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New South Wales Mining and Exploration Quarterly

No. 64

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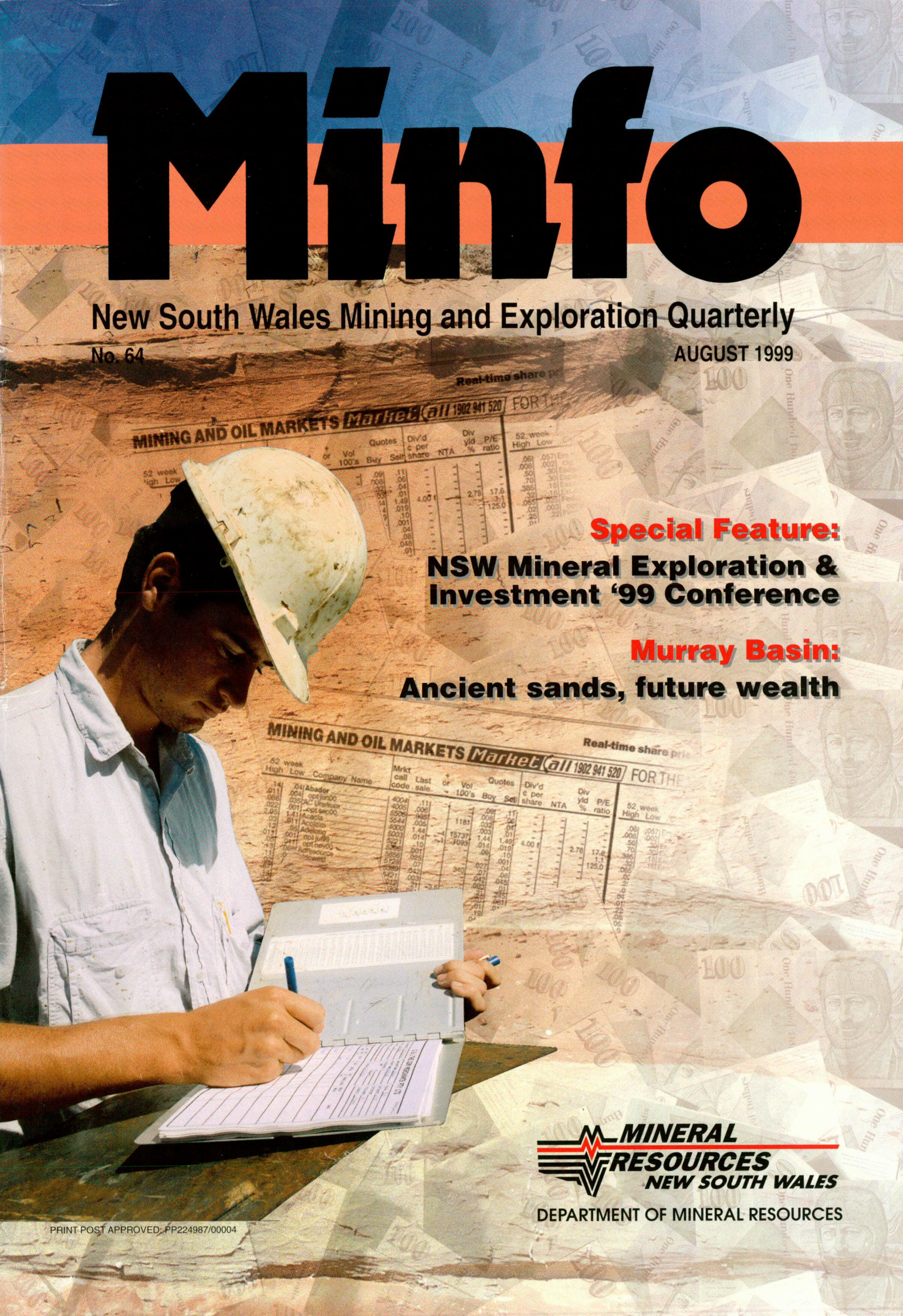

Special Feature:

NSW Mineral Exploration & Investment '99 Conference

Murray Basin:

Ancient sands, future wealth

MINERAL RESOURCES NEW SOUTH WALES

DEPARTMENT OF MINERAL RESOURCES

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New South Wales Mining and Exploration Quarterly
No. 64

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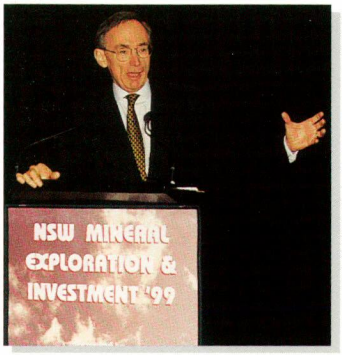
MINERAL RESOURCES NEW SOUTH WALES

CONTENTS

Resource wealth unearthed

— NSW Mineral Exploration & Investment '99 Conference

Major investment opportunities and key challenges for exploration, mining and minerals processing in NSW were top of the agenda at the biennial *NSW Mineral Exploration & Investment '99 Conference.* The conference was opened by the Premier of New South Wales, the Hon. Bob Carr, on 20 May, 1999. The Premier used his Opening Address to underline his Government's support for the minerals sector as a vital part of the State's economic strategy and to credit the industry's success in meeting environment protection challenges.



Premier Bob Carr focussed on the industry's economic importance and environmental achievements

"To keep minerals investment moving, we've invested $35 million over six years in Discovery 2000, a plan to lift mineral exploration across the State," the Premier said. "In 1997, exploration passed the $100 million mark for the first time, so there's no doubt that Discovery 2000 has worked brilliantly. It has [also] increased petroleum exploration and could result in the discovery and development of natural gas resources in the State."

"I think the industry has done very well in meeting the community's expectations on good environmental standards. This is an industry that represents the least of our problems when it comes to environmental protection in New South Wales," the Premier said.

"The impact on our environmental systems of urban expansion is a far more serious threat to the environment than the mining industry is. Again, agriculture represents a greater environmental and planning challenge than the mining industry."

The Premier also used the occasion to launch a new booklet 'New South Wales, Australia — The Minerals Investment Advantage.' Featuring an industry which accounts for about 40% of the State's merchandise exports, valued at $7.7 billion in 1997/98, the booklet summarises the many advantages the State offers to the minerals investor. It illustrates NSW's established minerals pedigree, exploration and development initiatives, plus the most developed mining infrastructure in Australia (see p. 71).

Department officer David Hayward (seated) demonstrates geoscience data systems for (from left) Premier Bob Carr, Director-General Alan Coutts, and Minister Edward Obeid

Director-General Alan Coutts welcomes the 240 delegates

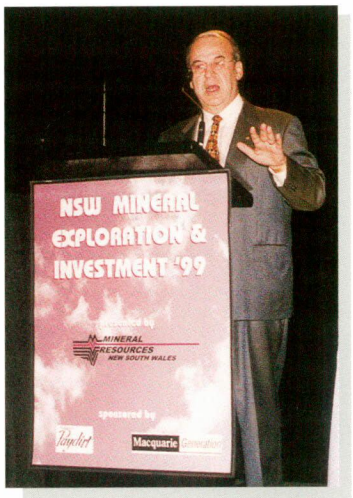
In their Day 1 keynote presentation, 'Exploration Success in NSW – Cadia and beyond', Mr Dan Wood and Dr Ray McLeod of Newcrest Mining, executive general manager, exploration, and exploration manager, Australia & SW Pacific, respectively, focussed on the vital roles that publicly available data and supportive senior management play in exploration success.

With the theme, *NSW — The place to explore,* Day 1 highlighted exploration activities such as PlatSearch's investigations in the Curnamona Province, Millennium Minerals work on unexplored targets in the Lachlan Fold Belt, BeMax Resources' focus on the mineral sands of the Murray Basin, and the success of Newcrest Mining's Cadia development.

Also on day one, Michael Lawrence, the 1999 President of the Australasian Institute of Mining & Metallurgy, gave a very stimulating address to the Conference luncheon — 'The way forward for Australia's resources sector and the AusIMM'.

NSW Mineral Exploration & Investment '99 Conference

With the theme, Investing in the NSW Minerals Industry, the Hon. Edward Obeid, the New South Wales Minister for Mineral Resources, opened Day 2 of the *NSW Mineral Exploration & Investment '99 Conference.*



Minister for Mineral Resources The Hon. Edward Obeid

North Limited managing director Malcolm Broomhead, built on this theme through his keynote presentation — 'Achieving and Maintaining World Competitiveness and Best Practice in the Minerals Industry.' Other papers on Day 2 covered the outlook and investment potential of the NSW Coal Industry, a financier's view of investing in the NSW Minerals Industry, and the impact of changes in the electricity industry on the minerals industry. Also featured were the Cowal gold project, CSA's mine redevelopment, the redevelopment of the Port Kembla copper smelter, the Ridgeway gold project, Peak Hill sulphide and Dubbo zirconia projects,Hillgrove gold expansion and antimony processing, and the Syerston nickel–cobalt project.

Departmental papers presented at the conference included 'Highlights of NSW Exploration — Building on the Discovery 2000 Framework', 'NSW Gas exploration — Turning Potential into Reality', 'Competitiveness of the NSW Gold and Copper Industries', and 'Initiatives to Facilitate Mineral Exploration in NSW' **(see Conference reports from page 4)**.

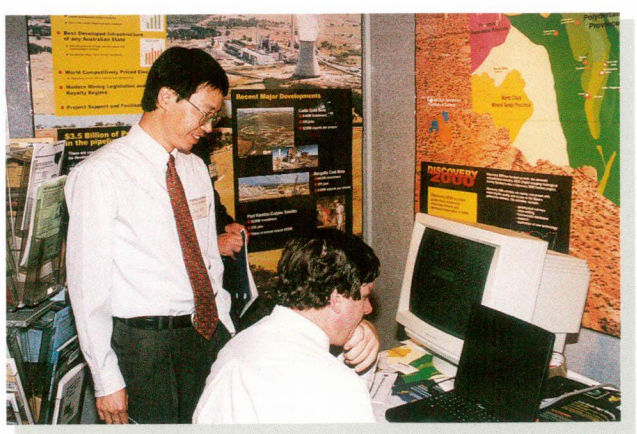
The adjacent Conference exhibition featured displays from the Department of Mineral Resources (DMR); a joint display by DMR and the Department of Land & Water Conservation on "Water and Mining in NSW"; and displays by Michelago Resources NL, Alkane Exploration NL, Triako Resources Ltd, Austminex NL, Scintrex - Auslog, Tesla Geophysical Group, CRCLEME, and CSIRO/CRCAMET.

Luncheon speaker Michael Lawrence, the 1999 President of The Australasian Institute of Mining & Metallurgy

The many challenges faced by the minerals industry in achieving world competitiveness and best practice were examined by North Limited Managing Director Malcolm Broomhead

Despite the prevailing depressed commodity prices and global downturn in mineral exploration budgets, the attendance of over 240 delegates and the positive nature of presentations at the conference augurs well for continued mineral investment and development in New South Wales.

Copies of the Conference Information Package, which includes Conference Summaries & Program, detailed List of Delegates, and full Keynote Addresses, are available for $50 each (plus $7 postage and handling) from the Information Counter at the Department's Head Office at St Leonards, on tel (02) 9901 8269; fax (02) 9901 8247. Copies of the 'Mineral Projects of New South Wales, Australia' map and the 'New South Wales, Australia – The Minerals Investment Advantage' booklet are also available (gratis), on request, from the Department's Information Counter.



Department officers Joe Xie (left) and Geoff Brookes at the Department's Conference exhibition booth

(Photography by Steve Hogg and John Leeks)

Barry Jackaman (left), Executive Director, CIBC Wood Gundy Securities Australia, offered a financier's view on investing in the NSW minerals industry.

After stressing that investment in this industry of course requires careful consideration of many factors, Mr Jackaman noted that three over-riding rules of thumb must be applied:

- exploration is funded by equity;
- development is funded by both debt and equity; and
- financiers not only want their money back, they want to make a very good return on their investment.

His checklist for finance-winning projects centred on management capability, technical feasibility, commodity price considerations, environmental and native title issues, completion risk and final ownership, political risk and the financiers' own portfolio risk.

Mr Jackaman also advised that project proponents should recognise market realities and spend their limited time and money on things such as drillholes and presentation tools — rather than wasting time flogging subeconomic 'dead horses'.

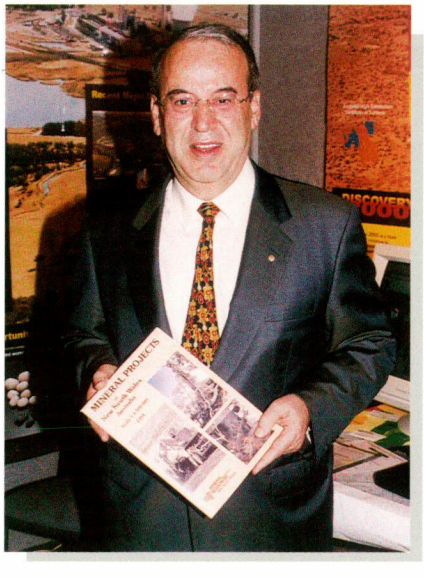
The busy registration desk

Exhibitor Tesla Geophysical Group

Brad Mullard (right), Assistant Director (Coal and Petroleum) Geological Survey, noted that while NSW has the largest potential Australian market for oil and natural gas, the State is sparsely explored for these resources with just 250 petroleum wells within 500 000 km^2 of sedimentary basins.

However, Mr Mullard highlighted the success the Discovery 2000 program has had in facilitating increased activity aimed at tapping the State's 'real' potential. This success is measured by the fact that the number of titles for petroleum exploration has risen from 11 in 1993 to about 30 in 1999, with expenditure over the next few years anticipated to total over $85 million.

Among the projects highlighted was the 'largest single petroleum exploration program in the history of NSW.' In this project, US company ForceEnergy and its partner, First Sourcenergy, is drilling to examine the coal seam methane potential of an area southwest of Narrabri.



Minerals Projects of New South Wales Map

The Hon. Edward Obeid (right), the NSW Minister for Mineral Resources, used the conference to launch the map — 'Mineral Projects of New South Wales, Australia'.

The 1:1.5 million scale map of the State shows the location of 381 minerals, coal and petroleum projects (including operating mines). The projects are listed alphabetically and their status shown as either operational (mines or collieries) or exploration/advanced assessment. Mineral commodities are also listed for each project. The projects are located by a map reference grid and are shown on the map by symbols, coloured according to broad commodity grouping. The base map shows the State's major structural geological units.

The map also shows the location of key infrastructure, including roads, rail, ports, major electricity transmission lines, gas pipelines, electricity generating stations and oil refineries, and major minerals processing plants.

Copies are available (gratis), on request, from the Department's Head Office at St Leonards, on (02) 9901 8269; fax (02) 9901 8247; e-mail: manikak@minerals.nsw.gov.au

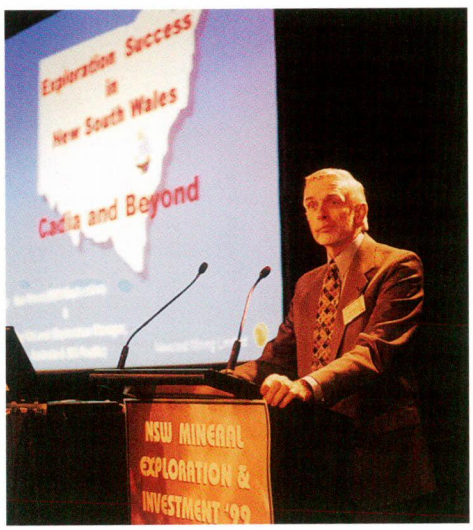
EXPLORATION SUCCESS IN NSW — CADIA AND BEYOND

A keynote address by Dr Ray McLeod, Exploration Manager, Australia & SW Pacific, Newcrest Mining Ltd to the NSW Mineral Exploration & Investment '99 Conference, held on 20-21 May 1999, Sydney

The discovery of an economic mineral deposit is a rare and difficult achievement, but it is just this possibility which drives the exploration industry and attracts the necessary investment.

The risk of failure is high and the ability to produce a satisfactory return on investment largely depends on the intangible creative talents and skills of exploration geologists. Unfortunately, making a discovery is not the end of the story. Converting discovery into a viable mining operation presents a whole new range of challenges and risks, and involves a much larger group of stakeholders. Understanding and addressing their needs is fundamental to managing the permitting process, which is one of the keys to developing a mine.

Newcrest has been through the complete cycle of this process in New South Wales during the past eight years at Cadia with the Cadia Hill deposit, and is about to revisit the latter part of the cycle with the Cadia–Ridgeway deposit. The company is also hopeful of repeating the cycle, either at Cadia or elsewhere in the central Lachlan Fold Belt of New South Wales.



Dr McLeod delivering his keynote address

For Newcrest, the discovery of the Cadia Hill deposit was crucial in providing the company with the capacity to grow and sustain its business over the longer term. The Cadia Hill porphyry gold–copper deposit was discovered at a time when New South Wales did not feature high on the list of preferred areas to explore for deposits of this type, notwithstanding the important pioneering work of North Limited at Northparkes.

In looking to the potential for further discoveries in New South Wales, it is useful to reflect on the factors which were important to the discovery of both Cadia Hill and Cadia–Ridgeway. Both relied heavily on previous experience with porphyry-style mineralisation to encourage exploration and persistence. Coupled with this was the ability to visualise the potential and act accordingly.

Australia is a largely mature exploration environment and increasingly discoveries are being made at depths for which, in times past, drilling would not have been sanctioned by most exploration managements. Potentially this is the key to further discoveries in New South Wales. While drilling in the first instance need not necessarily be exceedingly deep, it should sensibly explore for the type of deposit sought. The key words here are 'sensibly explore' and it is probable that previous exploration did not always justify this qualification.

Revisit earlier exploration

It is now worth revisiting much of the previous search for porphyry, volcanogenic massive sulphide and other mineralisation styles, which was carried out in possibly less enlightened times. The next discovery may be as simple as determining that previous drilling stopped in the outer envelope of a massive sulphide deposit.

In some respects gold exploration in New South Wales was in crisis in 1991 when Newcrest continued the search for gold deposits begun by its predecessor companies, Newmont Australia and BHP Gold.

When Cadia Hill was discovered in 1992, New South Wales attracted less than 10 per cent of gold exploration expenditure in Australia.This was the case even though the Geological Survey of New South Wales and others at the time were publicising and extolling the mineral potential of the Lachlan Fold Belt, and despite the role that gold production from this belt had played in developing the economies of New South Wales and Victoria in the second half of the 1800s. Since 1991 expenditure on gold exploration in New South Wales has increased but according to recent Australian Bureau of Statistics' figures still only accounted for less than five percent of Australian expenditure in the December quarter of 1998.

This lack of gold exploration activity was also in spite of the fact that, on a mineral occurrence basis, New South Wales appears to have received more than its fair share. A brief glance at a mineral occurrence map of New South Wales in the late 1980s would have shown a diverse and widespread distribution of metal occurrences, with a large number of gold and gold–copper prospects and mines.

Generally, there is truth in the saying that 'where there's smoke there's fire', and for the mineral potential of New South Wales, it is appropriate to think of the plethora of small mineral occurrences which dot the Geological Survey's metallogenic maps as the 'smoke'. The 'fire' is the world-class discovery which we all seek and which, in respect of porphyry-style gold–copper deposits, was first ignited

by North Limited at Northparkes more than twenty years ago.

Newcrest's current fortunes are inextricably linked to a train of gold–copper porphyry-style discoveries in the Cadia district of the central Lachlan Fold Belt of New South Wales, which began with the delineation of the Cadia Hill deposit in 1992. These subsequent discoveries include the Cadia East, Cadia Quarry, Ridgeway and the deep Cadia Far East mineralisation. Since then, at Cadia and elsewhere in Australia and offshore, Newcrest has accumulated almost 25 million gold equivalent ounces (with copper credit) of resources in six discoveries.

A rare and difficult achievement

As many in the mining business are painfully aware from their own experiences, the discovery of an economic mineral deposit is a rare and difficult achievement. Viewed objectively, the exploration business is not for the faint-hearted nor for those without reasonably deep pockets and a long-term commitment to mining. Also unfortunate, for the handful of successful exploration teams and companies, the quickly wasting nature of resource assets leaves little time to 'rest on laurels' and reflect on what has been achieved. To stay in business, particularly the gold business, a mining company has to either discover or acquire resources in relatively quick succession.

In hindsight, the discovery of the Cadia Hill deposit was relatively simple, in so far as it relied on basic exploration techniques and was not the product of state-of-the-art technology or sophisticated data manipulation. For many, the exploration philosophy pursued at Newcrest may seem anachronistic in its reliance on observation, mapping, intuitive thought, geochemistry and drilling, but it does work and we suggest that it will continue to work well into the next millennium.

The keys to the discovery of Cadia Hill were publicly available in the 1980s. The porphyry copper search in Australia in the 1960s had identified a number of sub-economic porphyry systems along the eastern seaboard, with several notable examples in the central Lachlan Fold Belt. North, through commendable persistence, had demonstrated that economic porphyry-style mineralisation could be discovered at Northparkes. Pacific Copper in the 1970s had

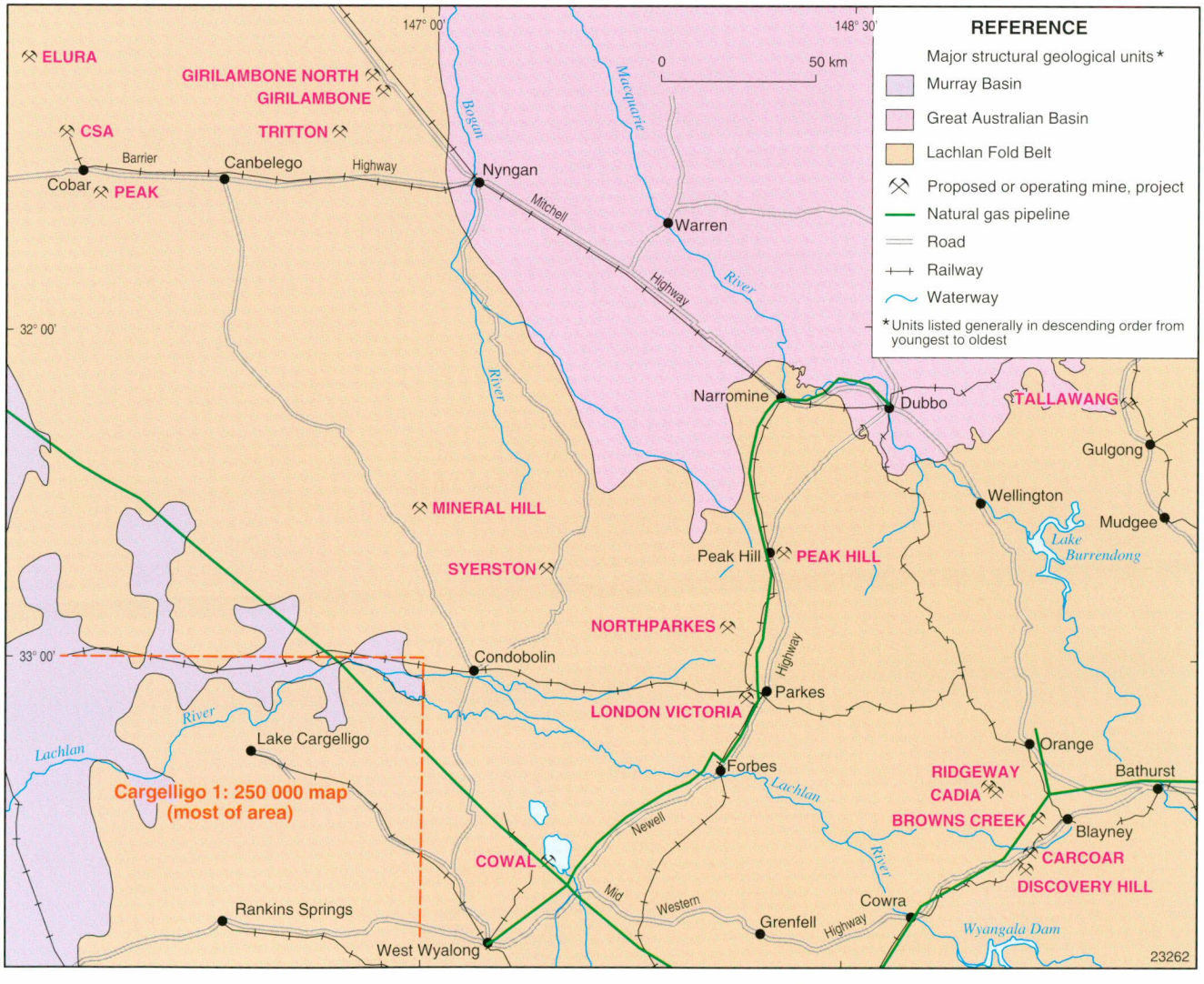


Figure 1. The location of operating mines and major projects in the central Lachlan Fold Belt, NSW

erroneously, but nevertheless somewhat presciently for the Cadia district, promoted the Big Cadia mineralisation as being of porphyry copper style.

When Newcrest began to investigate the Cadia district in 1991 it may have had several advantages over other companies, which collectively were influential in the discovery process:

- direct access to historical exploration data;
- previous experience with porphyry mineralisation dating back to the late 1960s;
- an economic imperative to quickly discover a major gold deposit; and
- an exceptionally supportive and aggressive senior management and Board.

These advantages reflect the crucial components of any discovery, namely that the past is often the key to the future, experience is essential, the need to succeed must be compelling, and support from the highest levels of a company is critical.

The intuitive thought necessary to move from the Big Cadia magnetite-hosted copper–gold mineralisation explored by Pacific Copper to discovery of Cadia Hill recognised that the Big Cadia mineralisation was skarn-related, and like at Ok Tedi in Papua New Guinea, the magnetite skarn was probably associated with porphyry mineralisation.

Direct access to previous exploration data and an aggressive senior management were vital to the Cadia discovery

The step from intuitive thought to factual basis was readily made by accessing reports and core available through the Geological Survey's record system.

Porphyry systems are relatively simple and to some extent predictable in respect of the distribution of potentially productive mineralisation, at least on a broad scale. This was ably demonstrated at Cadia Hill where, on the basis of soil geochemistry and the simple expedient of interpreting the geometrical source of the gold soil anomaly by draping it over topography, Newcrest was able to predict the probable geometry, potential size and possible grade of the mineralisation before drilling a single hole. Through detailed mapping of limited outcrop we were able to predict the major mineralisation controls and determine the optimum drilling direction. Most crucially, through previous experience, we were able to confidently decide the depth to which holes needed to be drilled.

It doesn't take a rocket scientist to determine that a company's philosophical approach to drilling is often as crucial to its capacity to make discoveries as is its experience with the target mineralisation style. Recognising an elephant might be difficult if all of one's experience has been with mice. We have a firmly held belief in Newcrest that discovery comes from not only choosing the correct 'where' but also from choosing the right people and 'doing things'. Crucial amongst the 'doing things' is drilling.

Collectively at Cadia we estimate that we have discovered at least 22 million equivalent ounces of gold (including copper credit) in the Cadia Hill, Cadia East and Ridgeway deposits. Added to this are as yet unquantified resources at Cadia Quarry and Cadia Far East which we expect will add significantly to the resource base over time and ensure a long-life mining operation at Cadia.

Previous drilling at Cadia Quarry has intersected mineralisation of similar style and broadly comparable gold and copper grades to those at Cadia Hill, although with marginally higher average copper grade. At Cadia Far East our deeper drilling to depths of over 2 km has intersected mineralisation which we believe may have future potential for large-scale underground mining. Intersections include 145 m @2.9 g/t Au and 0.42% Cu contained within a broad interval of 600 m averaging 1.1 g/t Au and 0.34% Cu.

Discovery of Ridgeway

Probably the most satisfying of the discoveries at Cadia has been that of the Ridgeway deposit in late 1996. It fulfilled a prediction made after the discovery of the low grade Cadia Hill deposit that potential existed for the discovery of much higher grade mineralisation. The Ridgeway discovery epitomises the high-risk high-reward equation we all seek to balance, but rarely do.

The discovery of Ridgeway was in many ways an outcome of the exploration culture which has been built up in Newcrest over the past eight years. It is a culture which encourages enquiry and considered risk taking. Above all, it is a culture firmly grounded in the belief that drilling is essential to discovery.

Ridgeway is a blind deposit, the top of which occurs 500 m below the surface. In simple terms the deposit was discovered because the Cadia exploration team had developed considerable experience with mineralisation in the Cadia district and was able to intuitively attribute importance to a relatively subtle change in the gold/copper ratio of an otherwise uninspiring intersection of 102 m @0.13 g/t Au and 0.40% Cu in drillhole NC371. It took four deep holes after this and a fortuitous decision in respect of drill-hole spacing to drill the discovery intersection of 430 m @ 4.5 g/t Au equivalent (1.0 g/t Au eq cutoff) in hole NC498, which included 87 m @6.7 g/t Au and 1.5% Cu and 84 m @ 7.4 g/t Au and 1.3% Cu.

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MINFO 3

The Ridgeway resource is presently estimated to be 5.8 million gold equivalent ounces (3.6Moz Au and 0.36 Mt Cu) contained in 44 million tonnes averaging 2.6 g/t Au and 0.82% Cu, at a 2.0 g/t gold equivalent cutoff. The resource estimate is to a local Relative Level (RL) of 4 800 m (1 100 m below surface). Mineralisation continues below this RL and remains open at depth.

For Cadia, Newcrest's previous experience with porphyry mineralisation was sufficient to encourage exploration and persistence. Coupled with this was the ability to visualise the potential and act accordingly by drilling holes to depths commensurate with the style of deposit sought. If the anticipated target is 300 m thick, there is no point drilling 100 m or 200 m holes, unless one happens to site the drill on ore and even then there is every likelihood that the holes will end in mineralisation. To understand a deposit one needs to drill through it and out the other side.

The Cadia Hill mine is relatively large for a gold operation, having an annual designed mill throughput of 17 Mt/yr from a deposit with a waste-to-ore ratio of a little over 1.3:1. Annual design output from the Cadia Hill deposit is 293 000 ounces of gold and 23 000 tonnes of copper, predominantly in concentrate. The mine will produce an estimated 200 million tonnes of tailings and 270 million tonnes of waste rock over a 12 year life. The operation has a make-up demand for water of up to 38.8 megalitres/day and accounts for some 65 megawatts of New South Wales daily electricity consumption.

The keys to the next major discovery may already be publicly available in Discovery 2000 data and at the Londonderry Core Library

The capital cost of engineering and constructing the Cadia Hill mine was $441 million and compares more than favourably with the actual or projected development costs for two other, albeit larger, porphyry gold–copper deposits — Bajo de la Alumbrera in Argentina and Batu Hijau in Indonesia.

Stakeholder consultation

Aside from being relatively large, the Cadia Hill mine is located in a well-developed rural setting, close to the large regional centre of Orange. However, the advantage of this location also provided a very real possibility for the development to be delayed by a lengthy permitting stage. Fortunately, careful planning and consultation which started early in the exploration stage with a gradually broadening base of stakeholders, allowed permitting to be completed in eleven months. Permitting activities were started in a structured way in 1995 and final approval for development was received in September 1996.

The whole process from first drillhole in September 1992 to development approval in September 1996 on a greenfields discovery site in a well-developed rural setting took 49 months. A further 26 months were taken in design engineering and construction.

Ahead of the pack on the 'good ground'

It may fly in the face of conventional wisdom, which in our book is an excellent thing to do, but we are of the view that 'good ground', in the sense that it produces a discovery, is often only recognised as such after the event. It is often too late by the time the pack has decided the ground is 'good'. The trick in exploration is to get to the 'not so good ground' first before it becomes 'good ground' through discovery — hopefully yours.

Even now, eastern Australia is not one of the preferred areas internationally to explore for porphyry gold–copper deposits. Possibly attitudes will change when a deposit of the size of a Bajo de la Alumbrera or Batu Hijau is discovered.

In some areas, Australia is a largely mature exploration environment for at least the top 50 m to 100 m below the surface. In other areas, Australia can probably only be described as a mature exploration environment for the first few tens of metres below the surface. Evidence of the significant untapped potential is now being seen in discoveries made at drilling depths which would not have been sanctioned by most exploration managements in the not too distant past. It has generally been easier to get permission to drill three 200 m holes than one 600 m hole. Times are changing, and thankfully many more companies are now able to consider drilling 600 m or deeper holes in a rational manner.

Because of the excellent exploration record system of the Geological Survey, the invaluable Core Library and the wealth of new data generated by the Discovery 2000 program, the keys to the next major discovery in New South Wales are already publicly available. ■

Article prepared from a paper by Dan Wood, Executive General Manager, Exploration and Dr Ray McLeod, Exploration Manager, Australia & SW Pacific, Newcrest Mining Limited. Dr McLeod presented this paper at the NSW Mineral Exploration & Investment '99 Conference. For further information, Dan Wood can be reached on (07) 3858 0858. Dr Ray McLeod can be reached on (08) 9270 7070.

COAL SEAM GAS POTENTIAL — DUD OR BONANZA?

For various reasons the State of New South Wales has been overlooked from a petroleum exploration perspective.

The exploration of oil, natural gas, and related hydrocarbons remains in an embryonic stage throughout most of Australia. The drilling of 150 wells per year in all of Australia's numerous geological basins compares poorly with 18 000 wells drilled per year in the Western Canadian Sedimentary Basin alone.

Only 250 wells have been drilled in NSW to date. The basins located in eastern NSW are gas-prone — either coal seam methane (csm) or the migration of csm into conventional reservoir traps.

Forcenergy has developed a strategy which embraces onshore exploration as opposed to offshore, a focus on NSW rather than on the producing states, exploring for gas targets and plans to develop coal seam methane as opposed to conventional gas.

NSW is highly prospective in terms of natural gas resources, and Forcenergy believes that a reasonable level of exploration activity would ultimately yield a significant indigenous gas production capacity for this state. Forcenergy and its partner First Sourcenergy have acquired a significant land position and have spent a substantial amount on exploration and testing to date.

The success of gas-targeted exploration and development is quite different from that of oil and other liquid petroleum products. In addition to geologically prospective sedimentary basins, the commercialisation of gas resources depends on access to gas infrastructure (pipelines, processing plants, and distribution systems) at low tariffs, access to a liquid gas market of material size, and confidence in the long term stability of the regulatory regime. In this context an economically attractive market is regarded as either 30 PJ/year (green field market) or 100 PJ/year (established market). It is possible to capture at least 25% market share in any liquid market simply by beating the existing prices.

A promising coal seam methane project area is in the Narrabri area of the Gunnedah Basin.

Market barriers include the poor reputation of csm in Australia (although credibility is growing in Queensland), a bias towards long term reserve dedicated contracts, and the view that the gas grid as currently configured is not conducive to new supplies entering the grid other than at Wilton.

Great benefits will flow to the general public of NSW if this exploration is successful. ■

Article prepared from paper presented by Glen Gill, Vice President Marketing, Forcenergy Australia Pty Ltd, at the NSW Mineral Exploration & Investment'99 Conference. He can be reached on (07) 3844 6220.

