QUEENSLAND CENTRE FOR ADVANCED TECHNOLOGIES

Pullenvale
Brisbane
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99/00

CSIRO

vision

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

mission

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

QCAT occupants

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 with the goal of increasing the international competitiveness and efficiency of Queensland's and Australia's resource based and related industries.

QCAT is a joint venture between the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the State Government of Queensland originating in 1990. 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 Science and Technology
Cooperative Research Centres for:
Black Coal Utilisation
Cast Metals Manufacturing (CASTMM)
Landscape Evolution and Mineral Exploration (LEME)
Commercial Occupants:
Australian Centre for Mining Environmental Research Limited (ACMER)
Cutting Edge Technology Pty Ltd
GeoTek Solutions Pty Ltd
Reservoir Solutions Pty Ltd

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FOREWORD

Rapid globalisation over the past decade has seen Australia emerge as one of a small number of key centres of the world minerals industry. It accounts for approximately 38 per cent of Australia's total exports ($33 billion) with oil and gas exports adding a further 6 per cent. More than 130 companies within Australia export mining equipment, technology and services to over 50 countries around the world.

The Queensland Centre for Advanced Technologies (QCAT) was established through an agreement between the Commonwealth and Queensland Governments to expand and diversify the research and development activities undertaken by CSIRO in Queensland. The Centre is now recognised as a world class research facility for the mining, energy and manufacturing industries.

The unique mix of disciplines and industry applications located at QCAT combined with state-of-the-art laboratories has achieved a spirit of excellence, cooperation and client industry delivery, providing substantial returns on the investment made by the Commonwealth and Queensland Governments into research and technology based infrastructure.

A further investment of $24.43 million by the Queensland Government for physical infrastructure, together with a continuing investment of $23 million through the Commonwealth Government and industry, has enabled the Centre to increase its research portfolio through a QCAT Stage 2 expansion. As part of the initial expansion the Centre has established new laboratory space, office and process bay accommodation and a technology transfer building to accommodate associated industry companies and staff.

The continuing investment made by the Commonwealth and Queensland Governments and CSIRO has ensured the growth and diversification of research and development activities in Queensland and Australia.

I commend the science and the new developments achieved by all the staff in 1999/2000. They provide the pathway to an exciting new era for Australia and the global economy.

Senator the Hon Nick Minchin
Minister for Industry, Science and Resources

Senator the Hon Nick Minchin, Minister for Industry, Science and Resources.

executive manager

Dr John Read, Executive Manager, Queensland Centre for Advanced Technologies.

During the last year we have witnessed significant changes to the Queensland Centre for Advanced Technologies (QCAT) as construction of the Stage 2 expansion has progressed through its various stages. Work commenced in July 1999. The technology transfer centre was completed in late June 2000 and the new research laboratory, technical and process bays and expanded research support facilities were handed over for occupation in late September 2000. These new facilities will increase the Centre's capacity from 250 to 360 research staff and provide a strong base for considerable expansion and diversification of the research and development now performed at the Centre for the Australian minerals industry.

During the expansion process, staff at QCAT continued their work on an assortment of innovative and challenging projects in collaboration with the minerals industry. Typical of these are:

In mineral exploration, where the Airborne Gravity Group has developed a prototype system which obviates the interference to gravity measurements caused by normal motions of the aircraft. The new system will be capable of enhancing geological interpretation by identification of buried structures and also of targeting buried orebodies down to a scale of approximately 300 metres at burial depths of 200 metres.

In sustainable mining, a prototype collision avoidance system incorporating digital RF technology and high resolution video has been developed, built and tested. This has eliminated the need for reversing alarms on large mining equipment and is greatly improving safety.

In coal processing and utilisation, successful field trials with a large diameter classifying cyclone at the Stratford mine in New South Wales have been completed. The unit has the potential to markedly simplify fine coal circuits. It now appears that this unit actually performs better than some conventional cyclones and a number of new design initiatives are now possible.

In iron ore processing, the group has constructed and commissioned at QCAT a fully instrumented pilot scale hydrocyclone test facility for optimising desliming of iron ores, improving hydrocyclone design and validation of holistic CFD models.

In foundry technology, a new cover gas system has been announced that can prevent oxidation of liquid magnesium. If this gas were adopted word-wide to replace the current industry standard (sulphur hexafluoride) the greenhouse savings would exceed 5 million tonnes of carbon dioxide equivalent per year.

Our work touches many aspects of Australian life, ranging from the discovery of new world class mineral deposits that improve Australia's economic performance to the continual improvement in environmental performance of the minerals industry for community benefit. I congratulate all of the staff at QCAT in 1999/2000 for their outstanding contribution to the success of the Centre and innovative new research developments as they ensure QCAT remains a world class facility vital to Australia's future.

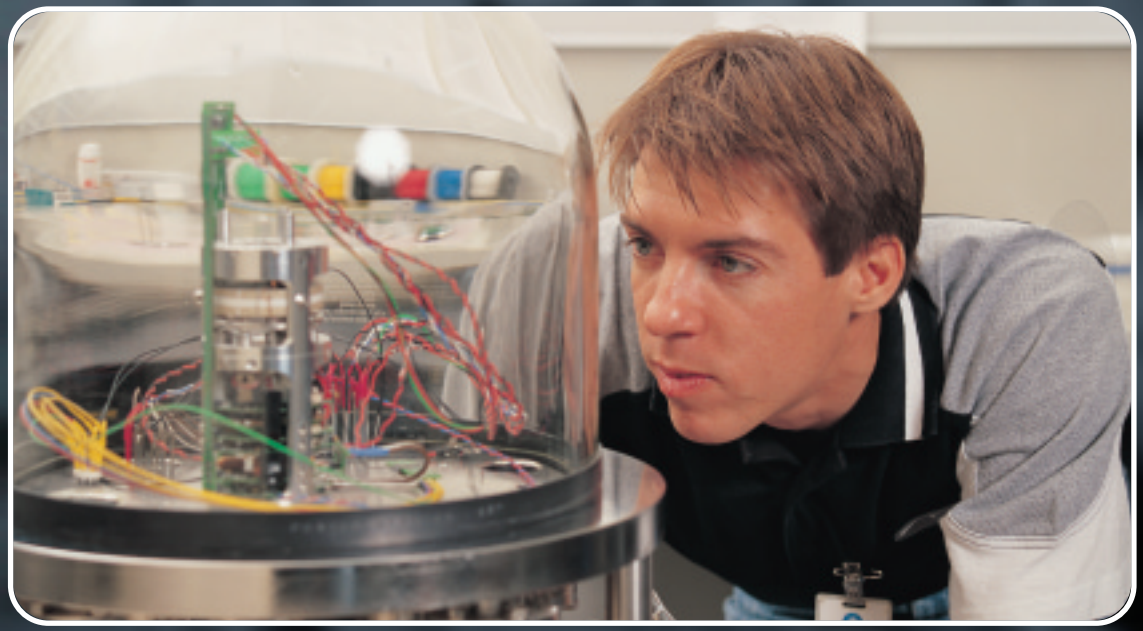
Dr John Read
Executive Manager
Queensland Centre for Advanced Technologies

The Cooperative Research Centre for Landscape Evolution and Mineral Exploration (CRC LEME) specialises in mineral exploration, geochemistry, landscape evolution, and in the processing and interpretation of digital spatial and exploration data. Activities this year have centred on regolith mapping, landscape evolution and geochemical dispersion studies in central Australia focusing on the Arunta Block and the Amadeus and Ngalia Basins. The Northern Territory Geological Survey and Gutnick Resources NL separately funded these activities.

