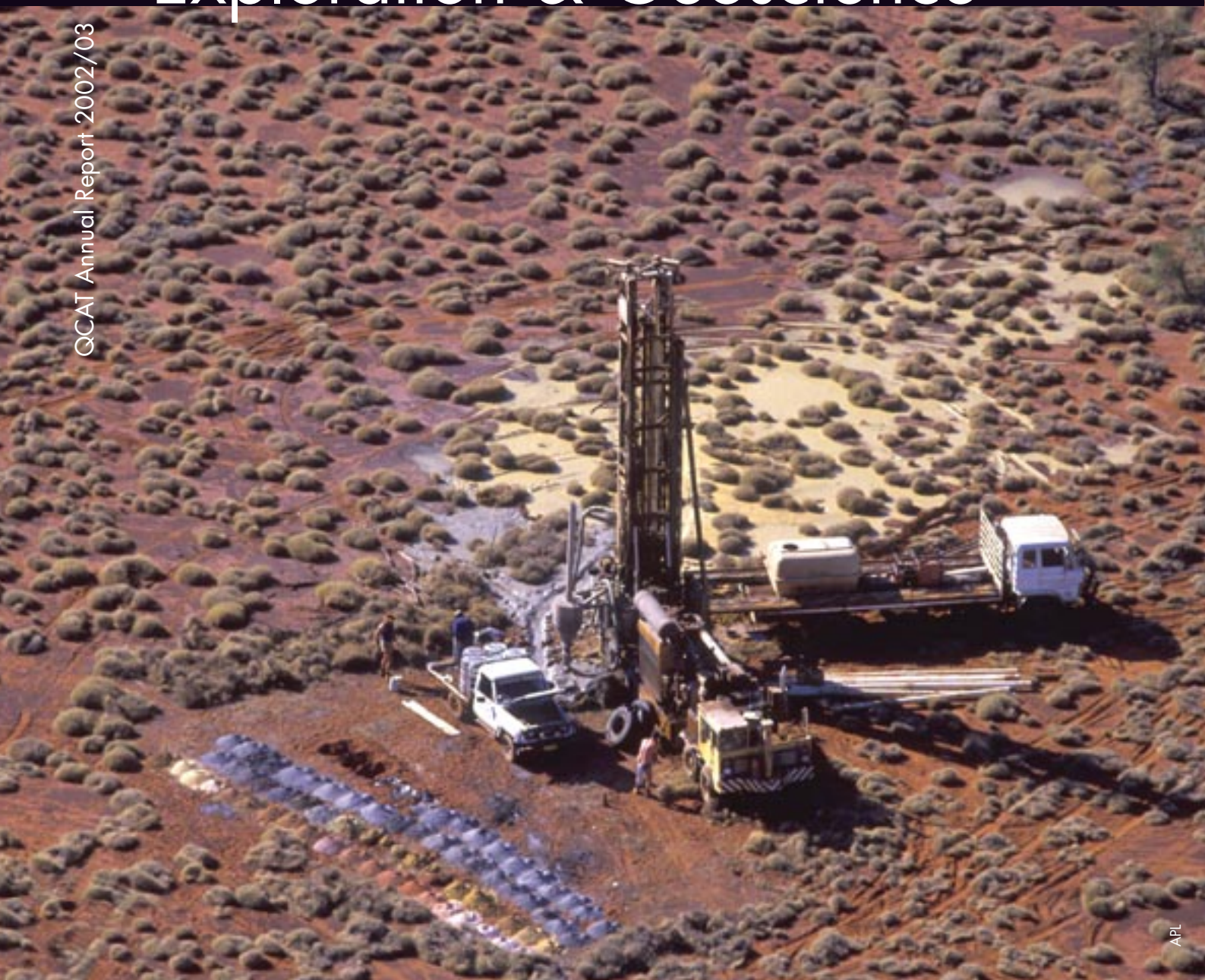


Dr John Read
Executive Manager
Queensland Centre for Advanced Technologies

The geosciences are crucial to the wellbeing and future growth of the mining industry. Exploration activities have already found trillions of dollars worth of resources in Australia — and these have mostly been the 'easy' finds, near the surface. Future discoveries at greater depths will far exceed those made so far.

Mining activities rely on a comprehensive understanding of the 3D geological picture, and ongoing improvements in safety, reliability and cost effectiveness depend on improved geological risk management.