DAUNTING CHALLENGES FAIL TO DIM BRIGHT COAL INDUSTRY OUTLOOK

The New South Wales coal industry faces a range of challenges in the core areas of safety, productivity, profitability and environmental emissions.

Meeting these challenges will require ongoing development of safer operating procedures, improvements in production and productivity, and enhancing profitability through a clearer understanding of supply and demand cycles.

This discussion addresses those matters, reviews the performance of the industry over the last decade and comments on future challenges.

Safety

No apology is needed to commence with a review of safety. Much has been achieved in addressing concerns about safety during the last ten years, with the LTIFR (lost time injury frequency rate) falling from 191 in 1989 to 52 in 1998. This represents a 73 percent improvement. However, while such improvement is good, there is no room for complacency. Much remains to be done to achieve the industry's vision of a workplace free of fatalities, injuries and related diseases.

Open pit mining at Bengalla Coal mine

The industry's vision for the future encompasses a range of beliefs.

- All fatalities, injuries and diseases are preventable.
- Every task, however urgent or important, can be done safely.
- All hazards can be identified and their risk managed.
- Everyone has a personal responsibility for the safety and health of themselves and others.
- Safety and health performance can always be improved.
- Companies are working to translate this vision into all aspects of operations. (Also see discussion in this and previous issues of *Minfo*.)

Production

Coal production in New South Wales has increased by 58 percent in the past decade, from 68.2 million tonnes in 1988/89 to 107.7 million tonnes in 1997/98. This is an annualised growth rate of 5.2% per year in coal production. Most of this growth has been in opencut mines where output has grown by 111% in the same time period, or 8.7% per year.

Coal shipments through the Port of Newcastle (PWCS), the principal export port for NSW, have grown at the compound rate of 10.5% per year for the last decade. Projections by the industry and market analyst Barlow Jonker see growth continuing for the next decade, albeit at rates closer to 3% to 6% per year with shipment levels approaching 100 million tonnes per year between 2004 and 2010, depending upon which forecast is used.

Of particular note is the fact that shipments increased by almost 12% last year alone. This runs counter to the expectations of many analysts who thought growth would be subdued due to the Asian crisis. One final comment on production is that, at the time of writing this paper, stocks of export coal in NSW are at the lowest level that have been seen for a number of years.

Productivity

Productivity in the industry has continued to show improvement, reflecting a corresponding decrease in the numbers of people employed — from 17 178 in June 1989 to 11 675 by June 1998. Job losses of this order of magnitude are of course very unfortunate and have a major impact on the local communities concerned. However, they have been necessary to ensure the ongoing viability of many mines.

Without detracting from the preceding paragraph, it is important to issue the caveat that productivity figures show trends and do not provide absolute numbers. The tonnage numbers are fine but the divisor of employee numbers is very rubbery depending on the amount of work assigned to contractors and whether management overheads are included or not.

Productivity improvements are also evident in rail and port charges.

Rail freight charges in NSW were some 25% less in 1997/98 than two years before, according to FreightCorp, reflecting its ongoing program of operating cost reductions. The common user charge through the Port of Newcastle has also declined from a high of A$6.83/tonne in 1986, to the current rate of A$2.70/tonne.

Profitability

Profitability — or the lack thereof. It is here that the aphorism of the Curate's Egg is most apt. Whilst the industry has had strong growth in production and productivity, it has languished from the shareholder's point of view. The average return on shareholders funds (including abnormal and extraordinary items) over the last decade has been 4.6% compared to the whole of the Australian mining industry of 10.1%. These numbers come from the annual Coal Industry Survey conducted by PriceWaterhouse-Coopers. It should be noted that the numbers for 1998 only include three months of the price decrease applying from 1 April 1998 (JFY'98) and obviously do not include any price decreases arising from the current round of negotiations.

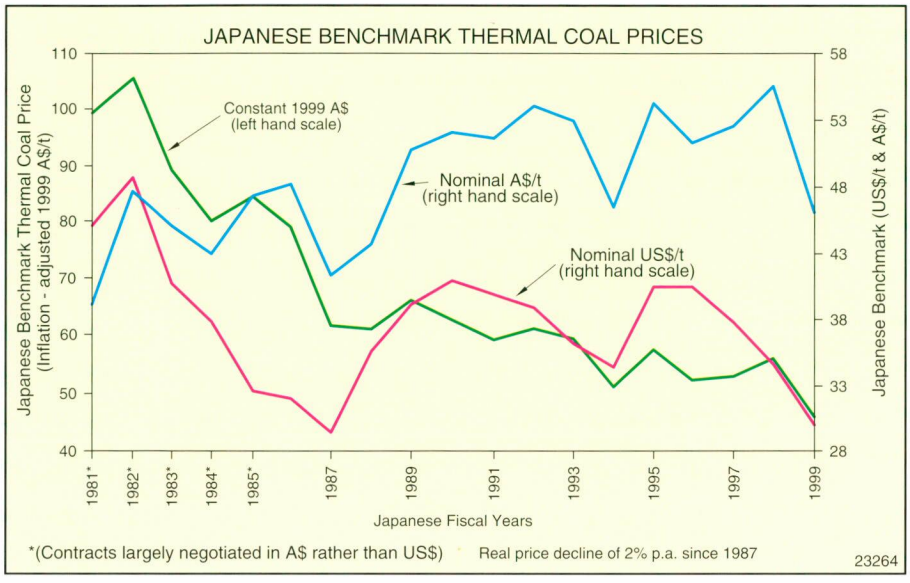

Figure 2. Steaming coal prices have declined at a steady 2% per year

Supply and demand

We do not have specific forecasts for supply and demand for NSW, but clearly as a predominantly thermal coal producing region, NSW is well placed to participate in the forecast growth of seaborne thermal coal.

However, there are many reputable industry observers who provide forecasts of supply and demand for the seaborne trade in thermal coal. These all have a reasonable degree of consistency.

Supply and demand is currently finely balanced for Hunter Valley producers — as shown by stocks of thermal coal being down 20% between December 1998 and January 1999 to 2.0 million tonnes. Levels also remained low during the first quarter. Further, FreightCorp has suspended railings on selected weekends due to lack of coal, and vessels have been loaded outside the customary turn of arrival at the Port of Newcastle.

Pricing nexus

It is arguable that a nexus in pricing exists between semi-soft coking coal, pulverised coal injection (PCI) coal and thermal coal. Certainly a majority of run-of-mine coal from these mines can be washed to meet these alternative markets. Accordingly, these comments on pricing concentrate on thermal coal. Figure 2 shows nominal prices since 1981 (about the advent of the thermal seaborne market) in both US$ and A$. It should be noted that from 1981 to 1985 contracts were predominantly negotiated in A$. Since 1986, contracts have been priced almost exclusively in US$.

For the last thirteen years, real steaming coal prices for 6 700 kcal/kg Japanese Benchmark coal have oscillated between A$46 and A$56. Whilst there has been much volatility in pricing from year to year it is reasonable to draw a conclusion that in A$ there has been an upward trend in nominal terms. However, figure 2 also shows that in 1999 constant dollars there has been a decline at a steady 2% per year in real terms.

Major challenges lie in predicting the rate of productivity improvements and cost management to offset the inevitable decrease in prices in real terms.

Future challenges

The NSW coal industry faces several broad challenges in the future.

- Competitive pressures arising from interactions between: coal producers; competitive pressures on major customers; changes in markets; and technological developments in mining, coal preparation and transportation. Further, coal is facing competition from other fuels, especially gas. These factors have led to significant changes in the coal market and have put increasing pressure on coal-producing countries to improve their efficiency and lower their cost structures.
- Creation of competitive electricity markets has reduced the cost of electricity but increased pressure on domestic suppliers.
- Environmental pressures include the impact on land and local communities, and impacts from sulphur and nitrogen oxides from combustion and global greenhouse emissions. Coal producers have worked hard to minimise direct impacts and also return mined land to productive use. In these areas, the industry generally does a good job. But it is fair to say that the community's perception of the industry's performance falls short of what the industry is actually achieving. Of course, the coal industry

faces its greatest environmental challenge in relation to greenhouse gas emissions, especially carbon dioxide and methane. The industry is responding by focussing on energy-saving technologies and investigating and applying innovative methane capture and usage technologies.

- Community support and safety: the coal industry needs to improve its image and to gain more widespread community support for its determination to improve safety.

The key messages which need to be better understood by the community include the industry's determination to improve safety and the importance of coal in economic terms.

Economic importance is seen in the fact that coal generates 80% of Australia's electricity (compared to 40% globally) and is the nation's leading commodity export. Electricity from coal is low cost and gives Australian industries a competitive advantage.

Another key message is that modern combustion technology can dramatically reduce SOx, NOx and particulate emissions and provide higher thermal efficiencies. Australia has higher quality coals which can make a significant contribution to lowering the environmental impact of combustion.

Expectations about the future for coal should not be pessimistic as there are many factors working for the industry. Coal demand in developing countries will continue to grow for the foreseeable future and in many countries coal will continue to be the lowest cost option for base load electricity. Internationally, there is also a significant potential to improve efficiency and lower emissions and at the same time boost coal's image as an environmentally acceptable fuel. Lower coal prices are providing an incentive for importing countries to boost their use of coal. The additional competitive pressures on generators to use the cheapest source of energy should not be underestimated. ■

Article prepared from a paper presented by Robert Humphris, Managing Director, Peabody Resources Ltd, at the NSW Mineral Exploration & Investment'99 Conference. For further information, Robert Humphris can be reached on (02) 9900 7777.

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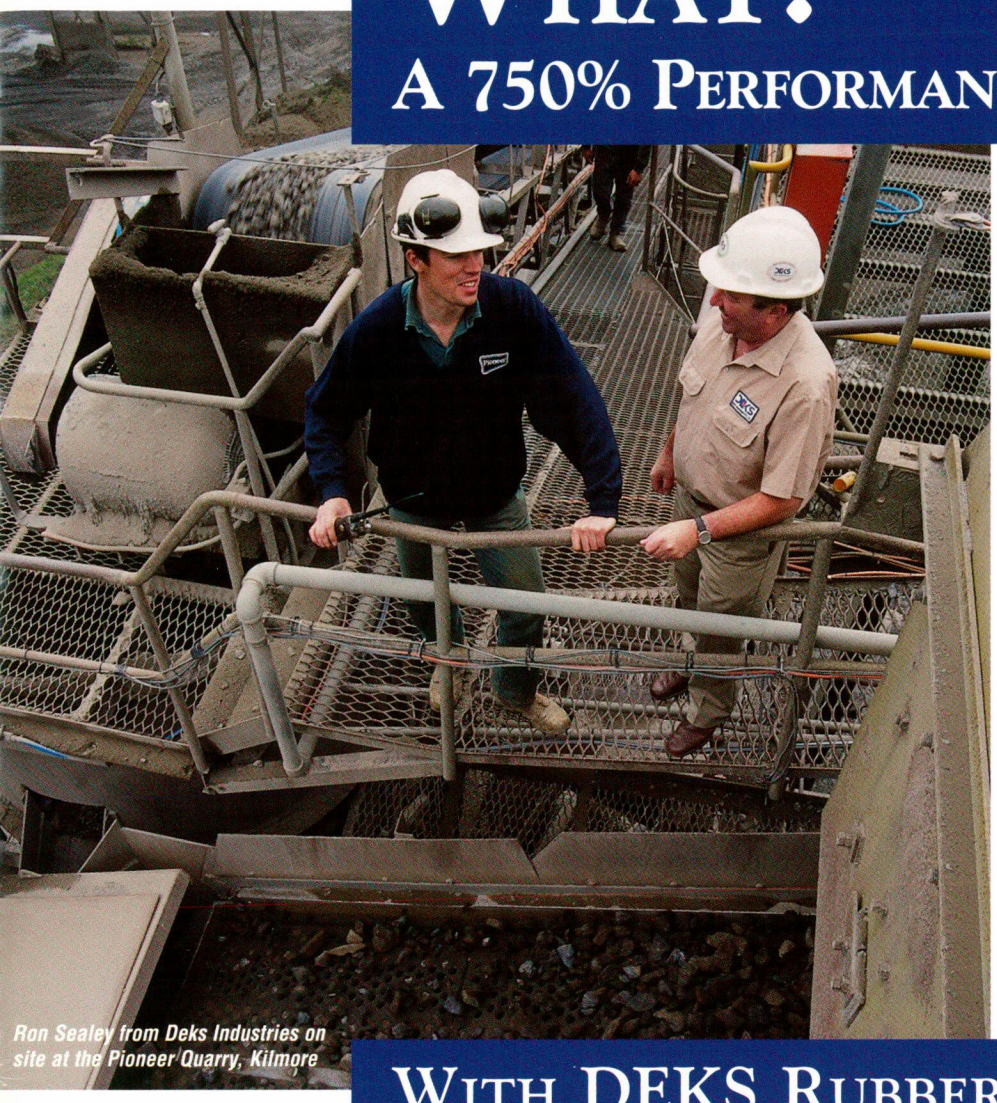

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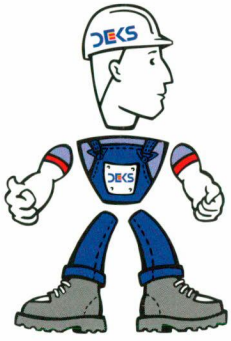

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CURNAMONA PROVINCE — THE NEW EXPLORATION HOT SPOT

Over a century after the discovery of the great Broken Hill silver–lead–zinc deposit, now with only another six years of projected mine life explorers have rediscovered the Curnamona Province (figure 3) as a region with immense exploration potential for world-class mineral deposits.

The area of potential embraces some 60 000 square km and includes the well known Broken Hill Block in New South Wales, and the Olary Block in South Australia. It straddles the border and stretches from Mount Painter in the north-west to Broken Hill in the south-east, with the Portia gold–copper prospect (Pasminco/Werrie) in the approximate centre near Olary, SA (see *Minfo* **62**, pp 6-9, 22-24, 30-34). Combined with the nearby Koonenberry Belt and the Murray Basin north-east and south of Broken Hill, respectively, this region is the source for intense exploration activity, mostly by major companies.

There is no equivalent mineral province in Australia with as much apparent untested potential and with such a diversity of mineralisation styles and commodities.

These mineralisation styles include:

- stratiform and stratabound iron formation and calcsilicate-associated 'sedex' (sedimentary-exhalative) lead–zinc–silver (Broken Hill, Cannington style);
- stratiform and stratabound iron formation and metasomatic breccia-associated copper–gold (Osborne, Starra, Ernest Henry style);
- porphyry copper–gold (Parkes, Cadia style); and
- granite breccia complex copper–gold–uranium–silver (Olympic Dam).

Other commodities with good potential for discoveries and/or development include cobalt, uranium, heavy mineral sands and industrial minerals.

PlatSearch is one of the larger tenement holders on the Curnamona Province. As a junior company, PlatSearch concentrates on generative work to identify prospective areas and to develop the concepts and targets, and then introduces larger companies to fund the higher cost activities. How far PlatSearch takes a project using its own funds depends on the risk/cost profile of each project. PlatSearch's joint venture partners in the region include BHP Minerals, WMC, Homestake, Pasminco, Iluka and Triako.

Outside the immediate Broken Hill Block and the southern part of the Olary Block in South Australia, the region is extensively covered by overburden. This has inhibited effective exploration until recently. The overburden is as much as 500 m thick in the central and northern parts of the Curnamona Province.

The key to rejuvenation of interest and activity in the Province has been the availability of good quality aeromagnetic and gravity data provided through the government-funded Discovery 2000 (NSW), the South Australian Exploration Initiative and the Broken Hill Exploration Initiative (AGSO, jointly with NSW and SA

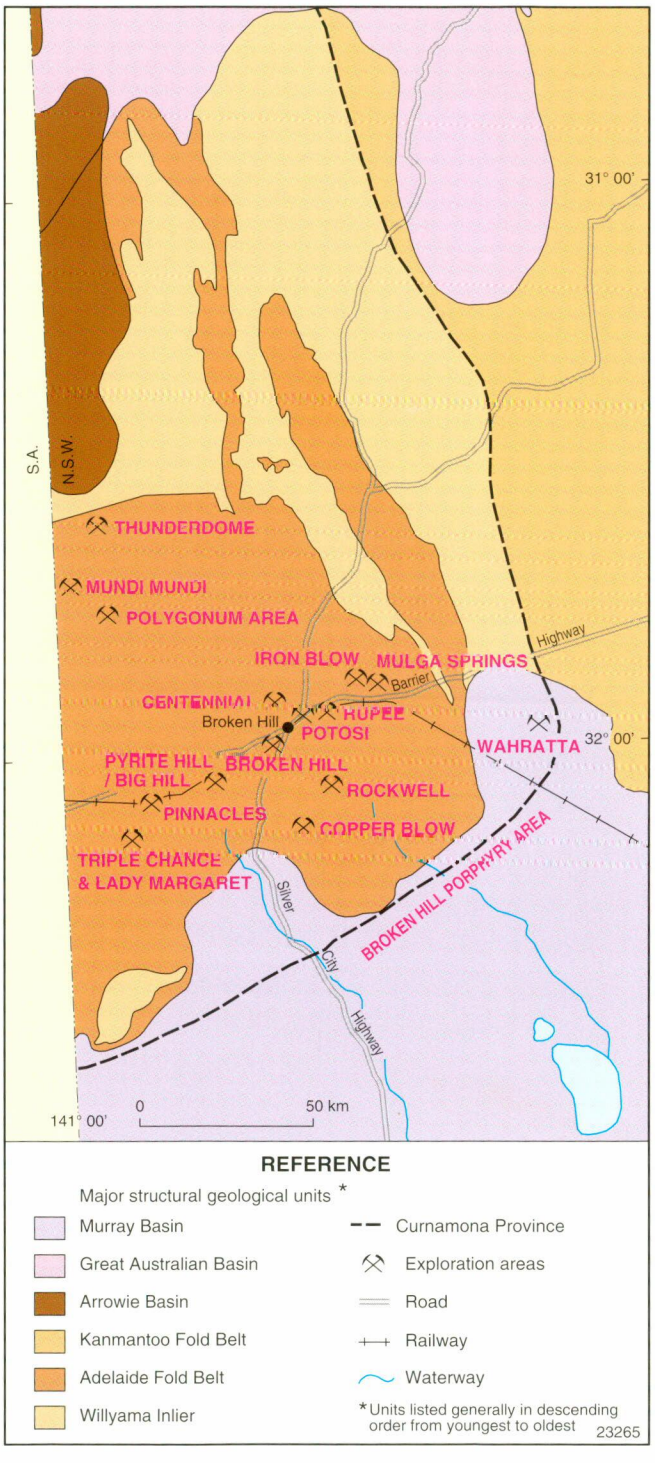


Figure 3. NSW portion of the Curnamona Province

Mines departments) programs (see *Minfo* **60**, p 25, and *Minfo* **62**, pp 1-5).

Those remote sensing data have helped explorers 'peel back' the cover and identify prospective settings for mineral deposits and define drilling targets. A measure of interest in the region is the extent to which many explorers are prepared to drill deep holes to test specific geophysical targets.

This expensive exploration work includes the prospects: Wahratta where PlatSearch/Rio Tinto have drilled 1 103 m; Thunderdome where PlatSearch/Homestake have drilled 923 m; Bibliando where Minotaur/Gawler Gold have drilled 1 106 m; and Rupee where Triako has drilled 1 224 m. Other work includes the prospects: Callabonna where PlatSearch/BHP have drilled 549 m; and Polygonum where PlatSearch/Savage have drilled 698 m.

Extensive and often deep cover determines that exploration is both technically challenging and expensive. This is an environment for serious explorers who are prepared to make a long term commitment to the area. The geology is complex and difficult to interpret even in areas of extensive outcrop, such as the Broken Hill Block, as shown by the extensive mapping programs of the Geological Survey of New South Wales (*Minfo* **60**, pp 28-33).

There is still disagreement about the genesis of the Broken Hill orebody one hundred years after its discovery (*Minfo* **62**, pp 18-21).

View of eastern edge of Mundi Mundi Plain (hiding deep targets) and adjacent Barrier Ranges

However, given the pedigree of the area and the plethora of emerging prospects, the ultimate pay-off to those explorers who are prepared to persevere, could well be another Broken Hill, Ernest Henry or Olympic Dam. ■

Article prepared from a paper presented by Bob Richardson, Managing Director, PlatSearch NL, at the NSW Mineral Exploration & Investment '99 Conference. For further information, Bob Richardson can be reached on (02) 9906 5220.

COWAL GOLD PROJECT REACHES MILESTONE

A great deal of commitment and effort over many years was needed to drive North Limited's Cowal Gold Project to the milestone it reached in March of this year when the NSW Government granted Development Consent.

Since achieving this milestone, considerable interest has been shown in the history of the project and in the steps that still must be taken to bring the project into production.

The Cowal project, located 38 km north-east of West Wyalong in NSW (figure 1, p. 5), can trace its origins back to 1972 when a major exploration initiative was commenced by GeoPeko. At that time the regional geology of the area was poorly known. However, the initiative was rewarded with the discovery of several major copper–gold deposits, including the Cowal gold orebody (known to North as Endeavour 42) in 1981.

By 1977 the company had discovered a porphyry copper–gold deposit near Goonumbla north of Parkes (Endeavour 22) later to become one of two open-cut pits at the Northparkes mine.

Regional exploration was subsequently expanded, based on the discovery of this new style of mineralisation. Four exploration areas were selected in the Lachlan Fold Belt, with the discovery of a major copper–gold porphyry prospect south of Lake Cowal. Further drilling identified a major north–south trending gold anomaly running beside Lake Cowal with gold values in excess of 1g/t gold over an area of 6 km by 1.5 km. The significant potential of the region had been clearly demonstrated. By 1988 four major prospects were identified, with the largest (Endeavour 42) extensively drilled and sufficiently proved up to justify a full feasibility study. A Development Application (DA) was made to the NSW Government in 1995 (refer *Minfo* **48**, pp 34-38).

That DA was subsequently refused in 1996 on environmental grounds. This occurred during a set of difficult circumstances for the company, which included a birdkill incident at the Northparkes mine. There was, however, a belief that this discovery was worthy of perseverance, although the project only had ongoing value if it gained NSW Government development approval.

A second DA was pursued with a philosophy that a failure to gain approval this time round would put the project out of reach in terms of expected environmental performance. A low-risk approach was required and one which, at the end of the day, had to deliver a win to all stakeholders.

The resultant second Environmental Impact Statement was five volumes and over 1 500 pages in length. It included a separate EIS for the 100 km electricity transmission line to the project and a 200 page Species Impact Statement. It also included a revised tailings curtailment design (figure 4) and a new type of study which examined the project's long term compatibility with its surrounding environment. This study formed an eight month 'pre–assessment' for the project before the EIS was commenced.

Further precedents were set. A Memorandum of Understanding (MOU) was pursued with several NSW environmental groups. The MOU commits North to establish an environmental trust to receive funding over the life of the project estimated at about $6 million. This money is to be used to purchase land for conservation purposes and for funding other land management initiatives in the region directly surrounding the mine.

The consent conditions arising from the public assessment of the project are comprehensive but manageable and place the onus on carefully designed environmental management planning. In a new initiative for the NSW Government, there is a requirement for an independent panel of three people to provide an overview of monitoring programs and Government audits of the operational project. The panel is also expected to produce a public Annual State of the Environment Report for Lake Cowal.

PROJECT SNAPSHOT

- Measured and Indicated Mineral Resources at 30 June 1998 total 66.4 million tonnes grading 1.5 g/t gold at a 0.8 g/t gold cut-off for 3.2 million ounces of contained gold.
- The capital cost is approximately $220 million (including $10 million for the electricity transmission line). There would be a two year construction period.
- The development case for the project is based on the production of 2.7 million ounces of gold over 13 years (approximately 270 000 oz/yr for eight years then 120 000 oz/yr for just over four years).
- Conventional open pit methods will be used to mine 204 Mt of material over eight years.
- Milling will be by conventional flotation and cyanide leaching processes. Mill capacity will be 6.0 Mt per year for a total throughput of 76 Mt of ore and a similar amount of tailings.

One of the more difficult balancing acts in gaining Government approval for a project is matching the heightened expectations in the community for a commencement of the project. At the time of writing, the decision to commit construction capital to the Cowal Gold Project has yet to be taken by North. Since 1996 little expenditure has been directed towards the financial enhancement of the project given the uncertainty surrounding the ability to clear the Government's environmental hurdle.

The process of fine tuning the project's financial model is now again underway, with an internal study to identify key areas for improving costs associated with the project. In the meantime, North is pursuing other activities that have been deferred, including the formalities necessary for obtaining a mining lease.

The current Consent is valid for 21 years from granting of the mining lease and construction is required to commence within the next five years. ■

Article prepared from a paper presented by Richard Peters, Group Adviser-Community Relations, North Limited, at the NSW Mineral Exploration & Investment '99 Conference. For further information, Richard Peters can be reached on (03) 9207 5111.

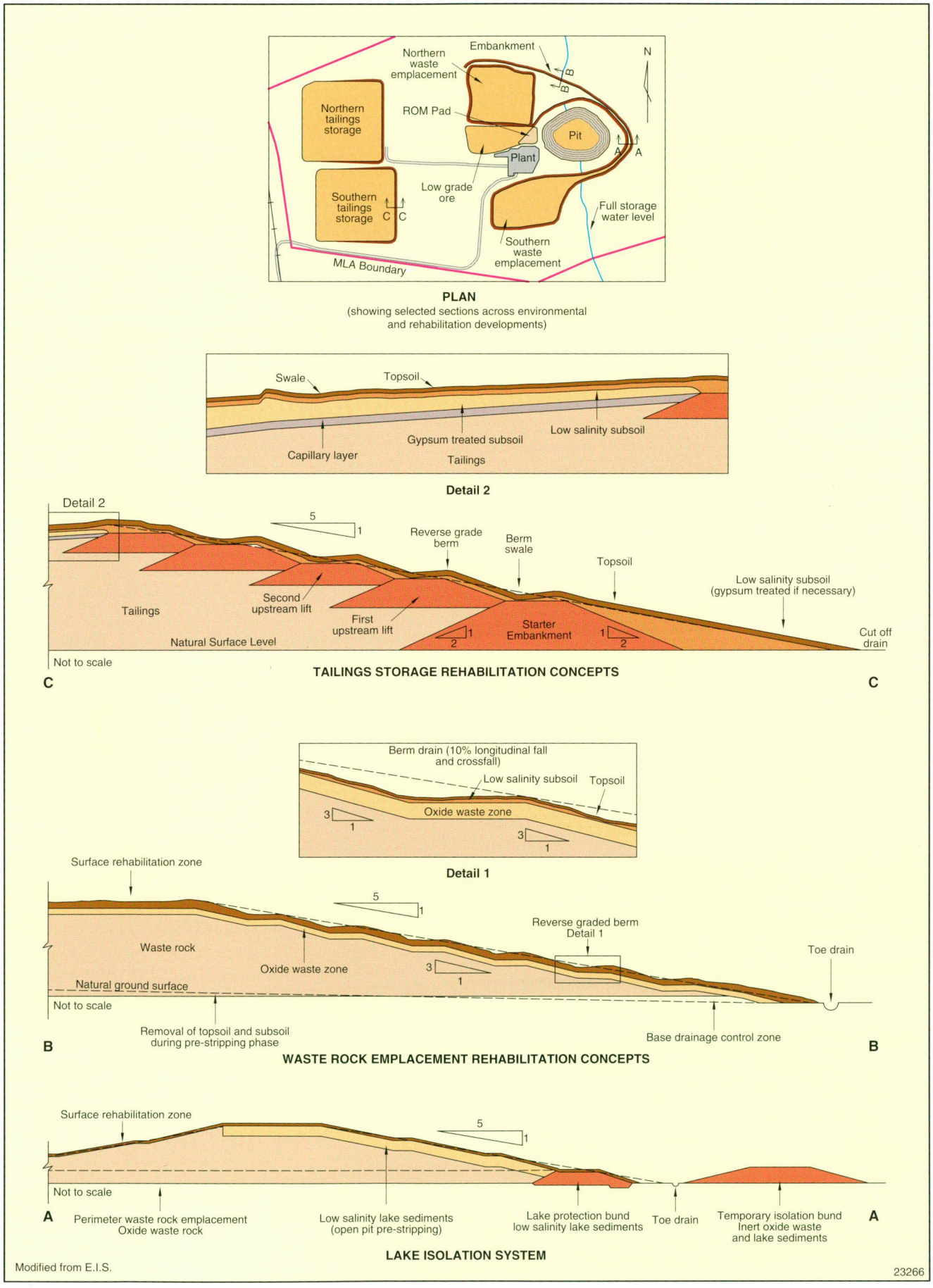


Figure 4. Environmental and rehabilitation plans for the Cowal Project (redrawn from second EIS)

COMPELLING CASE FOR RIDGEWAY GOLD PROJECT

Access to, and sampling of, an estimated 44 million tonne gold resource at Ridgeway is now well advanced.

The Ridgeway gold–copper orebody (*Minfo* **57**, p 35) is three kilometres to the north–west of the recently commissioned Cadia operation (*Minfo* **62**, p 48), which is south of Orange NSW (figure 1).

The Ridgeway resource was discovered in 1996. Since that date, additional drilling, assaying, resource estimation and substantial environmental studies have been carried out, as well as the construction of 3 100 m of an exploration decline (as at April 1999).

The Ridgeway project is owned by Cadia Holdings Pty Ltd, a wholly owned subsidiary of Newcrest Mining Limited.

Ridgeway is a stockwork style of deposit consisting of a high grade gold–copper–magnetite–quartz vein stockwork within a lower grade sheeted quartz vein package.

The stockwork at Ridgeway is a complex of interlocking sets of veins, which is set within a sequence of subparallel veins. All veins might have formed by mineral being deposited along fractures, with the stockwork developed in association with a monzodiorite intrusion.

The whole stockwork/sheeted vein complex is hosted predominantly by the Late Ordovician Forest Reefs Volcanics and extends down into the underlying Weemalla Formation. The top of the deposit is some 450 m to 500 m below the surface and is totally blind, being covered by 30 m to 80 m of Tertiary basalt.

At a cut-off grade of 2.0 g/t (gold equivalent) the current estimated resource at Ridgeway is:

Indicated resource	32 million tonnes at 2.9 g/t Au and 0.9% Cu
Inferred resource	12 million tonnes at 1.8 g/t Au and 0.7% Cu
Total resource	44 million tonnes at 2.6 g/t Au and 0.8% Cu

The rock at the proposed mining depth is fresh and empirical studies indicate that it has a high strength. However, locally weaker zones are associated with prominent faults and shears.

Project development

The Ridgeway orebody is a massive deposit and, as a result of studies to date, it is evident that Ridgeway could be developed in any of a broad range of mining methods. Having established the potential of Ridgeway, much additional information about 'bulk' properties was required. A 'base case development plan' based on sub-level open stoping with cemented backfill was compiled to represent a 'minimum case' outcome. This plan clearly demonstrated a low risk, viable project.

A real opportunity for Ridgeway, however, is a mining method which can eliminate or significantly reduce the requirement for cemented backfill. In order to realise such a result, additional information is needed, particularly with respect to orebody geotechnical data and hydrogeological confirmation, both of which require multiple exposures of the 'orebody'. Early development in accordance with the base case development plan will enable this information to be collated.

The base case development plan would mine and process 15.3 million tonnes of ore with a grade 3.5 g/t gold and 0.9% copper, based on a cut-off of 4 g/t gold equivalent. The nominal production rate would be 1.5 million tonnes per year. A preliminary review of that concept indicated that alternative mining development strategies and mining methods based on greater knowledge of the 'orebody' were likely to

Some 3 100 m of exploration decline was constructed by April 1999

significantly improve project economics and allow the cut-off grade to be lowered and production rates increased.

Development of the decline and the consequent enhanced sampling will proceed in accordance with the base case plan in order to gain the geotechnical and geological information required. Concurrent with that work, the feasibility study process will commence at conceptual level leading to pre-feasibility and final feasibility, anticipated by late 1999.

If no further improvement in project economics results from the additional work, it is proposed to finalise the feasibility study and develop the project in accordance with the base case development plan.

Mining, processing and permitting

The mining method selected for conceptual planning takes into account the key factors identified. That method is a combination of primary stope extraction by sub-level open stoping with cemented rockfill, and secondary stope extraction by long hole open stoping with continuous (uncemented) rockfill.

Three options were considered for the processing of ore from Ridgeway.

1) Treatment through the existing Cadia Hill concentrator with only minimum modifications made to the concentrate handling facilities.
2) Treatment through the existing Cadia Hill concentrator, with additions to the flotation, regrind and concentrate handling facilities.
3) Treatment through a dedicated Ridgeway concentrator.

Ridgeway ore would be treated through the Cadia Hill concentrator for the first three years of production for all options.

The option of treatment through a dedicated Ridgeway concentrator was preferred due to higher metallurgical recoveries and a lower impact on Cadia Hill economics.

The exploration-based licence under which the early decline work was developed places limits on the extraction of ore to a bulk sample of 2 000 tonnes. This scope of work was completed in June 1999.

Following discussions with the Department of Mineral Resources and Department of Urban Affairs and Planning, it was recommended that two staged permits be sought. The first is an interim permit to allow further development and trial mining of up to 100 000 tonnes per month for a period of 18 months commencing in May 1999. This would enable the necessary information to be gathered in order to complete a thorough feasibility study which will optimise the resource extraction and enable presentation of a fully detailed Environmental Impact Statement (EIS) associated with the proposed development.

The second stage of permitting will be for full-scale development at Ridgeway and will be based on the results of the optimisation and feasibility studies. ■

Article prepared from a paper presented by Don Runge, Project Manager – Ridgeway Project, Newcrest Mining Limited, at the NSW Mineral Exploration & Investment '99 Conference. For further information Don Runge can be reached on (02) 6392 2550 or e-mail: runged@newcrest.com.au

JAPANESE INVESTMENT IN PORT KEMBLA COPPER

After meeting a number of legal, environmental and industrial relations challenges, Port Kembla Copper is ready to begin smelting operations at its Port Kembla site.

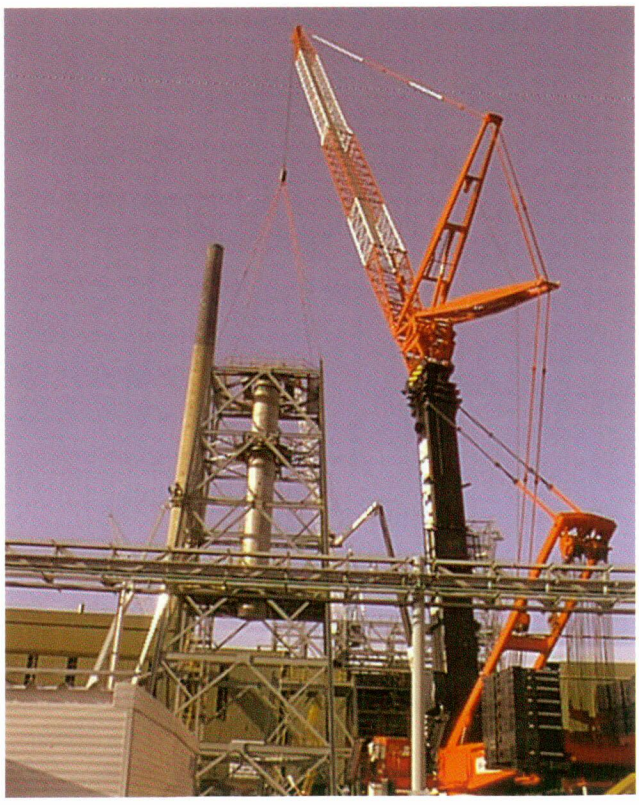
Redeveloped by four Japanese companies, led by Furukawa Co. Ltd with a 52.5% stake, the project will directly employ 220 people (plus contractors) and is due to begin smelting operations this coming October.