Following the successful completion of AMIRA P491 (Interpretation of Aerial Gamma-Ray Surveys) project, work has continued to develop spatial analysis techniques to assist in the interpretation of exploration data sets, resulting in a new AMIRA proposal being circulated (Innovative Analysis of Multiple and Complex Spatially-Located Exploration Data – AMIRA P688).

As part of ongoing collaboration between CSIRO Exploration and Mining and the Queensland Department of Mines and Energy, several sites in Central Queensland were examined for their mineral prospectivity. Aerial geophysics and satellite data were integrated with mineral occurrence information to outline prospective areas.

mineral exploration



Mr Mark Kochanek evaluating components of a prototype airborne exploration system.

Airborne Gravity

A major development program to design and produce an airborne gravity gradiometer is progressing particularly well. The system will allow exploitation of the remaining window of geophysical opportunity for airborne exploration and will complement magnetic, electromagnetic and spectrometric surface minerals analysis techniques developed at other sites. It will be capable of enhancing geological interpretation by identification of buried structures and also of targeting buried orebodies down to a scale of approximately 300 metres at burial depths of 200 metres. Details of the system are currently held as commercial in confidence to enhance its commercial viability in the industry.

The first laboratory prototype of the system has now been completed, and proof of concept experimentation is proceeding. Commercialisation partners are being sought to complete the work.

Research Achievements

CSIRO's Airborne Gravity Group has developed a prototype system, which obviates the interference to gravity measurements caused by normal motions of the aircraft.

Reports as to the mineral prospectivity of sites near Mount Morgan in Central Queensland have been prepared for the Queensland Deparment of Mines and Energy.

The final meeting of the extension to AMIRA Project P-491 was held in September 1999. Code for algorithms developed during the project have been made available to sponsors.

Technology Transfer

CRC LEME workshops were held for sponsors of AMIRA Project P-491 at various locations around Australia.

geophysics

Mr Michael Stevens assembling a miniature strain instrument.

Geophysical data acquisition systems will control next century mining systems, monitor real time development of the mining operation, and contribute to safety in mining by enabling improved automation, and by better monitoring of the stability and ground response to mining. The key targets of this group are to develop and demonstrate new techniques for deposit delineation and rock mass characterisation necessary for maximisation of recovery of reserves and for minimisation of dilution.

The requirements for deposit delineation, rock mass characterisation and safety are shared by the metalliferous and coal mining sectors and are addressed from a common technology base.

Research Achievements

New spectrometric nuclear logging tools have been provided for the industry through our licensee Scintrex/Auslog. These provide coal and ore quality estimates from boreholes for precise resource quality maps used in production scheduling.

Computer based analysis procedures are being applied to 3D seismic and borehole tomographic data to provide images of geological structures and boundaries beneath the earth's surface. Through geophysical imaging, geological boundaries and rock structures can be mapped without extensive drilling. Geophysical imaging is allowing overall geological conditions to be established with far greater certainty.

Thirteen field studies of induced failure mechanisms using microseismics at Australian coal mines have been performed. One system has been exported to China. This tool is now being used at several minesites to enhance the understanding of dynamic migration of stress failures associated with longwall mining and goaf generation in underground mining and for the study of gas emissions.

Development of new and simplified instrumentation to directly measure ground deformation for mine planning, safety and productivity. In a trial project observations of loading and deformation have been used to increase longwall recovery ratios by 5% without compromising safety margins.

Technology Transfer

Technology transfer is by licensed agreements with equipment manufacturers and geophysical software vendors.

coal mining

Research and development in coal mining is focussed on multidisciplinary areas, which effectively use fundamental science to feed applied approaches to the coal industry. Several groups in CSIRO Exploration and Mining and Manufacturing Science and Technology are working together with several external groups to deliver applied technology solutions to major industry issues. These range from optimising mine design, lowering pit costs, enhancing reserve estimation, increasing recovery to reducing geotechnical risk in mining operations. A team approach is crucial, as industry problems require the integration of disparate disciplines.

Research Achievements

Investigations into improved techniques of thick seam mining are underway. These are focusing on top coal caving (TCC), as practiced in China, and on hydraulic mining. A relationship agreement has been signed with the YanKuang group to assist in the introduction of TCC techniques into Australia. Both methods have the potential to access several billion tonnes of prime Australian coal that can not be accessed with conventional mining methods.

Development of the geological 'supermodel' has already shown benefits to several mining operations. The ACARP supported project joins all of the operations in the Central to Northern Bowen Basin and has helped to better characterise regional sedimentological and structural controls on mining conditions.

Techniques developed in past highwall mining projects are now moving underground. Span and pillar stability tools are now being applied to proposed augering layouts and place changing for underground mines.

A CSIRO/JCOAL project 'Rapid Roadway Development' has successfully demonstrated the world's first autonomous feed and bolting system. The system will be utilised in a new Autonomous Conveying and Bolting Module (ACBM) to be constructed in 2001. The system uses the new BHP (OneSteel) self-drilling Ezybolt and will have up to 400 roof-bolts and 200 rib-bolts live on the machine.

A JCOAL sponsored gas project at a Hunter valley mine successfully assisted the mine to improve its gas capture by more than 250%. This research is contributing to safety goals and minimising lost production from shutdown due to gas problems.

Newly developed 3D mapping techniques that utilise digital photogrammetry to map rock mass structure are being used in open pit mines. 3D maps of sections of a highwall up to 10,000 square metres can be produced from a stereo pair of photographs to map the geology and joint structure quickly and effectively.

3D-visualisation research this year centered on ACARP project C8015. Its primary objective was to demonstrate an interactive, 3D computer visualisation technique that integrates drilling, 3D-seismic, geology, pit-layout data for assessment, prediction and communication of mining conditions and geological disturbance of coal in an underground mine. This technique utilises current Internet based technologies and manifests itself as the CSIRO 'Virtual Mine' which has been well received by BHP Coal and Anglo-American.

New automated imaging techniques to fingerprint coals have been developed. For single seam coals this fingerprint can be used to determine the coal's rank and type, and to predict its performance during coking and combustion.

A joint CSIRO / Julius Kruttschnitt Centre project has resulted in a pit to port fragmentation model for coal. Improved practices as a result of the utilisation of the model may improve coal recovery by several percentage points and result in significant improvements in site profitability.

Technology Transfer

Enhanced 3D sedimentary and structural models have been transferred to several Central Queensland mines.

Dr Guy Le Blanc Smith and Dr Joel Yago evaluating sedimentological and structural models.

Improved guidance technology for highwall mining is being directly used by manufacturers and highwall mining operators.

Improved geotechnical assessment tools are being implemented via one on one contracts with specific Australian coal mines.

Improved gas control techniques have improved one mine's productivity by up to 20,000 tonnes per week.

3D visualisation models are being used to assist new mine development in the northern Bowen basin.

sustainable mining

The highest standards in safety, health and environmental performance are crucial to the long-term viability and acceptability of the mining industry. The Sustainable Mining Group is working to assist the industry in improving its safety and environmental performance through its research in mine gas control, heavy vehicle collision avoidance, greenhouse gas mitigation and new environmentally acceptable resource recovery methods. The group works closely with other researchers within CSIRO Exploration and Mining and CSIRO Energy Technology, and with commercial partners to bring research developments to market.

Research Achievements

A prototype collision avoidance system incorporating digital RF technology, and high resolution video has been developed built and tested in conjunction with Advanced Mining Technology and supported by ACARP. This has eliminated the need for reversing alarms on large mining equipment and is greatly improving safety.

Studies at Dartbrook Mine have developed methods to control high gas flow into the mine from goafs. These are based on goaf gas flow models using FLUENT Computational Fluid Dynamic code which have been verified by tracer gas testing. This is the first work of its type in Australia and is a cooperative venture with the Japan Coal Energy Centre, Dartbrook Mine and ACARP.