Exploration & Geoscience



APL

Exploration & Geoscience

Gravity

Research into the detection of significant ore bodies from the air involves scientists from CSIRO Exploration and Mining, and CSIRO Manufacturing and Infrastructure Technology.

Airborne exploration has previously been based on combining methods of magnetics, electromagnetics, natural gamma spectrometry and thermal infrared surface spectrometry. CSIRO scientists played an important role in developing these technologies. Work at QCAT is now aimed at developing a second-generation airborne measurement system for detecting buried ore bodies and geological structures based on gravity measurements from aircraft.

The project is now in its final year for proof of concept.

Mining geoscience

The fundamental objective of mining geoscience is to provide solutions that reduce uncertainty associated with the knowledge of the mine scale geological environment. A sound 3D geological model is the basic building block that feeds into resource and reserve estimation, geotechnical, geomechanical and metallurgical characterisation, mining method selection, material movement, processing design strategies, waste treatment, storage, rehabilitation and environmental monitoring. Our primary focus is the development, demonstration and transfer of new techniques and technologies to assist these areas of the mining industry.

In 2002/03 CSIRO researchers working with the mining industry, coal ports and Queensland Rail completed an initial investigation into the fundamental causes of 'sticky' coal at ports. Coal transported long distances by rail often becomes sticky and difficult to unload. This project characterised the main factors contributing to the problem. The success of the project resulted in a follow-up project to assess solutions.

Spectrometric nuclear logging research continued and several key projects were completed, notably the successful evaluation of SIROLOG Prompt Gamma Neutron Activation Analysis techniques for Anglo American at five Chilean copper mines. This project resulted in an order for a logging system for the Mantos Blancos copper mine and a commitment from Anglo American to trial this technique at some of its other mining operations in South America.

Theoretical and applied research in the field of microseismicity associated with mining continued apace over the year. The main project completed during the year was a trial at Lihir gold mine in PNG to assess the potential of microseismic monitoring to discriminate stress release associated with geothermal events from stresses caused by mining. This trial was successful and suggests that microseismic systems could potentially provide early warning of dangerous steam and gas outbursts.

CSIRO Exploration & Mining and CSIRO Manufacturing and Infrastructure Technology work together to provide applied technology solutions to major issues confronting the coal and metalliferous mining industries.

Mining is Queensland's largest export industry. In 1999–2000 alone, mining exports totalled $6.1 billion or 36.6% of total Queensland exports. The sector is currently responsible for around 16,000 direct and 64,000 indirect Queensland jobs. Mining has evolved into an extremely sophisticated, 21st century industry and Australia is a global leader in developing new technologies.

Australia also supports a mining technology services industry of $3.1 billion. Modern computer and communication technology is used throughout for mathematical modelling, mine design, and control and optimisation of all process stages.

Mining

Mining

Coal mining

Queensland is the largest seaborne coal exporting province in the world, shipping 129.2 million tonnes in 2001/02, an increase of 5% on the previous year. Queensland has coal reserves for several hundred years — a wonderful resource that can provide energy in many forms for centuries if the industry can adapt to the changing needs and demands of contemporary society.

QCAT scientists and engineers have made significant progress in developing safer and more efficient approaches to coal mining. Major new research has begun at QCAT into longwall automation and communication risk mapping systems. Further research into optimising mine design, lowering pit costs and reducing geotechnical risk in mining operations has also been undertaken.

The Australian Coal Association Research Program (ACARP) project on longwall automation is developing automation techniques that allow for a longwall face that will operate automatically within pre-defined parameters to enhance health and safety, and production consistency, lowering operating costs and improving the return on capital. The project will trial an autonomous face alignment module in February 2004. Other modules involving face steering, horizon control and automatic haulage will soon follow.

The rapid roadway development project has completed construction of the Autonomous Conveying–Bolting Module, which was exhibited at AIMEX in 2003. Underground trials will follow surface commissioning in December 2003. The system will improve the productivity and safety for building access roadways in longwall operations.

Significant progress was made in a number of other projects. A four-year project to better control gas in underground coal mines is nearing completion, with significant advances in improved safety and viability. The team has developed a wide range of tools and methods for managing gas in coal mines, with a particular emphasis on industry applications and utilisation.

Research into a new communication and risk management system for mine ventilation, strata control and emergency response, which started in May 2002, has now progressed to site trials. The system allows for real-time risk analysis.

Manufacture has begun of prototype drilling technology for enhanced coal seam methane recovery.