On completion, the plant will smelt 400 000 tonnes of concentrates and produce 120 000 tonnes of refined copper and 350 000 tonnes of sulphuric acid each year. It will also process around five tonnes of gold and 30 tonnes of silver every year.

The New South Wales Government has been very supportive of this project at all stages, from initial planning through to current development, and has provided considerable assistance in dealing with many complex issues facing the developers.

The project is extremely sensitive because of environmental issues arising from past operations at the site and its close proximity to residential areas.

Best practice is being adopted by the company to meet the stringent conditions agreed with the New South Wales Environment Protection Authority. This includes a second, additional, acid plant to improve sulphur dioxide (SO_2) recoveries, a new converter furnace and enclosed ladle transfers. The smelter building will be fully enclosed, replacing the earlier 'open-aisle' arrangement. Port Kembla Copper (PKC) is also installing a new state-of-the-art water treatment plant, which will allow most water to be recirculated and kept on site.



Acid stack under construction

Anode furnace in place

Approvals for development were granted following a public Commission of Inquiry. Despite this, a legal challenge was mounted in the Land and Environment Court against the Government in an attempt to stop the development. Although confident of the outcome of the Court's deliberations, the Government was concerned about delays for the project and consequent delays to its employment benefits while the matter was locked up in litigation. As a result, the Government introduced legislation into the Parliament to ratify approval, removing any potential for doubt. This move was supported by both major political parties and passed through both Houses.

Budgetary constraints limited the financial incentives available from the Government, but some assistance was granted in the form of payroll tax relief.

A major issue for the investors has been industrial relations in the Illawarra Region.

A single union site agreement providing maximum flexibility was required. As a result, a Memorandum Of Understanding (MOU) was negotiated with the Australian Workers' Union (AWU) prior to making the investment decision. This was developed into a Draft Agreement (EBA) which recognised the 'greenfield' status of the project and the need for best practice. The practical issues of converting the Draft into a registered Agreement proved more difficult. However, after some months of negotiation, the Agreement was signed in July, and is now submitted for approval. Key elements include annualised salaries, no demarcation, 'seamless' conditions between staff and EBA employees and

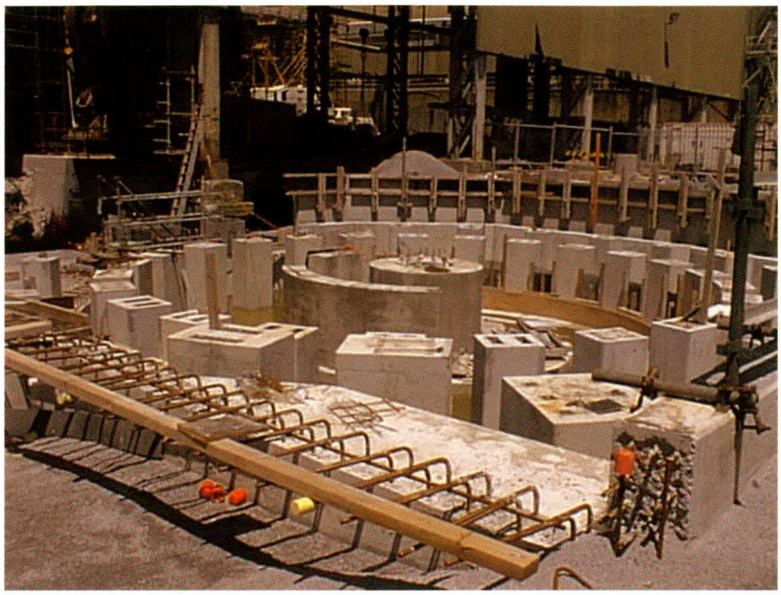
recognition that the company must compete in world markets.

The operation of a domestic smelter in New South Wales brings significant benefits for local copper mines, including savings in transportation costs and more efficient cash flows. Mines which otherwise may not be viable may be able to remain open, while others may now be able to re-open.

Consumers will also benefit from more competitive pricing and increased flexibility.

The new owners have developed a unique 'Simplified Process Flowsheet' which deploys some of the best smelting technology available to achieve many economic and environmental improvements. Core plant includes a Noranda Furnace (from Canada) for Primary Smelting, a Mitsubishi Continuous Convertor for Secondary Smelting, and an Anode Casting Process from Finnish company Wenmac. The new acid plant's 'double contact' process, which includes a new Hitachi Zosen plant, brings 99.5% (plus) efficiency in SO_2 recoveries. A completely new refinery using Australian 'ISA' technology completes the major plant components.

For Port Kembla Copper, the strong intercompany relationships which exist in Japan proved invaluable in providing access to the best smelting technology available. ■



Anode wheel foundations

Article prepared from a paper presented by Malcolm Taylor, President & CEO, Port Kembla Copper Pty Ltd, at the NSW Mineral Exploration & Investment '99 Conference. For further information, Malcolm Taylor can be reached on (02) 4275 0200.

SYERSTON NICKEL–COBALT PROJECT PROMISES HIGH GRADES AND LOW COSTS

The Syerston Nickel–Cobalt Project is planned as a stable long-term source of refined nickel and cobalt that could supply up to 10 per cent of the world's cobalt metal during a 30-year plus operational life.

Syerston is located in central New South Wales in proximity to Parkes and Condobolin and is owned by listed Australian company Black Range Minerals NL (figures 1, 5).

With current capital cost estimates of A$490 million, this project would employ more than 1 000 people during construction and over 300 when operational (figure 6).

The orebody at Syerston is a limonitic nickel–cobalt laterite which is currently estimated to contain a resource of 100 million tonnes with a grade 0.66% nickel and 0.11% cobalt. This is an equivalent grade of 1.06 % Ni (assuming Ni eq = Ni + 3.64 x Co). The ore would be treated using autoclave leaching (pressure acid leach) at an estimated leach feed rate of 1.5 million tonnes per year.

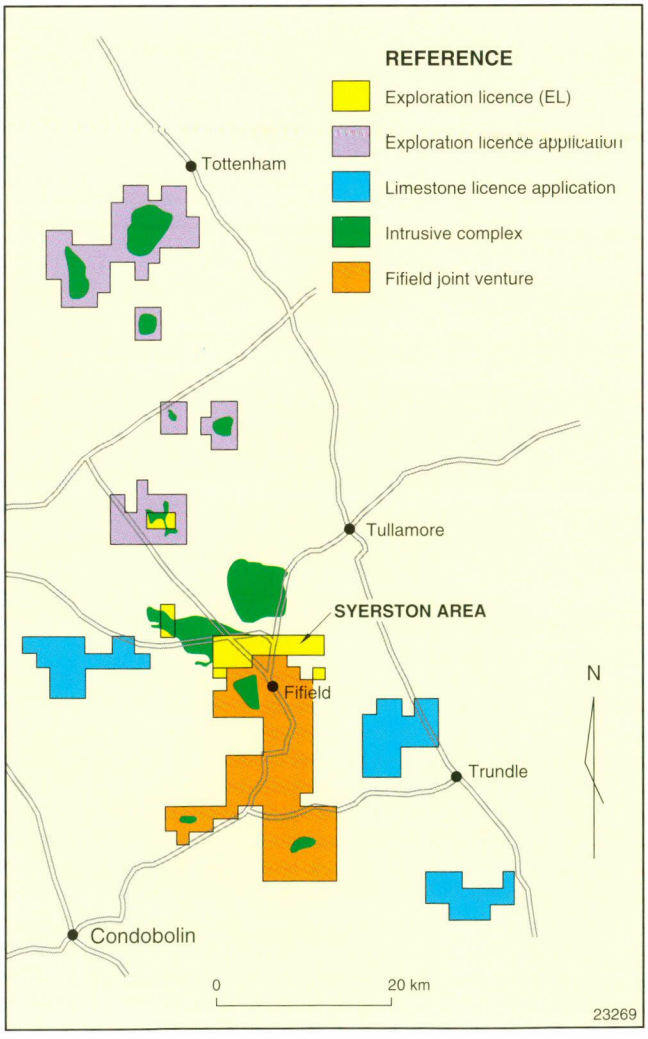


Figure 5. Location of Black Range Minerals NL tenements

The ore zones are typically flat lying and are between 10 m and 40 m below the surface (figure 7). They lend themselves to extraction of higher grade goethite mineralisation from upper zones during initial mining. Lower grade ore from deeper zones can be upgraded significantly by removal of barren silica.

The mineralisation at Syerston is similar to that treated by pressure acid leaching at Moa Bay in Cuba since 1959. This type of ore responds well to the proven pressure acid leach process. Standard refining practices will be used to produce LME grade nickel and LME grade cobalt metals.

Low costs

A number of favourable factors contribute to the project's projected low operating costs.

- The ore is free digging and has a low strip ratio due to thick ore sequences.
- It is a compact resource, covering some two by three kilometres only, reducing ore haul distances to the plant relative to other laterite projects.
- The limonitic (iron-rich) nature of the ore enables rapid leaching and permits high autoclave feed densities. Leach kinetics indicate that at least 95% of both Ni and Co are extracted within 60 minutes.
- The ore has a low acid consumption requiring an estimated 250 kg of acid per tonne of ore, compared to typical Western Australia laterites which require over 400 kg per tonne. This is because of the low magnesium and aluminium (clay) content of the limonitic ore and the quality of water to be used.
- Energy costs (electricity and steam) would be low because the project benefits from its proximity to the Moomba to Sydney natural gas pipeline and the competitive electricity market. The gas pipeline is some 70 km from the project area, while it is anticipated that electricity will be available at less than $0.05/kWh.
- The project is located close to established infrastructure such as standard gauge rail, bitumen roads, grid electricity and mining communities.
- Good quality water will be obtained from borefields within the Lachlan palaeochannel about 60 km distant.

Additional factors could enhance the project include.

- Potential for upgrading by rejecting siliceous components in the ore. Test work has indicated an upgrading of feed by over 50% from the lower siliceous zones.
- Potential limestone resources have been pegged within 20 km of the project site. The limestone is necessary for acid neutralisation purposes during processing.
- Platinum mineralisation has been identified within the overburden and within the nickel–cobalt ore zones.

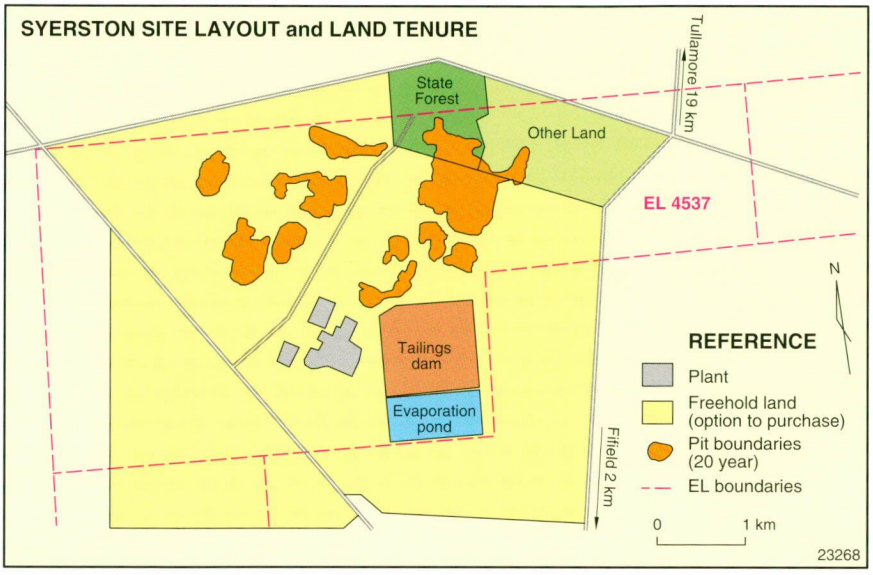


Figure 6. Syerston's compact resource, covering two by three kilometres only, allows for short ore haul distances to the plant

- Potential exists for platinum recovery with minor credits and pilot plant test work will be used to develop a recovery circuit.

The project development schedule for Syerston involves completion of the feasibility study by the end of the first quarter 2000, followed by detailed design of items with long lead times. Project financing activities are scheduled to begin in the fourth quarter of 1999 following completion of reserve definition drilling and pilot plant work.

Site construction is scheduled to begin at the end of the third quarter of 2000, following project approvals anticipated for the second quarter of next year.

Commissioning on ore is scheduled to begin from the end of the first quarter in 2002. Over the first five years of the project the feed grade of the ore would be 1.18% Ni and 0.30% Co (2.27% Ni eq). The 1.5 million tonnes per year of feed would yield 14 700 tonnes of nickel per year and 2 800 tonnes of cobalt per year.

It is estimated that the cash operating costs over the first five years of the project would average minus US$0.65/lb nickel after cobalt credits (before tax but after royalties). Without cobalt credits the cost would be US$1.87/lb nickel.

For the first twenty years of the project the average ore grade would be lower than over the first five years, although the tonnage of metal produced will be only slightly lower (14 670 tonnes nickel ore and 2 770 tonnes of cobalt per year). Cash operating costs are estimated to average US$2.05/lb nickel, or US$0.16/lb nickel after credits. ■

Article prepared from a paper presented by Geoff Motteram, Executive Director, Black Range Minerals NL, at the NSW Mineral Exploration & Investment '99 Conference. Geoff Motteram can be reached on (08) 9326 5700.

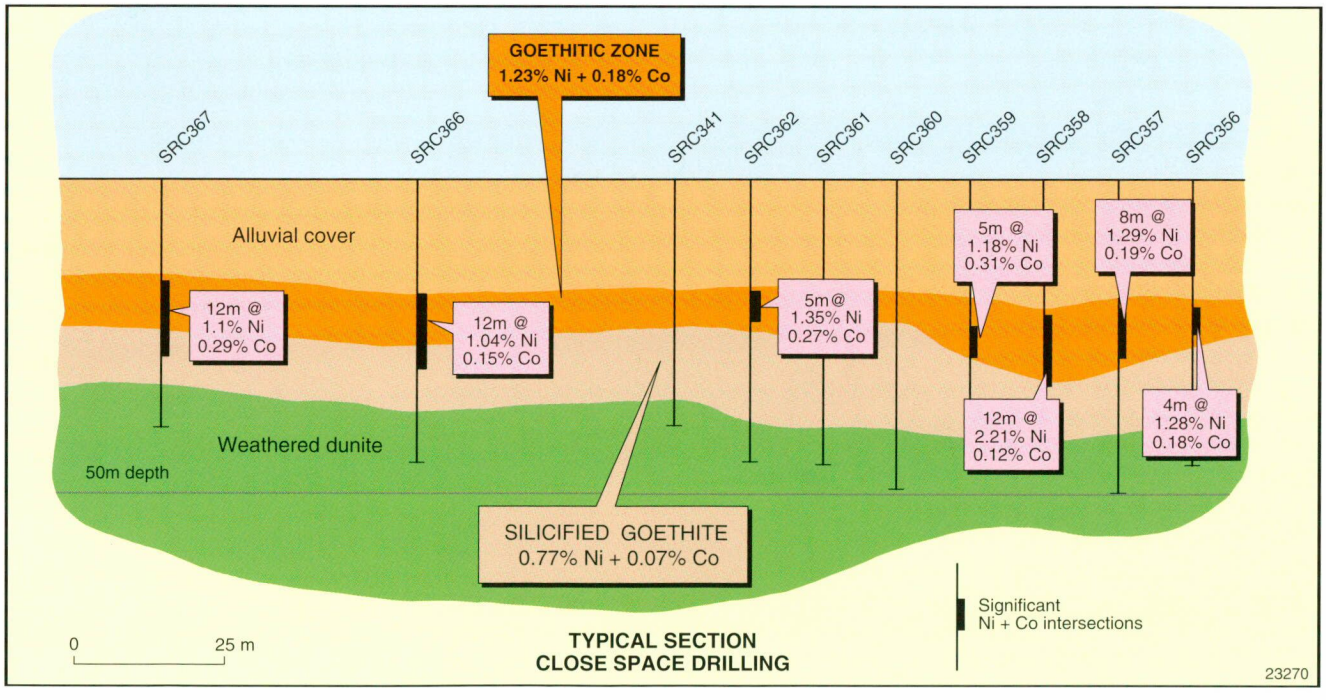


Figure 7. The orebody at Syerston is a limonitic nickel–cobalt laterite which is estimated to contain a resource of 100 million tonnes with a grade 0.66% nickel and 0.11% cobalt

CSA COPPER MINE REOPENED WITH RENEWED FOCUS

With plans in place to improve work practices and minimise mining dilution, Cobar Management Pty Ltd has recommenced mining operations at the Cobar CSA copper mine.

The deposit was discovered in central western New South Wales in 1870, with large scale underground production beginning in 1965. The CSA Mine lies in the Cobar Trough with the Elura Mine to the north and the Peak Gold Mine to the south (see figure 1, p 5).

After Cobar Mines Proprietary Limited was placed in receivership, Cobar Management Pty Ltd (a wholly owned subsidiary of Glencore International AG) is now focussed on profitably mining the QTS North ore zones, particularly the K and M lenses.

The key elements of the new operating philosophy require: minimising the mining dilution; improving the efficiency of work practices; and reducing the throughput while maximising the grade.

This operating philosophy is accompanied by the company's commitment to:

- repay the debt owed to Glencore;
- achieve profitable growth;
- achieve the highest possible return on the capital invested;
- practise responsible environmental management;
- provide a safe and healthy workplace;
- improve the culture of CSA by giving people meaningful work that offers opportunities to develop new skills; and
- to be a good corporate citizen of Cobar.

Efficiency gains

Shareholders are demanding greater returns on the cash invested. The previous work practices and organisation structure were inappropriate to achieving profitable operations at current commodity prices. To survive with such pricing levels, a mining business must ensure that all tasks either add value or result in adding value to the business objectives.

Cobar Management is building a business-focussed organisation in which all stakeholders will benefit. Now in place is a flat organisational structure with integrated teams working within two primary and two service units. The primary business units of Metallurgy and Mining are responsible for all planning, maintenance and production requirements for each unit. The Administration and Engineering units deliver support functions such as costing, audits, and planning support to the primary units.

Business unit managers will be measured against key performance indicators and subject to comprehensive performance reviews to ensure that they continue to add to the company's success.

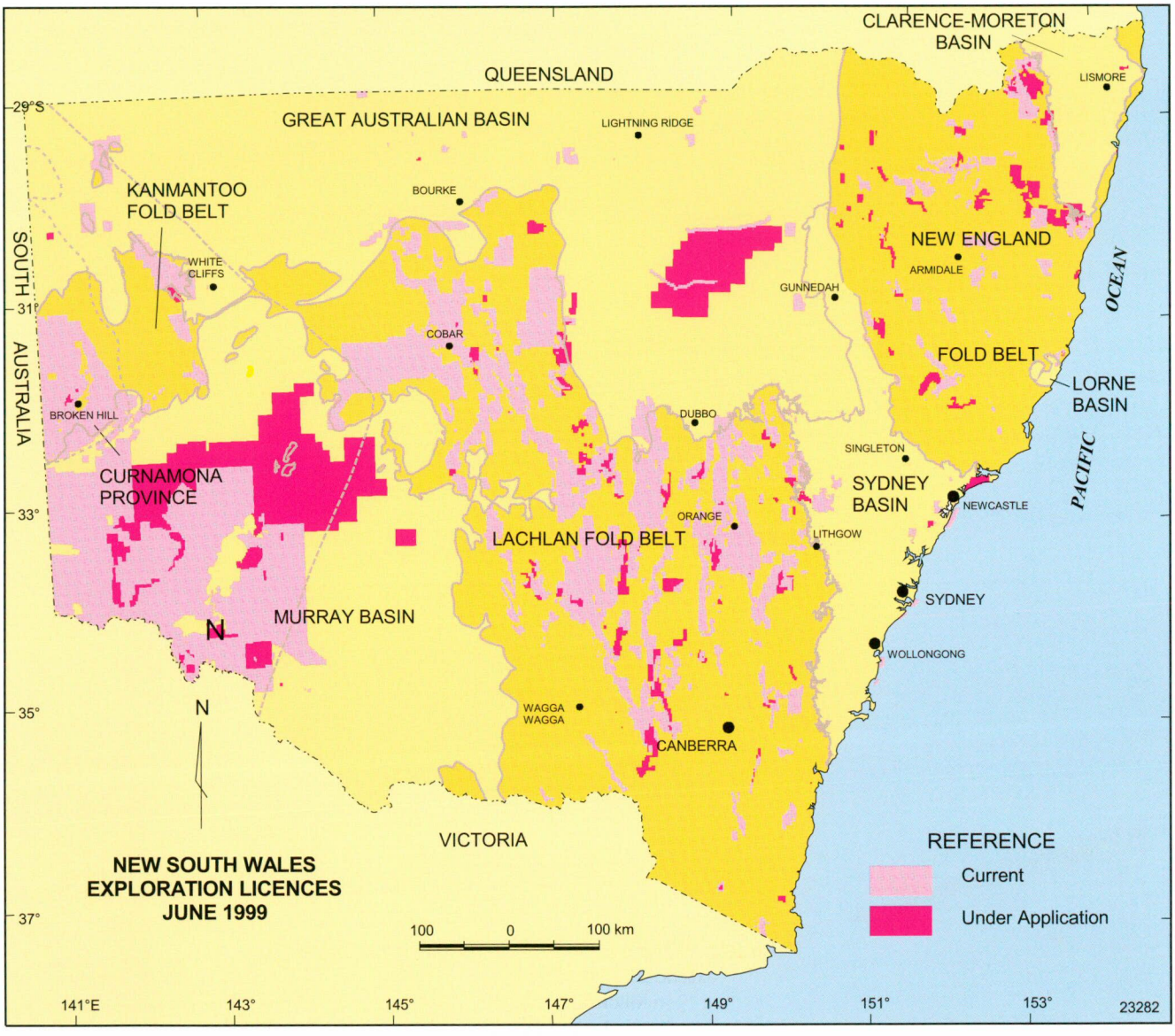
Contractors have been engaged to provide resources for the operation as part of a partnering alliance strategy where the risk and rewards are shared. A planned total workforce of 107 people will be employed to produce 500 000 tonnes of ore for 30 000 tonnes of copper per year. Previously, 365 people produced 1 100 000 tonnes of ore per year for a total copper production of 30 000 tonnes.

A planned total work force of 107 people will produce 30 000 tonnes of copper per year

Reduce mining dilution

Historically there was excessive dilution within stopes where the sub-level was spaced at 40 m and extracted over an extended strike length. The proposed stoping method is the longhole bottom slicing method incorporating a 40 m sub-level interval with a strike extension of 15 m. A geotechnical review indicated the span will be stable at the proposed stope dimension. The extraction sequence of the mining operation is critical, with a series of primary and secondary stopes incorporated in the mine plan. A hydraulic fill system will be

EXPLORATION LICENCES IN FORCE JUNE 1999



SUMMARIES OF TERMINATED EXPLORATION LICENCES

EXPLORATION LICENCES CANCELLED/EXPIRED JANUARY — MARCH 1999

EL 2774 **J.M. Stephen P/L**

Location: 50 km SW of Tamworth

Objectives: Zeolite

Geological mapping, sampling and drilling were used to assess Late Carboniferous volcaniclastic and pyroclastic rocks west and north of the Escott mine. Several tens of millions of tonnes at greater than 60% zeolite have been identified in several deposits. Applications for mining leases and assessment leases have been lodged over some of these.

EL 3465 **Pasminco Exploration Ltd**

Location: 55 km N of Cobar

Objectives: Gold and base metals

Work undertaken includes detailed magnetic studies and deep drilling to test gravity, magnetic and geochemical anomalies. Principal interest was on the Burri prospect where surface arsenic, copper and gold anomalies are associated with magnetic and gravity anomalies. No significant results were obtained.

EL 3620 **Gold Mines of Australia (NSW) P/L**

Location: 15 km SE of West Wyalong

Objectives: Porphyry copper–gold

The tenement is proximal to the Gilmore Fault Zone. Regional geological mapping, modelling and interpretation of airborne magnetic and gravity data and drilling was conducted. The lack of possible intrusive centres and the thick (greater than 120 m) regolith cover downgraded the prospectivity of the area.

EL 4023 **LFB Resources NL**

Location: 35 km-90 km N of Orange

Objectives: Gold

The licence surrounded the historic Stuart Town Goldfield. Stream sediment and soil sampling identified areas of gold and arsenic–antimony anomalism but these were not drill tested. A gravity anomaly near Manna Hill, where there are known felsic intrusions, also remains untested.

ELs 4535, 4536 **Rio Tinto Exploration P/L**

Location: 35 km WSW of Broken Hill

Objectives: Base and precious metals

The Thackaringa mineral field was evaluated for polymetallic vein deposits. Detailed mapping, geochemical sampling and induced polarisation (IP) surveys outlined a 750 m x 750 m anomalous zone. Diamond drilling (10 holes) intersected infrequent siderite–quartz–sulphide veins associated with narrow sericite–chlorite altered zones. The best intersection was 2.6 m at 6.44% Pb, 2.70% Zn and 112 g/t Ag. Bulk tonnage potential was concluded as low. Aeromagnetic data were assessed for Carrington-type targets. Six anomalies were followed up with no significant results. Drainage geochemistry highlighted a number of anomalies but auger drilling failed to identify any bedrock source.

EL 4591 **Nosebi Mining & Management & Dowmill P/L**

Location: 20 km S of Goulburn

Objectives: Base and precious metals

Exploration by joint venture partners PlatSearch NL and CRA Exploration PL focussed on mineralisation associated with magnetite and pyrrhotite. An airborne survey identified a number of "bullseye" anomalies. Rotary air blast (RAB) and diamond drilling at three of these intersected mineralised skarn with patchy gold, copper, zinc and minor lead and molybdenum. Intersections included 1.7 m at 1.2 ppm Au, 4 m at 1.11% Cu and 1.5 m at 4.09% Zn. Further testing of these prospects was planned but not carried out.

EL 4808 **Minerals Corporation Limited**

Location: 35 km SE of Bathurst

Objectives: Garnet

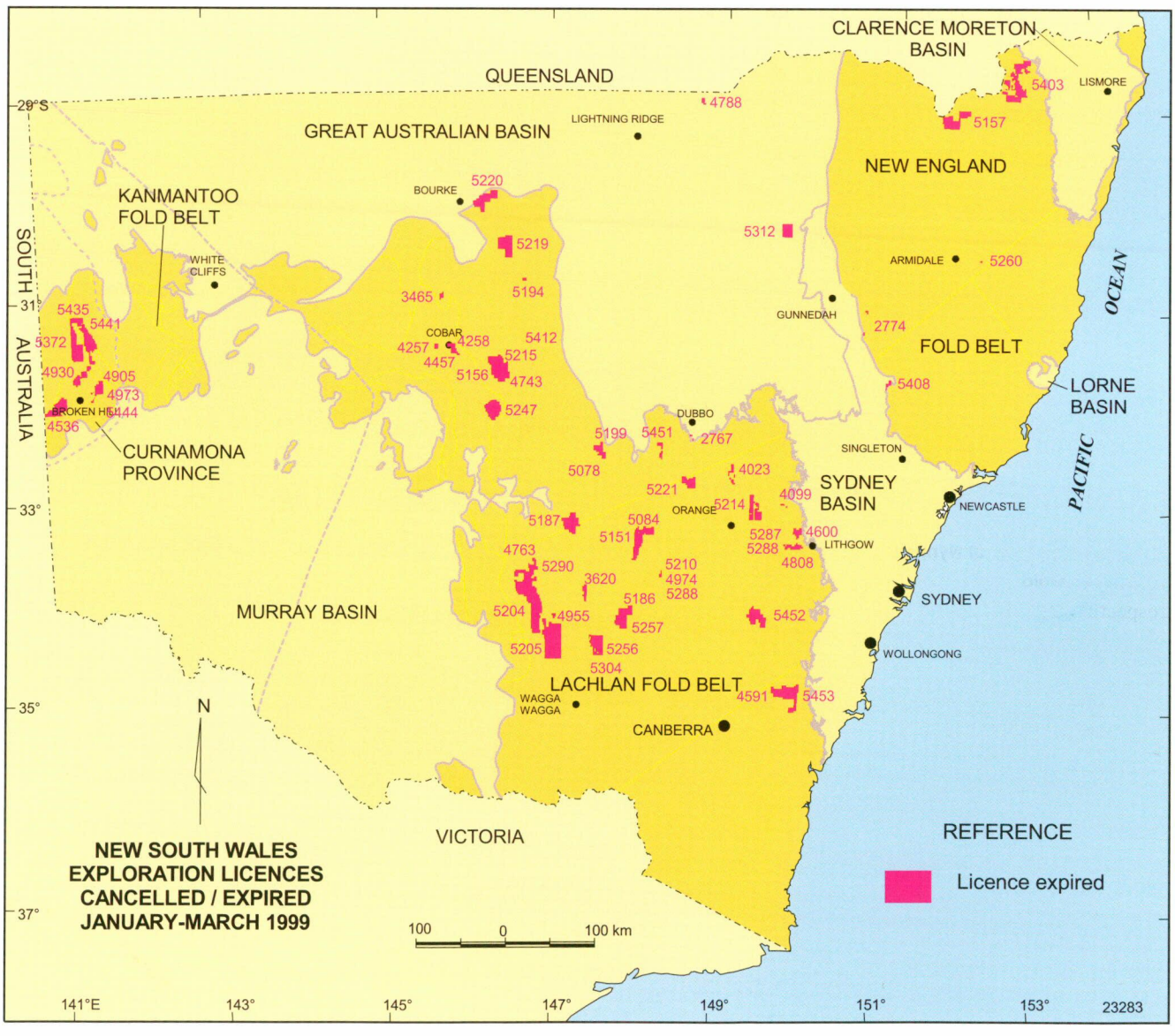
The licence was acquired to explore the Mount Tennyson garnet molybdenum deposit and other similar small skarn deposits. However, field activities were hindered by access difficulties. Metallurgical work confirmed easy recovery of molybdenite by froth floatation and that garnet could be separated by a variety of methods. The garnet, mainly andradite and grossular andradite, was concluded as less desirable than the almandite available elsewhere in the State.

EL 4930 **Exodus Minerals Limited**

Location: 20 km N of Broken Hill

Objective: Base metals

Work comprised reprocessing of aeromagnetic data and interpretation, aerial colour photography, and data review. Following company restructure, work was ended in order to concentrate on more advanced projects elsewhere.



constructed to use deslimed tails, with 10% cement added to allow crown extraction, 6% cement in the primary stopes for stability during the extraction on the secondary stopes, and uncemented fill in the secondary stopes.

The mineralisation at the CSA Mine occurs within veins and sub-massive to massive orebodies, with five major ore zones having been identified. They all strike north–south, are steeply dipping to the east and plunge steeply to the north.

The QTS North orebody is a blind system that commences approximately 700 m below the surface and has been traced to a depth of 1900 m below the surface. The QTS north system consists of five lenses (K, M, P, Q and R) containing high grade copper-rich ore, with some intersections up to 20%. A 42-hole drilling program completed by Mt Lyell Mining Company in 1998 indicated a measured and indicated resource of 3.5 million tonnes at 6.5% Cu. The mineable reserves estimated using a cutoff grade of 3% Cu are 2.9 million tonnes at 6.25% Cu.

Mining operations will initially target the higher-grade K and M lenses (of the QTS North ore body) at a production rate of 450 000 tonnes per year between the RL9190 and RL8890 levels. This is to help repay the debt to Glencore. Other areas will be evaluated to add marginal (cost) tonnage that increases the return on cash invested. Present drill intersections showing the grade and tonnage indicate that the QTS North system continues at least 550 m below present planned mining operations. Further modelling of the geological information will determine the resource tonnages at different cut-off grades.

There is an excellent opportunity for the CSA Mine to grow to be one of the premier copper mines in New South Wales. ■

Article prepared from a paper presented by David Woodall, General Manager, Operations, Cobar Management Pty Ltd, at the NSW Mineral Exploration & Investment'99 Conference. For further information, David Woodall can be reached on (02) 6836 2001.

HOT ROCKS COULD YIELD MEGAWATTS

Pacific Power has been granted an exploration licence in the Jerrys Plains area to assess its potential as a source of hot rock geothermal energy.

The area (figure 8) was identified in 1991 when high temperatures were obtained in two Pacific Power gas investigation boreholes, drilled three kilometres apart, about twenty kilometres south of Muswellbrook. The area around the boreholes has been termed the 'Muswellbrook Geothermal Anomaly'.

The temperature of the Earth's crust increases with increasing depth. In some locations, the temperature increases so rapidly that rock at temperatures well in excess of 250°C ('hot rock') can be found at depths as shallow as three kilometres.

Under favourable circumstances, the hot rock can be fractured and water from the surface can be circulated through it by means of high pressure pumps. The superheated water can then be returned to the surface and used to generate electricity (figure 9).

Hot rock geothermal energy ('hot dry rock') is quite different from conventional geothermal energy which involves the recovery of naturally occurring superheated groundwaters in active or recently active volcanic areas, such as those in Italy, Japan and New Zealand. For the Muswellbrook locality it is possible that a 'hot' granite may be present below the coal-bearing Sydney Basin. The coals can act as an insulating blanket to keep the heat contained.

Energy recovery

In a hot rock geothermal energy recovery system, an artificial reservoir is engineered in a hot rock and high pressure water from the surface is used to recover energy from the reservoir.

Initially, a water injection well is sunk into the rock mass. A network of fractures, which penetrates as much as 500 m into the rock from the well, is then developed by means of hydraulic fracturing. This fracture network and the host rock constitute the hot rock geothermal energy reservoir.

