UNDERGROUND MINING
SETTING GLOBAL BENCHMARKS FOR PRODUCTIVITY AND SAFETY

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Cover Image

GEO-LABOUR

'Geo’s find it, Engineers design it and Surveyors keep it in line' by Greg Tossel. Snowden Photo Competition 2011. Image courtesy of Snowden.

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UNDERGROUND MINING
Australian expertise and innovation in underground mining has been developed over many years of domestic and export success.

Australia’s large and diverse local underground mining industry produces a significant proportion of its coal, gold, nickel, copper, zinc, lead, tin, uranium and diamond exports.

The size and scope of Australia’s underground mining industry, its safety culture, high production rates, and the technical challenges associated with depth, geology, seismicity, and mining methods have fostered a thriving services and technology sector. This sector has also been instrumental in the transition of large-scale openpits and associated mine infrastructure to underground operations.

Australia has some of the world’s most productive and technologically advanced longwall coal mines, and many mature, deep base and precious metal underground operations accessed by both declines and shafts.

It is the largest single market in the world for large underground articulated dump trucks, load-haul-dump (LHD) loaders, and technologically advanced development and production drills, and one of the top five markets for high-powered longwall shearers, face conveyors and ancillary coal mining machines.

Much of this expertise and intellectual property is now being exported around the world.

This industry capability statement provides an overview of Australian capability in the underground mining sector, including examples of some of the many Australian companies with specialist expertise.

Talk to your local Austrade representative for more tailored advice and information about connecting and partnering with the Australian mining industry.
Australian underground coal and metal mine safety and productivity benchmarks are among the world's best. At June 2015 in New South Wales, 17 underground coal mines with longwall operations and 4 bord and pillar mines produced 77.4 million tonnes of the state's annual 253 million total raw production. In Queensland, 13 underground longwall mines (out of 53 operating mines in total) produced 46.4 million tonnes of that State's annual production of 253 million total raw coal output.1,2

Australia-wide, about 70 operating underground hard-rock mines used open stoping, sub-level caving, various narrow stoping, and block caving methods to produce ore containing gold, nickel, copper, diamond, uranium, silver, lead, zinc, tin and molybdenum. The majority of underground mines are located in Western Australia, Queensland and New South Wales, with a smaller number operated in South Australia, Victoria and Tasmania.3-9

These mines include one of the world's largest block caving projects at Cadia East in New South Wales and the Olympic Dam mine operated in South Australia, the world's largest known single deposit of uranium and tenth largest copper deposit. Some of the large companies involved in underground mining in Australia are BHP Billiton, Rio Tinto, Anglo American Australia, Glencore Coal Investments, Peabody Energy and Fortescue Metals.

The Australian mining industry's strong equipment, technology and services (METS) sector has made an important contribution to its record of safety and international cost competitiveness. More than 200 companies in Australia supply specialised products and services developed specifically for underground mines.10

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The Australian mining industry has developed products that are delivering safety, efficiency and cost benefits at mines around the world. A number of factors have helped drive growth in this area:

• stringent government safety and health regulations
• strict mining company safety codes
• ground support and monitoring requirements of deep and seismically active mines
• demand for innovative ventilation, remote control, mine dewatering and rock fragmentation solutions
• calls for better, more reliable communication systems in underground environments.

Adding value at every stage -
Australian underground mining areas of expertise
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Key areas of Australian expertise

- remote and tele-remote control of plant and mobile equipment
- machine guidance and automation
- one and two-way underground communication
- mining and blasting
- resource definition drilling
- dewatering and water recycling
- mine backfill formulation and application
- vehicle collision avoidance and detection
- personnel fatigue monitoring and management
- mine production reporting and management
- mine ventilation design and modelling
- mine safety training
- mining equipment
- ancillary items and parts
- material movement and handling
- underground crushing and pre-concentration of ore

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METS companies have created a number of world-leading products, technologies and services to help mines around the world deal with the challenges of harsh and sometimes hazardous environments.

Rising mine development and operating costs during a period of declining average ore grades and generally increasing mine depths and geological complexity have meant that clever design, technology and innovation have become increasingly important in Australian mines.