Development of a comprehensive low cost, quantitative 3D highwall risk mapping system that will enable rapid visual 3D characterisation of rock faces into risk domains has now been commercialised. Commercial development of new 3D visualisation software was also completed in the past twelve months.

New projects include demonstration of a surface-based spontaneous combustion method and development of techniques utilising power plant waste that will limit mining subsidence under important surface features.

Metalliferous mining

Queensland has a wealth of mineral bodies yielding 30 mineral commodities. Metalliferous mining research at QCAT includes work in rock cutting, geomechanics, automation and new mining techniques. These activities involve staff from CSIRO Manufacturing and Infrastructure Technology and CSIRO Exploration and Mining.

Several new projects were initiated in 2002/03 and substantial progress was made on projects already under way. CSIRO Mining Automation began a second project in the sand mining domain to undertake a scoping study for remote control of sand mining dredges. New initiatives were also taken into surface mining for control of excavators and automation of surface truck and loader operations.

With the commercial launch of MINEGEM by Dynamic Automation Systems in April 2003, the research and commercial transfer of the underground loader automation technology is now complete. The QCAT and Dynamic Automation Systems technologies were integrated and three commercial loader systems were established — two at Olympic Dam and one at Northparkes Mine.

Test facilities have been prepared for the development of the Remote Ore Extraction System, a new hard-rock mining method. This will provide central control of drilling, blasting and recovery of the ore. In addition, enhanced measurement of the mining process and ore conditions will also be provided. Research is delivering promising results for rock-drill control. A joint scoping project is under way with Orica, for potential inclusion of its explosives and blasting technology.

Development of the SMART*CUT technology continued, with the completion of an AMIRA-sponsored project. CSIRO is developing follow-on projects with AMIRA and mining companies and is actively exploring commercial opportunities to take the technology to the market. This will provide long-lasting cutting material for retro-fit to existing mining machines that will make rock-cutting in hard-rock mines feasible.

Mining support

The development of 3D imaging systems for applications in the mining and construction industries has continued. This system is now in use at over 20 sites and development of a version for use underground is nearly complete.

The system is being used to improve safety and productivity by supporting the analysis of rock mass structure for geological and geotechnical assessment. The ability to deliver improvements in mine design, safety and productivity means that these systems will become an integral part of mining and construction. They can also be used in the automation of mining equipment. A prototype of an automated system for use with mining equipment will be developed in 2004.

Innovative and effective processing of Australia's mineral wealth is essential to the industry. Researchers at QCAT are conducting research and development to assist the industry in Australia and overseas.

Processing

Iron ore and non-ferrous mineral processing

Unprecedented expansion has led today's iron ore industry to demand more from its existing resources and equipment, and to develop new resources. QCAT-based researchers with CSIRO Minerals are continuing to work closely with industry to meet these demands using their unique expertise, which extends from detailed mineralogical, beneficiation and agglomeration evaluations to predicting the processing performance of sinter, pellets and lump in the blast furnace.

The accurate prediction of downstream processing performance is critical to resource evaluation and development decisions. This involves linking ore mineralogy and petrology to metallurgical performance using optical microscopy/computer-based image analysis and mineralogy-based models of unit processes developed at QCAT. Significant cost and productivity benefits are currently being generated for industry through early determination of ore properties and processing options, thereby reducing expensive laboratory- and pilot-scale research on ores that are not promising. Recent advances for iron ore include automatic liberation analysis by phase or by total iron, and provision of statistical information on particle dimensions, modal analysis and mineral associations.

More effective beneficiation strategies are also being developed at QCAT as alternative iron ore sources, such as Marra Mamba and Channel Iron Deposits, are being exploited. The challenge is to accommodate changing ore blends and to remove gangue components while also minimising loss of iron units. Over the past year, the fully instrumented pilot-scale hydrocyclone facility at QCAT was used to assess the beneficiation potential and evaluate the comparative performance of different hydrocyclone designs and flowsheets on a number of these new ore types. This included screening and dewatering of the feed and products. Spiral and low intensity magnetic separation modules are currently under development to enhance QCAT's pilot-scale beneficiation facilities and meet future industry needs.