Development of a new process utilising methane gas and waste coal which could significantly reduce Australia's greenhouse gas emissions. The collaborative project will significantly increase the level of reserve recovery and will provide a way of reducing up to 85% of fugitive methane gas produced by Australian underground coal mines.

Technology Transfer

Goaf gas modelling and implementation of the results at Dartbrook Mine has increased the efficiency of goaf gas drainage by 40% and allowed the mine to reach ventilation specifications required by regulators and control heatings in the goaf.

As a result of the collision avoidance system project taking place at Bengalla Mine, they have adopted the use of high resolution colour cameras on their haul trucks. The camera systems alone have provided a tremendous safety and operational improvement. A commercial system is now available.

CSIRO's prototype collision avoidance system is greatly improving mine safety.

coal processing and utilisation

CSIRO Energy Technology has a major component of its Coal Preparation Group based at QCAT. This group is strongly focussed on addressing the issues associated with preparing Australian coals for sale on the international market.

CSIRO Energy Technology has also moved part of its Energy Conversion Group to QCAT. An Advanced Gasification Research Facility has been established to evaluate the performance of Australian coals in emerging power generation technologies. The focus of the work is on the performance of Australian coals in Integrated Gasification Combined Cycle (IGCC) power generation technologies. These technologies have the potential to significantly reduce emissions and enhance the efficiency of large-scale power generation from coal. The research with the new facility is aimed at supporting future export markets of Australian coal into these new technologies to provide technical data necessary to assess and adapt these technologies for use in the Australian power generation industry. This work is being performed through the Cooperative Research Centre for Black Coal Utilisation.

Research Achievements

The coal preparation team completed successful field trials with a large diameter classifying cyclone at the Stratford mine in NSW. This unit has the potential to markedly simplify fine coal circuits. It now appears that this type of unit actually performs better than would be expected and a number of new design initiatives are now possible.

The pilot scale Turboflotation system has been shown to produce acceptable metallurgical performance with four different coals feeds with a capacity rating twenty times that of normal flotation. A 30cm diameter development system has been constructed and detailed investigations carried out at South Blackwater and Catherine Hill Bay coal preparation plants. The results were encouraging enough for the next phase of the project to be initiated. Ludowici Mineral Processing Equipment and CSIRO are combining efforts to construct and investigate a full commercial scale (1m diameter) system at Coppabella. Numerous other applications of this new technology have been identified.

Mr Daniel Henderson with Advanced Gasification Research Facility.

ACARP have provided funding to the CRC for Black Coal Utilisation to perform an initial assessment of a wide range of Australian coals using the gasification facility. A second ACARP/CRC funded project has also been established to undertake more detailed examinations of promising Australian coals in order to define appropriate coal test procedures and to determine optimum operating conditions for different coal types.

Technology Transfer

Presentations on the outcomes of the large diameter cyclone, coal breakage and Turboflotation project were given at the ACARP Symposiums in Singleton and Emerald.

The CRC 'Research Symposium on Entrained-Flow Gasification' was held at QCAT on 27-28 October 1999 where CRC work on coal pyrolysis and gasification, mineral reactions, slagging issues, technology assessment and modelling were presented. Guest speakers from Japan and Korea described their experience with IGCC technology development and the use of Australian coals in their pilot scale facilities.

The CRC for Black Coal Utilisation has been invited to join the advisory panel for an international project on high-pressure gasification kinetics that is being developed with the United States Department of Energy. This project involves Brigham Young and Brown Universities in the US and the University of Stuttgart. This represents a valuable opportunity for the group to maintain effective working links with some of the worlds most active research groups in the fundamentals of high-pressure gasification systems.

The major focus of research within the Mining Technology Group is the mechanical excavation of minerals. Over the past 12 months, two key areas in hard rock cutting have been under intensive investigation;

The use of ultra-hard materials (UHM) as the cutting elements in conventional tool designs such as picks, saw blades and drill bits.

The use of an 'activated' tool in the Oscillating Disc Cutter (ODC), a technology that has been proposed for sometime and recently successfully demonstrated at QCAT.

While UHMs in the form of polycrystalline diamond (PCD) have made in-roads into the drilling technology for the oil and gas industries, there has been little progress with these smart, hi-tech materials in coal and metalliferous mining. This temporary impasse has changed with the commercialisation of Advanced Diamond Composite (ADC), which is an Australian scientific discovery of the late 1980s. With this revolutionary new material it has been possible to produce suitably shaped cutting elements for mounting in tools that can be transferred directly into existing mechanical extraction machines such as road headers and continuous miners. Cutting trials at QCAT indicate that the forces required to cut hard rock (UCS greater than 240 MPa) using ADC are quite small. The added advantage of an ADC-based cutting tool is its outstanding wear resistance and hence its capacity to remain sharp and reduced frictional heating at the cutting face which is vitally important in mining conditions exposed to the risk of frictional ignition. ODC has progressed from a laboratory set-up into a prototype machine that is currently undergoing cutting trials in the field.

Both research activities have demonstrated that there are viable alternatives to the traditional method of excavating strong rock using drill and blast methods. With mechanical excavation it is now possible to plan operations based on selective mining. The continuous nature of these cutting operations along with greater control over product-size distribution offers great potential for more economic excavation of ores with the added advantage of producing minimum environmental disturbances.

Research Achievements

ADC can now be moulded into selective shapes for attachment to conventional cutting tool bodies.

Innovative bonding processes have been developed to attach ADC elements to the tool body.

Three provisional patents have been submitted to cover the use of ADC in picks, drill bits and saw blades.

A prototype ODC machine has been developed and is currently under trial to assess the operating parameters.

Technology Transfer

Successful trialing of ADC-based pick designs has formed the basis for the development of a commercial group to market ADC tools for rock excavation in both mining and civil engineering applications.

Commercialisation of ODC worldwide is currently being negotiated with Terratec Asia Pacific Pty Ltd. Funding for prototype field tests comes from the Australian Mineral Industries Research Association (AMIRA) via a consortium of eight major mining companies around the world.

Mr Craig Harbers evaluating a prototype advanced diamond composite pick design.

automation

Automation activities at QCAT are performed by staff from CSIRO Manufacturing Science and Technology and CSIRO Exploration and Mining. Research and development is normally applications-oriented with staff using skills in the areas of robotics, machine vision, image analysis and systems control. The majority of work is currently focussed on research towards the automation of existing mining systems and the development of new automated mining techniques. The prime objectives of the group are to improve safety by removing people from hazardous areas and to improve productivity.

Other significant research areas include, the development of automated volume estimation technology (particularly in the freight handling industry) and research into automated flight control of small helicopters.

Research Achievements

The AMIRA sponsored autonomous vehicle research project successfully developed and demonstrated a new system for relative navigation and guidance. The project was restructured to assist the commercialiser to integrate the technology into a commercial product.

Dragline swing automation has been demonstrated, with the system controlling all major elements of a dragline's swing cycle. The productivity increase for a typical mine is equivalent to $3 million per year or an industry wide potential of $280 million per year. The system was successfully demonstrated on a BE 1370 production dragline at Tarong in late 1998, and the system is currently being installed in a production BE 1350 dragline at Callide for extended field trails.

Automatic estimation of the volume of material in a shovel dipper (bucket) and in haul trucks has been achieved. This was achieved with the aid of 2D range image processing techniques.

An expedition onboard the Research Vessel Franklin was undertaken to the Bismarck Sea to study the hydrothermal mineral deposits. Life forms such as bacteria and mineral samples were collected and identified. The vents are rich in sulphide mineralisation that may be a future source of minerals. The biological life forms may be useful for terrestrial mining and mineral processing. A range of geophysical instruments was also tested.

Development of the Location And Monitoring for Personal Safety (LAMPS), was successfully completed and culminated in a demonstration within an underground metal mine. This project produced generic technology including a survivable wireless communication network.