Building on a long history of working with the country’s export-focused underground mines to meet technical challenges and maintain high safety and environmental standards, Australia’s METS sector has accumulated a wealth of valuable expertise and know-how to bring to international markets.

MINE PLANNING, DESIGN AND OPTIMISATION

The specific challenges of the underground mining environment have led to the development of some unique innovations. Australian consulting companies, contractors and engineering procurement and construction management experts provide input into all aspects of mine planning.

Underground mine ventilation modelling software has been designed by Australian firm Chasm Consulting to simulate airflow, pressure, heat and refrigeration, radon, fire and other critical ventilation data from a model of mine airways. The software is currently being used by more than 1000 mines, universities, consultants and research organisations worldwide.11

A range of highly sophisticated, yet easy-to-use software has been developed by Australian companies for mine planning, advanced numerical modeling and simulation, and ground-surface mapping.

Dr David Beck
General Manager
Beck Engineering

"The mining industry stands to benefit greatly from high-performance computing. There is capacity and opportunities that could be turned on now in simulation, optimisation, forecasting and design."

Image courtesy of Palaris
SAFETY AND PRODUCTIVITY

Automation now plays an important role in surface and underground mines. As part of this shift, Australian mines have tested and proven pilot technologies that have helped the industry achieve new productivity and safety benchmarks. Remote and tele-remote control technologies, sophisticated machine guidance, fit-for-purpose, reliable one and two-way underground communication, and state-of-the-art vehicle collision avoidance and detection systems are major innovation technologies. Australia has an advanced engineering, manufacturing and services base, and global supply presence in these areas. Although automation is increasing, most of the advanced machinery working in mines today is still operated by people.

Two areas in which Australia has developed state-of-the-art expertise and technology are personnel fatigue monitoring and management devices, and simulation training for underground equipment operators. The leading companies in these fields have customers in all significant mining regions of the world.

‘Safety in Mines Testing and Research Station (Simtars) is a professionally independent, functional entity of the Queensland Department of Natural Resources and Mines. It is the premier facility responsible for mine safety research in Queensland. Simtars has developed state of the art mine gas monitoring systems and mine safety training solutions for numerous international clients. Simtars has the advantage of a multi-disciplinary team of scientists and engineers. This knowledge and experience enables Simtars to advise on a wide range of issues related to mine safety training, environmental and occupational health and safety.’

Martin Watkinson
Executive Mining Engineer
Simtars

The Detonation Tube (pictured here) is a national facility established with funding from the Australian Government and ACA Low Emission Technologies (ACALET). The facility, led by Professor Moghtaderi from the Newcastle Institute for Energy and Resources, is part of a $30 million research program on Ventilation Air Methane (VAM) safety and abatement. The Detonation Tube investigates the science behind explosions of hybrid mixtures of coal dust and methane. The findings will determine which countermeasures might be employed to stop and eliminate any flame and explosion propagation along a large-scale VAM capture duct used in an operating coal mine.
Software developers have focused on improved program display features with logical workflow layouts, new auto-population tools and streamlined menus, increased file size handling and outputting, customisable settings, and simpler integration with complementary programs. This has resulted in improved operational efficiencies in the industry.

Similarly, mine production reporting and management systems have been developed for underground mines, with the capacity to allow users to easily scale up from simple voice and tag data logging to advanced automated systems as required.

Numerical modelling and simulation is an increasingly important field. Specialists in geomechanics, in particular, are using advanced software to tackle complicated geological problems with the aim of increasing mining safety and productivity.

In addition, specialist underground engineering services are available through firms such as AMC Consultants, Ripe Projects, and Snowden, CSA Global and Mining Plus. Systems and equipment to improve in-mine drilling efficiency and safety to another area where Australian companies have developed expertise.

Australian companies also have proven expertise in horizontal and vertical shaft development and strong project delivery track records, as well as experience operating coal and hard-rock mines in all conditions.

Earth, water, and blasting

Increasing depths, higher mining rates and complex geology are some of the challenges that rock mechanics experts, drill and blast engineers and hydrogeologists face in modern underground mining.

Australian companies have led the way in the application of new blasting techniques and technologies, including advanced blast management software and initiation systems. Underground tunnel perimetric control methods are also improving rock fragmentation control, reducing costs and enhancing safety.