Agglomeration research at QCAT is proving instrumental in helping iron ore companies improve product quality and reduce environmental emissions. Together with industry, existing practices are being optimised in trials on new ores and ore blends at scales ranging from laboratory to pilot. One significant facility is a state-of-the-art pilot-scale sinter rig. This well instrumented facility features automatic computer-based data logging and monitoring of gas and particulate emissions, including CO, CO_2, NO_X and SO_X. Research is being conducted on reducing emissions at the source, including replacing coke with alternative biomass fuels. For particulate emissions, it has been shown that significant quantities of dust are emitted from the sinter bed only after the dry zone has reached the bottom of the bed, indicating that the moisture front ahead of the heat front plays a significant role in containing dust within the bed until it reaches the bottom of the bed. Preliminary studies on replacing coke with charcoal have also shown that NO_X and SO_X emissions can potentially be reduced by a factor of four or more. In addition, a pilot-scale pelletising facility has now been fully commissioned for optimising balling, drying and induration of iron ore pellets.

A new research focus at QCAT is whole plant optimisation, particularly for fine grinding and SAG mill optimisation for the non-ferrous mining industry. This involves review of specific equipment, unit operations and flowsheets at the conceptual design and operational stages. A major thrust at present is reduction of ultrafines generation to improve downstream flotation performance. The initial two-year AMIRA project to develop a prototype SAG mill monitor using surface vibrations was successful, demonstrating that it was possible to monitor the toe and shoulder positions of the charge inside the mill as well as other operating parameters, such as mill load. A three-year extension has begun to develop a ruggedised industrial monitor for optimising SAG mill performance.

Our researchers continue to play a leading role in both ISO and Australian Standards development for international trade in iron ore, coal, base metals and nickel. Current efforts are aimed at improving the sampling of iron ores, coal, and base metal and nickel ores, concentrates and smelter residues, as well as the analysis and physical testing of blast furnace and direct reduction feedstocks for iron and steel making. Examples of recent work include development of new ISO Standards for sampling hot briquetted iron, slurries and smelter residues, and improvement of the current Standard for determining the decrepitation index of lump iron ore.

Processing

QEMSCAN

The QEMSCAN system, renowned for its speed, accuracy and suitability to almost any form of particle analysis, continues to provide a powerful profit-making tool for mining and mineral exploration companies world wide. Two smaller systems, SITESCAN and MINESCAN, have been developed. SITESCAN is a ruggedised version that can be used at remote locations while MINSCAN is an entry level system that provides excellent analytical data for minimum capital outlay.

In the past year, Rio Tinto installed a second QEMSCAN system at its Melbourne Technical Services Centre, Anglo Platinum a third at its research centre in Johannesburg. A QEMSCAN system was installed at CVRD in Belo Horizonte, Brazil, and Phelps Dodge recently commissioned its third system at the Technology Center in Safford, Arizona.

Building on a history of more than 20 years of rigorous scientific research and development, QEMSCAN technology has been transferred to a new company, Intellection. Intellection has begun operations to develop and commercialise the technology. It also supplies analytical services, as well as extensive consulting, interpretive and training services.

Coal processing

QCAT-based researchers from CSIRO Energy Technology's Coal Preparation Group are working with the coal industry to improve the quality and competitiveness of Australian coal on international markets.

Supported by ACARP and the coal producers themselves, the group is developing an intelligent plant system using hardware and software that will allow a processing plant to know its 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.

Our researchers are also attempting to identify factors controlling the efficiency of fluid recovery, partition curves and magnetite recovery.

We are also exploring the potential of electrical impedance spectroscopy as a new tool for monitoring unit operations in coal preparation plants, and new capabilities for optimising plant performance. A number of proof of concept projects were completed successfully with dense medium cyclones and coal flotation systems at the pilot scale. Industry funding has been obtained to continue the work with focussed plant trials.

The manufacturing industry contributes over $10 billion to Australia's export earnings. Work at QCAT benefits the manufacturing industry by supporting and anticipating industry needs and by providing the resource and knowledge bases for technological advance.

Manufacturing

Manufacturing

Casting and alloys

Research and development at QCAT by CSIRO Manufacturing and Infrastructure Technology scientists looks at productivity, performance and quality concerns in the light metals smelter and foundry industry. Our research focus is on developing technologies for casting magnesium and aluminium alloys.

Work on aluminium is in two areas. The first deals with hot tearing in continuously cast billet, in partnership with the Cooperative Research Centre for Cast Metals Manufacturing. This type of billet is produced by the Comalco casthouse operation at Boyne Island, and elsewhere. Hot tearing has impacts on product quality and, therefore, on productivity.