Successful CSIRO INS-based highwall coal mining guidance technology is being applied to underground longwall automation. A new method for navigation of a longwall shearer has been patented.

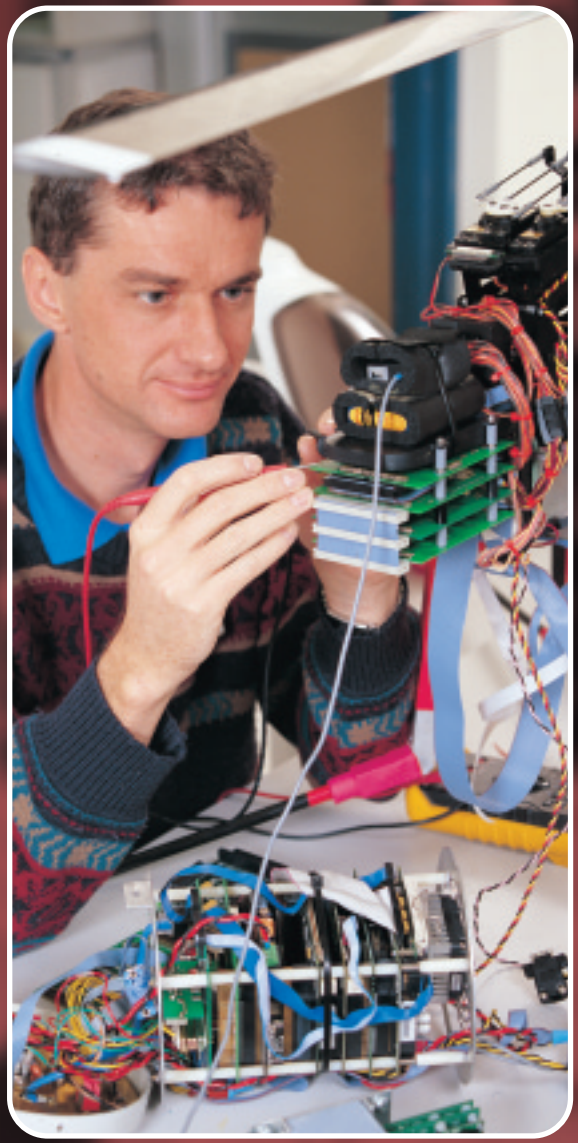
Technology Transfer

The new automated vehicle technology has been licensed to a new company (Dynamic Automation Systems) formed as a joint venture between Caterpillar Elphinstone and Lateral Dynamics to commercialise the technology.

Negotiations have begun to develop a commercial prototype instrument that will automatically measure the volume of mining equipment such as trucks, rail wagons and shovels.

A project to commercialise the LAMPS technology has begun with in collaboration Mine Com Australia as a commercial partner.

Roche Highwall Mining has commercialised the guidance system used in continuous miner-based highwall mining operations.



Mr Leslie Overs working on the automated flight control of a small helicopter.

processing non-ferrous minerals

Mrs Brenda Peckin preparing sample blocks for mineralogical analysis.

Non-ferrous mineral processing research at QCAT is focused on developing new and improved methods for ore characterisation, comminution, liberation analysis, process optimisation and process modelling to meet the current and future needs of the mining industry. CSIRO Mineral's research staff are at the cutting edge in mineral processing research with a strong appreciation of the key technological issues facing industry.

The industry drivers continue to be improved ore characterisation methods and more efficient techniques for processing fine grained ores, particularly improved feed preparation and grinding optimisation. Leo Electron Microscopy Ltd is now actively marketing the CSIRO QEM*SEM technology as QemSCAN. In the last year one machine has been sold in North America, with further prospects in North and South America, Europe, South Africa and the Middle East. Mineralogical skills are currently being coupled with processing expertise to deliver a multidisciplined research package. This will enhance research efforts and will provide better solutions for industrial clients in plant problem solving and optimisation.

Research Achievements

Development of new techniques for monitoring and, ultimately, control of Autogenous Grinding (AG) and Semi Autogenous Grinding (SAG) mills using a combination of online capture of mill shell vibration data together with a better understanding of mill charge behaviour derived from discrete element modelling.

Further development of new ways of using high pressure grinding rolls in mineral processing, and the further improvement of process models of the units operation.

Application of QemSCAN technology to the characterisation of drill cuttings to assist in stratigraphic sequencing in petroleum and gas reservoirs.

Application of QemSCAN technology to the location, identification and classification of indicator minerals as an aid to mineral exploration.

Technology Transfer

Collaborative projects and strong linkages with mining companies, equipment manufacturers and service suppliers to demonstrate the application of new and improved mineral processing technologies in company operations.

QemSCAN measurement service to industry for supply of mineralogical data. Approximately 2000 samples were measured during the year for Australian mining companies. This work helps to ensure that QemSCAN technology is appropriate to present and future industry needs.

Presentation of papers at several conferences, including Minerals Engineering 2500 in Adelaide and the International Mineral Processing Conference in Rome.

A further QemSCAN Users meeting in Johannesburg to share experience in the application of QemSCAN to mineral processing.

Training of undergraduate and postgraduate students from overseas Universities in mineral processing.

iron ore processing

With the gradual depletion of premium grade Brockman ores and the continuous downward pressure on prices in real terms, Australia's iron ore industry continues to face challenging times. New ore types, such as pisolitic, Marra Mamba and magnetite ores, are either being developed or are under consideration, and new products such as hot briquetted iron (HBI) are being introduced onto the market. Consequently, iron ore processing research at QCAT is still focused on development of new and improved methods for ore characterisation, comminution, beneficiation, sintering, sampling and quality control. Characterisation of iron ores and prediction of downstream processing performance using optical microscopy and computer-based image analysis techniques continue to be a key aspect of current research. This is backed up by a wide range of complementary techniques such as electron microscopy and electron microprobe analysis at the Melbourne laboratories of CSIRO Minerals. Following development of a large diameter (100 mm) Hopkinson bar facility for breakage characterisation, an instrumented crusher for optimising comminution performance, and a wet beneficiation pilot plant for production of high grade concentrates for direct reduction processes, attention has now been directed to development of a hydrocyclone pilot plant for processing the lower grade ore deposits in Australia. The fully instrumented facility has been commissioned and can accommodate hydrocyclones up to about 250 mm in diameter. It is being used for the development and optimisation of flowsheets for desliming iron ores. Data collected using the facility will also be used to validate CFD (Computational Fluid Dynamics) models of hydrocyclones, which will be used to improve their design. In addition, because the proportion of Australian iron ores being mined from below the water table is increasing, expertise in the dewatering of iron ores is being developed. Finally, development of better sampling methods and standards for iron ore is continuing both to improve quality control procedures and optimise the life of ore resources.

Mr Jonathan Campbell monitoring hydrocyclone performance.

Research Achievements

Successful demonstration and laboratory scale validation of a model for predicting iron ore beneficiation performance from optical image analysis and liberation data.

Development of dedicated laboratory facilities for small scale sintering, reduction and degradation testing of iron ores.

Construction and commissioning of a fully instrumented pilot scale hydrocyclone test facility for optimising desliming of iron ores, improving hydrocyclone design and validation of holistic CFD models.

Construction of a state-of-the-art pilot scale sintering facility at CSIRO Minerals' Melbourne laboratory for installation and commissioning at QCAT in late 2000.

Development of a draft ISO (International Standards Organisation) standard for sampling DRI (direct reduced iron) and HBI.

Technology Transfer

Collaborative projects with mining companies, equipment manufacturers and service suppliers to demonstrate the application of new and improved iron ore processing technologies in company operations.

In-house training of company mine geologists and metallurgists in iron ore classification schemes to help maintain product quality and consistency.