In the field of geomechanics and ground support, there have been rapid advances in support design and support products, as well as breakthroughs in ground stabilisation and stope control, geotechnical monitoring and analysis, and surface support (e.g., shotcrete and mesh) application.

Australian researchers, consultants, ground support product manufacturers and technology companies continue to be at the forefront of these developments.

In mine water management, Australia is a global leader in the application and development of water production through desalination, dewatering systems, water recycling methods and also, in more recent times, liquid-solidification technologies purposely formulated for the underground mining environment.

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Mineralisation and integration of replacement and ‘satellite’ underground orebodies to sustain production from large, high-cost processing plants on the surface has also helped drive innovation in the contracting, consulting and engineering fields.

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Remote Control Technologies delivers an integrated solution

Australian company Remote Control Technologies (RCT) offers a wide range of mobile equipment safety, guidance and control products.

The company is best known for remote and tele-remote control technologies that have helped transform underground mine safety and productivity in Australia. RCT has recently worked closely with Rio Tinto and others on projects focused on advanced equipment control and guidance.

For RCT’s remote control, guidance and automation technologies, ‘the size of [mining] projects both nationally and internationally has grown, and there is greater demand for project remote control solutions – for example, stockpile dozers which require remote control solutions, operator accommodation, communications infrastructure and operator aids such as obstacle detection,’ says founding managing director Bob Muirhead.

‘If a task is inherently unsafe it should be remote-controlled; if it is repetitive it should be automated,’ he adds.

‘Being an independent supplier means that our integrated solution will operate reliably across all equipment platforms, which does not lock the customer into a single supplier.’

MST keeps miners around the world safe and productive

Case study: mine communications

Mine Site Technologies (MST) has a long track record of installing underground and surface mine communication technologies throughout Australia and internationally. MST was at the forefront of introducing the digital age for mine communications, developing the first purpose-built Wi-Fi networks for underground mines. MST has been deploying these digital networks in mines for over ten years, along with associated applications such as WiFi Tracking, WiFi Communications, vehicle data and support for automation systems.

Established by mining engineer Gary Zamel in 1989, MST deployed the first commercial personal emergency device (PED) using ‘through-the-earth’ technology developed in conjunction with Australia’s national science organisation, the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

MST has subsequently built an international presence with VDV leaky feeder radio systems, and over the last ten years has been supplying Wi-Fi based digital communications with its ‘Intact’ digital product suite.

Today, the Intact System is the most widely deployed underground Wi-Fi network in the world, whilst PED systems are worn by 85 per cent of Australia’s underground coal miners and many of the hardrock miners. MST’s technologies are deployed in hundreds of mines around the world in Russia, South America, Africa, Asia and Asia.

MST’s office and partner network now extends throughout these regions, ensuring a high level of technical support to their mining customers.

‘We’ve been able to demonstrate that we’ve got fit-for-purpose kit, that we’re available to service it, but more importantly it goes underground into a harsh environment and it works, it functions and it delivers them value for money,’ says Zamel, founder and director of MST.

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Case study: automation and remote control

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Swick Mining Services drills down to greater efficiency

Case study: underground drills

Kent Swick, a mechanical engineer and fourth generation driller, runs one of the world’s leading underground drilling contractors from the company’s Western Australian base. Swick Mining Services has operations in North America and Europe, a large fleet of purpose-built rigs, and more than 600 staff.

Swick now produces 95 per cent of its unique underground drills internally after switching from outside sourcing. The company invests A$3 million a year into research and development and is determined to introduce design changes, technology and contract management methods that are expected to significantly enhance the productivity of its drill fleet within a few years.

The introduction of new rod handling and automation systems is set to follow the installation of high-pressure, high-flow pumps on all the company’s drill rigs as part of its ‘high-speed core recovery’ project.

An automation package has been developed specifically for the company’s mobile, purpose-built drill rigs, and the company is now looking to integrate this system into its existing fleet.

Developments such as bringing rig engineering and production in-house, developing new technology, and the company’s use of a customised business intelligence platform which has given management clearer, immediate insights into operations and potential operational management improvements, are part of Swick’s focus on its global competitiveness.