The second area is an assessment of the properties (especially the tensile strength and the ductility) of aluminium alloys cast by different techniques. This work supports industry decisions on installing new equipment.

QCAT scientists are working with colleagues in CSIRO, Melbourne, and at the University of Queensland on strengthening magnesium alloys for use in car engines. The QCAT contribution to this work has mainly been in assessing and understanding the fatigue properties of the candidate alloys. The ultimate aim is to provide lightweight metals with sufficient strength to meet industry needs. The value to Australia if the world's car manufacturers switched to magnesium engine blocks would be immense. Fifty million cars are made each year world-wide, and their engine blocks currently account for an annual consumption of over a million tons of aluminium and cast iron.

During the year, the group conducted successful trials on its cover-gas melt protection system in North American and European magnesium foundries. In addition, we are continuing to develop methods for measuring and improving the refining of magnesium, and to reduce its impact on the environment.

Light Metals Flagship

In response to the Australian Government's national research priorities, the Light Metals Flagship links industry and research agencies by focussing on five themes from across the light metals industry — alumina, aluminium, magnesium, magnesium and aluminium manufacturing, and titanium. Its vision is to position Australia as a world leader in sustainable light metals production and manufacture. Current research at QCAT in magnesium, and the decision by Alcan to establish its R&D Centre here, provide excellent opportunities for the Flagship to achieve this goal. It seeks to transform industrial practices in ways that create opportunities for our industrial partners, and reinforce CSIRO's reputation as the 'R&D innovator of choice' in the light metals industry.

Research into coal utilisation at QCAT includes assessing the gasification performance of coal. The ultimate goal is to improve power generation efficiencies and reduce emissions.

Energy

Energy

Coal utilisation

As a participant in the CRC for Coal in Sustainable Development, CSIRO Energy Technology is conducting research using an advanced coal gasification facility at QCAT. The facility is used to evaluate the performance of Australian coals under the high temperature, high pressure gasification conditions of advanced power generation processes. This research will assist in the provision of practical information to help demonstrate that coal can be used effectively in 'clean energy technologies' that will form the cornerstone of future development of coal-based power generation systems capable of operating with low, and ultimately zero, atmospheric emissions. It provides the detailed technical information required to introduce and support coal use in new domestic and international markets, based on high-efficiency coal utilisation processes.

Laboratory-scale research facilities at QCAT complement the high temperature, high pressure gasification reactor, allowing detailed interrogation of the physical and chemical processes that control the conversion rates of coals and other fuels under intense gasification conditions. An understanding of the carbon gasification reactions, and mineral matter reactions and flow behaviour allows a detailed understanding of gasification systems, leading to process optimisation and suitable matching of fuels and technologies.

In this field, QCAT is a recognised centre of excellence, with the necessary facilities and expertise for the evaluation of coals for advanced technologies. It will provide technical data to support coal selection and marketing in emerging high-efficiency power generation technologies. Technical capabilities and facilities are also being established to evaluate fuel and energy strategies to help develop and implement sustainable energy conversion technologies in Australia.

The Australian minerals industry is crucial to the country's economic and social wellbeing. Without a viable minerals industry we cannot maintain the social, economic and environmental processes that underpin sustainable development.

The industry's long-term future, however, rests not only on how it responds to this century's economic challenges, but also how it responds to the challenges of sustainable development. Research at QCAT provides the industry with strategies and technologies for developing sound sustainability practices — minimising the effect of mining on the environment, and rehabilitating the landscape.

Environment

Environment

Sustainable mining

Our research into sustainable mining assists mineral and energy companies to protect and enhance their operations — safety, environmental management and social integration.

Safety management uses technology to address specific hazards in mines associated with vehicles, ventilation, explosions, fires, strata instability and emergencies. It also works with safety management systems that deliver safer conditions in operations. Environmental management concentrates on reducing the long-term impact of mining and energy production. This research has evolved from an investigation of greenhouse gas sources to techniques for improved efficiency and greenhouse gas mitigation. It also looks at the environmental aspects of post-mining land use. Social integration is about understanding the links between mining and energy technology and social issues, to develop better practices for using resources on behalf of society.

During 2002/03 much of the work at QCAT concentrated on the development of systems to enable real-time analysis of the mine environment. Our goal is a communications system that will improve the ability to respond speedily and appropriately to different situations.