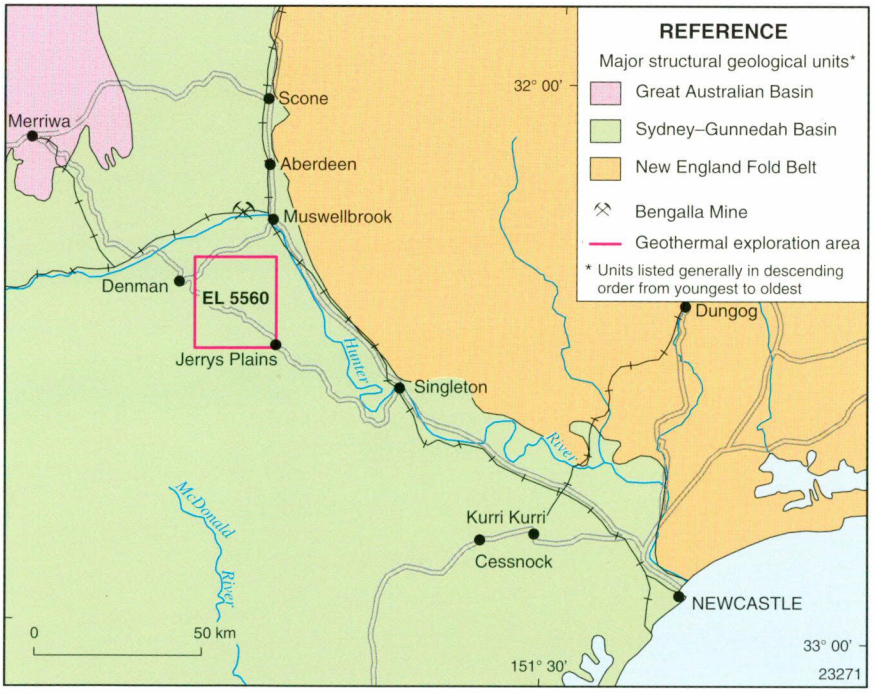


Figure 8. Location of Exploration Licence for geothermal energy

A second well is then sunk into the fracture network and this acts as the water return or production well.

Water at high pressure is pumped down the injection well, forced through the fracture network in the rock, gaining heat along the way, and then returned to the surface via the production well (figure 9).

At the surface, the superheated water can be used in a plant to generate electricity.

Pacific Power plans to drill and undertake testing in 12 investigation boreholes over the period 1999-2000. These boreholes, which will be up to 1000 m deep, will provide information on the temperature and stress of the rocks at depth. This phase of the program aims to determine the location of the hottest part of the Muswellbrook geothermal anomaly.

If commercial quantities of geothermal energy are ultimately identified, water injection and production wells would need to be drilled at some future time to extract the heat from the hot rock.

Provided that the existence of the resource is confirmed, investigations between 2001 and 2005 could include deep drilling to a depth of about four kilometres, hydraulic fracture of the rock and contouring of fractures as they are generated, and mapping of the distribution of the fractures, water circulation trials and feasibility studies for a 10 to 20 megawatt electricity generating plant.

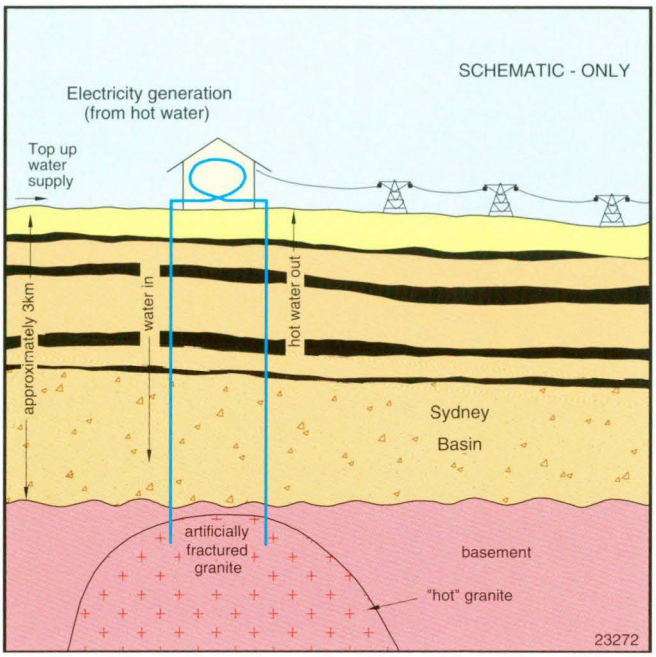
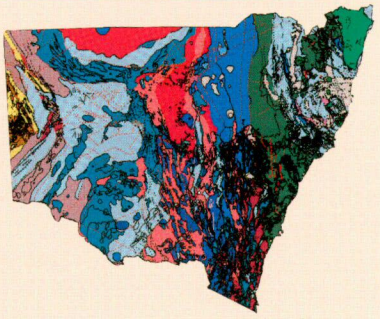


Figure 9. Water is superheated by the fractured granite and used to drive electricity generation turbines

Article prepared from information presented at the NSW Mineral Exploration & Investment'99 Conference by Carl Weber, Energy Resources Development Manager, Pacific Power. For further information contact Carl Weber on (02) 9268 7970.

NSW STATE GEOSCIENCE PACKAGE



A CD is now available for the NSW State Geoscience Package. The package has been released in PC-based ArcView 3.

Software and MapInfo 4.5/5.
The package provides full GIS functionality to manage, manipulate, and analyse the following datasets:

Geological datasets	Stratotectonic units Structures and lineaments Major basins Major structural units Scanned maps Scanned photographs
Exploration datasets	Major mineral deposits
Geophysical datasets	State magnetics image State gravity image
Geographical datasets	Major roads, rivers and towns 100 000 and 250 000 sheet boundaries Lat/Long tics

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From the Director-General

Alan Coutts
Director-General

Wide powers for new Accidents Investigation Unit

Australia's first mining and quarry accidents Investigation Unit has been formed and is in operation.

The Investigation Unit has wide powers to find the causes of all fatal accidents and selected serious accidents and dangerous occurrences in coal and metalliferous mines and quarries throughout New South Wales. It can also take over other investigations that may be of significance.

The objective of the Unit is to improve safety by maximising the impact and the benefits of investigations, by identifying deficiencies in safety systems and analysing contributing factors to accidents.

The Investigation Unit is separate from the Department's Inspectorate and will report directly to me, as Director-General. The Unit will be able to conduct independent investigations free from any conflicts of interest and removed from issues which involved the Department and stakeholders. Investigation Unit staff will follow up recommendations to ensure they are implemented.

The Unit will be staffed by a manager and four specialist officers (see p. 64 for more information).

Amended legislation tightens land rehabilitation requirements

The Government has signalled a tougher approach on companies which leave environmental problems at the end of mining or exploration activities.

The Mining Amendment Bill, passed by State Parliament, contains enhanced provisions so that a mining title holder simply cannot walk away from operations without attending to rehabilitation of the land.

These amendments give legal support for the holding of security deposits until all the agreed rehabilitation work is stable. They also give the Government greater authority to ensure that the work is carried out.

Previously the Government could only bring companies' attention to environmental breaches, with cancellation of the title the only penalty available. The amendments bring in a system of financial penalties for non-compliance.

Positive signs amidst exploration downturn

The exploration industry has taken some massive blows over the past six months, with major companies cutting back on their minerals exploration budgets. New exploration investment has waned substantially. But amidst all the gloom are indications that New South Wales remains an attractive exploration area for companies.

Although all States have been hit hard by the downturn, New South Wales has increased its proportion of Australia's total exploration expenditure to 9.4 per cent.

The Department's regional mapping and Discovery 2000 programs have consistently produced high quality regional geological and geophysical datasets over the past five years, which have been responsible for maintaining a strong exploration interest in the Lachlan Fold Belt and in the Broken Hill region.

The recent releases of new geophysical data packages for the Cobar and New England areas and new geoscience map packages for Forbes and Cootamundra have all resulted in marked rises in exploration licence applications for those regions. New geoscience information packages for the Cobar, Dubbo and Goulburn areas are expected to spur further applications for titles.

The new Broken Hill North Block metallogenic map will be followed in the next few months with the final of the set of four in the Broken Hill–Euriowie area. That final map, together with new airborne geophysical surveys for the Kayrunnera and Menindee areas, should generate substantial interest at the Broken Hill Exploration Initiative Conference to be held in May, 2000. ■

Drilling to follow seismic survey in the west

Stratigraphic investigations target oil and gas

Following on from the seismic surveys undertaken in western areas of New South Wales (*Minfo* **63**, p 29) as an initiative of the Discovery 2000 program, stratigraphic boreholes will be drilled into areas of sedimentary troughs hidden by the Mesozoic and Tertiary cover that have been defined by those surveys (figure 10).

The Paka Tank and northern Balranald seismic lines have indicated deep underlying troughs, adjacent to large thrust blocks, that appear to be filled with relatively undisturbed sediments similar in seismic character to those seen in the Darling Basin (*Minfo* **60**, p 8). The Paka Tank line (figure 11) indicates a north-east to south-west trending trough with a thrusted northern margin and sedimentary rocks thinning and onlapping onto Lachlan Fold Belt along the southern margin. The seismic survey indicates a maximum depth of sedimentary rocks in the trough of about 2.5 seconds or about a 4 500 m section. It is proposed to drill the stratigraphic bore close to the southern margin in order to maximise the stratigraphic sequence intersected. It is expected that under the 500 m of Mesozoic cover a Late Devonian sandstone sequence followed by an Early Devonian marine sequence will be encountered. It is hoped that a previously untested pre-Devonian sequence of either volcanic or marine sedimentary rocks will also be encountered. Of particular interest in this area is that water bores over the trough have anomalously high gas contents (*Minfo* **49**, p 29).

The Northern Balranald line shot across the Booligal Trough (*Minfo* **48**, p 16) has indicated a large trough of sedimentary rocks with a northern thrusted margin deepening to the south (figure 12). At its maximum depth on the section surveyed sedimentary rocks reach a depth in excess of three seconds or over 6 000 m of section. It is proposed to drill a borehole close to the northern thrust where the survey indicates a degree of thinning and foreshortening of the sedimentary rocks against the thrust. It is expected that under about 500 m of Tertiary and Mesozoic cover a similar sequence to that encountered in the Paka Tank will be found.

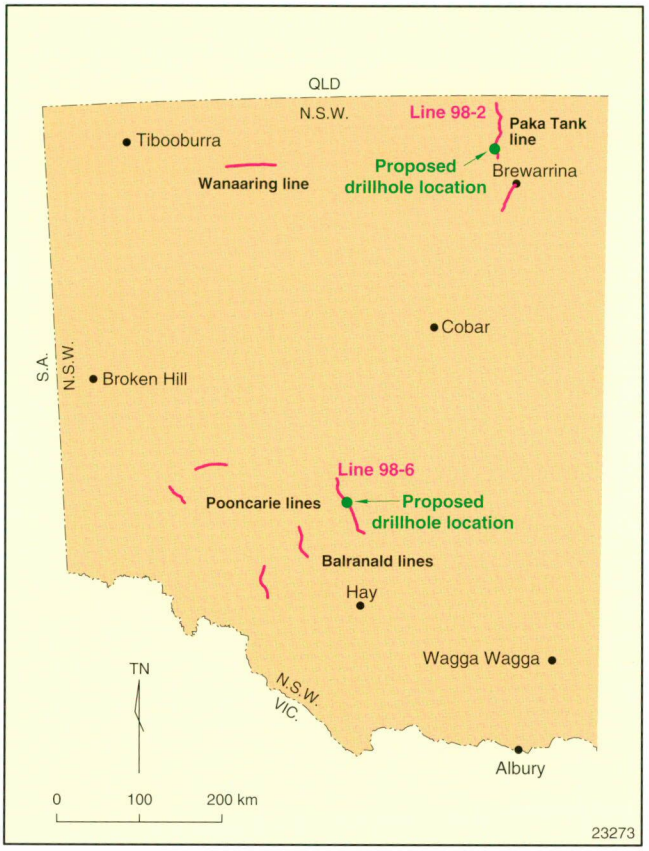


Figure 10. Map showing 1998 seismic survey lines and proposed boreholes

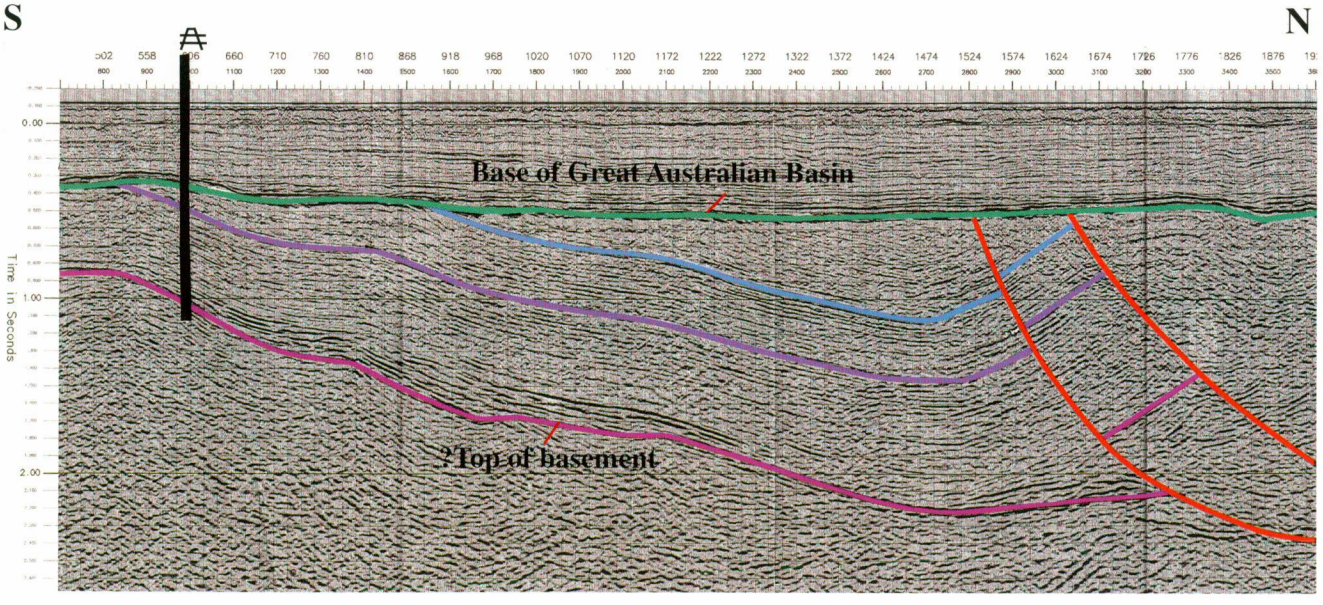


Figure 11. Interpreted seismic line 98-2 across the Paka Tank Trough showing selected inferred rock boundaries and proposed borehole location. The section shown is approximately 35 km long.

The drilling is planned to take place later this year and each borehole will be continuously cored so that a full stratigraphic sequence can be preserved and tested. The boreholes will also be geophysically logged with a full suite of sondes, including gamma ray, density, neutron, sonic and resistivity. It is hoped that the information from these boreholes will establish the presence of both reservoir and source rocks suitable for the generation and entrapment of oil and gas. An overview of the results of these investigations will be presented in a later issue of *Minfo*.

For furthe information, contact Dave Alder, Principal Geologist (Petroleum) on (02) 9901 8512, fax (02) 9901 8520 or email: alderd@minerals.nsw.gov.au

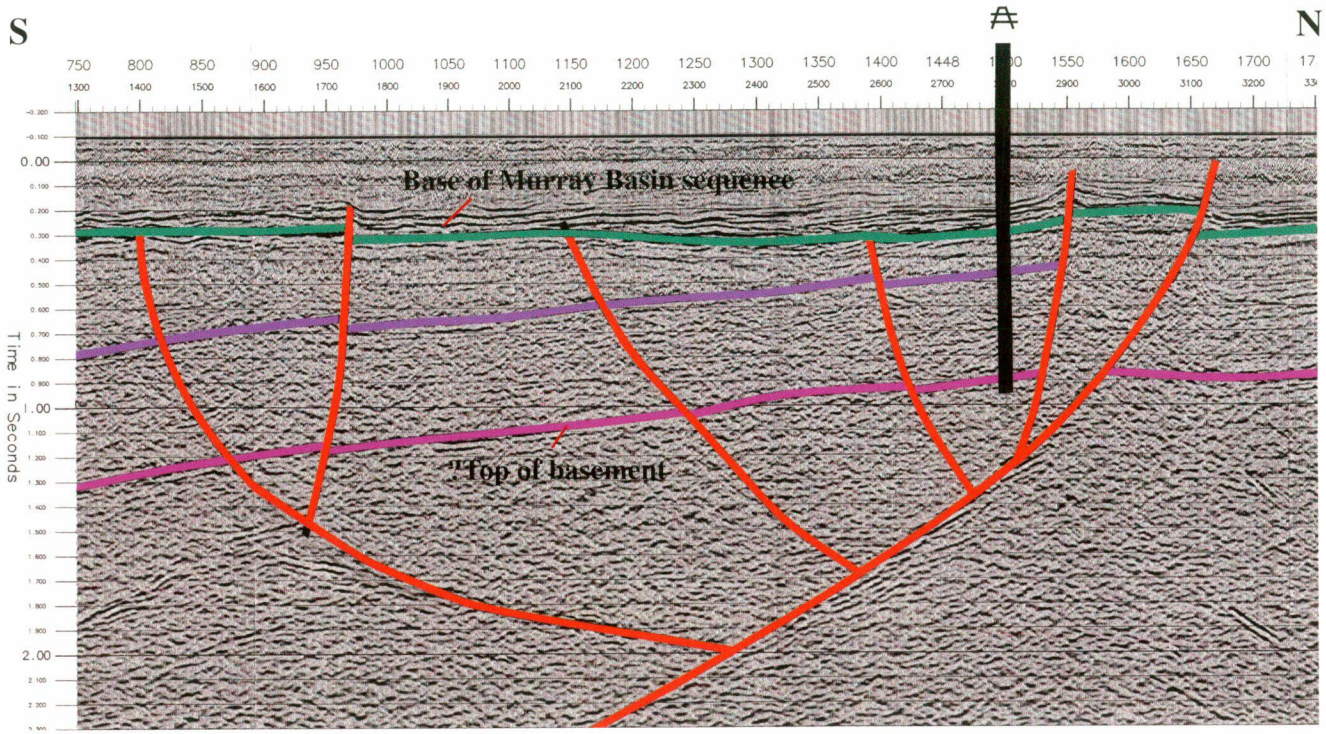
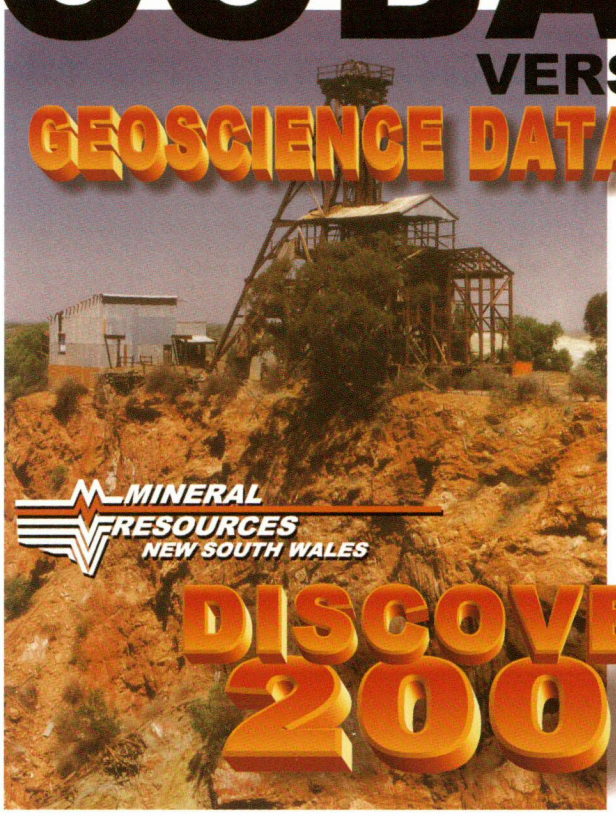


Figure 12. Interpreted seismic line 98-6 across the Booligal Trough, showing selected inferred rock boundaries and proposed borehole location. The section shown is approximately 25 km long.

COBAR

VERSION 1

GEOSCIENCE DATABASE



Contains many new datasets!

Geology
Cobar 1:250 000 metallogenic geology & structure
Nymagee 1:250 000 metallogenic geology & structure
Cobar 1:100 000 geology & structure
Wrightville 1:100 000 geology & structure
Canbelego 1:100 000 geology & structure
Lachlan Downs 1:100 000 geology & structure
Nymagee 1:100 000 geology & structure
Bobadah 1:100 000 geology & structure
Mount Allen 1:100 000 geology & structure
Kilparney 1:100 000 geology & structure
Gindoono 1:100 000 geology & structure
Canbelego Special 1:100 000 geology & structure
Booroondarra 1;100 000 geology & structure
The Meadows 1:100 000 geology & structure
Metadata Statements for all of above

Geophysics data
magnetic TMI image
1st VD magnetic image
gravity line contours
AEROFIND survey data

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MURRAY BASIN – Ancient sands

Ignoring processing problems with the fine grained resources, the total current value of all heavy mineral deposits (currently economic or otherwise) in the Murray Basin is of the order of A$50 billion.

With the background of such enormous potential, The Murray Basin Mineral Sands Conference, held in Mildura on 21-23 April 1999 proved to be timely and of significant value. Some 300 delegates from Australia and overseas enjoyed the technical sessions and the associated activities.

The conference was organised jointly by the Australian Institute of Geoscientists, the Australasian Institute of Mining and Metallurgy and the Geological Society of Australia. The conference was held at Mildura Settlers, and the excellence of the overall arrangements were a tribute to the work of Kevin and Amanda Ashelford.

The 48 papers presented traversed the whole field of interest — geology, mining, metallurgy, possible constraints on development and markets for the expected products

From an economic point of view, the Murray Basin constitutes a major new mineral sand resource. At this stage of exploration, the Birthday Gift and Jacks Tank North deposits in New South Wales have a present estimated in situ value in excess of A$650 million.

The total coarse grained mineral sand resources in the Murray Basin may be over 50 Mt, the in situ value of which could exceed A$12 billion at today's prices.

The Conference proceedings were organised under six headings: geology and geophysics; ore dressing and processing; mining; economics and markets; environment; and project facilitation.

The following notes summarise the main points and key issues brought out under these session headings.

future wealth

Geology and geophysics

The Murray Basin is an extensive, shallow, intracratonic Cainozoic basin extending over some 300 000 km^2 in New South Wales, Victoria and South Australia. More than one third of this area (135 000 km^2) is located in the south-western corner of New South Wales (figure 13).

Exploration history

In the Murray Basin there have been four distinct phases of heavy mineral sand exploration over a period of 29 years before the first commercial development at Wemen in Victoria.

1st phase. In 1969 a geologist (P. Macumber) reported a 'continuous heavy mineral band up to three feet thick' in a quarry near Kerang. Reconnaissance work revealed that other quarries showed heavy minerals, but drilling outlined only two small, uneconomic deposits.

2nd phase. During 1974-1975 the price of rutile increased and the price of zircon skyrocketed. This sparked renewed interest in the Murray Basin.

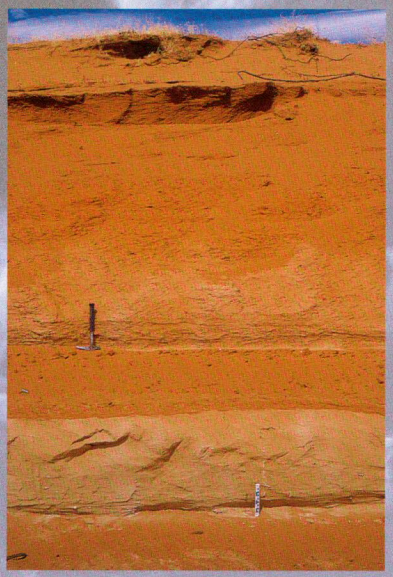
Following a belief that north-trending ridges represented old coastal strandlines, drilling outlined a large deposit along the Tyrrell Ridge — but it was recognised that the high chrome content of the ilmenite (the main heavy mineral constituent) and surface coatings on the grains would downgrade the product.

3rd phase. The third exploration phase was dominated by the discovery of the fine to very fine grained WIM style of deposit, named after the Wimmera region of Victoria. Interest was maintained by further increases in prices for rutile and zircon.

Although huge resources were located — the global WIM 150 resource, discovered by CRA (now Rio Tinto), comprises about 4 900 million tonnes of mineral sand averaging 2.8% heavy minerals — the mineral bodies outlined could not be economically exploited at the time. This was mainly because of their very fine grainsize (generally <63 µm), especially in the light of declining rutile and zircon prices. By 1993 the third phase of exploration had come to an end.

4th phase. Initiation of the fourth phase of exploration was the result of the perseverance of Aberfoyle Resources Ltd and an opportune return in rutile and zircon prices to 1990 levels by 1996.

Aberfoyle explored for coarse grained beach placer deposits along the Neckarboo and Iona Ridges on either side of the Willandra Lakes World Heritage Area in New South Wales and the extension of the Iona Ridge into Victoria as the Robinvale Ridge (figure 13). The first definition drillhole was put into the Wemen orebody (in the Victorian Robinvale sector) in November 1995. This deposit is expected to be in production later this year.



It should be pointed out that Wemen was discovered initially in a water bore which passed through a section containing 10% heavy minerals, but the importance of this intersection was not appreciated until Aberfoyle commenced exploration in 1992.

Much the same can be said for the Jacks Tank and Birthday Gift deposits — both were actually discovered by CRA holes in 1986. More intense exploration of both areas began in 1992.

RGC Mineral Sands Ltd obtained exploration titles immediately south of Wemen and found the Kulwin, Woornack and Rownack (KWR) deposits about a year after the Wemen discovery. The extensive interest is indicated by the wide spread of ELs in New South Wales (figure 14).

Regional geology

The flat-lying Cainozoic sediments of the Murray Basin form a blanket generally less than 200-300 m thick, but up to 600 m thick in the deeper west-central part of the basin.

The Tertiary succession accumulated over three major depositional events. Each depositional cycle involved marine sedimentation with a hiatus between each cycle. Only the sediments of the third depositional cycle (Miocene–Pliocene) are known to contain mineral sand deposits of economic interest.

Sediments of the third depositional cycle were laid down in a fluvial floodplain environment in the east, which flanked an extensive marine strandplain of prograding beach ridges with inter-ridge fluvial and estuarine quartz sand deposits

Photography by Roger Cameron

to the west and south. Initial marine transgression resulted in the deposition of marine clay (Bookpurnong beds) and the marginal marine to fluvial clastics of the Loxton and Parilla sand units.

In broad terms, as the ocean advanced and retreated through Tertiary and Quaternary time, successive shorelines were established, younging south-west towards the current Murray Basin shoreline.

The stratigraphic units Loxton Sand and the overlying Parilla Sand were first described in South Australia and traced into Victoria. Because of the perceived difficulty of distinguishing between the two units in parts of the Murray Basin, particularly in New South Wales, the combined name 'Loxton–Parilla Sands' was coined. It is now becoming increasingly apparent that the two units should be considered separately and recent work, particularly by the RZM Pty Limited/Western Metals Resources Limited (previously known as Aberfoyle Resources) joint venture, has shown that the two units can be distinguished in parts of the New South Wales portion of the Murray Basin as well as in South Australia and Victoria.

Specifically, there is an erosional break marked by a ferruginised zone, commonly only a few centimetres thick, between the two units. In places tree roots have been found passing down into the Loxton Sand beneath. This erosion surface is below the Karoonda Surface, a widespread stratigraphic marker identified by ferruginisation and silicification of the upper surface of the Parilla Sand. It can perhaps be tentatively referred to as the 'Loxton Surface'. It clearly represents a major event and has been recognised over a wide area in New South Wales by RZM and also in South Australia by Professor Ian Plimer.

Briefly, the Loxton Sand comprises marginal marine, beach and estuarine sediments. The Parilla Sand, on the other hand, comprises sediment laid down in valley fill, lagoonal and fluviolacustrine environments. The two units are overlain by the aeolian Pleistocene Bridgewater Formation.

RZM's work has shown that there are three main distinguishing features between the Loxton Sand and the overlying Parilla Sand.

- The Loxton Sand is rich in rutile and zircon compared with the Parilla Sand, which is ilmenite-rich.
- The clay mineral content of the Parilla Sand includes a significant proportion of smectite, which does not occur in the Loxton Sand. This is an interesting observation because the smectite (group of clay) are an alteration product of volcanic ash. In this regard, the Arumpo bentonite deposit, which immediately overlies the Loxton Sand, is indicative of a major explosive volcanic event following the deposition of the Loxton Sand.
- The strandlines in the Loxton Sand are all noticeably straight, whereas those in the Parilla Sand are curved.

Thus there was clearly a marked erosional hiatus, a change in the components of the provenance and also a change in the physical conditions of deposition between deposition of the Loxton Sand and of the Parilla Sand. Needless to say, detailed followup work will be required to test the proposition outlined above.

Distinguishing between the Loxton Sand and the Parilla Sand is of vital economic importance because the heavy mineral sand deposits are predominantly within the Loxton Sand, although local reworking of the underlying heavy mineral-rich layers occurs at the base of the Parilla Sand sequence in places.

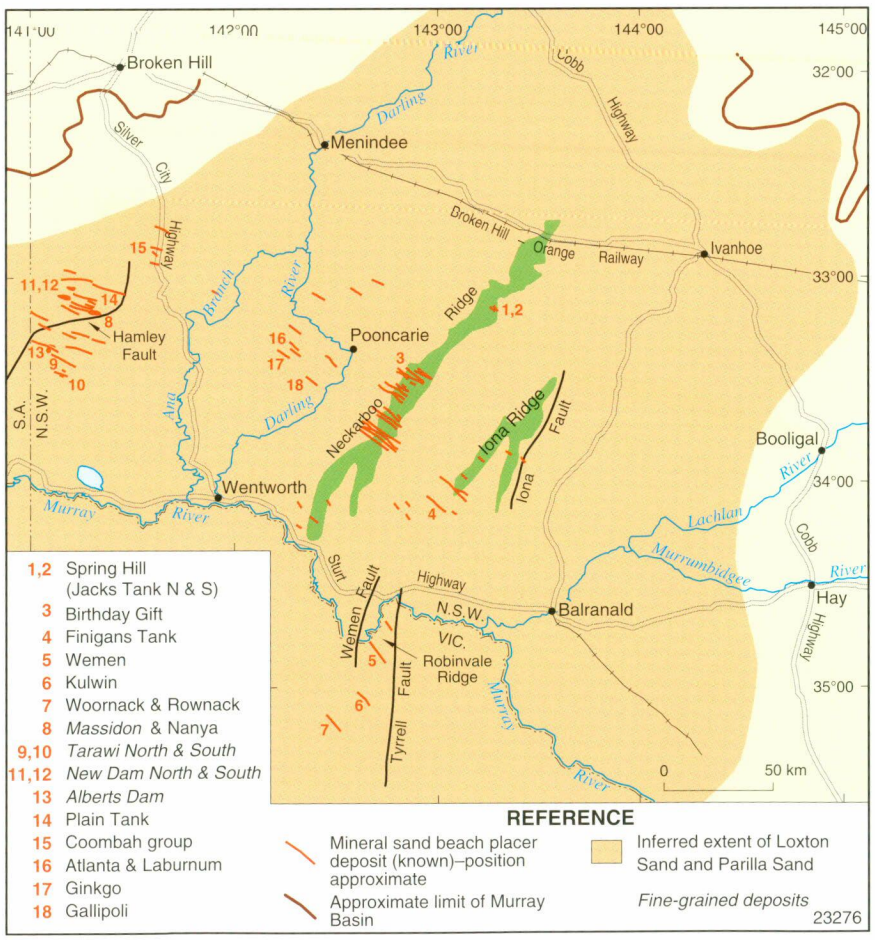


Figure 13. Ancient strand lines in the Murray Basin. The Birthday Gift (Twelve Mile) and Jacks Tank North deposits have a present estimated in situ value in excess of A$650 million.

Mineral sand deposition

Within the Murray Basin there are two types of mineral sand deposits:

- fine to very fine grained (38–73 µm diameter) mainly offshore deposits of WIM type; and
- medium to coarse grained (73–300 µm diameter) higher grade beach deposits.

In the past, the two types of deposit tended to be regarded as mutually exclusive exploration targets. However, they both conform to the same genetic model and most of the known beach deposits have an associated offshore deposit. This is important from the exploration point of view because the widespread fine grained deposits are easier to find than the coarse grained beach placers.

In the Pliocene there were cyclic, multiple transgressions and regressions of the sea. Each inundation of the basin created a major new shoreline. Post-Pliocene warping of the basin resulted in greater uplift towards the south, with resultant partial stripping of the Pliocene sequences. Shorelines, and hence heavy mineral deposits, are thus revealed at shallower depths in the south.

An interesting comparison was presented between the Murray Basin deposits and the mineral sand deposits at Viney Creek in New South Wales (figure 15). Two strandline zones of heavy minerals have been caused by storm events from the south-east. A sheet-like body of heavy minerals developed when waves reflected back to the south-west.

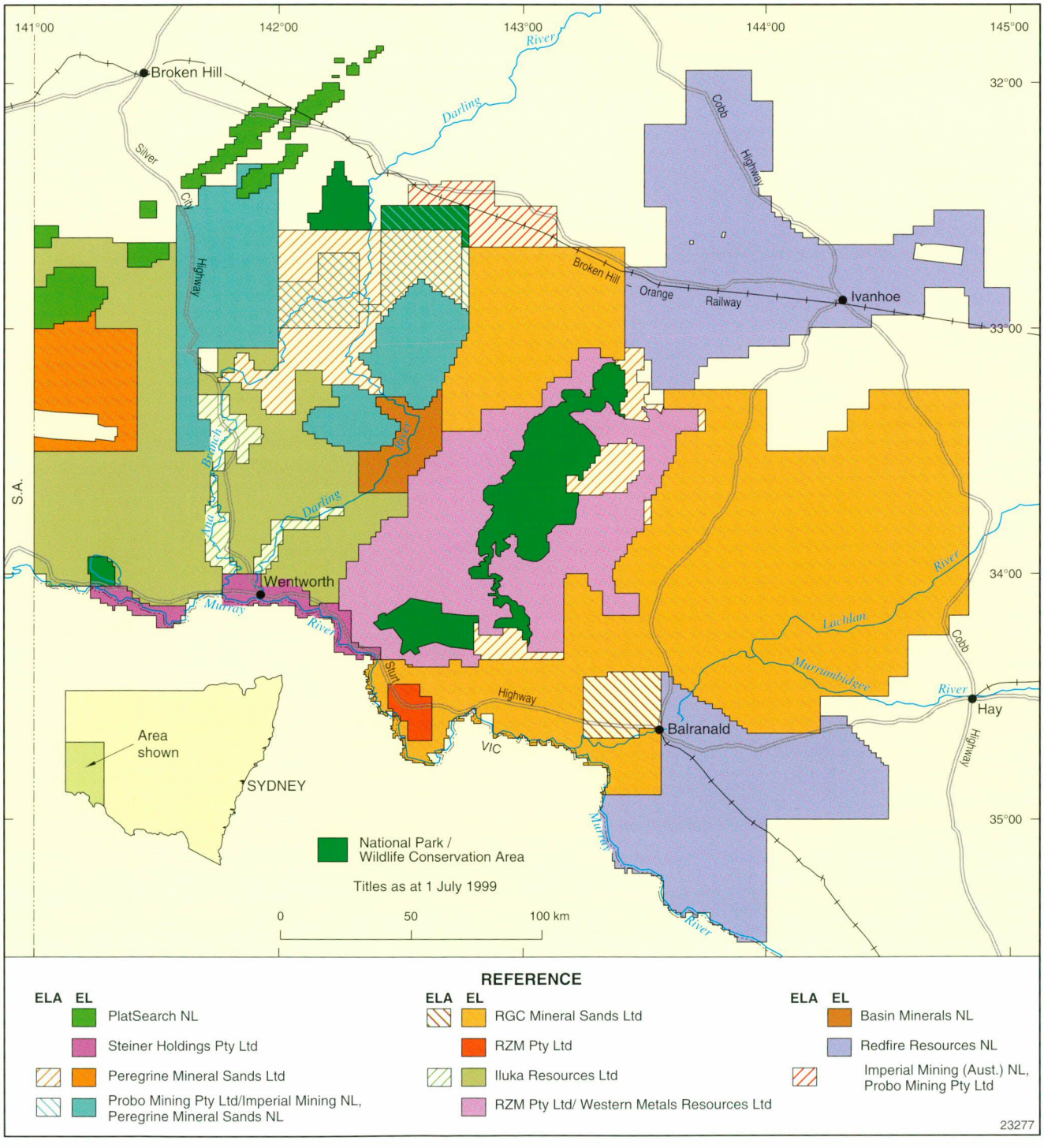


Figure 14. Exploration Licences in the Murray Basin in New South Wales

Contact between the Loxton Sand and overlying Parilla Sand

The WIM mineralisation in Victoria occurs in sheet-like bodies within planar areas abutting high land which would have formed a former southern shoreline of the Murray Basin. Wave reflection would have destroyed strandline/dunal features close to the southern margin, creating a planar surface and assisting formation of the sheet-like bodies of heavy minerals.