Sampling and quality control audits of mining company operations.

Training of undergraduate and postgraduate students from Queensland and overseas Universities in mineral processing.

CSIRO Minerals bursaries at Queensland University of Technology.

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

ACMER provides research and training in environmental management for the Australian Minerals Industry.

The ACMER vision is to be an internationally recognised centre of excellence supporting continual improvement in environmental performance in the minerals industry for community benefit.
It is pursuing this vision by:
conducting environmental research on issues of strategic importance to the minerals industry to implement sustainable solutions which are acceptable to industry, government and the community; providing the scientific and technological foundations to facilitate industry and government in defining and achieving acceptable standards for environmental management; acting as a networking and communications focus of mining environmental research and practice in Australia; and enhancing education and training in mining environmental management.

Major research programs of the Centre include waste rock dump stability, final void water quality, acid mine drainage, tailings disposal and remediation, and ecosystem reconstruction processes and strategies.

Research Achievements

National review of practices on mine sites to manage sulfidic wastes and associated production of manuals for the minerals industry on (1) techniques for characterization of sulfidic wastes, (2) management of these wastes and acid drainage and (3) the use of risk assessment as a tool in sulfidic waste management.

Identification of the factors affecting the seed dormancy of key native plant species used in revegetation programs across Australia and development of methods to break dormancy.

Creation of a national database (Floradata) on the collection, storage, germination, propogation and field establishment of seed of Australian plants for use by mining companies and community groups in revegetation programs.

Technology Transfer

During 1999/2000, the Centre conducted Short Courses (SC) and Workshops (W) which were attended by mining industry, government, research and consulting personnel. Topics included:
Rehabilitation Issues for the Coal Industry in Queensland (W), (Emerald);
Practical Implications of Greenhouse Emissions Management for the Minerals and Energy Industries (W) (Brisbane);
Cyanide Management in Mining (SC) (Townsville);
Environmental Issues in Decommissioning and Temporary Closure (SC) (Townsville);
Tailings Management for Decision Makers (W) (Sydney) (in conjunction with ACG);
Introductory Course on Acid Mine Drainage (SC) (Townsville);
4th Australian Workshop on Acid Mine Drainage (W) (Townsville).

In addition, with assistance from the Department of Industry, Science and Resources, the Centre commenced a program to assist small-medium miners and quarry operators in improving their environmental performance. Courses were presented in Townsville, Rockhampton and Charters Towers.

foundry technology

CSIRO Manufacturing Science and Technology scientists undertake research in casting technology and in alloy design in three main areas:

Process technology - developing existing casting processes in order to improve both quality and productivity; investigating new processes for making high integrity castings and adapting existing processes for use with new alloys.

Tooling performance - modifying the design of dies to produce improved castings; extending die-life by appropriate surface engineering and also by the development of new die coating materials.

Alloy performance - developing and optimising both aluminium and magnesium alloys to produce increased strength and fatigue resistance at room temperature and at elevated temperature.

The total effort in the Division in these areas (including our laboratories in Melbourne and Adelaide) is over 50 full-time technical and research staff in collaboration with several external agencies, including the Cooperative Research Centre for Cast Metals Manufacturing (CASTMM). QCAT utilises 6 full-time staff working in the areas of Process Technology and Alloy Performance. The research team at QCAT has developed leading edge technologies for the casting of magnesium and for the production of magnesium alloys. Capability in numerical modelling of casting is of world standard with work being undertaken for Australian foundries in addition to supporting internal projects. The work on mechanical properties of both aluminium and magnesium alloys is being used to support Australian foundries, notably those supplying castings to the automotive industry.

Research Achievements

The magnesium project team has 6 patent applications in various stages of progress. The first Australian patent from this work was granted in June 2000, for an ingot-casting wheel.

Details were released in early 2000 of a new cover gas system to prevent oxidation of liquid magnesium. If this gas were adopted word-wide to replace the current industry standard (sulphur hexafluoride) the greenhouse savings would exceed 5 million tonnes of carbon dioxide equivalent per year.

Mr Bruce Lanham, Mr Stephen Peck and Mr Craig Korn casting a prototype magnesium casting.

A number of magnesium prototype castings have been produced at QCAT over the past year, including some for the aXcess Australia Low Emission Vehicle.

Al-Si-Cu-Mg is an alloy widely used for engine blocks and cylinder heads. Research has been carried out on behalf of a foundry supplying castings to the automotive industry and recommendations have been made for improving current heat-treatment practices and composition specifications.

The fatigue strengths of aluminium alloy castings are largely determined by the presence of casting defects. The relative importance of two common sorts of defect oxide films and shrinkage porosity, have been investigated.

Technology Transfer

Magnesium casting technology developed at QCAT has been successfully transferred to the AMC Demonstration Plant in Gladstone and is now routinely used for producing ingots.

Strategies developed at QCAT for preventing oxidation of liquid magnesium are now being tested internationally as part of plans to make them available to industry.

Earlier research at QCAT showed that the heat-treatment time used for certain automotive castings could be halved with no adverse effect on the tensile or fatigue properties. This work is now the basis for an improved production line being set up by a Victorian-based foundry.

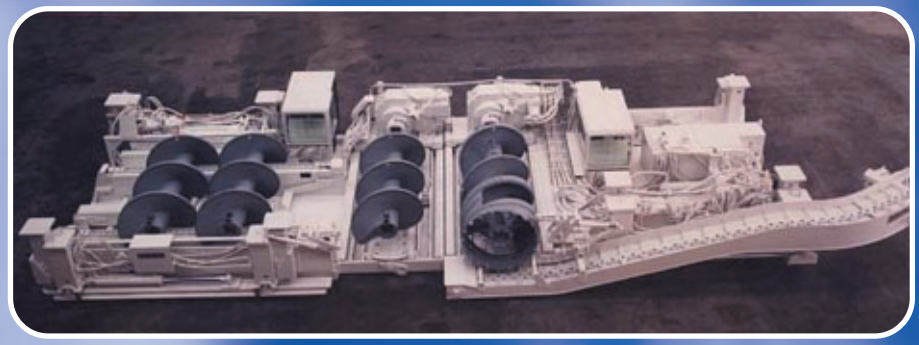
Computer simulation of direct-chill continuous casting is being used to help design a pilot plant in Gladstone that will extend the range of alloys and billet that can be supplied.

pty ltd

cutting edge technology

After several years of research and development of highwall augering systems in surface coal mines, CET has recently embarked upon three new underground mining systems.

A collaborative project between the BryDet Development Corporation, Eskom and Cutting Edge Technology to develop and demonstrate an underground auger mining system culminated in the prototype BryDet BUA 600 starting trials in March 2000 at the Matla Mine in South Africa. The initial trials were undertaken in a box cut to facilitate the commissioning and training associated with a prototype mining machine. The target depth, of 80m, was achieved for the first time in only the third hole drilled. A total of 30 holes were augered in the box cut before the machine was moved underground. The prototype machine continued to perform well in the underground environment and proved itself able to auger coal, handle auger flights and manoeuvre effectively within the physical constraints of the roadway.



The BryDet BUA 600 underground Auger in South Africa.

In January 2000, CET was awarded a second R&D Start grant from the Federal Government to develop the Roadway Development Auger Mining System (RDAMS). RDAMS utilises an innovative underground auger designed to drill circular cross cut entries between development roadways in longwall coal mines. The unique auger machine (patents in progress) is combined with innovative conveying technology, and existing continuous miners to form the basis for a dramatic increase in the current development rate of underground roadways. Field trials of this system will begin in 2001.