In contrast to many of its competitors, Swick Mining Services is almost completely focused on underground mine drilling. ‘I think we’ll just become more and more competitive, and offer greater and greater value to the marketplace,’ Swick says.

Gekko’s Python gets to grips with underground ore processing

Case study: automated systems

Australian high tech manufacturer Gekko Systems has designed and built hundreds of its innovative gravity separation, leach reactor and feed preparation plants over nearly 20 years of operation, exporting to around 40 countries. Five years ago it introduced a new offering, the Python.

With its origins in an Australian Government sponsored R&D effort which started some 10 years previously, Python is a modular, automated plant that crushes, grinds and pre-concentrates ore underground where it is actually mined – leaving only 5-30 per cent of the material, now in concentrate form, to be pumped to the surface.

‘Tailings are disposed in voids, haulage, operating and processing costs are substantially reduced, and environmental impacts are minimised,’ Gekko technical director Sandy Gray says.

Ventilation savings on diesel equipment are also substantial, he adds. ‘Then there is the cost of energy and, in some places such as South Africa, the actual reliability of supply. There is a tremendous level of energy intensity in areas of mining that won’t be able to sustain that level of use. Certainly in underground gold mining in Western Australia, where we’re seeing that transition from oxide ores, and simple processing plants, to deeper, more complex ores, there is a lot more thought going into processing options and energy efficiency.’

As well as initial sales in South Africa, Gekko is now exporting Python systems all around the world. New Python units, double the size of the original ones, have also been sold.
When the key stakeholders of a major southern hemisphere coal producer decided to undertake a comprehensive review of their operations, they engaged Australian consultants Palaris. The project involved examining the technical, operational and financial aspects of their open cut mines, underground mines, port facilities and tenement areas.

Taking a multi-disciplinary approach, Palaris appointed a team of specialists in geology, mining engineering, maintenance management, environment, finance, marketing, processing and operations management. Using a portfolio of business review tools, the team focused on:
- reducing operating costs
- reducing or deferring capital expenditure
- improving revenue via additional coal sales and blending.

After extensive consultation, site visits and data analysis, the review delivered significant opportunities:
- operating cost reductions across operations of between 15 and 24 per cent
- capital expenditure reductions of 19 per cent
- revenue improvements of 6 per cent.

The team also provided recommendations and advice on achieving the reductions and improvements.

Originally established in the Hunter Valley coal mining region of NSW, Palaris now has offices around Australia and a presence in London. It provides project management, business analysis and specialist consultancy services to mining companies in existing and emerging markets around the world. Palaris expertise spans coal, metals, coal seam gas and ventilation, and its services cover the mining life cycle from geology and exploration through to sustainability management when the life of a mine is complete.
The following are some of the government and industry bodies involved in the Australian mining industry. Contact your local Austrade representative about connecting and partnering with the Australian mining industry.

austrade.gov.au

The Department of Industry, Innovation and Science provides advice and policy support to the Australian Government regarding Australia’s resources sector.

industry.gov.au/resource

The Mining and Energy Services Council of Australia (MESCA) is an industry body that represents and promotes a diverse range of skilled, innovative providers which include:

- capital equipment
- contractor and consultancy resources
- OEM (Original Equipment Manufacturers) project management
- engineering
- MRO (Maintenance Repair and Operational) suppliers to the energy and mineral resource industries across Australia.

mesca.com.au

The Minerals Council of Australia (MCA) represents Australia’s exploration, mining and minerals processing industry, nationally and internationally, in its contribution to sustainable development and society.

minerals.org.au

Austmine is an industry body representing the Australian mining equipment, technology and services (METS) sector.

austmine.com.au

AusIMM (the Minerals Institute) provides services to professionals engaged in all facets of the global minerals sector.

ausimm.com.au

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- promote international education
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Our assistance includes:

- providing insight on Australian capabilities
- identifying potential investment projects and strategic alliance partners
- helping you to identify and contact Australian suppliers.

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REFERENCES

3. dmp.wa.gov.au
4. resourcesandenergy.qgov.au
5. mineralsstanddevelopment.qgov.au
6. mining.org.au
7. dnr.wa.gov.au
8. dpewr.qld.gov.au/natural-earth-resources
10. Australian METS survey, 2013
11. ventian.com