The offshore deposits located to date are as yet all too fine grained to be economically exploited, but coarse grained beach placer deposits are attractive exploration targets.

By way of comparison, there are about 200 mineral sand deposits along the east coast of Australia. Deposits typically have dimensions 200-1 000 m wide, 4-5 m thick and 10-20 km long. The placer deposits commonly occur towards the northern ends of embayments, associated with headlands or rocky outcrops, and are due to a net northward littoral transport system combined with episodic storm wave action. Over a long period the parent sand, deposited from the hinterland, was progressively upgraded in heavy mineral content. A vital part of the process was removal of very large quantities of light material, ie quartz sand.

The Loxton Sand deposits are interpreted as multiple barrier and backbarrier (lagoonal) deposits formed by long-period swell waves generated in the Southern Ocean during a 3 to 4 million year period in the Pliocene.

With regard to formation of the beach placer deposits in the central part of the basin, faulting has clearly been more important than was originally recognised. The presence of several down-thrown fault blocks between the Neckarboo and Iona Ridges resulted in constraint of drainage and the development of the Willandra Lakes system and other nearby lakes. The upfaulted blocks now forming the Neckarboo and Iona topographic ridges are clearly associated with numerous mineral sand deposits (figure 13), suggesting a genetic relationship between growth faulting and heavy mineral fractionation mechanisms. Local retardation of shoreface deposition due to slow tectonic uplift would have had the effect of increasing sand bypassing on the uplift block and thus promoting an increase in winnowing, resulting in the buildup of heavy mineral lag concentrates.

One author raised the possibility of heavy mineral sand deposits in a second system of late Cainozoic shoreline deposits related to Lake Bungunnia. This was a large body of fresh water that covered up to 33 000 km^2 of the western Murray Basin in Late Pliocene–Middle Pleistocene time. The lake at its maximum extent was large enough to sustain a high-energy shoreline and heavy mineral-bearing Loxton Sand may have been reworked into the younger lacustrine environment.

Deposit descriptions

The RZM joint venture has defined a series of 30 subparallel zones of mineralisation with a 320° trend. Three potentially economic deposits have been discovered: Jacks Tank (Spring Hill) and Twelve Mile in New South Wales; and Wemen in Victoria (table 1).

The deposits are 200–1 000 m wide and up to 13 km long. They may be relatively simple with only one or two beach placer deposits, as at Wemen, or may comprise multiple beach deposits as at Jacks Tank (figure 16). Each beach deposit contains a number of closely related strandlines.

The mineralogy of the strandlines and the quality of the rutile and zircon are comparable with the east coast deposits, now mainly worked out. The heavy mineral assemblage varies within

TABLE 1

IDENTIFIED MINERAL SAND RESOURCES, RZM PTY LIMITED PROGRAM, AT 1% HEAVY MINERAL CUT-OFF, JUNE 1997

Project and deposit name	Resource category	Sand (Mt)	Heavy mineral (%)	Heavy mineral content (%) Rutile	Zircon	Ilmenite	Leucoxene
Wemen	Measured[1]	9.16	5.0	28	12	44	
	Indicated[2]	10.0	3.8				
	Inferred[2]	1	3.0				
Spring Hill–Jacks Tank South (fine grained)	Inferred[2]	41	2.6	21	15	55	
Spring Hill–Jacks Tank North	Inferred[2]	13	1.9	11	31	50	
Twelve Mile–Birthday Gift	Inferred[2]	61	3.6	19	11	49	8

[1] Based on a 160 x 20 m drilling pattern [2] Based on a drilling pattern of 320 x 40 m with some closer spaced drilling

Source: T. Mason, Conference proceedings, p. 70

and between strandlines, but is generally in the range:

rutile	15-30%;
zircon	8-31%; and
ilmenite	40-60%.

Wemen is made up of two major beach deposits which are up to 10 km long with an economically extractable width of about 160 metres. The thickness is 4-15 m.

The beach placer deposits are defined by a natural 1% HM (heavy mineral) cutoff and the outlines of the strandlines are defined by the 2.5% HM cut-off and have grades up to 35% over a one metre interval. Most of the strandlines have a high grade core with grades in excess of 10% HM.

The northern resource has a mining reserve of 10.3 Mt with a grade of 3.7% HM giving a mine life of 4.5 years. The mining proposal is to dry mine the topsoil and overburden and to dredge the orebody at a rate of 2.5 Mt/year. Rutile and zircon will be produced as primary products and ilmenite will be stockpiled for later use. Including the southern deposit, the overall potential mine life is 9 years.

RZM's Tomago dry separation plant will be moved to a site in the Mildura district to process the concentrates.

Iluka Resources Limited (merged Westralian Sands Limited and RGC Limited) has identified 200 strandlines in its exploration area. Its current indicated resources in the **KWR area** of Victoria are shown in table 2.

The **WIM-type** deposits can be very large. For example, WIM 150, one of several deposits in the Horsham region, is 26 km long, covers about 220 km^2 and is typically 6–15 m thick.

The strandline deposits commonly contain a higher proportion of rutile — 28% at Wemen compared with 9% in the fine grained WIM 150 deposit. This is important because a rutile product has many inherent advantages over an upgraded ilmenite product.

Exploration

Whatever other exploration methods are used, most companies use stratigraphic drilling to seek and/or follow up targets.

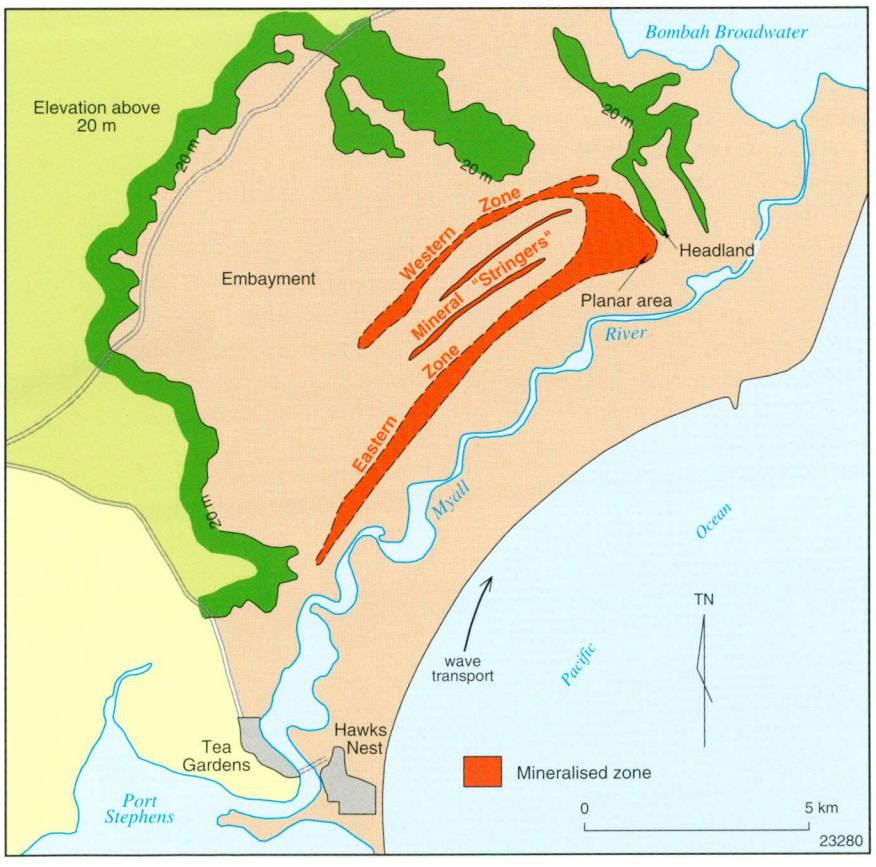


Figure 15. Viney Creek heavy mineral sand resources as at 1985. Redrawn from P. Stitt, Conference proceedings, AIG Bulletin No 26, 1999

TABLE 2

INDICATED MINERAL SAND RESOURCES, ILUKA RESOURCES LIMITED

	HM cutoff	Sand Mt	Heavy Mineral %	Heavy Mineral Mt	Rutile %	Rutile kt	Zircon %	Zircon kt	Ilmenite %	Ilmenite kt
Kulwin	1%	24.0	11.5	2.76	16.7	460	10.1	280	30.8	850
	3%	10.6	24.1	2.55	16.8	430	10.2	260	30.9	790
Woornack	1%	40.5	9.3	3.77	17.8	670	9.3	350	29.7	1120
& Rownack	3%	21.9	15.8	3.46	17.9	620	9.2	320	30.1	1040

Based on: M. Macpherson, Conference proceedings, p. 79

When it comes to definitive resource drilling, the preferred method is RC aircore drilling. The heavy mineral content of the drill samples is usually then separated out by, for example, centrifugal heavy liquid separation. The heavy mineral concentrate is then subjected to grainsize determination and mineral species content estimation by grain counting.

Geophysical methods have limitations. The magnetic response from both WIM and strandline bodies is very variable — some can be detected, others cannot. A paper dealing with geophysical exploration methods emphasised that magnetic data must not be gridded as this assessment method usually makes use of one fifth only of the data along each line and blurs any trends across the lines. This is particularly important as a mineral sand-bearing strandline may have a maximum signature of 1 or 2 nT (nanoTesla) only — not much above the background noise level. With regard to radiometric surveying, there have been significant advances in interpretation — signal to noise ratio for the U and Th channels has been doubled within the last year. Gravity should be a useful tool but has not been used as yet in the Murray Basin. Trialing magnetic interpretation in the KWR area, 50% of the known strandlines were found using magnetic 'worms'.

Other companies which have adopted additional/different exploration strategies are Redfire Resources NL and Basin Minerals NL.

Redfire Resources, using all available data, has 'reconstructed' headlands and offshore islands around the northern edge of the Murray Basin. These basement outcrops would have arrested longshore drift, resulting in the deposition of arcuate strandlines during regression of the sea.

Basin Minerals is using a combination of detailed photogeological interpretation, low level airborne magnetic surveying and broad stratigraphic drilling to identify targets. Identified targets are tested by intensive RC aircore drilling.

Exploration continues apace. RZM hinted at a significant new discovery in New South Wales and BeMaX Resources NL reported encouraging results west of Pooncarie, also in New South Wales.

Mining

An interesting paper dealt with determination of the optimum production size for a mining project as compared with rather simplistic methods based on such criteria as mine life, common plant sizes, etc. Maximum profit is achieved when the marginal cost (the cost of the next tonne of product produced) equals the revenue received for that tonne.

Where dredging of a mineral sand deposit is appropriate and the demarcation between ore and overburden is largely a matter of grade, it may well pay to use a double dredging system. A separate dredge and low capital cost treatment plant would work ahead of the main dredge and treatment plant to recover portion of the heavy minerals contained in the overburden at a concentration ratio of 3:1 or better. The recovered crude concentrate could be dropped to the bottom of the pond for subsequent recovery by the following main dredge. From a cost point of view, undercut sluices are cheaper and lighter than spirals and could be used in the overburden concentrating plant.

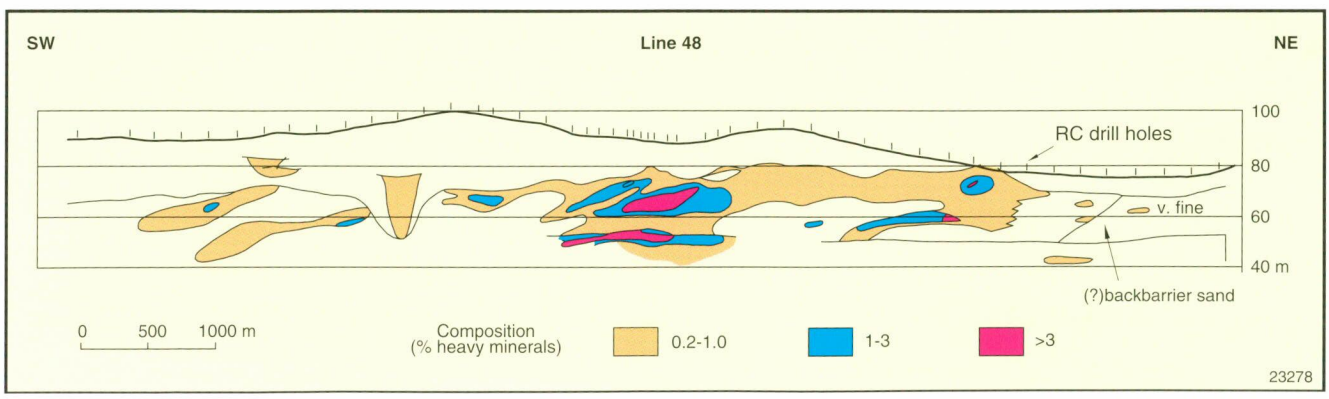


Figure 16. Cross section, Jacks Tank heavy mineral deposit, Neckarboo Ridge (redrawn from Geological Survey Report GS1999/038)

The proprietary BOSMIN overburden slusher may well be useful for mining in the Murray Basin as it has operational and environmental advantages. The action of this equipment is quite different from that of scraper hoes and bulldozers in that, once loaded in the hoe, the payload stays substantially still while it is transported across the pit. Dust emission is therefore minimal.

Land rehabilitation will be very important in the Murray Basin as significant areas will be mined. To avoid future landuse being affected by long term settlement and/or changes to the nature and movement of groundwater, it will be important to consider tailings management carefully. Options are sand tailings combined with thickened or unthickened clay slimes, or separate disposal of sand and thickened or unthickened clay slimes.

Ore dressing and processing

The Julius Kruttschnitt Mineral Research Centre (at the University of Queensland) is developing a comprehensive range of instruments and process models for the optimisation and control of mineral sands separation plants.

Quality control is very important in the separation and presentation of individual mineral products. To this end, Eriez Magnetics has been carrying out experimental work which has shown that careful control of the parameters of magnetic separation can give improved product quality.

The radioactive mineral monazite (present in small amounts) is a significant problem. Not only is it difficult to recover selectively into a saleable product, but it is also a particularly serious contaminant in other products. Furthermore, it is a possible health hazard when present in dust in dry processing streams.

Although flotation is the main concentration process used in the treatment of metal ores, it has not been used to any great extent in the past in the mineral sands industry. However, for two main reasons, it may become important in the Murray Basin. Firstly, many of the Murray Basin deposits are fine grained and do not respond satisfactorily to conventional heavy mineral sand processing techniques (eg gravity, magnetic, electrostatic). Secondly, flotation offers a means of removing monazite.

In addition to monazite (which contains the radioactive element thorium), uranium is present in trace quantities in zircon and, to a lesser extent, rutile. Where the trace concentration of uranium is higher than normal, due for example to a different provenance, the value of the final product may be significantly downgraded. The fission track analysis technique allows the rapid identification of the particular mineral species hosting above-average uranium, and the absolute content. This information allows the heavy mineral processing procedures to be adjusted to separate out desirable low-uranium mineral products.

The presence of impurities in zircon is a problem both in the magnetic and electrostatic separation stages of the heavy mineral concentration process and in meeting customer specifications. In addition to coloured stains coating the grain surfaces, these impurities take two forms — some are located in surface irregularities in the grains (pits, cracks, etc) and the remainder are locked within the zircon crystal lattice.

Impurities can be lowered significantly by careful ore beneficiation and leaching, but not completely because of impurity components held within crystal lattices. One method of carrying out surface cleaning of zircon (and other) grains is sonication by use of ultrasound.

Untreated ilmenite concentrates produced from Murray Basin deposits would contain significant amounts of chromium (mainly as chrome spinel) and magnesium. When carried through into synthetic rutile derived from the concentrates, these impurities would adversely affect production of titanium pigment by the common chloride route.

Test work by CSIRO Minerals, following detailed characterisation of an ilmenite concentrate from the KWR deposit, has shown that chromium content can be lowered significantly by heat treatment followed by magnetic separation. Magnesium and manganese contents can be reduced by oxidation followed by reduction and acid leaching. Further work is necessary to design a commercial process.

CSIRO Minerals has also carried out experimental work on further

Parilla Sand outcrop and close up views of heavy mineral sand concentrations

processing of Murray Basin ilmenite to produce titania slag.

Austpac Resources NL outlined an alternative to the two systems currently in use for production of synthetic rutile, the principal feedstock for TiO_2 pigment production. One of these, the Becher process used in Western Australia, involves reduction of the ilmenite with coal at ~1 150°C to form metallic iron and titanium oxides, followed by accelerated rusting and removal of the iron to give an upgraded product containing >90% TiO_2.

Unlike the other process — the Benilite process, used extensively overseas — which involves leaching treated ilmenite with hot hydrochloric acid under pressure, the Austpac process uses a proprietary roasting step followed by hydrochloric acid leaching at atmospheric pressure. High quality product can be produced from any heavy mineral concentrate source material; radioactive and other deleterious elements (eg chromium) are fixed in waste iron oxide pellets; and hydrochloric acid is regenerated.

Current production of the final product, ie pigment grade TiO_2, is via the sulphate or chloride process.

In the sulphate process, ilmenite is reacted with sulphuric acid to form titanyl sulphate which is then hydrolysed and calcined to TiO_2. Drawbacks of this process are the type of ilmenite which can be processed and the amount of acid waste.

The chloride process requires feedstock of high titanium content (>93% TiO_2) which is chlorinated in the presence of carbon to produce $TiCl_2$, which is separated from impurities by distillation and then heated in oxygen to give TiO_2. This process is more acceptable environmentally but needs a high grade feed material.

Recent research at the University of Melbourne has shown promise for the production of titanium and zirconium oxides and the respective metals using a fluoride route (based on silicon tetrafluoride SiF_4). Should it prove to be economically viable, this route would have a number of significant advantages over the chloride and sulphate processes in use at present. These would include no requirement to upgrade ilmenite feedstock, and environmental and OH&S advantages.

Environment

The economy of the Murray–Darling Basin is dominated by agriculture, a situation that is unlikely to change. The annual farmgate value of its production is over $9 billion, of which $4 billion is derived from irrigated agriculture.

Maintaining and improving the health of the Murray River is of paramount importance in land management in the Murray–Darling Basin. The main concern is the increased salt load being delivered to the river as a result of the expansion of irrigated and dry land farming. Irrigation increases recharge rates to regional aquifers and this results in the formation of 'groundwater mounds'. The water entering these mounds displaces saline groundwater, which finds its way into the river system.

Regulators will view favourably any mining proposal which results in the permanent disposal or containment of groundwater mounds. However, theywill be particularly strict with any projects close to streams which may create new mounds, or exacerbate existing mounds.

To reduce groundwater problems, dry mining should be adopted where appropriate, and water bores should be sited between a mine and a river environment.

A 1995 audit of water use in the Murray–Darling Basin demonstrated clearly that the continuing growth in consumption of the surface water resources of the region was unsustainable. As a result, the Murray–Darling Basin Ministerial Council placed a cap on consumption, preventing further increase in consumption.

As a result of the cap, there is no more surface water available and existing supplies will therefore have to be shared between existing and new users. In practice this will mean that mines will have to purchase any surface water they require. The use of groundwater will be subject to careful assessment to gauge recharge capacity, possible detriment to other users, possible salinity effects and the interconnections between surface water and groundwater.

On a broader perspective, the Murray Basin is a very sensitive environment. European exploitation of this region has caused significant changes, particularly to the hydrology and river systems. Exploitation of the mineral sands deposits will add a new factor, the long term impact of which needs to be considered carefully. The negative consequences of past well-

intentioned management decisions in the Murray–Darling Basin, such as locking the rivers and developing irrigation schemes, would suggest a cautionary approach. In addition to the natural environment, due account will also have to be taken of the Aboriginal and European heritage in the basin.

Economics, markets and facilitation

Several junior companies are reporting good exploration results in the Murray Basin, but this is not yet generally recognised. Perceptions of the potential of the basin continue to be clouded by the idea that the province is more likely to host large, low grade, metallurgically complex deposits similar to WIM 150 rather than more economically attractive deposits.

Two papers dealt with the supply and demand covering such topics as uses of TiO_2 pigments, industry structure, product plants currently in operation and forward markets for ilmenite feedstocks and zircon. Conclusions reached were:

- major new sources of ilmenite will be required to satisfy the growing supply gap; and
- prices for rutile and zircon should maintain their real value in the long term and ilmenite prices should increase in real terms.

Although the technical issues to be considered in environmental impact statements will probably present no surprises, extensive and sustained consultation with the local community concerned will be vital to a successful outcome. Such consultation may include visits to similar mining operations elsewhere to allow local community representatives to see for themselves how similar projects are undertaken. In New South Wales, Department of Mineral Resources technical experts will be in a position to provide factual technical information to local community groups.

The main development issues will fall under the headings: water, geomorphic features with high conservation value, biological diversity (both flora and fauna) and cultural heritage (both Aboriginal and European). ■

This article is a summary of and commentary on papers presented at the Murray Basin Mineral Sands Conference, held in Mildura 21-23 April 1999. It was prepared by Ross Stewart, Geological Editor, Department of Mineral Resources.

Conference Proceedings and DMR report 'Mineral Sand Resources Potential of the Murray Basin' are available from the Department's Information Counter; on (02) 9901 8269; fax 9901 8247 or e-mail: virdiv@minerals.nsw.gov.au

For further information contact Geoff Oakes, John Whitehouse or Peter Roy on (02) 9901 8888, fax (02) 9901 8256.

State Geoscience Package launched

The NSW State Geoscience Package provides a comprehensive range of information that is easily accessed and queried using PC-based ArcView 3 or MapInfo 4.5/5.

Available now on CD, the package contains over 30 themes of data, including state stratotectonic geology compiled by Erwin Scheibner. This theme provides a geological coverage of the state, compiled at a scale of 1:1 million and deemed accurate to 1:250 000 scale. A comprehensive database offers information on volcanic, intrusive and sedimentary rocks.

Other integrated data sources include original cartographic maps which have been georeferenced to serve as a backdrop to the digital data layers. Scanned photographs from the Department of Mineral Resources' photographic library provide views of geological and structural features which are useful for international clients unfamiliar with NSW.

State-wide magnetic and gravity images provide backdrops to the geology and can be displayed transparently to assist interpretation of the geophysical and geological data.

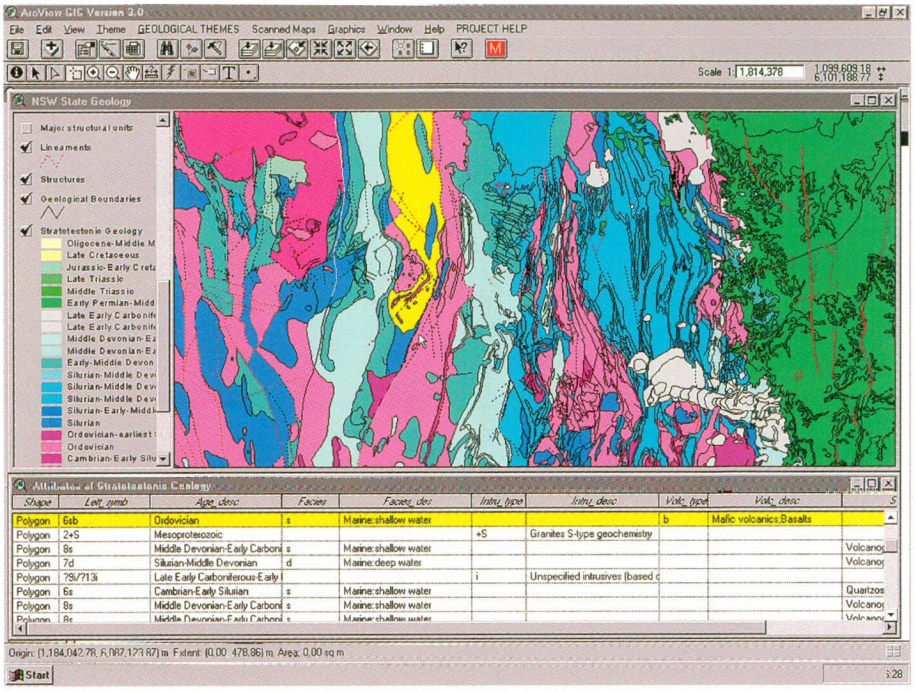


Figure 17. The Package integrates many data sources

The package also includes information from the DMR's METMIN-99 database about the State's 200 most significant mineral deposits.

The NSW State Geoscience Package is priced at $500 (plus $7.50 postage and handling). The product is the second of its type produced by the Minerals Assessment Program, following on from an earlier data package which focused on the Lachlan Fold Belt.

For more information contact David Hayward, GIS Analyst, Geological Survey on (02) 9901 8303, fax (02) 9901 8753; e-mail: haywardd@minerals.nsw.gov.au

The PDAC'99 road to international investment

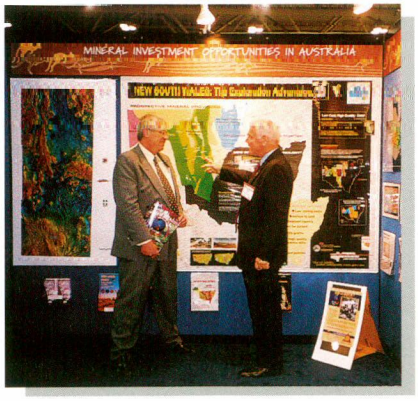
Representatives from the NSW Department of Mineral Resources, the Federal Government and three other State Governments, joined forces to promote Australia at the Prospectors and Developers Association of Canada 67th Annual International Convention and Trade Show (PDAC'99), held in Toronto from 13–17 March.

The delegation met leading Canadian mining companies and financial institutions with the goal of promoting Australia as a favourable location for mineral exploration investment. Toronto is recognised as the world's leading centre for mining industry finance.

Discussions were also held with the Ontario Ministry of Northern Development and Mines with a view to establishing ongoing information exchange and benchmarking of geoscience activities. The delegation investigated developments and trends in both the international minerals industry, and in government policies and programs which support the industry.

PDAC, widely acknowledged as the most significant and successful international minerals investment conference, attracted over 6 000 delegates and more than 500 exhibitors.

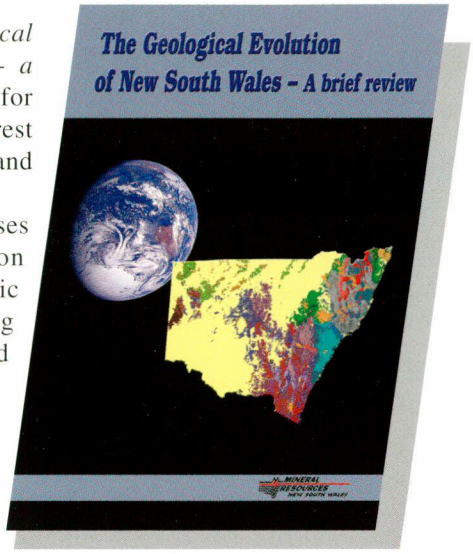
(continued opposite)



Photography by Lindsay Gilligan

John Cramsie, Director of the Geological Survey (right), highlights the merits of exploration in New South Wales at PDAC

NSW's geological evolution — in brief



A new booklet — *The Geological Evolution of New South Wales - a brief review* — is now available for geologists and others with an interest in the topic, especially university and senior high school students.

The 32-page booklet summarises the State's geological evolution through an overview of the tectonic processes that shape the Earth, using numerous colour maps and diagrams.

The booklet, which was compiled by Erwin Scheibner and edited by Helena Basden and Dorothy Pearson, also acts as a primer for the *Geology of New South Wales – Synthesis, Volumes 1 and 2* (refer *Minfo* **62**, p 49).

A new 1:2.5 million scale Geological Map of New South Wales has also been compiled by Dr Scheibner to accompany the booklet, or for separate purchase. This is a full colour map of (2 x A3) size which replaces the long out of print 1963 edition.

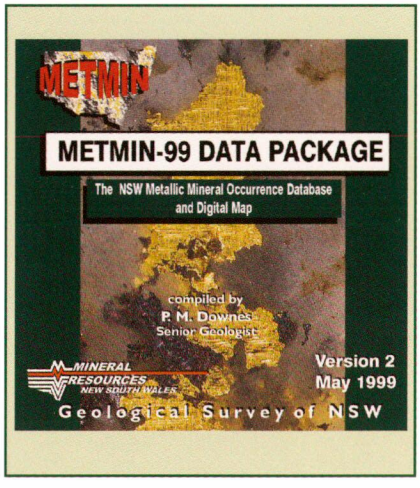
The booklet and map are both published by the NSW Department of Mineral Resources and can be purchased as a package for $15, plus $5 for postage and handling. They are available separately for $10 (booklet) and $5 (map).

To obtain a copy contact the Information Counter at the Head Office of the Department on (02) 9901 8269, fax (02) 9901 8247, or e-mail: maniakak@minerals.nsw.gov.au ■

METMIN data enhanced

The METMIN-99 Data Package contains details of more than 16 000 mineral occurrences in New South Wales. This information summarises the results of the Statewide Metallogenic Mapping program which commenced in the late 1960s.

The METMIN dataset has been extensively updated since it was first released in 1997. The dataset now includes the recently completed Dubbo, Inverell and Broken Hill datasets — as well as the preliminary data for the Goulburn, Forbes and Grafton–Maclean areas.



The second version of the METMIN data package is now available

The CD package is designed for use in a GIS environment and provides a fully functional database in Microsoft Access v97 and Access v2 formats. A digital Statewide mineral occurrence map (with selected attributes) in MapInfo and ArcView formats is also included.

METMIN-99 is priced at $500 (+$7.50 postage and handling). A discount of $200 is available for purchasers of the METMIN-97 data package.

For further information contact Peter Downes, Senior Geologist, on (02) 9901 8296, fax (02) 9901 8256 or e-mail: downesp@minerals.nsw.gov.au ■

PDAC'99 (continued from p 42)

The Australian presence at PDAC'99 included a combined display facilitated by Austrade. This display represented eight mineral sector companies along with the Commonwealth Department of Industry, Science and Resources, the Australian Geological Survey Organisation, and the minerals departments/geological surveys of New South Wales, Western Australia, Victoria and Tasmania. At least eleven other Australian companies exhibited at PDAC'99.

The State displays highlighted the most prospective provinces and promoted the availability of information from government exploration initiatives and other programs. Solid interest was shown by executives from North American and South African companies, who were particularly impressed with both the concept of Discovery 2000 and the quality of the Department's products.

The New South Wales Department of Mineral Resources was represented by John Cramsie, Director of the Geological Survey, and Lindsay Gilligan, Assistant Director (Minerals).

Further information please contact John Cramsie on (02) 9901 8300 or Lindsay Gilligan on (02) 9901 8301, e-mail: gilligal@minerals.nsw.gov.au ■

Clive, New England exploration data on 1300 deposits

A comprehensive two volume exploration data package reviewing the mineral deposits, metallogeny and geology of the Clive 1:100 000 map sheet area is due for release in the fourth quarter of 1999.

The package is a product of a study of the New England region (refer *Minfo* **63**) and is the sixth and final package for the Grafton 1:250 000 map sheet area.

This package (Geological Survey report GS1998/125) includes two coloured maps. The Clive 1:100 000 map depicts geology and mineral deposits on a topographic base and shows 1383 recorded mineral occurrences as deposit-classified, numbered symbols. A 1:50 000 scale map of the Mole Granite area shows the vast number of deposits within that heavily mineralised area. The areal extents of the numerous and sometimes very large, alluvial occurrences are also shown on both maps.

Volume one of the package includes discussion on geology, mineral deposits, exploration and geochemistry. Volume two is a set of mineral deposit data sheets with an explanation of the data sheet format. The mineral deposit data sheets are available in MS Excel, HTML and ASCII formats on disk. The raw data are available from the Department's METMIN-99 database in MS ACCESS format.

Highlights of the study include:

- identification and classification of more than 1300 mineral deposits, most of which have not previously been described;
- improved understanding of the role of the Mole Granite in mineral deposit genesis and of the controls on mineralisation and its distribution; and
- confirmation of two suites of mineralising granites, including the polymetallic tin–tungsten-rich Mole Granite and older molybdenum–bismuth-rich leucogranites.

The subject area is part of the Central Block of the southern New England Fold Belt. The Central Block consists of broad tracts of Carboniferous and Permian metasediments, Late Permian felsic volcanic rocks and Late Permian to Early Triassic granitoids. Granitic intrusions include large leucogranites (including the Mole Granite), a Uralla Plutonic Suite granitoid (Wards Mistake Adamellite), and a Moonbi Plutonic Suite body ('Bungulla porphyritic adamellite'). These are overlain by Tertiary strata and Quaternary sediments.

The mole granite

The leucogranites are the major sources of mineralisation in the area (see accompanying table). The Mole Granite is the dominant body, producing more than 1200 base metal, arsenic, gem and gold deposits in the Clive and Ashford 1:100 000 sheet areas. This tin-rich granite is credited with producing more than 89 000 tonnes of tin, mainly from alluvial deposits.

The majority of lode base metal deposits related to the Mole Granite have been emplaced along pre-existing structural features. These include jointing within the Mole Granite, fracturing related to arching of country rock above upwelling ridges of Mole Granite, and regional-scale fissure filling. Stratabound skarn mineralisation is present in altered metabasalts. Multiple pulses of fluids from the Mole Granite have resulted in deposition of complex ore assemblages.

Some gold mineralisation is associated with the Mole Granite. Few lodes have been mined, and most gold occurs as accessory accumulations in many creeks.

Some leucogranites, including the Kingsgate Granite, Bolivia Range Leucoadamellite, Mackenzie Adamellite and Mount Jonblee Leucoadamellite, are accompanied by molybdenum–bismuth pipes and veins along their margins. Greisen-related occurrences of tin, tungsten, molybdenum and base metal mineralisation is broadly developed east of Deepwater.