CET, GeoTek Solutions Pty Ltd and CSIRO Exploration and Mining continue to collaborate on geomechanical analysis of highwall mining and more recently, underground auger mining pillars and roadway/entry stability for the RDAMS project. CSIRO Exploration and Mining and GeoTek Solutions Pty Ltd are also providing geomechanical insight into two new underground mining methods that CET has been developing with its operating and manufacturing partners, both in Australia and overseas.

geotek solutions pty ltd

GeoTek Solutions Pty Ltd (GTS) is a new geotechnical and geological engineering consultancy. Its director, Paul Maconochie, has worked in the field for nearly twenty five years and now is operating his own practice.

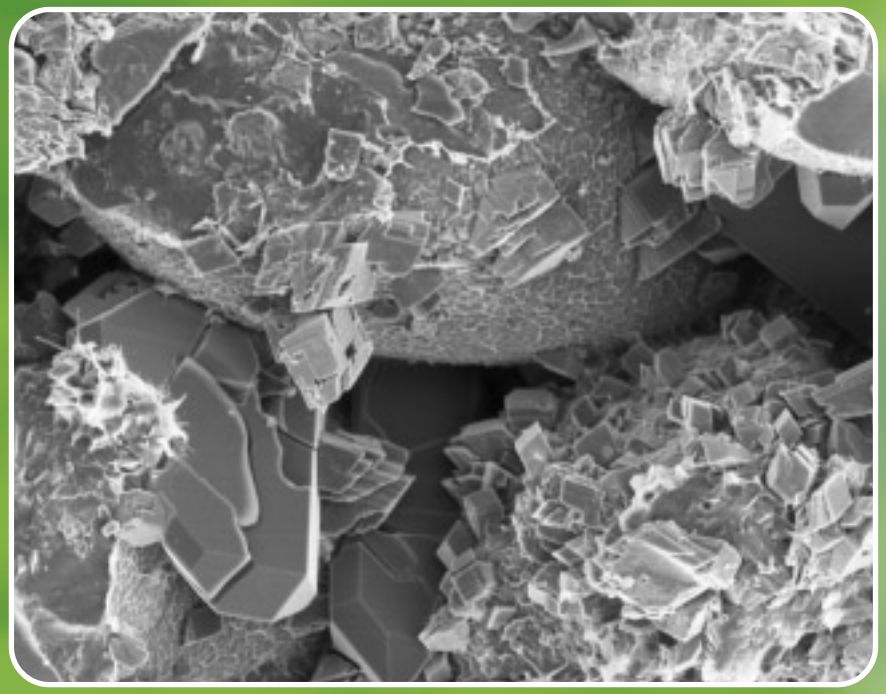
Locating at QCAT was a conscious decision by GTS in its pursuit of building synergistic relationships with other occupants of the site. In the current reporting period, GTS has carried out a number of projects with CSIRO and Cutting Edge Technology Pty Ltd to improve understanding of the geomechanics of longwall, underground auger and highwall coal mining methods. GTS's role has been to provide essential geological engineering input and to undertake numerical modelling. Beyond immediate mining issues, GTS has also provided geotechnical advice for potential water storage in a disused coal pit.

The capabilities of GeoTek Solutions extends beyond coal mining to geotechnical and geological engineering investigations for civil construction and open pit mine engineering. Services include terrain evaluation and slope stability evaluation and analysis. Paul has had extensive experience in the tropics including Papua New Guinea, the Solomon Islands and Fiji where problems like landslip are common and require economical and quick solutions.

In all the work that GTS carries out, the underlying philosophy is that there is no point in attempting engineering design until there is an adequate understanding of the geology and how it will respond to the proposed engineering works. GTS's objective is to work closely with its clients and collaborators to achieve this goal.

Problems such as landslip require prompt economical solutions.

reservoir solutions pty ltd



Reservoir sandstone from the NW Shelf in which pores are partially occupied by quartz and siderite crystals.

Reservoir Solutions Pty Ltd was formed in August 1999 and began operating from QCAT in January 2000. The prime role of the company is to provide petrographic information on hydrocarbon reservoir rocks for the Australian oil and gas industry. Such information can assist in the interpretation and calibration of wireline logs and can be used to better predict porosity and permeability in undrilled areas.

The Director Dr Julian C. Baker, has over 10 years experience working as a consultant sedimentary petrologist. He also has a strong research background, having worked as a Postdoctoral Research Fellow with CSIRO Petroleum Resources and as a Research Associate/Senior Research Associate with the Centre for Microscopy and Microanalysis at the University of Queensland.

Reservoir Solutions Pty Ltd has already carried out a large number of petrographic studies for some of Australia's major oil and gas explorers. Core samples have come from such areas as the NW Shelf, Timor Sea and SW Queensland.

research support

QCAT's 238 staff are employed by CSIRO, the University of Queensland and a small number of commercial companies. CSIRO Exploration and Mining, by means of the QCAT Site Management Committee, is responsible for managing the Centre and for providing safe and environmentally friendly state-of-the-art research facilities for all staff and guests.

The workforce at QCAT is diverse and staff are recruited from Australia and overseas. We employ research scientists, programmers, engineers, and technical and research support staff. Consistent with its mission to create a competitive advantage for Australia's resource and manufacturing industries, QCAT's staffing profile reflects a strong focus on research and development activities.

In 1999/2000 QCAT performed 56 research projects each with annual budgets over $100K. The total value of research expenditure during this period amounted to over $26.7 million of which 67% was funded from CSIRO and 33% from Government, CRC grants and industry funding.

Research activities are conducted in close partnership and consultation with industrial, academic and Government groups to guarantee that the quality of research and development undertaken at QCAT is of only the highest standards.

The Queensland Centre for Advanced Technologies is a facility dedicated to internationally respected research and development. These high-quality research activities demand a specialised IT and user support infrastructure. This vital service is delivered by QCAT's Information Resources Group, which incorporates the Computer Support Group, Records Management and the Library.

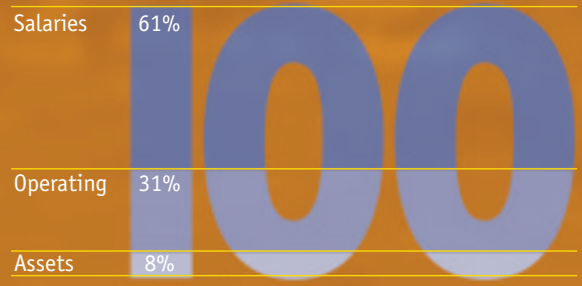
QCAT's Computer Support Group administers a customised TCP/IP network and advises research staff on a case-management basis. Over 600 PCs, printers, workstations, servers and other network devices are maintained by the Computer Support Group, in addition to the operation of a purpose-built and extensive communications network.