Much work has also focussed on the mitigation of fugitive gases that come either from the coal or are generated by spontaneous combustion of coal in mine wastes. A vital aspect is improvement of the efficiency of energy generation at mine sites and in general. Additionally, work continued on developing cleaner forms of energy from coal, based on underground coal gasification. Underground coal gasification works by converting coal (including some grades that can't be used otherwise) into liquid fuels. This might become the basis of new synthetic liquid fuels and chemical industries for Australia, with net greenhouse gas benefits.

In the interests of social integration, a report was produced on potential social issues around the use of waste gas to generate electricity. This resulted from a collaboration between QCAT engineers and researchers looking at social values.

Behind the innovative science and technology researched and developed at QCAT is a dedicated team employed in a wide range of professions.

Our people

Our people

Commercial occupants

QCAT hosts a number of commercial tenants in the purpose-built Technology Transfer Centre. The Centre provides commercial space for technology-based companies, and the opportunity for them to develop synergistic relationships with CSIRO.

Work conducted by our commercial occupants includes high accuracy navigation systems, engineering geology, television production, environmental research, coal research, design and manufacture of underground auger mining systems, and the development of new power generation technologies.

Current commercial occupants

Advanced Mining Technologies Pty Ltd
Alcan Queensland R&D Centre
Applied Mining Technologies Pty Ltd
Australian Centre for Mining Environmental Research Ltd
Coal Recovery Australia
ComEnergy
CRC for Coal in Sustainable Development
Cutting Edge Technology Pty Ltd
Geotek Solutions
Instinct Television
Jenkins–Kwan Technology Pty Ltd

Site conservation

QCAT remains committed to improving the local environment. This dedication was recognised by the CSIRO Environmental Award for 2002. The prize money which accompanies the Award will be used to enhance the natural heritage value of the subject of the Award, Farm Creek. The creek is surrounded by original vine forest that is uncommon in the area. It is also rich in local flora and fauna, providing an ideal wildlife corridor from the Brisbane River to Brisbane's Forest Park. Staff continue to volunteer for working bees to clear out weeds and plant native trees. Listed as a Land for Wildlife project, it demonstrates the depth of staff concern for the preservation of the environment.

Research and support

In 2002/03 QCAT attracted 49 research and development projects, each with a budget of more than $100,000. The total value of these projects was $31.4 million. Working on these projects and other enterprises are scientists, engineers, programmers, and technical and research support staff.

In line with its mission to create a competitive advantage for Australia's mining, energy and manufacturing industries, the majority of the 220 CSIRO staff working at the Centre were engaged in research and development activities. Alongside those people are a range of personnel providing support, production and logistics. Human Resources, Finance, Information Resources, Computing Support and Site Services staff deliver specialised services in support of QCAT's primary objective — high quality scientific and industrial research.

Specialised design and construction work is carried out by a comprehensively equipped engineering workshop.

Awards

A number of QCAT staff were acknowledged with awards for their efforts during the year.

The CSIRO Environment Award for 2002 was awarded to volunteers from the QCAT Farm Creek Revegetation Project, and was received by Stephen Peck, Andrew Taylor, Norm O'Neil and Alan Scott on behalf of the group. The project, undertaken voluntarily by QCAT staff, seeks to preserve and enhance a small, neglected watercourse on site (Farm Creek) and to assist endemic species to re-establish themselves. Demonstrating CSIRO's concern for the environment in its own 'backyard', staff organised fund raising activities and engaged the support and assistance of members of the local community. The creek and its immediate surroundings were recognised by the Land for Wildlife Program in 2002.

Graham O'Brien from Exploration and Mining's Mining Geoscience Group shared the ACARP Research Excellence Award in Coal Utilisation for 2002 with Barry Jenkins (Jenkins–Kwan Technology Pty Ltd) for the Coal Grain Analysis project and its parent project, Automated Full Phase Reflectograms. The project developed a method for characterising the individual coal grains in samples. This information is used to optimise coal recovery and usage.