Placer deposits

Cainozoic placer deposits hold major resources in the subject area. Alluvial tin has been worked from numerous creeks and several deep leads, including Vegetable Creek, Graveyard, Y-water, Avoca and Stannum Vale. Alluvial gold occurs with tin in small quantities in many of the creeks draining the Mole Granite. Topaz is also common in many creeks draining the Mole Granite, and is locally accompanied by beryl, corundum and monazite. Eluvial tungsten has been worked in the vicinity of some tungsten lodes.

Other deposits

The region hosts a variety of miscellaneous deposits. These include manganese oxide, bauxite, clays, hard rock aggregate and quartz crystals.

The Clive 1:100 000 map sheet area holds high potential for the discovery of mineable resources. (continued page 45)

SIGNIFICANT DEPOSITS RELATED TO THE MOLE GRANITE

Deposit	Production and/or Resource
Vegetable Creek alluvial deposit	15 000 t cassiterite concentrate
Vegetable Creek deep lead	>6500 t cassiterite concentrate
Taronga stockwork tin prospect	46.8 Mt 0.145% tin measured resource
Ottery tin–arsenic mine	2737 t tin, 1873 t arsenic
Dutchman, Curnows and Butlers tin mines	total >3800 t cassiterite concentrate
de Milhous emerald mine	up to 40 000 carats beryl, emerald
Fielders Hill west	>470 t wolframite concentrate
Bismuth mine	30 250 t 'ore' produced
Torny, Castle Rag and Webbs silver mines	total >6000 t lead, 450 t zinc, 30 t silver in concentrate

Dubbo geological map and notes

The Dubbo 1:250 000 Geological Map (second edition) and Explanatory Notes are now available.

Mapping was carried out by a combined team from the Geological Survey of New South Wales and the Australian Geological Survey Organisation under the National Geoscience Mapping Accord.

Centred 250 km north-west of Sydney, the Dubbo 1:250 000 map sheet area includes the exposed north-eastern portion of the Palaeozoic Lachlan Orogen (or Fold Belt) and overlying marginal areas of the Permo-Triassic Sydney-Gunnedah Basin and Jurassic Surat Basin.

The Dubbo map area has identified metalliferous and coal resources, with past production totalling over A$37 billion. Coal accounts for A$33 billion of that amount.

The majority of the mapping team and authors of the Dubbo 1:250 000 map and notes

(continued from p 44)

Numerous large silexite bodies are currently the subject of feasibility studies for production of mullite. Potential for gem-quality beryl or emerald exists in certain areas and is currently being explored. Tin (stockwork, lode alluvial, deep lead) and tungsten–bismuth deposits warrant reappraisal or await discovery.

The prospectivity of the region is enhanced by the recognition of structural features responsible for controlling mineralisation. Regional-scale, linear arching of country rock has produced prospective sites for buried cupolas. Extensive fracture zones have channelled fluids to produce polymetallic deposits, eg Webbs and Arvid (and Webbs Consols and Tangoa prospects, Inverell 1:250 000 map sheet area). Identification of domains of joint-controlled tin and tungsten mineralisation within the Mole Granite offer potential for discovery of new lodes, or of strike extensions of known deposits.

The data package is available from the Information Counter at DMR head office and from the Armidale office (prices on application).

For further information contact Harvey Henley or Bob Brown, Geologists, Armidale office, on (02) 6770 2100, fax (02) 6770 2121 or e-mail: henleyh@minerals.nsw.gov.au ■

The 520-page Explanatory Notes are copiously illustrated with 108 figures and 92 photographs. An extensive reference list and comprehensive index are also included.

All 250, or so, stratigraphic units present in the area are described and extensive palaeontological lists are provided in appendixes. Geochemical data for selected igneous units are also included.

Substantial chapters deal with structure and mineralisation of the Dubbo area, which has produced significant gold, along with copper, lead, zinc, iron, diamonds, sapphires, coal, clay and other commodities. Exploration continues in that area.

Copies of both publications may be obtained by contacting the Information Counter at the Head Office of the Department of Mineral Resources on (02) 9901 8269, fax (02) 9901 8247, or e-mail: virdiv@minerals.nsw.gov.au ■

First National Opal Mining Symposium

The first National Opal Mining Symposium was held in Lightning Ridge on 30-31 March 1999. It brought together about 80 attendees from Australia and overseas. The symposium was enthusiastically supported by the whole opal industry.

Papers on opals, opal formation, opal mining and legislation were presented. Speakers from the Department of Mineral Resources included John Watkins, Michael Leys, Gary Burton and Alex Ramsland. Information on opal mining from New South Wales, Queensland and South Australia was presented.

Lively discussion, including from an attendee from Germany, dealt with research and ideas about opal formation. That topic will be the subject of later discussion in *Minfo*.

For further information contact John Watkins on (02) 9901 8330 or e-mail:watkinsj@minerals.nsw.gov.au

IMPORTANT NEW SOUTH WALES MINERAL PROJECTS

Name	Commodities	Location	Resource
GOLD			
Cadia East (Cadia Project)	Gold, copper	21 km SSW of Orange	120 Mt at 0.42 g/t Au, 0.48% Cu (1998)
Cadia Ridgeway (Cadia Project)	Gold, copper	20 km SW of Orange (3 km NW of Cadia Hill)	44 Mt at 2.6 g/t Au, 0.82% Cu (1998)
Cobar Central Project (New Cobar, New Occidental, Chesney)	Gold, copper	3 km SE of Cobar	New Occidental: 3.0 Mt at 7.4 g/t Au New Cobar: Oxide - 0.73 Mt at 2.5 g/t Au Sulphide -0.97 Mt at 5.8 g/t Au, 0.8% Cu (1998)
Cowal Project (Lake Cowal, Endeavour 42)	Gold	40 km NE of West Wyalong	49.6 Mt at 1.53 g/t Au (1995)
Peak Hill Sulphide Project	Gold, copper, silver	Adjacent to Peak Hill	10.2 Mt at 1.27 g/t Au, 0.11% Cu (1998)
Timbarra Project* (Poverty Point, Big Hill, RMT)	Gold	30 km SE of Tenterfield	9.9 Mt at 0.89 g/t Au (1995), plus 2.85 Mt at 0.73 g/t Au (RMT deposit, 1996)
SILVER & BASE METALS			
Bowdens prospect (Bowdens Gift)	Silver (lead, zinc)	25 km ESE of Mudgee	18.8 Mt at 99 g/t Ag, 0.32% Pb, 0.37% Zn (1995)
Hillgrove Extension	Antimony, gold	25 km E of Armidale	1.813 Mt at 1.83% Sb, 5.8 g/t Au (1998)
Lake Innes prospect (Hurlls Hill, Pacific Hwy)	Nickel, cobalt, (chromium, scandium)	7 km SW of Port Macquarie	Hurlls Hill + Pacific Hwy + Innes Peninsular combined: 19.2 Mt at 0.63% Ni, 0.10% Co, 40 ppm Sc (1998)
Syerston project (Fifield laterite)	Nickel, cobalt, platinum, chromium	6 km NW of Fifield	100.6 Mt at 0.66% Ni, 0.11% Co (1999)
Tritton Copper Project (Bonnie Dundee project area)	Copper (gold, silver)	22 km SW of Girilambone	10.88 Mt at 2.87% Cu, 0.22 g/t Au, 10.8 g/t Ag (1998)
INDUSTRIAL MINERALS			
Cowra Project (includes Glenella)	High purity silica for silicon metal	16 km SE of Cowra	5 Mt of recoverable quartz pebbles (1998)
Dubbo Zirconia Project (Toongi)	Zirconium, yttrium tantalum, niobium	20 km S of Dubbo	10 Mt at 2% ZrO_2, 0.12% Y_2O_3, 0.5% Nb_2O_5, 0.03% Ta_2O_5, 0.75% Rare Earth Oxides. 40 Mt at depth (30–100 m) at similar grades (1998)
Oberon Project	Feldspar, mica (silica)	6 km E of Oberon	3.3 Mt at 57% feldspar, 11% mica (1996). Very large additional resources available
Twelve Mile Project (Birthday Gift)	Rutile, zircon, ilmenite (leucoxene)	210 km SE of Broken Hill (Murray Basin)	61 Mt at 3.6% HM containing 19% rutile, 11% zircon, 49% ilmenite, 8% leucoxene (1997)

*Last entry in Minfo as mining has commenced

The Department lists on these pages details of important exploration and mining projects that may proceed to development within the next three years. All information is based on non-confidential company reports and published data.

The information is updated as developments arise. New projects will be added to the list, and others deleted. For information contact John Chapman, on (02) 9901 8347, fax (02) 9901 8256 or Garth Holmes on (02) 9901 8480, fax (02) 9901 8493.

Resource Status	Proposed Mine Type	Operator	Project Status
Resource – in situ (Inferred)	Opencut & underground	Newcrest Mining Ltd	Conceptual study underway. Drilling continuing on higher grade zones at Cadia Far East.
Resource – in situ (Indicated + Inferred)	Underground	Newcrest Mining Ltd	Mining lease granted in June 1999 for trial mining over an 18 month period, prior to proposal for full-scale development.
Resource – in situ (Measured + Indicated)	Opencut & underground	Peak Gold Mines P/L	Tenders for the sale of Peak Gold Mines P/L were due to close in late August. Development plans for Cobar Central are on hold.
Resource – in situ (Measured + Indicated + Inferred)	Opencut	North Ltd	Development consent granted in March 1999.
Resource – in situ (Indicated + Inferred)	Open cut & underground	Alkane Exploration NL	Further exploration drilling and feasibility studies in progress.
Reserve – mineable (Proved + Probable)	Opencut (heap leach)	Ross Mining NL	Mining commenced with first gold pour in May 1999.
Resource – in situ (Indicated + Inferred)	Opencut and possible u/ground	Silver Standard Resources Inc	Feasibility and EIS studies underway. Resource drilling continuing.
Resource – in situ (Measured + Indicated)	Underground	Hillgrove Gold Ltd	Mining leases granted in February 1999. Commencement of development work is imminent.
Resource – in situ (Measured + Indicated)	Opencut	Jervois Mining NL	Exploration and metallurgical studies are continuing.
Resource – in situ (Measured + Indicated + Inferred)	Opencut	Black Range Minerals NL	Mining lease application lodged. Planning focus held in September 1998. EIS and feasibility studies in progress.
Resource – in situ (Measured + Indicated + Inferred)	Underground	Nord Resources (Pacific) P/L (JV with Straits Resources Ltd)	Feasibility study completed, and development application lodged in June 1998. Assessment of development application is continuing.
Resource – in situ (Indicated + Inferred)	Shallow opencut	Doral Mineral Industries Ltd & Portman Mining Ltd	Planning Focus held for mining operation in March 1999. EIS and feasibility studies being finalised based on Lithgow plant location.
Resource – in situ (Indicated + Inferred)	Opencut	Alkane Exploration NL	Prefeasibility study completed. Further metallurgical and process studies in progress and full feasibility study planned for completion by the end of 1999.
Resource – in situ (Measured)	Opencut	Minerals Corporation Ltd	Feasibility studies completed. Currently negotiating with possible JV partners to facilitate development of project.
Resource – in situ (Indicated + Inferred)	Opencut	RZM P/L (JV: Western Metals Resources)	Mining lease applications lodged. EIS and feasibility studies in progress. Earliest time frame for mining is 2–3 years.

EXPLORATION LICENCES GRANTED MARCH 1999 – MAY 1999

No	Mining Div'n*	Holder	Area$	Expiry date+	Min Grp#
5557	OR	Alkane Exploration NL	20 U	02.03.2001	1
5558	OR	Compass Resources NL	28 U	03.03.2001	1
5559	BH	Macapika Pty Ltd	4 U	08.03.2001	2
5561	CO	Peak Gold Mines Pty Ltd, Dominion Gold Operations Pty Ltd	39 U	17.03.2001	1
5562	CO	Golden Cross Operations Pty Ltd	122 U	18.03.2001	1
5563	OR	Compass Resources NL	15 U	22.03.2001	1
5565	OR	Rimfire Pacific Mining NL	36 U	23.03.2001	1
5566	OR	Golden Cross Operations Pty Ltd	79 U	23.03.2001	1
5567	BH	Golden Cross Operations Pty Ltd	50 U	24.03.2001	1
5568	CO	Carrington Holdings Pty Ltd	28 U	24.03.2001	1,2
5569	CO	Australian Geoscientists Pty Ltd	16 U	25.03.2001	1
5570	SY	Young Mining Company Pty Ltd	24 U	18.04.2001	2
5571	SY	Jervois Mining NL	21 U	05.05.2001	1
5572	OR	Michelago Resources NL	19 U	12.05.2001	1
5574	OR	Straits Exploration (Australia) Pty Ltd	93 U	03.06.2001	1
5577	CO	Redfire Resources NL	3199 U	10.06.2001	1
5579	BH	Tinas Gold Exploration Pty Ltd	18 U	15.06.2001	1
5580	BH	Rimfire Pacific Mining NL	101 U	15.06.2001	1
5581	OR	Rimfire Pacific Mining NL	77 U	16.06.2001	1

Reference

* AR Armidale
BH Broken Hill
CH Coffs Harbour
CO Cobar
IN Inverell
LM Lismore
LR Lightning Ridge
OR Orange
SI Singleton
SY Sydney
WA Wagga Wagga

\# Group 1 - Elemental minerals (metallics)
Group 2 -Elemental minerals, Non-metallics
Group 3 - Semi-precious stones
Group 4 - Hard rock minerals
Group 5 - Clay minerals
Group 6 - Diamond, corundum, ruby, sapphire
Group 7 - Opal
Group 8 - Geothermal substances
Group 9 - Coal, oil shale

$ U = Graticular system units
\+ = ELs with passed expiry dates may either be subject to renewal applications or continue by virtue of "flow-on" applications

EL 4955 **Golden Hills Mining NL**

Location: 42 km SW of West Wyalong

Objectives: Porphyry copper–gold

A regional study of aeromagnetic and radiometric data identified no significant targets. A zone of interpreted thrusting and intrusions was not followed up. Reconnaissance identified weakly altered dacite porphyry intruding Ordovician sediments.

ELs 4743, 4974, 5156, 5215 **Golden Cross Operations P/L**

Location: 20 km S of Canbelego

Objectives: Cobar type gold and base metals

Ten areas anomalous in gold or base metals have been identified. The best prospect is Pipeline Ridge, with an estimated 725 000 t at 0.6 g/t Au and potential for down-plunge extensions. This mineralisation may be compared to the Peak mine at Cobar. The area is covered by "flow on" EL 5562 but reports have been made non-confidential.

EL 5084 **Sipa Exploration NL**

Location: 10 km E of Forbes

Objectives: Gold

The licence was acquired with particular interest in a large magnetic complex. It was relinquished without significant fieldwork, after review of geology and cover thickness.

EL 5157 **New England Tin NL**

Location: 20 km NW of Torrington

Objectives: Tin

Rock chip sampling was carried out across the contact between Permian rhyolite and metasediments. The results, while low (less than 0.1% Sn in rock chips composited over 10 m-50 m lengths), suggested a possible strike extension of very low grade copper and tin stockwork veining at Beardy Cliff.

EL 5186 **Tresmonay P/L**

Location: 40 km NE of Temora

Objectives: Gold

The area was applied for to assess the Bribbaree gold deposits. Work was restricted to a literature review.

EL 5187 **Tresmonay P/L**

Location: 25 km S of Condobolin

Objectives: Gold

This EL was applied for to assess the potential of the Weelah gold field. Work was restricted to literature review.

EL 5194 **Fairey A.W.**

Location: 93 km NW of Nyngan

Objectives: Gold

Prospecting located small outcrops of ironstone, for which intended assay work was not completed. One of the outcrops has an old shaft of unrecorded history.

EL 5199 **Tresmonay P/L**

Location: Tullamore

Objectives: Gold, base metals

Work was restricted to a literature review.

EL 5204 **Straits Gold P/L**

Location: 45 km SW of West Wyalong

Objectives: Gold

Geophysical and structural data were compiled in a geographic information system (GIS) study which identified twenty anomalous areas. These were followed up with geological reconnaissance, petrology, rock chip sampling and aircore drilling. No significant assay results were obtained.

EL 5205 **Straits Gold P/L**

Location: Ardlethan

Objectives: Copper and gold

Twelve anomalies were identified from airborne magnetic and radiometric data. Following geological reconnaissance, six of these were selected for wide-spaced grid sampling and aircore or reverse circulation (RC) drilling. No significant results were obtained.

EL 5210 **Golden Cross Operations P/L**

Location: 15 km NNE of Grenfell

Objectives: Gold

Reconnaissance stream sediment and rock chip geochemistry returned only weakly anomalous values from ironstone samples, including 447 ppm Zn, 181 ppm As and 29 ppm Mo.

EL 5214 **King Minerals NL**

Location: 30 km NE of Orange

Objectives: Gold

Exploration was for gold along the southern trace of the Hill End Anticline. Minor bulk leach extractable gold (BLEG), mobile metal ion (MMI) and rock geochemistry was carried out. Results indicated gold is restricted to narrow zones of quartz veining.

EL 5219 **Tresmonay P/L**

Location: 5 km NE of Byrock

Objectives: Base metals, gold

The area was applied for to examine projected extensions of the Gilmore Suture. Activities were restricted to a literature review.

EL 5220 **Tresmonay P/L**

Location: 10 km E of Bourke

Objectives: Base metals

The area was applied for to examine base metal prospects and their possible relationship to a peripheral andesitic complex. Work was restricted to a literature review.

EL 5221 Mount Conqueror Minerals NL & Central West Gold NL

Location: 16 km S of Yeoval

Objectives: Gold

The licence was acquired to explore for intrusion-related gold mineralisation related to several discerned phases of the Yeoval granite. Reconnaissance sampling gave no significant results.

EL 5256 **Gold Mines of Australia (NSW) P/L**

Location: Temora

Objectives: Porphyry copper-gold

Re-interpretation of aeromagnetic and radiometric data was combined with geological and structural review. The area of interest was adjacent to and within Temora township but no Late Ordovician volcanic or intrusive in rocks were identified.

EL 5257 **Newcrest Operations Limited**

Location: East of Temora

Objectives: Gold, copper

The licence was applied for to explore for porphyry-related gold–copper mineralisation in Ordovician shoshonitic volcanic rocks. A review of previous exploration data downgraded the potential for large deposits.

EL 5260 **Centfield Mining P/L**

Location: 25 km ESE of Armidale

Objectives: Gold, antimony

The licence was applied for to search for Hillgrove-style mineralisation. It surrounds mining lease application 216 Armidale that is proceeding to grant. No exploration was undertaken on the licence.

EL 5304 **Climax Mining Limited**

Location: 9 km SSW of Temora

Objectives: Porphyry copper-gold

The licence area contains andesitic volcanic and intrusive rocks, under cover, in proximity to the Gilmore Fault. MMI geochemistry was applied systematically but proved extremely sensitive to contamination from gold mine waste spread along roads. No drill targets were generated and the geochemical results were suggestive of only small scale mineralisation.

EL 5312 **New Ind Resources P/L**

Location: 11 km WNW of Narrabri

Objectives: Bicarbonate in groundwater

Review of available borehole data suggested a source of bicarbonate-rich water in the Permian formations in the deeper parts of the Bohena Trough (part of the Gunnedah Basin) west of Baan Baa. No additional work was done.

EL 5372 **Alphadale P/L**

Location: 50 km N of Broken Hill

Objectives: Copper, gold

Exploration of the Paragon Group was carried out by drainage BLEG sampling, and rock sampling from old workings. Some low order gold and gold–arsenic anomalies were defined, the most noteworthy being along the Kantappa Fault.

EL 5403 **Probe Resources NL**

Location: 2 km NW of Drake

Objectives: Gold

The licence was acquired to explore for Timbarra-style mineralisation but was cancelled after reconnaissance prospecting.

EL 5408 **L.H. & R.J. Savage**

Location: Wingen

Objectives: Bentonite

Outcropping bentonite seams were sampled at five sites. Testing gave generally satisfactory results. However, dips of the bentonite seams are considered too steep to allow for easy mining.

EL 5435 **Alphadale P/L**

Location: 60 km N of Broken Hill

Objectives: Gold

BLEG drainage geochemistry gave no anomalous gold results but did identify a discrete low order arsenic anomaly. Minor soil sampling confirmed the anomalous arsenic and also returned weakly anomalous gold. Geological reconnaissance of the area gave no further encouragement.

EL 5441 **Rio Tinto Exploration P/L**

Location: 70 km NNE of Broken Hill

Objectives: Base metals and silver

The area was acquired to explore for Century-style zinc mineralisation in the Euriowie Block. Three low priority geochemical targets were defined by literature review but not followed up.

EL 5451 **Michelago Resources NL**

Location: 17 km NNE of Peak Hill

Objectives: Gold and copper

A geological review did not identify any NW-trending structures considered important to gold mineralisation in this area.

EL 5452 **Michelago Resources NL**

Location: 30 km N of Crookwell

Objectives: Base metals

The licence covered felsic volcanic sequences with known areas of disseminated pyrite. Reconnaissance of gossans marked on previous maps suggested these were derived from disseminated rather than massive sulphides.

EL 5453 **Michelago Resources NL**

Location: 30 km SE of Goulburn

Objectives: Base metals

Reconnaissance confirmed thin cobaltiferous manganese wads developed in the lower levels of Tertiary gravels. Minor sampling gave cobalt concentrations of up to 1.04%, coincident nickel to 3070 ppm and minor copper.

Other exploration licences cancelled or expired

At the time of compilation, final reports had not been received for the following licences:

ELs 4099; 4257; 4258, 4457; 4763; 4788; 5151; 5247; and 5290.

Partial relinquishment reports

Reports to remain confidential due to "flow-on" titles for the following licences:

ELs 2767; 4600; 4819; 4905; 4973; 5287; 5288; and 5444.

EXPLORATION LICENCES TERMINATED BEFORE MARCH 1999

EL 3320 **Southpac Limited**

Location: 20 km SE of Cowra

Objectives: Dimension stone

The licence area covered a portion of the composite stressed Wyangala Batholith and contains at least six granite varieties. Granite dimension stone was sought for the south-east Asian market. However, re-assessment was forced by market collapse since 1997 and increased granite supply from China.

EL 3352 **Southpac Limited**

Location: 18 km NE of Wellington

Objectives: Dimension stone — granite

Work concentrated on one quarry. Several shallow drillholes were used to expose fresh rock and some bulk samples were removed and tested. The rock has interesting pink megacrysts in a greenish matrix but the colour is not consistent, and clay alteration results in surface pitting.

EL 3710 **Delta Gold NL**

Location: 20 km W of Bombala

Objectives: Lead, zinc, silver and gold

The Silurian Quidong Basin was explored for stratabound base metal mineralisation. The best drilling intercept was 14 m at 7.6% Zn+Pb and trench sampling yielded a best result of 7.95 m at 6.7 g/t Au. Mississippi Valley and other models of mineralisation were invoked but the source of the metals remained conjectural. Continuity of mineralised zones could not be demonstrated.

EL 4624 **Muller, P.J.**

Location: 17 km E of Bathurst

Objectives: Gold and kaolin

Three holes were drilled to test for kaolin and gold in gravel overlying granite. There were no significant results.

ELs 4854, 4890 **Currumbin Sands & Gravel P/L**

Location: 10 km E of Bingara

Objectives: Gold

Rock chip and bulk cyanide leach (BCL) drainage sampling gave generally low results. BCL results of up to 8.5 ppb Au were detected, but not considered worthy of further follow-up.

EL 5114 **Monier PGH Holdings Ltd**

Location: 2 km N of Wyong

Objectives: Clay-shale for ceramics

Five holes were drilled to test the extent and quality of clay at Warnervale Hill. This intersected moderate amounts of red mudstone interbedded with sandstone. The clay samples fired a terracotta colour with shrinkages of 7.6%.

EL 5146 **Golden Reef Enterprises P/L**

Location: 70 km SE of Armidale

Objectives: Base metals

Re-interpretation of geophysical data highlighted prospectivity for Besshi and other volcanogenic style mineralisation, but this was not followed up.

EL 5150 **Rootes, E.G.**

Location: 20 km SW of West Wyalong

Objectives: Gold

The licence covered Ordovician metasediments intruded by Silurian granite and was explored by Golden Hills Mining NL. An airborne geophysical survey was followed by soil and rock chip sampling and RC drilling. No significant results were obtained.

EL 5166 **Australian Dolomite Company P/L**

Location: 15 km NNW of Tuena

Objectives: Marble

A bulk sample of 5 cubic metres taken from an existing quarry in coarse grained marble was found to be suitable for some forms of terrazzo work.

EL 5168 **Polymetals Australia P/L**

Location: 75 km SSE of Cobar

Objectives: Copper and gold

This licence covered the Crowl Creek and Shuttleton line of copper mines. Literature research and data review identified targets for oxide or supergene copper–gold mineralisation but no field activities were undertaken.

EL 5201 **GDR Mines Development P/L**

Location: 26 km E of Canowindra

Objectives: Gold

The initial work was carried out on EL 4781 by Newcrest Mining Ltd. The licence was transferred to GDR Mines Development and subsequently replaced by follow-on EL 5201. Following soil and rock chip sampling, the Myalla prospect was tested with 32 vertical aircore holes. Only one anomalous intersection was made, 3 m at 0.15 g/t Au.

EL 5246 **Gold Mines of Australia (NSW) P/L**

Location: 16 km E of Cootamundra

Objectives: Gold, silver and base metals

Exploration concentrated on the contact between the Cambrian Jindalee Group and the Silurian Blowering Formation. Stream sediment, orientation soil and rock chip geochemistry was conducted about Cullinga mines and other areas of interest. Several interesting targets were identified but not followed up.

EL 5322 **Alkane Exploration NL**

Location: 38 km NE of Parkes

Objectives: Gold

A review of previous work identified an untested BCL gold anomaly similar to that over the nearby Mounty Aubrey gold deposit. No further work was done.

EL 5382 **Casanza P/L**

Location: 10 km ESE of Blayney

Objectives: Slate

No work was undertaken.

OTHER NOTEWORTHY REPORTS PLACED ON "OPEN FILE"

MC 132 **Minerals Corporation Ltd**

Location: 49 km SW of Broken Hill

Objectives: Garnet

Drilling of 34 holes showed that garnet–biotite schist bands are up to 10 m wide and average up to 20% garnet. A bulk sample of about 1000 t was taken from three pits for magnetic separation testing. The product proved suitable only as low demand filtration grade garnet.

Coal Industry Updates

Job losses

In the two years to June 1999, employment in the NSW coal industry has declined by 30%. This fall has coincided with a reduction of over 20 per cent in benchmark coal prices over the same period. Many companies have responded to these price cuts by reducing staff numbers and improving productivity, thereby retaining production at previous levels. In fact saleable coal production in the State declined by only four per cent in 1998/99.

Job losses have occurred in all coalfields in NSW and in both coking and steaming coal mines. In the Singleton area, the Camberwell Open Cut shed 23 jobs in February because of the market situation. Muswellbrook Colliery lost a major export coal contract to Taiwan in June and was forced to retrench 78 workers. Wambo laid off 34 workers from its open cut, while Mount Thorley will shed 160 workers by October 1999.

The Newcastle Coalfield has experienced some job losses in 1999. Great Greta closed in February because of the depletion of economically mineable reserves, with the loss of 16 jobs. Fifty two miners were laid off in January when Chain Valley Colliery was put on care and maintenance.

The Southern Coalfield, which is predominantly a coking coal producer, has also been severely affected by the price cuts and the over-supplied export market. BHP has retrenched 140 miners from Westcliff, 66 at Elouera, 27 at Cordeaux and 34 at Appin as part of its restructuring to significantly improve productivity. This was partly in response to the loss of some of its domestic market through the pending closure of the Newcastle Steelworks. Tahmoor Colliery shed about 60 jobs as it reacted to lower prices and restricted markets. Oakdale Colliery closed in June with the loss of 125 jobs, partly as a result of operational problems early this year which halted production for a time. A cut of 18 per cent in the price of one of its major contracts was also a major factor.

In the Western Coalfield, the Springvale Colliery retrenched 30 workers in April. The Ivanhoe Colliery announced in June that it would reduce its workforce from 48 to 20. The mine will close completely within 12 months if new coal reserves cannot be secured, as its reserves are almost exhausted. Blue Mountains Colliery workforce was reduced by 32 following its purchase by Centennial Coal Company.

Changes of ownership

Swiss company Glencore is set to rival Rio Tinto as the Hunter Valley's largest coal miner, after buying the Liddell Open Cut, northwest of Singleton, from Pasminco. Pasminco had earlier acquired a number of coal properties in its takeover of Savage Resources. Glencore purchased all of these coal assets, including the Glendell project, for $69 million. At about the same time, Glencore bought the Oceanic group of mines, including Teralba, West Wallsend and Westside in the lower Hunter, for $139 million. Its Hunter mines produced about 11 million tonnes of saleable coal in 1997-98, compared with 13 million tonnes produced from Rio Tinto's mines.

Centennial Coal Company Limited acquired the Blue Mountains Colliery near Lithgow, in June 1999. This mine produces about 220 000 tonnes annually for the domestic market and has a 200 000 tonne a year contract with Delta Electricity, running until the end of 2002. Centennial currently operates five other coal mines in NSW, all but one of these in the Western Coalfield. In addition it owns the Airly Project, at which some trial mining has occurred.

Donaldson Project

Donaldson is a small opencut coal project located 5 km south-east of Maitland in the Newcastle Coalfield. The project was the subject of a Commission of Inquiry which concluded in December 1998. The Commissioner, in his report released in April 1999, found that environmental aspects would not preclude approval of a mine development, subject to conditions of consent to control and mitigate environmental impacts and to protect Steggles' poultry activities adjacent to the southern boundary of the project.

The Commissioner recommended that reduced mining occur in the western part of the project area to protect a number of residences from excessive noise and dust levels and to preserve an occurrence of the threatened flora species *Tetratheca juncea*. The Commissioner found that the company would need to implement a comprehensive environmental management system, complaint and dispute resolution protocols, community information and consultation forums and environmental monitoring systems to meet its environmental obligations.

Status of other coal projects

The **Gretley Colliery** has been sold to York Mining by Oakbridge, who closed the mine in June 1998. York Mining renamed the mine the **New Wallsend Colliery** and commenced operations in June. When the mine is fully on production, it will employ around 100 workers. The predominantly semi-soft coking coal produced by the mine has been guaranteed a market by Oakbridge.

The **Newstan Colliery**, in the Lake Macquarie area, has received development consent for the extension of mining, which will extend the life of the mine for at least 21 years. As well as protecting the 320 jobs at the mine, the project will lift annual production from 2.7 million tonnes to between three and four million tonnes. Environmental impacts have been carefully considered and are covered in the consent conditions.

Tahmoor Colliery, in the Southern Coalfield, has also received develop-ment consent for its Tahmoor North project. This approval has

extended the future of the mine from a short-term scale of four years to the long-term future of 12-15 years.

Planning Focus meetings were held for an extension to the **South Bulga** underground mine, near Broke in the Upper Hunter Valley, on 17 June.

Meetings were also held for the Mount Arthur North Project, near Muswellbrook, were held on 24 June.

Strategic studies of NSW coalfields

The Department of Mineral Resources is coordinating Strategic Studies of the Northern, Southern and Western Coalfields of NSW. The objective of the studies is to review the short and medium term outlook for the coalfields, by assessing the supply and demand for coal from the fields over a ten year period. The studies will assess the current infrastructure and whether it is adequate to cope with the expected task over the next 10 years. They will also identify the broad relationships and impacts of mining and mining development on the environment and local communities in the coalfields. Finally, the reports will make recommendations to Government, local Councils and industry to enable all those involved with coal mining and related activities to plan for development and associated infrastructure requirements, based on the findings of the study.

Similar strategic studies on the coalfields were carried out eight years ago under the auspices of the Coal Resources Development Committee (CRDC), which contained representatives of all the major stakeholders in the coal mining industry. The current studies are being undertaken at the direction of the Minerals Consultative Committee, the successor to the CRDC.

Drafts of the studies have been completed and will be published after they have been approved by the Minerals Consultative Committee.

For more information, contact Denis Casey, Senior Project Officer, on (02) 9901 8511; fax (02) 9901 8493; e-mail: caseyd@minerals.nsw.gov.au

Bengalla opens for world markets

Bringing more than 200 jobs to the Upper Hunter and achieving leading benchmmarks in productivity and environmental protection, the Bengalla coal mine was officially opened by the Premier of NSW, the Hon. Bob Carr on 30 July.

The mine is some four kilometres west of Muswellbrook, and covers about 10 square kilometres over a coal seam estimated at 361 Mt. The open cut mine is expected to have a life span of more than 40 years, with initial coal production estimated to reach two million tonnes by March next year, increasing to six million tonnes of export steaming coal a year by 2003.

"More than 200 workers will be directly employed at the mine and hundreds more in support and supply," the Premier said. "The size of production and long mine life span will help deliver secure long term employment to a region hit hard by recent mining and meat industry cutbacks.

"Importantly, every effort has gone into protecting the natural environment and controlling noise and dust. More than 35 000 trees have been planted across the site and native grasses and historic buildings protected within the mine lease area. With more than 90 environmental and development controls imposed on the mine, the operators are confident it will be seen as a good neighbour for Muswellbrook," the Premier said.

The Bengalla Joint Venture acquired about 3 000 hectares to develop the project, including the mining lease area of 1 000 hectares, to secure the coal resource for opencut mining. The project which includes dairy farms producing about four million litres of milk a year and a well-established horse stud. This diverse range of activity is in accordance with Development Consents that require current land uses of the surrounding region be sustained.

"A strong international consortium developed the $500 million-plus coal mine," said Consortium Chairman Bob Humphris. "Development of the mine at a time when much of Asia was experiencing economic difficulties, and in the face of fierce competition from other coal producing nations, required unwavering commitment by the joint venture participants."

"Our development consent conditions are amongst the most stringent

ever set down for a mining operation, anywhere in the world," Mr Humphris added. "To ensure we meet these conditions we have developed state-of-the-art technology which allows us to monitor the meteorological conditions, dust, vibration and noise surrounding Bengalla every sixty seconds."

Environmental protection measures include a site design which puts mine infrastructure (washery, stockpiles, workshops, etc) at the south-western end of the mining area to maximise its distance from Muswellbrook, low noise emissions and noise suppression for all major plant including the drag lines, construction of an artificial hill for visual screening, and roadside earth bunding to prevent truck headlights being visible from outside of the site. A 4.5 kilometre overland conveyor carries coal to the raw coal stockpile and serves to limit truck movements. Rehabilitation of mined out areas will commence within two years, as the electric drag lines move west. There will be no mining of alluvial agricultural land adjacent to the Hunter River.

Bengalla is managed by Peabody Resources Ltd, of which Bob Humphris is Managing Director.

Enhanced coal potential in the Wilpinjong–Moolarben area

Stage two of a drilling program in A449 south-east of the Ulan Mine indicates that over 400 million tonnes (Mt) of coal may be present in the area.

This second phase of exploration, undertaken during 1998 and 1999 by the Coal and Petroleum Geology Program of the Geological Survey, covered an area (A449) to the immediate south-east of the operating colliery at Ulan in the Western Coalfield (figure 18). Referred to as Wilpinjong–Moolarben and held by the Department of Mineral Resources, the area has been the subject of a number of exploration programs under previous titles investigating both underground and opencut coal potential.