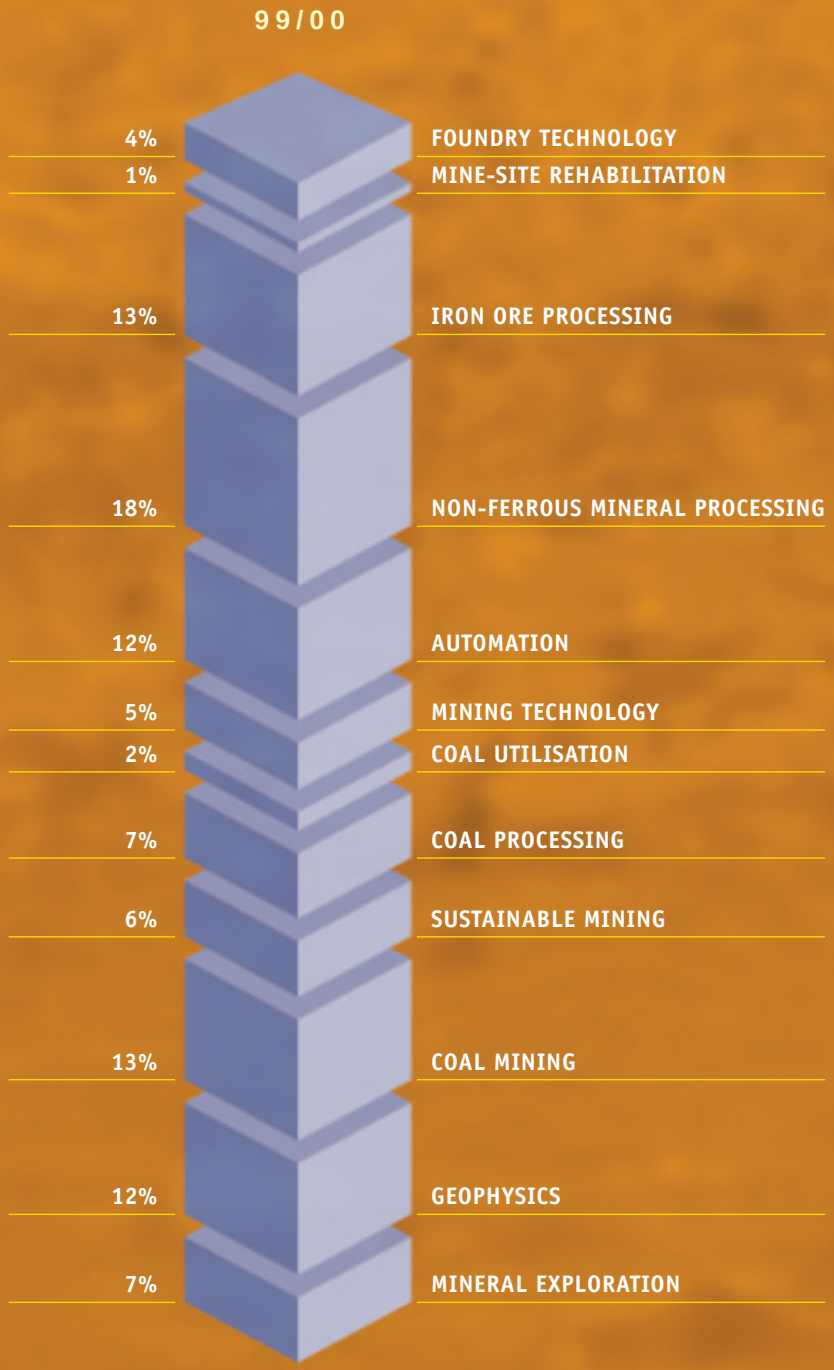
QCAT's professional Records Management staff develop, coordinate and implement records management procedures for participating CSIRO divisions onsite. Staff gather and maintain scientific, corporate and commercial records in accordance with CSIRO policy and best practice procedures.

The QCAT Library is a gateway to a powerful suite of information services which enable CSIRO divisions onsite, CRCs and tenant companies to take advantage of sophisticated electronic information delivery options to realise QCAT's world class research vision.
The library's website is available at "http://www.cat.csiro.au/qcat/services/library/about.htm".

The engineering workshop at QCAT supports research projects requiring the construction of specialised prototypes for mining and processing applications. The workshop operates on a user pays system and is maintained by a workshop supervisor and an apprentice. The workshop carries a wide range of specialised equipment including computer numerical control (CNC) facilities. Examples of their work throughout the year include the construction of a fully instrumented pilot scale hydrocyclone test facility for optimising desliming of iron ores and a range of pressure chambers to carry geophysical instruments onboard the Research Vessel Franklin to study hydrothermal mineral deposits 2500 metres below sea level.

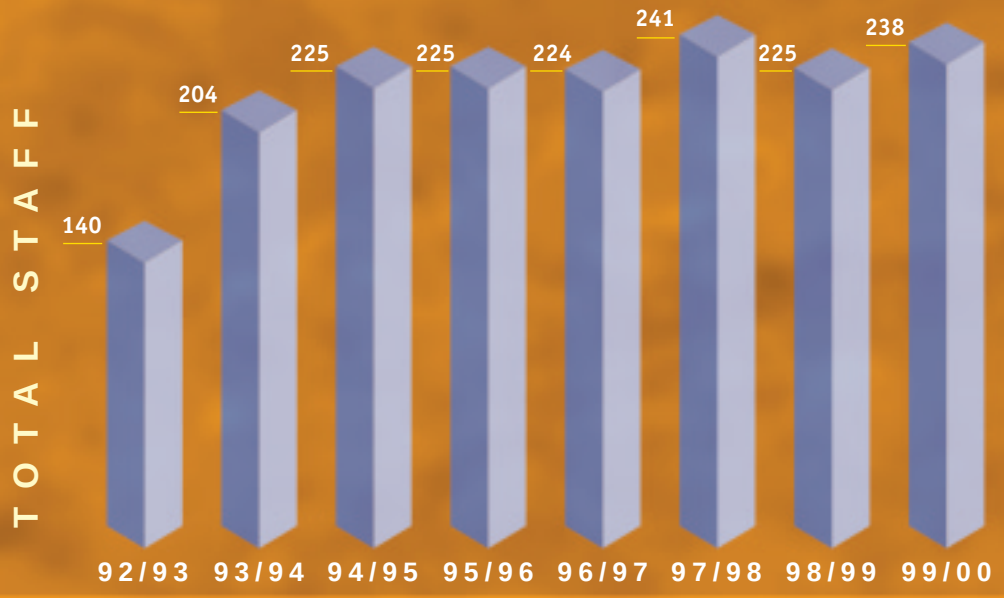
CSIRO QCAT expenditure breakdown



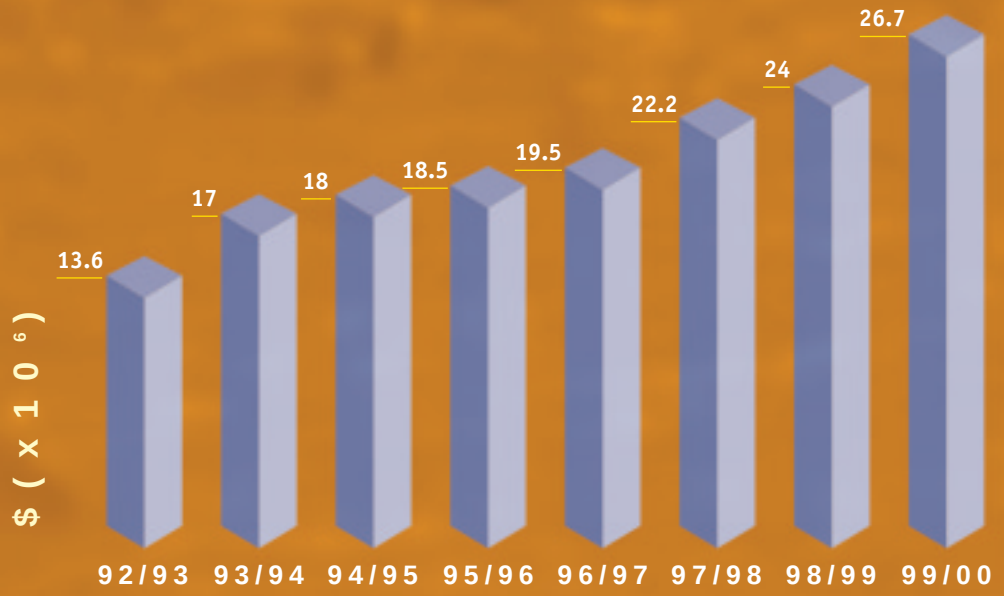


Expenditure by Research Area
as a % of Total CSIRO QCAT Budget

TOTAL STAFF



CSIRO QCAT Total Staff Numbers



CSIRO QCAT Total Research Expenditure

A staged handover of the expansion has been completed in order to utilise the new facilities delivered by the Stage 2 project as early as possible. The wastewater treatment facility was completed in early March 2000. The Technology Transfer Centre was completed in late June 2000, enabling the re-location of commercial collaborators in early July. Early August 2000 saw the handover of the new carparking facility and roadways. The formal Certificate of Practical Completion was issued in early September, and relocation of staff and equipment (including a sintering rig from interstate) completed later that month. The installation of scrubbers for the Sintering facility of the Division of Minerals will not occur until mid-2001, but this is not expected to inhibit any current or projected research.