The Iron Ore Processing Team from CSIRO Minerals, led by Dr Ralph Holmes, won the CSIRO 2002 'Go for Growth' Award. Team members were Jonathan Campbell, Simon Campbell-Hardwick, Dr John Clout, Dr Mark Dell'Amico, Jeff Douglas, Angela Drabble, Trevor Dunne, Alex Edenton, Dr Andrew Firth, John Garden, Jasbir Khosa, Kathy Laurenceson, James Manuel, Andre Metzeler, Rod Nicholson, Paul Nielsen, Maureen O'Connor, Anne Porter, Ross Price, Dr Thressa Rowlands, Rod Smyth, John Theaker, Dr Alfonso Trudu, Keith Vining, Natalie Ware, Jason Young and Dr Zhu Rui. The team's contribution was rated as the best initiative contributing to the growth and/or sustainability of CSIRO through the establishment of strategic alliances and excellence in service delivery. This involved restructuring the program and consolidating staff and equipment on one site, thereby removing geographic constraints to staff moving between projects and promoting more effective interaction among team members. The consolidation positioned the program as a world class research provider with state-of-the-art facilities and resulted in increased industry funding over the past year.

Steve Fraser was part of an Exploration and Mining team which won the CSIRO 2002 Occupational Health and Safety Award. The team developed standard operating procedures that provide a safety net and reduce the risk to field staff by implementing uniform and endorsed authorisation, communication and emergency procedures that are acknowledged as current industry best practice. The project was also highly commended in 2003 by the Safety, Rehabilitation and Compensation Commission.

Con Caris from Exploration and Mining's Coal Mining Group shared an award for the Group's collaborative work on the X3D graphics browser, Flux. Presented at Siggraph 2003 (USA), the award was for the Best New Web 3D Technology. Con and Tony Parisi of Media Machines in the USA have worked together over the Internet for the past 18 months designing enhancements and testing this next generation of 3D graphics browser for the Web. Tony Parisi, the co-author of VRML/X3D (ISO format for 3D web graphics content) has assisted us to incorporate Flux into our virtual mine and real-time equipment visualisation projects. Our team was also responsible for the addition of pixel and vertex shader functionality in Flux, which was showcased recently at Siggraph in San Diego. The shader technology takes advantage of the programmability of high end graphics accelerator hardware, which has enabled Flux to become the first commercially available X3D browser in the world with this capability.

Progress at the Technology Transfer Centre

Progress at the Technology Transfer Centre

ComEnergy

In 1999 CSIRO and Liquatech formed a partnership to build a prototype Hybrid Coal and Gas Turbine. Previous attempts to convert methane in mine ventilation systems to fuel failed because methane concentrations were too low to enable self-sustaining combustion, or methane levels fluctuated too much to maintain a constant fuel supply.

The prototype demonstrated the feasibility of the concept. The new system uses variable fuel supplies to maintain a constant temperature — adding waste coal from the stockpile if the methane concentration gets too low. It has the potential to significantly reduce greenhouse gas emissions by replacing hundreds of megawatts of conventionally produced power with electricity fuelled by burnt methane.

In 2003 a joint venture company, ComEnergy, was formed by CSIRO and Liquatech (in equal shares) to commercialise the system. ComEnergy has taken out a 20-year patent in 80 countries.

Recently the partners brought the project to the point of commercialisation, with two major backers signalling their preparedness to invest $13 million to build a mine-scale plant at the United Colliery near Singleton in the Hunter Valley, New South Wales.

The plant is designed to generate 10 megawatts of electricity, and burn 112,000 tonnes a year of carbon dioxide equivalent (greenhouse gas emissions). In signatory countries to the Kyoto agreement, each tonne of carbon dioxide equivalent abated will earn credits. There are reports in Europe of payments of up to 30 euros (about $52) for each tonne of carbon dioxide equivalent abated. ComEnergy has signed agreements with several corporations in China for the 10 megawatt plants.

Alcan Queensland Research & Development Centre

The Alcan Queensland Research & Development Centre was established at QCAT after an extensive review of possible locations in Australia. Destined to become a world leader in the development of bauxite and Bayer (alumina refining) technology, it also has a local focus to engage universities, CSIRO and specialised technology companies in contract and joint research activities. Currently employing ten research and support staff, Alcan's research is in the area of Bayer technology, with a particular focus on precipitation technology and corrosion.

Negotiations to provide Alcan with a purpose-built facility on the QCAT site are nearing finality. Alcan looks forward with confidence to a long and mutually beneficial relationship.

Australian Centre for Mining Environmental Research (ACMER)

ACMER is an incorporated research institution comprising the major groups in Australia carrying out environmental research in the mining industry. The groups include: CSIRO; The University of Queensland (Centre for Mined Land Rehabilitation); Australian Nuclear Science and Technology Organisation (ANSTO) (Environment Division); Curtin University of Technology (Mulga Research Centre and the Mine Rehabilitation Group); the University of Western Australia (Centre for Land Rehabilitation); and six of Australia's major mining companies — AngloGold Australia Limited, BHP Billiton Limited, Newmont Australia Limited, Placer Dome Asia Pacific Limited, Rio Tinto Limited and WMC Resources Ltd.