The geological setting of the Wilpinjong–Moolarben area was reasonably well defined from previous exploration. However, due to a lack of appropriate coal quality data, particularly washability testing, and the unreliability of some of the earlier data, the Department in 1992 undertook the first of its exploration programs.

The most recent program, Wilpinjong–Moolarben Stage 2, was designed to enhance the knowledge of the raw and clean coal characteristics of the target 'Ulan seam' (formally, Ulan Coal). The 'Ulan seam' in the Wilpinjong–Moolarben area is the only coal interval with economic potential and is located near the base of the Illawarra Coal Measures. Regionally, the 'Ulan seam' has been correlated with the upper portion of the Lidsdale Coal in the generalised Western Coalfield stratigraphy.

Detailed lithological logging and examination of geophysical logs of the 'Ulan seam' has enabled ply characterisation (properties of separate layers within the overall coal unit) that can be readily correlated with that at Ulan Colliery. The ply nomenclature was used in the detailed analytical program and has enabled direct comparison of coal quality with that of an operating colliery.

The basal section of the 'Ulan seam' as mined underground at Ulan Colliery is the DWS ply, and that extends into the Wilpinjong–Moolarben area (figure 19). Within this area it is amenable to underground extraction, albeit at slightly higher raw coal ash values, with an in situ underground resource within the DWS section of 203 Mt and raw ash values from 13.6% to 18.7%.

Within a number of separate areas in A449, the 'Ulan seam' occurs at depths suitable for opencut extraction. These areas have been defined by a combination of a maximum 40 m depth of cover and a cumulative linear overburden ratio of less than 5:1 to the basal mineable section. The tuffaceous CMK ply provides a logical break between an upper and lower mining section. The CMK ply thickens from 0.3 m to in excess of 4 m within A449. Hence, potential opencut extraction would most likely involve a two pass operation.

The Stage 2 review has defined an upper mineable section made up of plies UB1, UB2 and UC1 and referred to as the UB1C1 mining section (figure 19). The total in situ resource for the UB1C1 section in the Wilpinjong and Moolarben Creek opencut areas has been

(continued on page 57)

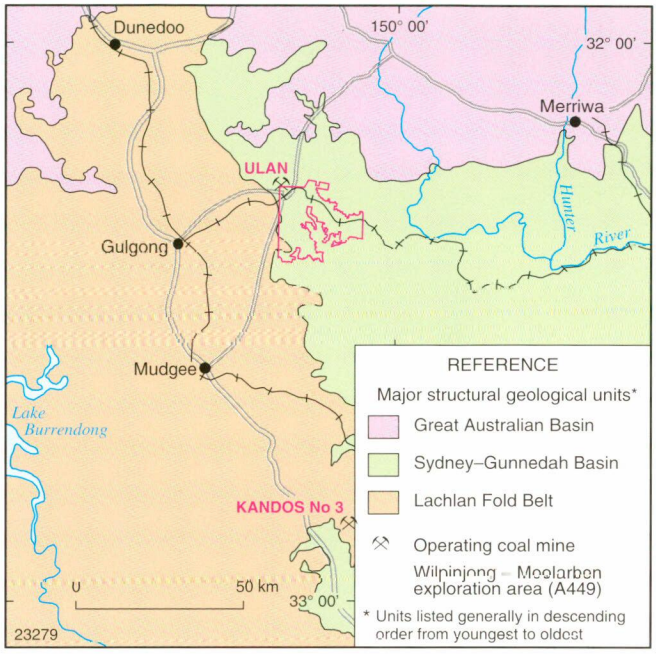


Figure 18. The Wilpinjong–Moolarben exploration area

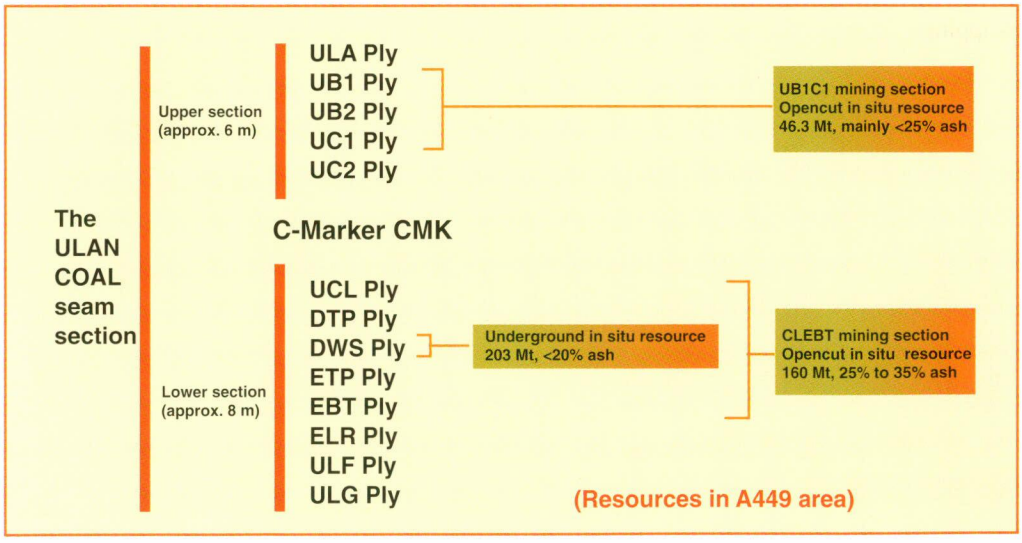


Figure 19. Subdivision of the 'Ulan seam', and potential working sections and their resources

Offshore petroleum exploration permit awarded for Sydney Basin

The Federal Minister for Industry, Science and Resources, Senator Nick Minchin has announced that Flare Petroleum NL was the successful bidder for a new petroleum exploration permit in the offshore Sydney Basin.

"Over the next six years, Flare Petroleum plans to spend around $13.5 million on the exploration of the area," Senator Minchin said. "This includes acquiring data from a 750 km seismic survey and drilling two exploration wells."

The permit area is about six kilometres from the coast at its nearest point and extends from Newcastle to south of Sydney (refer to PEPA 1 on map on page 63)

"At present there are no commercial oil or gas discoveries in the Sydney Basin, however exploration wells drilled in the onshore part of the basin have shown both oil and gas indications.

"Previous exploration in the offshore part of the basin has identified ten prospects and leads although significant work would need to be undertaken to prove up viable drilling targets.

"This area is adjacent to Australia's largest population centres covering more than five million inhabitants and major industries located within the Newcastle, Sydney and Wollongong regions."

The exploration permit is subject to stringent operating requirements of the Petroleum (Submerged Lands) Act 1967. Separate approvals are required for individual exploration activities, such as the drilling of a well to ensure environmental and other operating standards are met. The approval process involves close consultation with relevant Commonwealth and State environment and other agencies.

Southern Coalfield Map Sheet

The Department of Mineral Resources has released the 1:100 000 scale Coalfield Series which includes the Western Coalfield, Newcastle Coalfield, Hunter Coalfield and the Gunnedah Coalfield.

The map is a compilation of Departmental data packages, company exploration mapping, university theses, research papers, and field mapping. It depicts the geology of the southern area of the Sydney Basin and shows the main geological structures, extent of the main economic seams of the Illawarra Coal Measures, locations of the 87 historic coal mines in the Southern Coalfield, and the main landuse features.

The notes to the map are at the editing stage and are expected to be available this year. For further information contact Michael Armstrong, on (02) 9901 8506, fax (02) 9901 8520, e-mail: armstrong@minerals.nsw.gov.au. Alternatively contact Bob Moffit on (02) 9901 8516 or e-mail: moffittb@minerals.nsw.gov.au

(from page 56)

estimated at 46.3 Mt, the majority of which is at less than 25% raw coal ash.

Several alternative lower mining sections are available. The maximum potential mining section envisaged by the Stage 2 review is a combination of plies UCL, DTP, DWS, ETP and EBT, to form the CLEBT mining section (figure 19), for which an in situ resource of 160 Mt has been estimated.

The coal resources defined within the 'Ulan seam' are primarily domestic thermal. Washability testing has tentatively indicated that beneficiation of the ROM underground DWS section might yield an export thermal product and a domestic thermal middlings product with minimal reject material.

For further information, contact Kim Bayly, Geologist, Coal and Petroleum Geology, on (02) 9901 8534, fax (02) 9901 8520, e-mail: baylyk@minerals.nsw.gov.au

Conference reports

- **The Australian Petroleum Production and Exploration Association 1999 Annual Conference (APPEA)** was held in Perth 18–21 April, 1999, with the theme Energy for Growth in Australia. Key discussions centred on the increasing pressure to supply competitively priced petroleum to domestic markets. APPEA also served as a forum for federal and state governments to present exploration and development potential. New South Wales' very encouraging Discovery 2000 results were well received by industry delegates, with interest particularly expressed for the Eromanga Basin. Many delegates requested follow up information on Coal Seam Methane, the western areas of NSW, the Sydney Basin and the offshore Clarence–Moreton Basin.

- **The American Association of Petroleum Geologists (AAPG), 1999 Annual Convention** was held in San Antonio 11–14 April, 1999.

The conference attracted about 6 000 delegates and exhibits from 240 companies. An international pavilion featured exhibits from 40 countries, all vying to attract oil industry investment.

New South Wales exhibited as part of the Australia Stand, along with AGSO, Industry Science and Resources (ISR), Northern Territory, South Australia, Western Australia, Tasmania and Victoria.

The NSW exhibit highlighted the under-explored areas of the state, with particular emphasis on the Murray and Eromanga Basins as internationally attractive exploration areas. Department of Mineral Resources representatives Brad Mullard, Assistant Director (Coal and Petroleum), and Dave Alder, Principal Geologist (Petroleum) presented the attractions of petroleum exploration in NSW.

They noted that, while competition for petroleum exploration capital is intense, the State's potential was favourably acknowledged by representatives of international companies. Studies carried out under Discovery 2000 proved helpful in describing this potential.

Coal authorisations/exploration licences June 1999*

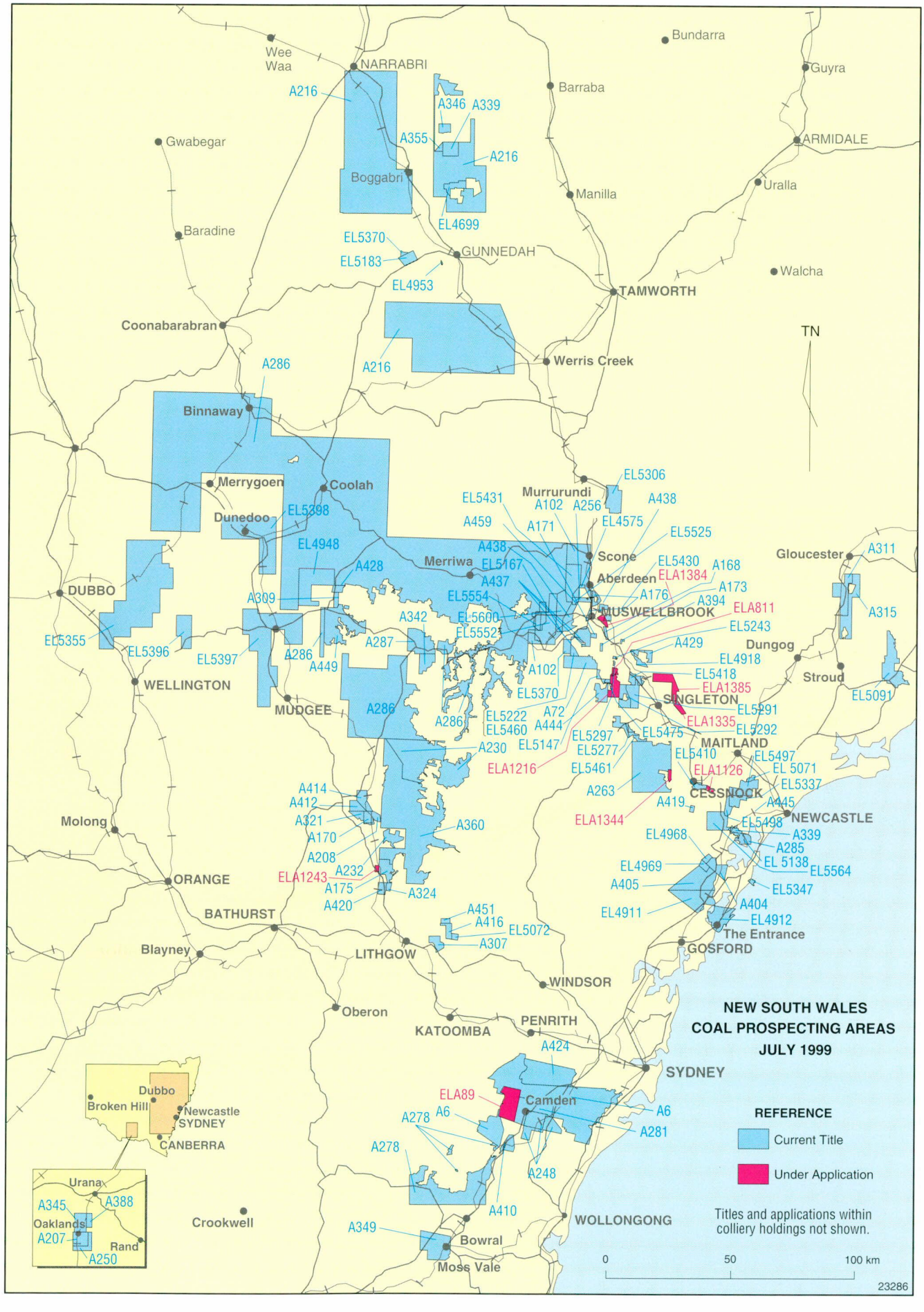
No	Holder	Nearest town
A6	Dept Mineral Resources	Campbelltown
A72	Novacoal Australia P/L Mitsubishi Development P/L	Jerrys Plains
A81	Navidale P/L Toyota Tsusho Mining (Aust) P/L DIA Coal Mining P/L	Camberwell
A102	Dept Mineral Resources	Muswellbrook
A168	Coal Operations Australia Ltd	Muswellbrook
A170	Genders Mining P/L	Capertee
A171	Bayswater Colliery Co P/L	Muswellbrook
A173	Drayton Coal P/L	Muswellbrook
A175	Coalex P/L	Ben Bullen
A176	Muswellbrook Coal Co Ltd	Muswellbrook
A208	Genders Mining P/L	Capertee
A216	Dept Mineral Resources	Gunnedah
A230	Dept Mineral Resources	Rylstone
A232	Airly Coal P/L	Capertee
A248	BHP Steel (AIS) P/L	Menangle
A250	Mitsubishi Development P/L Queensland Coal P/L	Oaklands
A256	The Bellambi Coal Co P/L Marubeni Thermal Coal P/L Showa Coal (NSW) P/L	Aberdeen
A263	Dept Mineral Resources	Wollombi
A278	Dept Mineral Resources	Mittagong
A281	Dept Mineral Resources	Camden
A285	Dept Mineral Resources	Toronto
A286	Dept Mineral Resources	Gulgong
A287	Austen & Butta Ltd	Bylong
A307	Hartley Valley Coal Co P/L	Lithgow
A309	Ulan Coal Mines Ltd	Ulan
A311	CIM Resources Ltd CIM Strathford P/L	Gloucester
A315	CIM Resources Ltd CIM Strathford P/L	Gloucester
A321	Genders Mining P/L	Capertee
A324	Lithgow Coal Co Ltd	Ben Bullen
A342	Austen & Butta Ltd	Bylong
A349	Austen & Butta Ltd	Sutton Forest
A355	Idemitsu Boggabri Coal P/L	Boggabri
A360	Dept Mineral Resources	Rylstone
A388	Queensland Coal P/L Mitsubishi Development P/L	Oaklands
A394	Liddell Tenements P/L	Muswellbrook
A404	Powercoal P/L	Morisset
A405	Coal Operations Australia Ltd	Cooranbong
A410	Tahmoor Coal P/L	Picton
A412	Genders Mining P/L	Ilford
A414	Charbon Coal P/L Yukong Aust P/L	Kandos
A419	Newcastle Wallsend Coal Co P/L	Cessnock
A420	Lithgow Coal Co Ltd	Ben Bullen
A423	Hunter Valley Coal Corporation	Ravensworth
A424	Dept Mineral Resources	Campbelltown
A428	Ulan Coal Mines Ltd	Gulgong
A429	Hunter Valley Coal Corp P/L	Singleton
A435	Coal & Allied Operations P/L	Singleton
A437	Bayswater Colliery Co P/L	Muswellbrook
A438	Bengalla Mining Co P/L	Muswellbrook
A444	The Construction Forestry Mining & Energy Union	Singleton
A445	Newcastle Wallsend Coal Co	Boolaroo
A449	Dept Mineral Resources	Ulan
A450	Saxonvale Coal P/L	Bulga
A451	Coalex P/L	Lithgow
A459	Coal & Allied Operations P/L	Aberdeen
4470	BHP Steel (AIS) P/L	Camden
4574	A & B Coal Co P/L Marubeni Thermal Coal P/L Showa Coal (NSW) P/L SsangYong Resources P/L	Muswellbrook

EL No	Holder	Nearest town
4575	A & B Coal Co P/L Marubeni Thermal Coal P/L Showa Coal (NSW) P/L SsangYong Resources P/L	Muswellbrook
4587	Cyprus Springvale P/L Samsung Development (Aust) P/L	Lithgow
4699	Namoi Valley Coal P/L	Boggabri
4911	Coal Operations Australia Ltd	Wyee
4912	Coal Operations Australia Ltd	Wyee
4918	Dept Mineral Resources	Ravensworth
4948	Dept Mineral Resources	Ulan
4953	Namoi Mining P/L	Gunnedah
4968	Powercoal P/L	Wyee
4969	Powercoal P/L	Wyee
5071	Donaldson Projects P/L	Thornton
5072	Coalex Pty Ltd	Lithgow
5091	Hunter Valley Mining Corp P/L	Bulahdelah
5138	Powercoal P/L	Awaba
5167	Bayswater Colliery P/L	Muswellbrook
5183	Namoi Mining P/L	Gunnedah
5243	Novacoal Aust Pty Ltd Mitsubishi Development P/L	Ravensworth
5277	Saxonvale Coal P/L	Warkworth
5291	Esso Australia Resources Ltd	Warkworth
5292	Esso Australia Resources Ltd	Warkworth
5297	Peabody Resources Ltd	Ravensworth
5337	Newcastle Coal Co P/L	Seahampton
5347	Coal Operations Australia Ltd Catherine Hill Resources P/L	Wyee
5355	Rio Tinto Exploration P/L	Dubbo
5370	Namoi Mining P/L	Gunnedah
5396	Rio Tinto Exploration P/L	Wellington
5397	Rio Tinto Exploration P/L	Gulgong
5398	Rio Tinto Exploration P/L	Gulgong
5410	Oceanic Coal Australia Ltd	Cessnock
5417	Coal & Allied Operations P/L	Warkworth
5418	Coal & Allied Operations P/L	Warkworth
5430	Bayswater Colliery Co P/L	Muswellbrook
5431	Muswellbrook Coal Co P/L	Bunnan
5460	AMP Life Ltd and others	Muswellbrook
5461	Saxonvale Coal P/L Nippon Steel Australia P/L	Broke
5475	Coal & Allied Operations P/L	Jerrys Plains
5497	Excel Equities P/L	West Wallsend
5498	Seaham Holdings Pty Ltd	Seahampton
5525	A&B Coal Company Pty Ltd	Muswellbrook
5552	Powercoal P/L	Denman
5554	Bengalla Mining Co P/L	Muswellbrook
5564	Hunter Valley Coal Processing P/L	Mulbring
5600	Muswellbrook Coal Co Ltd	Muswellbrook

Exploration Licence Applications

No	Mining Division	Applicant
89	Sydney	Burragorang Valley Coal P/L (Camden)
811	Singleton	Cumnock No 1 Colliery P/L (Ravensworth)
1126	Singleton	Oceanic Coal Australia Ltd (Kurri Kurri) Excel Mining P/L
1216	Singleton	Coal & Allied Operations P/L (Black Hill)
1243	Orange	Lithgow Coal Co Ltd (Cullen Bullen)
1335	Singleton	Henry Walker Group Ltd (Singleton)
1344	Singleton	Earth Technics Pty Ltd (Paxton)
1345	Singleton	Cumnock No 1 Colliery P/L (Liddell)
1384	Singleton	Newangle Mining P/L (Liddell)
1385	Singleton	Newangle Mining P/L (Singleton)
1392	Singleton	Muswellbrook Coal Co P/L (Muswellbrook)
1401	Sydney	BHP Steel (AIS) P/L (Port Kembla)

* Authorisations and Exploration Licences over colliery holdings are not listed.


Wee Waa
NARRABRI
Bundarra
Guyra
Barraba
ARMIDALE
Gwabegar
Boggabri
Manilla
Uralla
Baradine
GUNNEDAH
Walcha
TAMWORTH
Coonabarabran
Werris Creek
TN
Binnaway
Merrygoen
Coolah
Dunedoo
Murrurundi
Scone
Gloucester
Merriwa
Aberdeen
MUSWELLBROOK
DUBBO
Dungog
Stroud
WELLINGTON
MUDGEE
SINGLETON
MAITLAND
CESSNOCK
NEWCASTLE
Molong
ORANGE
BATHURST
Blayney
LITHGOW
WINDSOR
Oberon
KATOOMBA
PENRITH
SYDNEY
The Entrance
GOSFORD
WOLLONGONG
Bowral
Moss Vale
Crookwell
Dubbo
Broken Hill
Newcastle
SYDNEY
CANBERRA
Urana
Oaklands
Rand
Camden
NEW SOUTH WALES
COAL PROSPECTING AREAS
JULY 1999
REFERENCE
Current Title
Under Application
Titles and applications within colliery holdings not shown.
0
50
100 km
23286

Coal mining proposals — July 1999

Company	Location	Coal type	Mine type	Development stage
Austral Coal Ltd	Tahmoor Mine infill areas ('prohibited' in LEP)	Coking	Underground	C
Coal & Allied Operations Pty Ltd	Carrington, 18 km west of Singleton	Thermal	Opencut	B*
Coal & Allied Operations Pty Ltd	Cheshunt, 15 km west of Singleton	Thermal	Opencut	A
Coal & Allied Operations Pty Ltd	Mount Pleasant, 6 km north-west of Muswellbrook	CWM/thermal/ coking	Opencut	B
Dartbrook Joint Venture	Kayuga, south of Dartbrook Mine	Thermal	Opencut	A
Coal Operations Australia Ltd	Mount Arthur North, 5 km south-west of Muswellbrook	Thermal	Opencut	A
Donaldson Projects Pty Ltd	Donaldson, 5 km south-east of Maitland	Thermal/coking	Opencut	B
Duralie Coal Pty Ltd	Duralie, 20 km south of Gloucester	Coking	Opencut	D
Idemitsu Boggabri Coal Pty Ltd	Boggabri, 17 km north-east of Boggabri	Thermal	Opencut & underground	D
Lemington Coal Mines Ltd	Lemington Mine southern extension, 10 km west of Singleton	Coking/thermal	Opencut	C
Liddell Coal Operations Pty Ltd	Glendell, 18 km north-west of Singleton	Thermal	Opencut	D
Lithgow Coal Co Ltd	Feldmast, 20 km north of Lithgow	Thermal	Opencut & underground	C
Maitland Main Collieries	Glennies Creek, 12 km north-west of Singleton	Coking	Underground	F*
Nardell Coal Corp Pty Ltd	Nardell, 18 km north-west of Singleton	Coking/thermal	Underground	E
Oakbridge Pty Ltd	South Bulga, south-east extension	Thermal	Underground	A*
Oceanic Coal Aust Ltd	Lachlan, near Wakefield	Thermal/coking	Underground	D
Peabody Resources Ltd	Ravensworth West extension	Thermal	Opencut	B*
Peabody Resources Ltd	Ravensworth East	Thermal	Opencut	A
Powercoal Pty Ltd	Cooranbong extension	Thermal/coking	Underground	D
Powercoal Pty Ltd	Newstan Mine extension, 30 km south-west of Newcastle	Thermal/coking	Underground	D
Queensland Coal Pty Ltd	Maules Creek, 20 km north-east of Boggabri	Thermal	Opencut	D
Ulan Coal Mines Ltd	Ulan expansion	Thermal	Underground	B

CWM = coal–water mixture

DARTBROOK JOINT VENTURE PARTNERS

The Bellambi Coal Co P/L (75%)

Marubeni Thermal Coal P/L (15%)

SsangYong Resources P/L (7%)

Showa Coal (NSW) P/L (3%)

NOTES

Stages defined:

A Environmental and preliminary feasibility studies.

B Development application lodged, environmental impact statement complete.

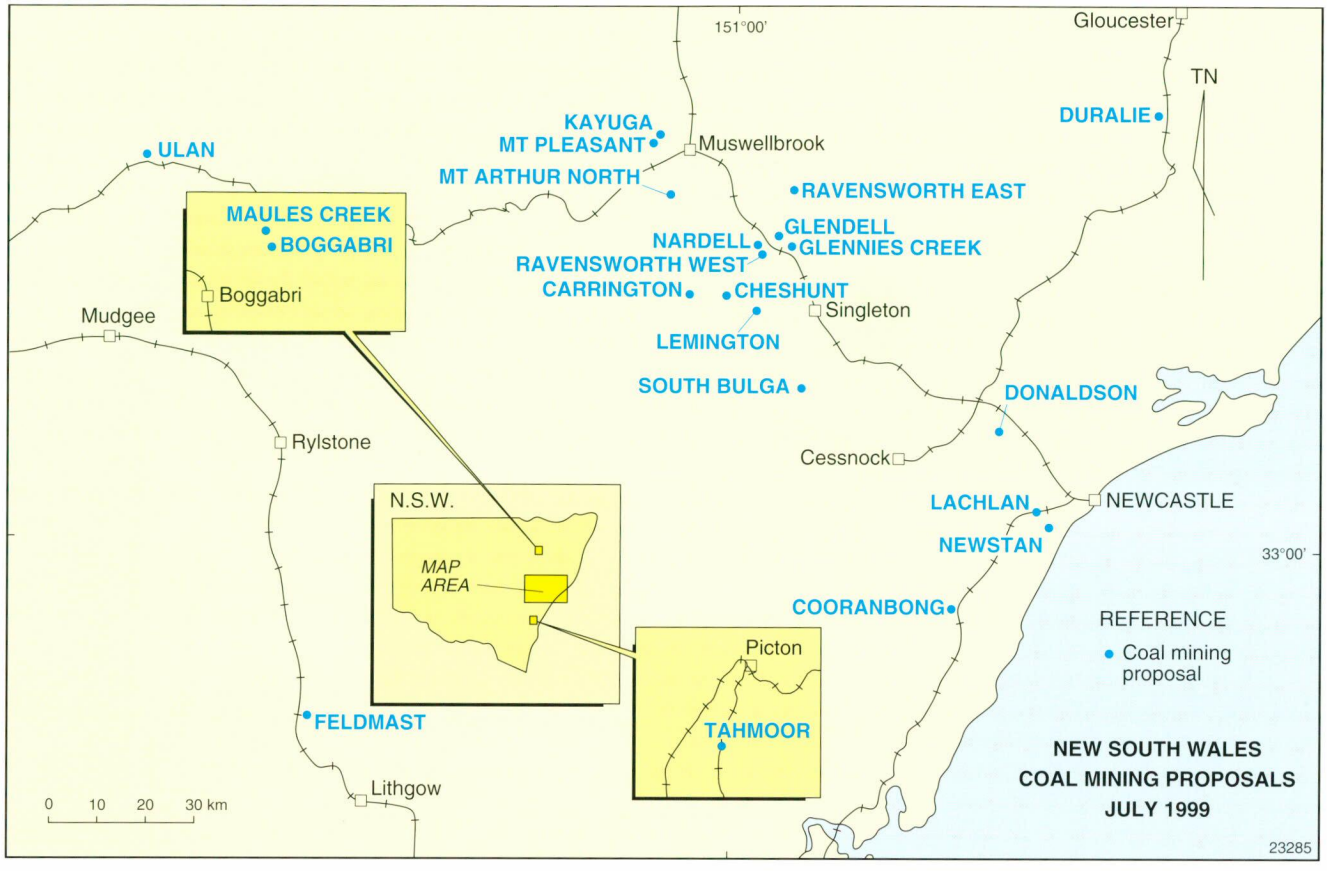
C Development consent determined.

D Coal lease granted.

E All government approvals obtained.

F Construction/development in progress.

*Development stage has advanced since publication of the previous schedule



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Address .....

City/Town ..... **State** ..... **Postcode** .....

Telephone ..... **Fax** .....

Please specify what your Company/Organisation does (eg Exploration or Mining Company, Colliery or Quarry Operator, Government, Mining Consultant, Educational, Supplier, Financial Investment, Individual, etc) .....

Petroleum Titles — June 1999

Petroleum Exploration Licences

No	Holder	Area (No of blocks)*	Expiry date#
PEL1	Australian Coalbed Methane P/L	127	10.02.1999
PEL2	CBM Australia Pty Ltd, Pacific Power & AGL Gas Networks Ltd	120	28.03.1999
PEL4	CBM Australia Pty Ltd & Pacific Power	113	10.11.1999
PEL5	Pacific Power	40	10.11.1999
PEL6	Eastern Energy Australia P/L	82	08.12.1999
PEL8	Maple Oil & Exploration NL	135	13.12.1999
PEL10	Australian Coalbed Methane P/L	6	10.02.1999
PEL12	Australian Coalbed Methane P/L	39	26.09.2001
PEL13	Oil Co Australia Ltd, Pacific Power, Claremont Petroleum NL St Barbara Mines Ltd	29	26.11.2001
PEL16	Carlita Holdings P/L	11	12.11.1999
PEL17	Capital Energy NL	91	30.01.2003
PEL18	Capital Energy NL	93	30.01.2003
PEL238	Eastern Energy Aust P/L, Great Southland Petroleum P/L and Ors.	132	31.08.1999
PEL267	CBM Australia Pty Ltd, GIO Finance Ltd	107	19.01.1999
PEL283	Capital Energy NL, Tyers Investment P/L	70	09.04.1999
PEL285	Pacific Power	24	15.04.1999
PEL286	Australian Coalbed Methane P/L	24	10.02.1999
PEL419	GO Resources (Aust) P/L	140	19.12.2003
PEL420	GO Resources (Aust) P/L	122	19.12.2003
PEL421	First Sourcenergy Group Inc	136	01.02.2004
PEL422	First Sourcenergy Group Inc	108	01.02.2004
PEL423	First Sourcenergy Group Inc	86	01.02.2004
PEL424	First Sourcenergy Group Inc	123	01.02.2004
PEL425	Otto Oil P/L	140	26.02.2004
PEL426	Oil Co Australia Ltd, Claremont Petroleum NL Pacific Power, St Barbara Mines Ltd	83	20.04.2004
PEL427	Strike Oil NL	122	20.05.2004
PEL428	Strike Oil NL	140	14.09.2004

* Total area, ie, area available plus exclusions where relevant. In New South Wales, 1 block equals approximately 5 minutes of latitude by 5 minutes of longitude and is approximately 75 km^2.

\# Title continues where valid renewal application has been lodged.

PETROLEUM EXPLORATION LICENCE APPLICATIONS

No	Applicant	Area (No of blocks)	Application date
44	Sunoco Inc.	73	12.03.1999
45	First Sourcenergy Group Inc.	140	19.05.1999

OFFSHORE PETROLEUM EXPLORATION PERMIT APPLICATION GRANTED

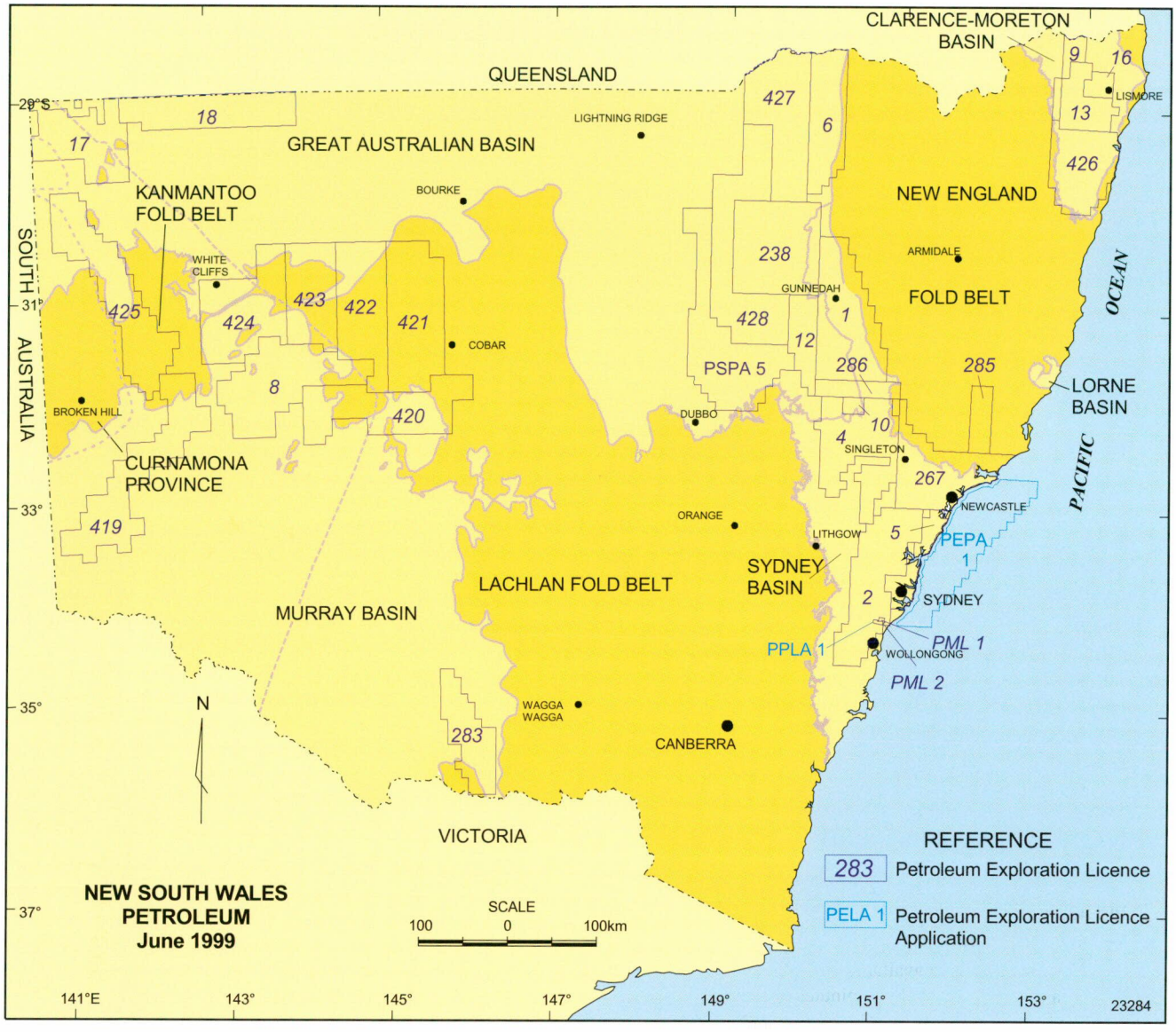
No	Applicant	Area (No of blocks)	Application date
PEPA 1	Flare Petroleum NL	129	27.11.1997

PETROLEUM MINING LEASES

No	Holder	Area (km^2)	Expiry date
PML 1	BHP Steel (AIS) P/L	28.5	12.05.2001
PML 2	BHP Steel (AIS) P/L	40.5	12.05.2001

PETROLEUM PRODUCTION LEASE APPLICATIONS

No	Applicant	Area (m^2)	Application date
PPLA 1	BHP Steel (AIS) P/L	8895	31.03.1995



Investigation Unit set up with wide powers

A newly formed Investigation Unit in the Department of Mineral Resources is open for business. Legislation to establish the Unit was enacted by the New South Wales Parliament in December 1998.