QCAT stage 2

The expanded facilities will further enhance QCAT's research portfolio and capabilities in the areas of iron ore sintering, ore benefication, non-ferrous processing, automation, mine-safety, rock cutting and coal utilisation. When combined with highly qualified staff and leading edge equipment, the Stage 2 expansion will provide a timely boost for the diversification of research and development activities in the mining, energy and related manufacturing industries in Queensland and the country as a whole.

CSIRO management, industry partners and state Government officials have commented favourably upon the potential of the new facilities delivered by the Stage 2 project. QCAT staff will undoubtedly transform that potential into reality.

Aerial view of the QCAT Stage 2 expansion.

awards and achievements

QCAT values its staff highly and recognises they constitute its most valuable asset. QCAT's workforce is highly skilled and talented as evidenced by the awards and recognition they receive.

Mr Paul Gottlieb, of CSIRO Minerals, received the Sir Ian McLennan Achievement for Industry Award for his development of the QEM*SEM mineral analysis system. QEM*SEM provides automatic computer analysis of stored mineral images and is used by companies to assess the value of exploration discoveries, to streamline the design of metallurgical processes and to optimise the performance of existing plants.

Named in honour of Sir Ian McLennan, the Award recognises his contributions to the application of science and technology to Australia's industrial development. Sir Ian was Chairman of BHP for many years and later Chairman of the ANZ Banking Group and Chairman of Elders IXL. He had been associated with Australian industry for over fifty years and was an enthusiastic supporter of new technology.

Ms Natalie Walker and Ms Elizabeth Scott recipients of the 2000 QCAT Awards.

Dr Binzhong Zhou and Dr Peter Hatherly of CSIRO Exploration and Mining received an ACARP Excellence in Research Award in the Underground category for 2000 for the ACARP project on the Interpretation of Small Scale Geological Features on Seismic Reflection Data.

Stuart Addinell, a final year student studying a Degree in Microelectronic Engineering with Griffith University, completed his Industrial Affiliates Program project (a 6 months full time subject) with QCAT's Automation Group. Stuart received the Farnell Price for the best electronic design solution in the university's Industrial Affiliates Program. Stuart's project involved the development of a dual HC12 based embedded controller to interface to a Tritronics Dragline Monitor.

In 1998 the QCAT Consultative Steering established two commemorative awards. The QCAT Work Achievement and Staff Service Award. The recipients of this years awards were Ms Elizabeth Scott (Work Achievement Award) for her outstanding commitment and contribution to the Computer Support Group, which administers the site computer network and Ms Natalie Walker (Staff Service Award) for fostering excellent staff relationships and for contributing significantly to the well-being and morale of her colleagues and to the improvement of the QCAT work environment.

research projects

CSIRO Exploration and Mining
Super Auger
Collision Warning
Inert Gas Generator
Mine Greenhouse Gas
Mine Gas Control
Tight Radius Drilling
Oscillating Disc Cutter
Fines Minimisation
Geotechnical Assessment
Horizon Control
Sirojoint/Sirofrag
Highwall Mining
Numbat
Location & Monitoring Personnel Monitors
Mine Telecommunications
Rapid Roadway Development
3D Visualisation
Vital Signs Monitoring
Microseismic Monitoring
Coal Quality Modelling
Earth Strain
Airborne Gravity
Advanced Geotechnical Mapping
Reliability of Closely Jointed Rock Slop
Virtual Mine Safety
Deep Sea Mining
Mining Robots
Slope Stability Systems
Recyclable Energy
High Speed Flexible Drilling
Longwall Geomechanics
Emergency Rescue Vehicle
Rock Cutting & Drilling Technologies
Mine-site Modelling & Visualisation
Rapid Roadway Development
Rapid Low Cost Mine Mapping
Longwall Steering
Borehole Surveying
Undersea Geophysics
Underground Coal Gasification
Waste Coal Turbine

CSIRO Coal and Energy Technology
Turboflotation
Banana Screens
Size Classification
Flow Visualisation
Centrifuging Coarse Coal
Gasification Performance of Australian Coals

CSIRO Minerals
SAG Mill Control by Acoustic Emission Monitoring
Chromite Mineralogy and Flotation Behaviour
Dry Preparation of Copper Ores
Feed and Unit Process Modelling
QemSCAN Applications Development
QemSCAN Hardware and Software Development
Characterisation of Iron Ores
Improved Iron Ore Beneficiation Methods
Hydrocyclone Desliming of Iron Ore
Dry Particle Processing Technology
Sintering of Magnetite Concentrates
Pelletising of Ore Types and Mineralogical Characterisation
Sampling Standards and Methods

CSIRO Manufacturing Science and Technology
Computer Simulation of Casting
Squeeze and Semisolid Casting for Al and Mg Alloys
Mechanical Properties of Al and Mg Castings
Magnesium Production Technologies
Dragline Automation
Automated Underground Haulage
Automated Helicopter
3D vision and Laser Imaging
Haul Truck Volume Estimation

site interactions

INDUSTRY

ACIRL

Australian Magnesium Corporation

AMIRA

ANASPEC – South Africa

ANSTO

Auslog

BHP Research

BHP Coal

Brambles Coal

Broad Spectrum Engineering

Callide Coalfields

Coalbed Concepts

Cobra Resources

Codelco – Chile

Comalco

DMT – Germany

Ernest Henery Mining

Fractal Graphics

Griffth Coal Colliery

Hamersley Iron

Jaques

JCOAL

McArthur River Mining

MIM Ltd

Mincom

Minserve

Mintek

Mt Isa Mines

Newcrest Mining

Nire Japan

Normandy Mining

Northparks Mines

Pacific Coal

Pasminco

Rio Tinto

Shell

SIMTARS

Tarong Coal

Transfield Energy

EDUCATION

University of Adelaide

Curtin University

Deakiun Universiry

Gatton University

Griffith University

University of Iowa State

Moreton Institute of TAFE

University of Newcastle

Oxford University

University of Queensland

Penn State University

University of Arizona

University of Sydney

University of Pupua New Guinea

University of Woollongong

University of Western Australia

University of Del Valle

GOVERNMENT

Australian Defence Department

Queensland Department of Public Works

Queensland Department of State Development

Queensland Department of Mines and Energy

Queensland Department of the Premier and Cabinet

Queensland Mines Rescue

QCAT consultative steering committee

The QCAT Consultative Steering Committee exists to ensure that the QCAT objectives are met. The role of the Consultative Steering Committee is:

to consult with and to provide advice to CSIRO on Research Plans to be prepared by CSIRO and

to review annually the activities of CSIRO at the Centre against the QCAT Objectives.

Dr John G Reid (Chairperson)
Director
Reid Resource Consulting Pty Ltd

Dr Bruce Hobbs
CSIRO
Deputy Chief Executive

Dr John Read
Executive Manager - QCAT
CSIRO Exploration and Mining

Dr Geoff Dickie
Director
Resource Development Division
Department of Mines and Energy
Queensland Government

Professor Paul Greenfield
Deputy Vice Chancellor – Research
University of Queensland

Mr David Whiting
Director
Australian Industry Group – Queensland

Mr Bob Gannon
Special Advisor, Major Projects
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Aerial view overlooking the expanded QCAT Facility and Brisbane CBD.

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