ACMER pursues its role through research, technology transfer, advisory services and facilitation of stakeholder forums. It also provides training to people working in the field.

Major research programs include waste rock dump stability, final void use, prevention and remediation of acid mine drainage, tailings disposal and remediation, and ecosystem reconstruction.

In 2002/03, ACMER undertook a number of new research projects, three of which involved CSIRO:

- In partnership with CSIRO and Environment Australia, ACMER produced the *Guide to the Application of the ANZECC/ARMCANZ Water Quality Guidelines in the Minerals Industry*, enabling the industry to effectively manage water quality.
- CSIRO and ANSTO scientists collaborated to determine the reasons for the deterioration of the Rum Jungle uranium mine waste rock dump cover.
- CSIRO and the Canada Centre for Minerals and Energy reviewed environmental issues and the current state of knowledge on deep sea tailings placement.

During the year, ACMER conducted five short courses and four workshops on a range of topics around the country. Two of the workshops addressed cyanide management, and were part of a national program on cyanide use supported by the Regional Minerals Program of the Commonwealth Department of Industry, Tourism and Resources.

Jenkins–Kwan Technology

Business during the past year focussed on development and commercialisation of automated instrumentation for the mining industry. Several new R&D projects were established with the assistance of ACARP grants. A highlight of the year was internal accreditation of the MACE 300 system for coal petrographic analysis. The capability of the MACE 200 mineral liberation analysis software, which has now seen two years in industrial service, is being expanded to include a wider range of mineral systems. A personal high point for company principal Dr Barry Jenkins was an invitation to be Keynote Speaker and Co-chairman at 'Microscopy and Microanalysis 2003' in San Antonio, Texas. This is the world's largest technical and trade meeting of its type.

Applied Mining Technologies

Applied Mining Technologies has continued with the development of mining guidance solutions for highwall mining applications. Machine guidance is considered essential for safe and productive highwall mining, and equipment manufacturers are now incorporating AMT technology into new production systems. This has resulted in significant improvements in production rates and resource recovery, and has provided the enabling technology for advances in automation. AMT will continue to work with equipment manufacturers with the goal of providing a complete and integrated highwall monitoring and control system incorporating AMT inertial and horizon control technologies.

GeoTek Solutions

GeoTek Solutions provides niche engineering geology and geotechnical services, particularly in the area of slope stability. It is now in its fourth year of operation. The decision to base its operations in the Technology Transfer Centre resulted from a recognition of the value of CSIRO technology and QCAT's excellent library.

GeoTek Solutions has taken up a licence to CSIRO's Sirovision technology and based on that technology has enjoyed a growing relationship with CSIRO. During the past year GeoTek Solutions, in association with another Queensland consultancy, Sherwood Géotechniques, has used Sirovision to produce detailed geotechnical 3D maps of highwalls in mines located in Queensland's coal fields. Sirovision, which is based on terrestrial photogrammetry, enables safe mapping of previously inaccessible rock faces from remote locations, without disrupting mining. The benefit to CSIRO of having a licensee located on its campus is improved understanding of users' needs, which has quickly flowed into product improvements. In the coming year, GeoTek Solutions will work with CSIRO to improve this technology, which is gaining international acceptance.

Cooperative Research Centre for Coal in Sustainable Development

The Centre established its headquarters at QCAT in 2002, bringing together most of Australia's black coal researchers as well as experts in sustainability. Government and industry have committed $61 million over a seven-year period to discover opportunities for coal chain efficiencies and reducing carbon intensity, providing a better understanding of Australian coal performance in combustion, gasification and emerging sustainable coal utilisation technologies. Other research includes environmental and social assessment, ironmaking, and by-product and waste utilisation. The Centre provides opportunities for postgraduate study, and enjoys strong support from industry, government departments, CSIRO and the universities.

During the year we reported on several important issues relating to coal in sustainable development. In studies of hazardous emissions from power stations we found that current reporting protocols over-estimate mercury emissions significantly. We also examined options for advanced technology power generation in Australia, taking account of greenhouse gas considerations and possible coal technology developments over the next 50 years.

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