The Investigation Unit, which has taken twelve months to establish, is the first of its kind in Australia. It has been given wide powers to probe in depth to find the causes of all fatal accidents, and selected serious accidents and dangerous occurrences in quarries and coal and metalliferous mines throughout the State.

The Department has begun an extensive campaign to let industry know about the new Unit and how it will operate.

The Mine Safety Review recommended the creation of a discrete accident and analysis unit within the Department of Mineral Resources to set new standards, conduct investigations into selected matters, participate in legal proceedings and disseminate information to industry.

The recommendations of the Mine Safety Review were reinforced by the findings of the Gretley Inquiry. The findings included a recommendation that a special unit investigate all fatal accidents, selected serious accidents and incidents, and the involvement of the Department. The Inquiry also recommended the training of Inspectors in how to conduct investigations and gather evidence for legal proceedings.

Why an Investigation Unit?

The objective of the Unit is to improve safety by maximising the impact and the benefits of investigations, by identifying deficiencies in safety systems and by analysing contributing factors to accidents. The Unit will investigate all fatalities and 'prescribed matters', which include gas and dust explosions and inrushes of water and materials. It can also take over other investigations that may be of significance.

The Investigation Unit is autonomous within the Department and reports directly to the Director-General. Because it is separate from the Department's Inspectorate, it will be able to conduct independent investigations without conflicts of interest, and be removed from issues which involve the Department and stakeholders at the time of the accident. It will be staffed by a manager and four specialist officers dedicated to the investigation of all fatalities and other major accidents.

Investigations and outcomes

In its investigations, the Unit will probe extensively to gather quality information to identify causes and events leading up to any accident or serious incident. It will have the power to examine the role of the mine where an incident has occurred, as well as suppliers and other people relevant to the accident. It will also examine the involvement of the Department leading up to an accident.

The Investigation Unit may recommend prosecution and will participate in legal proceedings as required. Staff will also provide information for the Coroner and participate in Coronial Inquests.

The outcomes of investigations will be passed on to industry when appropriate, and will also be used to develop accident prevention guidelines for industry. Investigation Unit staff will audit mine sites to ensure that guidelines have been implemented.

The Unit will involve employees, mine management, unions and other stakeholders in gathering information to bring about the changes that will make mining safer.

For further information contact Stede Coundouris, Manager, Investigation Unit, on (02) 9649 8959, fax (02) 9649 5631, or e-mail: coundous@minerals.nsw.gov.au

HOW THE UNIT WILL RESPOND TO ACCIDENTS

All serious mine accidents will be reported by the mine manager to a Regional/District Inspector. The relevant Inspector will go to the mine to ensure the safety of personnel, to oversee rescue, to serve notices where applicable, to ensure the accident site is secured and to prepare a preliminary report.

The preliminary report will enable the Investigation Unit's Manager and the relevant Department Area Manager to jointly decide whether the Inspector on site or the Investigation Unit will complete the investigation.

The Investigation Unit will respond to all accidents which have resulted in fatalities. It will assess the seriousness or consequences of other accidents as to whether it should respond.

Once the Investigation Unit arrives on site, it will take over the management of the mine investigation with the assistance of the Inspector. Teams may be formed subject to the complexity of the task.

A report will be issued documenting the findings.

Should the Mine Manager notify the Investigation Unit?

The Mine Manager is not obliged to notify the Investigation Unit of an accident. The responsibility of notifying the Unit rests with the Inspector or Area Manager.

Who will be involved in an investigation?

The Investigation Unit will require the assistance of all those who can provide information about the events leading up to the accident, and the accident itself, to identify the causes and contributing factors.

Verbal notification

To assist mine managers in reporting an accident, the Department has prepared a form called an 'Oral Notification Checklist'. This form identifies details which will assist the Department in resourcing, and to activate the Investigation Unit. Mine managers can obtain these forms from the Department.

Mine site drugs and alcohol — Pasminco's approach

The issue of drugs and alcohol in the workplace has recently received widespread publicity. The potential effects of these on safety are well known, and one company, Pasminco Ltd at Broken Hill, has developed a mine site policy and is now trialling an introductory drug and alcohol program.

Policy objectives

The company understands that it has a duty of care, both legally and morally, to all those working or visiting the Pasminco Broken Hill mine site under the OH&S Act 1983 and the Mines Inspection Act 1901.

When Pasminco decided to introduce a drug and alcohol program, it had several objectives.

- ✔ Create a safe and healthy environment for employees and others free from the hazards associated with the inappropriate use of drugs and alcohol.
- ✔ Provide education and awareness training for personnel to overcome inappropriate use of drugs or alcohol.
- ✔ Ensure that a rehabilitation process is provided for personnel with difficulties with drug and/or alcohol related issues.
- ✔ Foster an attitude that it is not acceptable to come to work under the influence of alcohol or any other drug that will prevent performing duties in a safe manner.
- ✔ Ensure that the company meets its legal and moral obligations by providing a safe working environment for its employees, contractors and the general public.
- ✔ Ensure that personnel are aware that repeated breaches of the policy may lead to termination of employment.

Pasminco's policy sets out that alcohol testing is to be done by breath test and drug testing by urine sample. Positive results are to be confirmed by pathology analysis and breaches remain on personnel records for 18 months.

A 0.05% blood alcohol level has been set as the policy limit for reducing risk. However, employees who record a blood alcohol level reading between 0.02% and 0.049% will be stood down on full pay until the reading is below 0.02%.Blood drug limits have been set individually for different groups of drugs. For instance, opiates, barbiturates, cocaine and methadone are set at 0.3 µg/ml, and cannabis at 0.10 µg/ml. These limits are consistent with those established in the Australian Standards.

The policy clearly sets out the processes that the company is to follow for personnel registering a positive testing result for drugs or alcohol, and for subsequent positive tests. Rehabilitation principles and guidelines are an integral part of the policy.

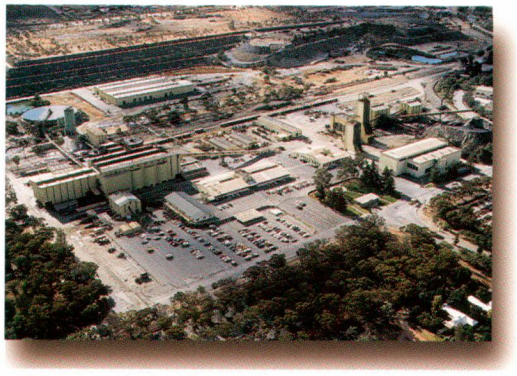
Drug and alcohol policy trial

The company introduced the three month trial on 1 March 1999, following a hearing in the Industrial Relations Commission. The agreed conditions of the trial were:

- The policy operates on the basis of a blood alcohol level of 0.05%.
- For individuals with a reading of between 0.02% and 0.05% the following apply:
  - remain at work, but not permitted to begin normal duties until the reading is below 0.02%;
  - no disciplinary action of any kind, including personnel record notes, will apply to employees within this range for the period of the trial.
- The company and unions are to meet regularly to assess the operation of the policy.
- The OH&S committee, which is made up of management and workforce representatives, is to be part of the review at the end of the trial.

Before the trial was introduced, the company conducted an education and awareness program for all employees. Topics in the program included:

- How alcohol and drugs affect the body, and the affect of these on work performance.
- Recognition of the health and safety implications of drug and alcohol abuse.
- Recognition of the early indication of drug and alcohol abuse.
- The procedures that the company would follow if an employee proved to have drug or alcohol levels above the agreed limits.



Pasminco's Broken Hill southern operations

Following the trial

The drug and alcohol policy trial period ended on 31 May 1999. A conciliation conference before Justice Walton of the New South Wales Industrial Relations Commission was completed on 18 June 1999, which resolved some outstanding matters before full implementation of the policy at the mine site.

Throughout the first trial, the company was concerned that the frequency and adequacy of testing did not fully discharge the moral and legal obligations of the company's duty of care and due diligence requirements. Data collected to date have underpinned this concern and the company successfully proposed increasing testing for randomly selected full time employees and contractors. It will also randomly test one of the 28 work groups of employees in conjunction with individual employee testing. This proposal has the support of the company's OH&S committee. (All employees are encouraged to self test before presenting for work. They were also given the opportunity during the introductory phase of the policy to obtain drug self-test kits from the local community health centre).

The union members will vote at a mass meeting to accept the recommendations of the NSW Industrial Relations Court and subsequent to their acceptance will commence a final trial that incorporates the modified recommendations.

For further information contact Terry Plush, Superintendent – Human Resources, or Steve Pavlich, Senior OH&S Officer, Pasminco Broken Hill Mine, on (08) 8088 8728, or e-mail: PavlichS@pasminco.com.au ■

Mine Safety Laboratory

The Department of Mineral Resources makes an important contribution to industry through the work of its Mine Safety Laboratory.

The laboratory offers both expert fee-for-service work for industry and supports the Inspectorate through scientific analysis, testing and evaluation.

Results obtained in the laboratory are critical in developing many of the Department's guidelines for industry and of other standards and codes.

The laboratory's three main areas of work are analytical services, occupational hygiene, and equipment certification.

Underground testing of diesel exhaust gases in an opal mine

Analytical services

This area of work covers the assessment of gas levels and conditions in coal mines.

- Laboratory staff carry out gas analysis for mine atmospheres to check for the presence of flammable or poisonous gases, to ensure the safety of the mine and the health of people in the mine.
- Gas analyses are also carried out where coal seams are required to be classified under the Coal Mines Regulation Act 1982 according to the level of methane they release into the mine air. The appropriate levels of explosion prevention can then be put in place.
- As an important contribution to underground coal mine safety, staff use standard gases to make sure that industry gas monitors are reading correctly.
- Equipment, such as alarms and gas monitors, are tested for commercial laboratories.
- Standard gas mixtures are prepared for industry use, so that coal and metalliferous mines can calibrate their gas-measuring equipment on site.
- The Department's roadway dust inspectors collect samples from the floors and walls of underground coal mines and, using a 'backscatter' instrument developed at the laboratory, measure the levels of spread limestone dust to ensure that they are sufficient to prevent explosions. If necessary, and as an audit function, further chemical analysis is carried out at the laboratory.

Gas. Two mobile gas laboratories are used for gas analysis in the field. About 90% of the analysis work is done for coal mines, mostly for diesel exhaust emission testing and monitoring fires and gases from explosions. If a fire occurs in a coal mine, gas analysis is needed to check levels of oxygen, carbon dioxide, carbon monoxide, nitrogen oxides and hydrogen during the fire.

Using the mobile gas laboratory, staff carry out tests on new diesel mine equipment at the manufacturer's site before it is released to mines. Such tests are normally requested by the manufacturer, the distributor or seller of the equipment.

Mining companies may also request testing of machinery already in use and of newly manufactured and already approved equipment before it is used on a mine site.

Occupational hygiene

Occupational hygiene covers airborne dust, chemicals, asbestos, noise, light and silica exposures.

Dust. Airborne dust monitoring is generally a fee for service function, with the aim of reducing mine workers' exposure to harmful dusts. Most of this work is done at non-coal mines, to avoid duplication of the work conducted by the Joint Coal Board.

Some minerals dusts are more harmful than others. For instance, some quartz dust can cause scarring of lung tissue which can lead to loss of lung function. Diatomite can cause scarring of lung tissue, but it is not as harmful as some other forms of silica.

Staff also monitor some of the solvents used in laboratories at minerals processing plants. Tetrabromethane (TBE), for instance, is a heavy liquid which helps to determine the quantities of heavy minerals present. TBE can cause irritation and affect the brain,

leading to nausea, vomiting and unconsciousness.

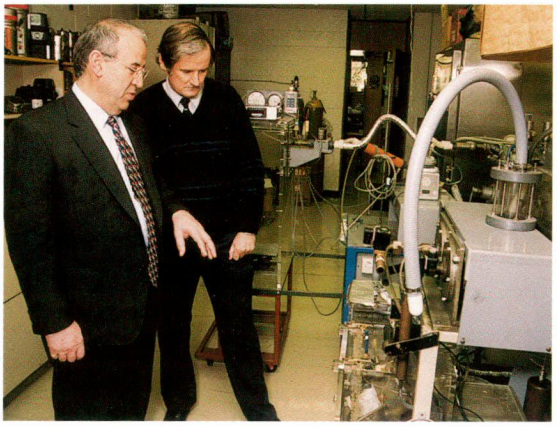
Chemicals. For chemical products that need to be evaluated by the Department, suppliers of chemicals are required to provide a Material Safety Data Sheet (MSDS) when a chemical is to be used on a mine site. The Mine Safety Laboratory checks the MSDS and tests each chemical to make sure that it is not flammable, toxic or corrosive under mine site conditions.

Asbestos. The laboratory does less identification now than when asbestos was being mined, but is still called on to carry out work to identify possible asbestos presence in a mine.

Noise. Standards are becoming stricter about the level of noise to which operators on mine sites can be exposed, with an obligation on the employer to make the workplace safe and healthy.

Mine noise surveys are often carried out when laboratory staff are on site carrying out dust monitoring. Staff use sound level meters to monitor noise levels and report back to the operator with a comparison of what are acceptable levels.

Illumination. Most of the laboratory's work on illumination is measuring light levels in mine site workplaces, including offices, to ensure that they are adequate.



The Hon. Edward Obeid, Minister for Mineral Resources(left) inspects breathing apparatus testing equipment with Grahame Fawcett, Manager, Mine Safety Laboratory

Equipment certification

The Mine Safety Laboratory provides testing for certification purposes of equipment and materials used in mining.

Gas monitors and breathing apparatus. Testing for certification of gas monitors and mine breathing apparatus is an important part of the laboratory's work. Recent work on self rescuers has provided the industry with important safety information on effectiveness and on possible defects in some models.

Self contained breathing apparatus and other breathing apparatus (such as that used by the Mines Rescue Service) are tested to see if they work effectively under mining conditions, and if they comply with the requirements of mining legislation and Standards Australia.

Material testing. The laboratory undertakes testing and assessment of materials, such as brattice cloth (used to help control ventilation in underground mines), conveyor belt materials, vent ducting, polyurethanes or any potentially flammable material to ensure that it is safe to use in coal mines. Liquids such as solvents, paint and sprays are also tested. Tests assess how flammable the material is, or if it is at all flammable or ignitable.

The antistatic properties of such materials as fibreglass for ducting in coal mines are also assessed by the laboratory. Static electricity can develop in non-antistatic material, and ensuing sparks can potentially lead to fire or explosion.

For further information on the work of the laboratory contact Grahame Fawcett, Manager, or Peter Hanson, Scientific Officer, on (02) 9646 1644, fax (02) 9646 3224, or e-mail: fawcettg@minerals.nsw.gov.au

Core capacity for the next 20 years

Stage four of the $8 million Londonderry Core Library was opened by the Minister for Mineral Resources, The Hon. Edward Obeid, OAM, MLC on Friday 16 July 1999.

With 141 000 boxes containing nearly 1000 kilometres of core, the library is the largest and most advanced facility of its type in Australia and the southern hemisphere. The replacement cost of the drillcore is estimated to be in the order of hundreds of millions of dollars. The $1.6 million Stage 4 brings capacity for up to 120 000 boxes, which is sufficient for up to 20 years at the current rate of input.

"The Government is committed to encouraging regional growth, and exploration and mining play a critical role in achieving this objective," the Minister said.

"The key to successful exploration is knowledge and the various geoscience datasets developed by the Department of Mineral Resources over the years. "Recent exploration has given the State notable successes, including the Black Range Syerston nickel-cobalt deposit, Straits Resources Tottenham copper discovery and Jervois Mining's cobalt-nickel find at Young.

"It is important to note that examining and sampling of core stored at the Londonderry Core Library has contributed to a number of substantial mineral projects, including the Cadia and Peak Hill mines and Syerston and Lewis Ponds."

As a repository for core collected from private sector and government exploration drilling over the past 40 years, the library provides an extremely valuable resource for the exploration industry, Departmental geologists and academic researchers.

Visitors should contact the Core Library on (02) 4777 4316, fax (02) 4777 4397 to arrange inspection of core.

For further information contact Dave Clift on (02) 9901 8231.

Minister for Mineral Resources, The Hon. Edward Obeid (centre) discusses Cadia drillcore with Department of Mineral Resources Assistant Director (Minerals) Lindsay Gilligan (left) and Member for Londonderry James Anderson

Youth ANZAAS field excursion through 'The Ponds'

High school students participating in Youth ANZAAS-1999 enjoyed a guided field trip to study the ecology and geology of Dundas Valley from the Galaringi Botanic Parkland to Sir Thomas Mitchell Reserve.

The field trip, on 6 July, commenced with an overview of Sydney Basin geology at Mobbs Hill Lookout, Carlingford which affords a panoramic view of the Cumberland Basin from the south-east to south-west. Features such as the monoclinal edge of the Hornsby Plateau, the Prospect intrusion, Mount Jellore, and the local ridges encircling the Dundas volcanic neck were readily observable. The students then followed the initial leg of a tour described in David Branagan's and Gordon Packham's *Field Geology of New South Wales* (third edition soon to be published by DMR).

The participants comprised 55 Year 11 and 12 students, along with first year university young scientists as guides, two Department of Mineral Resources officers, an environmental officer from Parramatta Council and members of the Friends of Galaringi.

Approximately one third of the students were Sydney locals with the balance from interstate and country New South Wales. Only five students were studying HSC geology.

Students were informed of the importance of the geological control on plant diversity and were asked to observe the changes in tree species associated with Ashfield Shale as opposed to growth on Hawkesbury Sandstone. The geological control on sedimentary aquifers creating springs was pointed out as an explanation for the original name of the area when first settled in 1791 and known as 'The Ponds'.

On reaching the former quarry site, now Sir Thomas Mitchell Reserve, the remains of a once substantial volcanic breccia were observed, along with photographs, a display of the early quarrying operations (1832-1940), samples of fresh basalt/breccia contact, photomicrographs and posters based on the writings of many early, eminent geologists (starting with W.B. Clarke) who have sampled and described the site.

For further information contact Steve Cozens, Geologist on (02) 9901 8517.

photograph by David Beynon

Steve Cozens points out Sydney Basin features such as the (distant) Mount Jellore volcanic intrusion

Native Title update: low impact exploration licences and opal fields

Issues of low impact exploration activities and the definition of approved opal fields have been resolved by the NSW Government and submitted to the Commonwealth Government for determination by the Attorney-General.

After the Attorney-General has made a determination, that determination must be tabled in both Houses within a period of 15 sitting days. The Senate then has a further 15 sitting days to give notice of a motion to disallow the determination and a further 15 days to pass the resolution. It is likely that it will take the remainder of the year before low impact exploration licences could be operational in NSW, assuming the Senate does not disallow the determination.

The major features of the New South Wales Native Title Amendment Act 1998 were proclaimed on 30 September 1998 (*Minfo* **62**). However, at that time, the section of the Act relating to Low Impact Exploration Licences was not proclaimed as the definition of low impact activities had yet to be considered. The provision came into effect on 1 March 1999 but will not be operative until the Commonwealth Minister makes his determination.

The Commonwealth Native Title Amendment Act 1998 provides that titles in approved opal or gem mining areas are exempt from the right to negotiate providing strict criteria are met in the definition of such areas.

Amendments to the Mining Act 1992 have been passed to ensure that it is compatible with the Commonwealth and NSW Native Title Amendment Acts.

Low Impact Activities

It is proposed that exploration licences with low impact exploration activity be exempt from the right to negotiate. There will be an obligation to notify registered native title claimants, registered native title bodies corporate and representative Aboriginal/Torres Strait Islander bodies. An access agreement has to be reached with each registered native title body corporate and each registered native title claimant in relation to the relevant land. Access agreements, which may involve the payment of compensation, must be negotiated at present with the occupiers of land. Similar arrangements might be expected with the registered native title claimant or registered body corporate.

Opal Fields

It is proposed that two opal fields be declared in NSW as exempt from the right to negotiate — Lightning Ridge and White Cliffs. The areas covered by these opal fields are being finalised.

The Mining Act was recently amended to provide for compensation to be payable by owners of mineral claims or opal prospecting licences to native title holders. Compensation will be collected upon the grant of such titles and held in trust in the Warden's Court. These funds will be held in trust for a period of five years, during which time native title holders can make a claim for compensation. The amount of compensation will be determined in accordance with a regulation, having regard to the interests of all relevant stakeholders.

For more information, contact Denis Casey, Senior Project Officer, on (02) 9901 8511; fax (02) 9901 8493 or e-mail: caseyd@minerals.nsw.gov.au

DIGS puts reports online for users in regional areas

DIGS (Digital Imaging Geological System) is now deployed at the Department of Mineral Resources' Orange, Singleton, Broken Hill and Armidale offices. This rollout enhances the Department's client service capabilities by providing regional offices with online access to Geological Survey exploration reports. Previously, clients were required to request hard copy reports from Head Office.

DIGS has been available at the Department's Head Office since March 1997 (*Minfo* **57**, p 28).

DIGS also provides extensive search capabilities and integrates with the Minfinder bibliographic database.

To speed access, the DIGS regional service allows the retrieval of a degraded colour or grey scale image. However, a "display alternate" button allows viewing of higher quality colour or grey scale images for users prepared to wait a few minutes while the data are transported via an ISDN telecommunications link. (DIGS was profiled in detail in the Department's *Quarterly Notes*, No. **109**, April 1999.)

For further information contact Geoff Brookes on (02) 9901 8232, e-mail: brookesg@minerals.nsw.gov.au

States agree on digital reporting standards

In an important move intended to streamline data processing, the States and Northern Territory have now agreed to a set of Australian Standards for the reporting of exploration information in digital form.

The standards will greatly assist the industry in the collection, transfer and re-use of exploration data.

The Department of Mineral Resources is developing a timetable for the introduction of digital reporting and this, together with details on digital standards, will feature in the next edition of *Minfo*.

For further information please contact John Chapman (Minerals) on (02) 9901 8347, fax (02) 9901 8256 or Sean Hawley (Coal and Petroleum) on (02) 9901 8321 or fax (02) 9901 8520.

Titles Administration System

The Department's Titles Administration System (TAS2) has been in operation since July 1998.

The Dealings/Reports Database at the core of TAS2 contains information relating to all dealings or transactions that have occurred against a title or application to mine or explore. This information is available for all titles and applications dating back to 1989.

Also core is the TAS2 Graphics Database, a spatial system which contains the graphic shapes for all current titles and applications to mine or explore. TAS2 users will also benefit from the inclusion of various 'administrative' spatial datasets such as a copy of the NSW cadastre (DCDB), the National Parks Estate dataset, Local Government Area boundaries, Parish/County boundaries and the exploration licence block/unit graticule. The spatial titles and applications dataset is linked to the aspatial or non-graphic dealings information.

Sub-systems of TAS2 are the Workflow Tracking System, Names Database and the Mineral Exploration Assessment (MEA) system.

The Workflow Tracking System enables the monitoring of the progress of the processing of applications to mine and explore. The Names Database contains names and address information relating to applicants, holders and registered interested parties of applications and titles. The Mineral Exploration Assessment (MEA) System enables mineral exploration reports to be reviewed by the Geological Survey.

TAS2 is also linked to the Digital Imaging Geological System (DIGS) for viewing and searching of Geological Survey reports.

Direct access to TAS2 for industry and the public is available through public inquiry terminals at Head Office in St Leonards and at the Singleton, Orange and Armidale regional offices.

Proposed TAS2 development includes deployment of the system as a Web application allowing access via the Internet and electronic lodgement of applications to mine or explore.

For further information on TAS2 contact Graham Hawkes, TAS2 Manager, on (02) 9901 8307; fax (02) 9901 8493; e-mail: hawkesg@minerals.nsw.gov.au.

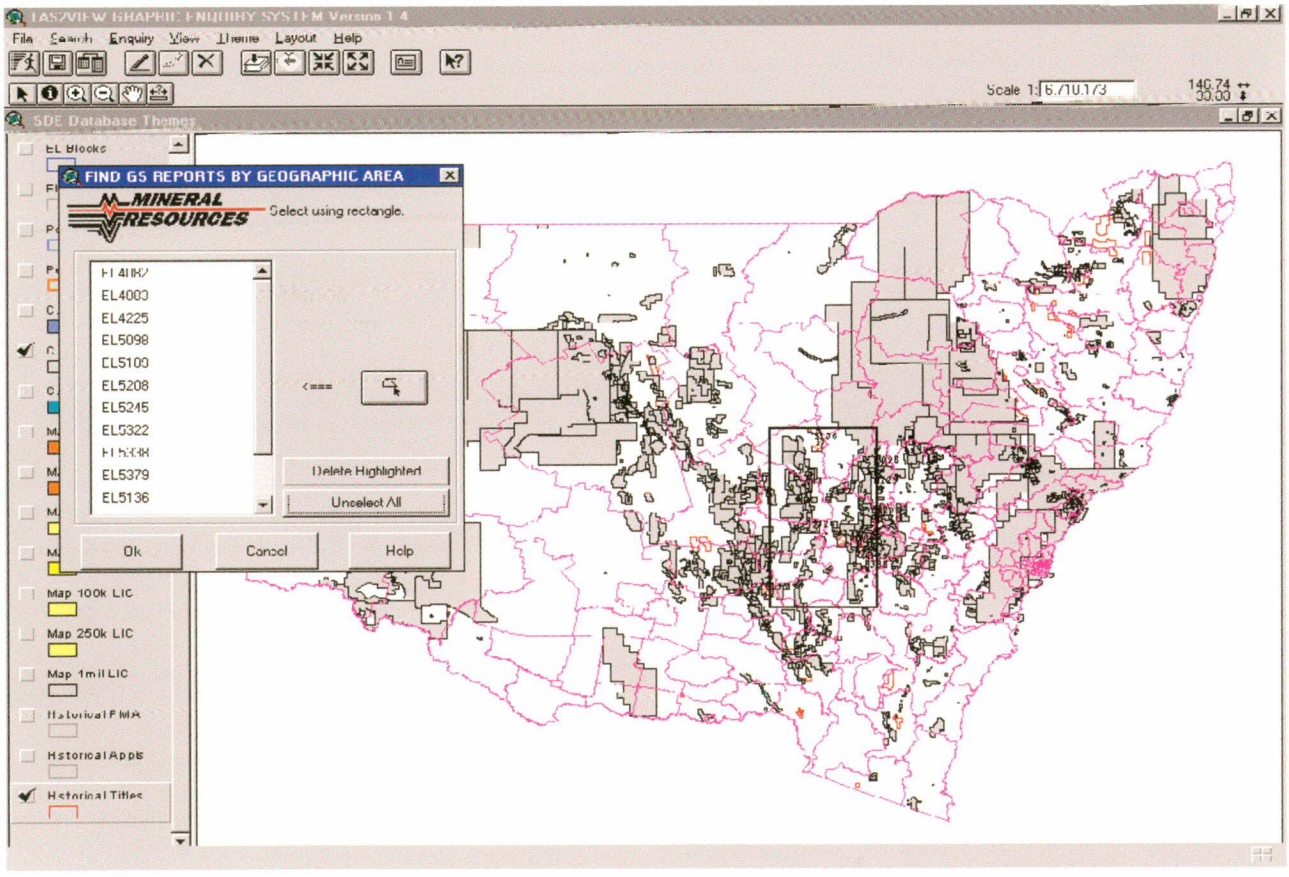
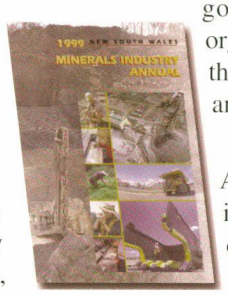


Figure 20. The link between DIGS and the Title Administration System (TAS2) allows searching for tenements (shown in this example as Exploration Licences) within a specified geographical area. This search is then sent to the DIGS system in which the reports can be viewed. The example shows an area being defined by using the mouse and then requesting all the Exploration Licences within the defined area.

Minerals Industry Annual 1999

The new 1999 edition of the *NSW Minerals Industry Annual* will be released in September. This Departmental best-seller is a comprehensive reference publication on the State's exploration, mining and minerals processing industries, and covers all significant mineral commodities mined in NSW.

The Annual's 152 pages are illustrated with numerous colour maps, photos and graphs, and contain a wealth of information, including the following.



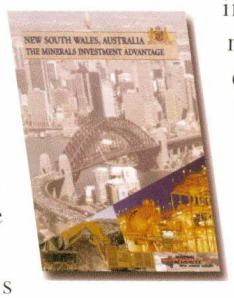
- NSW minerals industry overview, including summary data on industry and production trends, royalties, outlook, mineral exports, new mines and projects, exploration, mine safety, environmental management and minerals processing;
- chapters on all major commodities (including energy, metallic minerals and industrial minerals), covering production, developments and outlook;
- dossiers on significant metallic and industrial mineral mines, as well as proposed new mines and projects;
- minerals statistics for 1997-98 (and 1996-97), including quantity and value of production of commodities, average prices and employment;
- construction materials overview, outlook and listing of major quarries;
- suppliers index, with listings of products, services and suppliers; and
- reference information, including government and industry organisations, information about the Department and its products and services, and company index.

The Minerals Industry Annual is a vital source of information for companies and organisations involved in the NSW minerals industry. The 1999 edition will be available for $45 (plus postage and handling of $7 for Australian orders and $30 for overseas orders) from the Information Counter at the Department's Head Office on (02) 9901 8269 fax (02) 9901 8247, e-mail: virdiv@ minerals.nsw.gov.au

For further information on the Annual's contents, contact Garth Holmes, Principal Adviser, Minerals on (02) 9901 8480, fax (02) 9901 8493, e-mail: holmesg@minerals.nsw.gov.au

NSW — The Minerals Investment Advantage

The Premier of NSW, the Hon. Bob Carr, launched a new promotional booklet *New South Wales, Australia — The Minerals Investment Advantage* at the recent major 'NSW Mineral Exploration & Investment '99" conference' (see p. 1 of this issue).

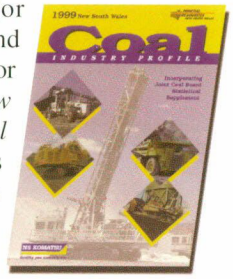


The booklet provides summary information to local and international minerals investors on the many attractions of investing in NSW, together with relevant contacts to pursue investment opportunities in the State.

Chapters of the booklet include information on NSW's established minerals pedigree, initiatives and incentives to encourage mineral and petroleum exploration, advantages to facilitate development, infrastructure and cost advantages, and the Department's advanced resource information systems.

The booklet can be fully accessed on the Department's website *www.minerals.nsw.gov.au* and copies of the booklet are also available (gratis) on request from the Department's Head Office at St Leonards, on (02) 9901 8269; fax (02) 9901 8247.

NSW Coal Industry Profile



Coal is a major export earner and source of jobs for the State. *The New South Wales Coal Industry Profile* is a comprehensive reference publication on the State's coal mining industry, and is widely used throughout the industry.

The Profile contains numerous colour maps, photos and graphs, and is packed with vital information, including the following:

- ✔ NSW coal industry overview, including production and consumption details, new mines and projects, future outlook, coal resources (listed by coalfield), and infrastructure (including coal preparation, transport and port facilities);
- ✔ mine dossier giving details of all existing and proposed mines, including resources/reserves, product specifications, and mining and processing details;
- ✔ coal terminal dossier;
- ✔ mining equipment index;
- ✔ Joint Coal Board statistical supplement of 60 tables and 30 graphs, covering production, consumption, output, exports, employment, productivity; and
- ✔ reference information, including government and industry organisations, and information on Departmental and Joint Coal Board offices and publications.

The Profile is available for $55 (plus postage and handling of $7 for Australian orders and $30 for overseas orders) from the Information Counter at the Department's Head Office on (02) 9901 8269 fax (02) 9901 8247, e-mail virdiv@ minerals.nsw.gov.au

For further information on the Profile's contents, contact Mike Armstrong, Principal Geologist, on (02) 9901 8506, fax (02) 9901 8520, e-mail armstrom@minerals.nsw.gov.au

To enquire about advertising in the Coal Profile, contact Commercial Advertising and Printing Services (the Department's advertising sales agent) on (02) 9882 3880, fax (02) 9882 3077, e-mail: caph@one.net.au

PUBLICATIONS RELEASED APRIL— JULY 1999

GEOLOGICAL MAPS AND PUBLICATIONS

* Broken Hill North Block Metallogenic 1:50 000 Map	$30
* Clive 1:100 000 Map (preliminary)	$30
* Dubbo 1:250 000 Geological Map Sheet	$30
* Southern Coalfield 1:100 000 Geological Map	$30
* Mineral Projects of New South Wales, Australia 1:1 500 000 Geological Map	free
* Coalfield Geology Council of New South Wales Bulletin No. 1 (edited and published by the Department of Mineral Resources)	price tba
* Explanatory Notes accompanying Dubbo 1:250 000 Geological Map Sheet	$75
* Mineral Sand Resources Potential of the Murray Basin GS Report 1999/038	$25
* The Geological Evolution of NSW- A Brief Review	$10
* Australian Institute of Geoscientists Bulletin No. 26: Murray Basin Mineral Sands Conference - Extended Abstracts (published by the AIG; edited, produced and co-sponsored by the Department of Mineral Resources)	$35

BROCHURES AND PROMOTIONAL MATERIALS

* New South Wales, Australia — The Minerals Investment Advantage booklet	free
* Water: Lifeblood of the Mining Industry (brochure)	free

QUARTERLY NOTES No. 109 April 1999 (subscription gratis) — per single purchase $3.00

Minfo No. 63 April 1999 (subscription gratis) — per single purchase $5.00

GENERAL PUBLICATIONS

* Investmin Newsletter No. 6 July 1999 issue	free
* MDG No. 1009: Free Steered Vehicles in Underground Coal Mines	$30
* MDG No. 37: Compressed Air Powered Ventilation Devices	$30
* Minfo No. 63 April 1999 issue. Feature: New England Fold Belt	subscription free to relevant companies and organisations, back copies $5
* Mining Royalties and Statistics in New South Wales 1999	free
* NSW Mineral Exploration & Investment '99 Conference Information Package	$50
* Mine Safety News No. 2 June 1999 issue	free
* Fossickers Guide Discovering the Earth's Riches, Edition 2	$20

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