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New South Wales Mining and Exploration Quarterly

No.27

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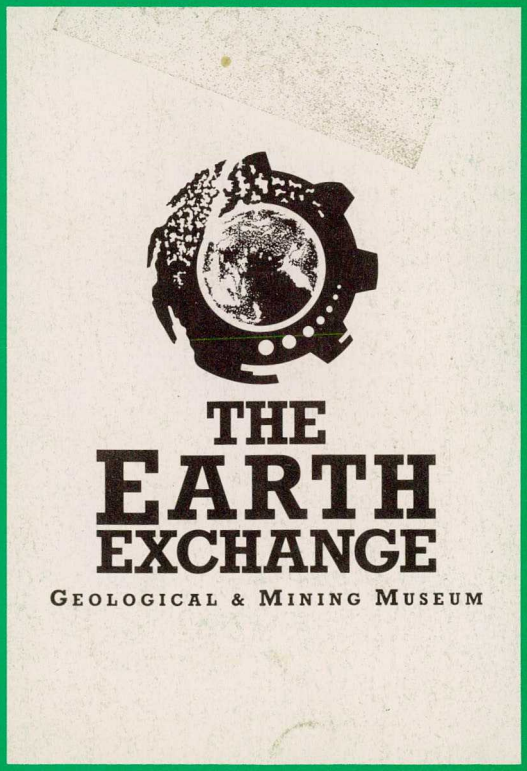

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Contents

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Formation and Transformation

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COMMODITY OVERVIEW – GOLD

There has been a resurgence of gold mining in New South Wales in the last decade. Stronger gold prices and improved ore processing methods have stimulated a more systematic and intensive search for new deposits, and a reassessment of some deposits previously considered sub-economic. In many cases additional resources have been identified adjacent to known deposits and have added to the economic viability of existing mining operations.

Economic occurrences of gold are widely distributed throughout New South Wales (figure 1). Most attention is focussed on primary deposits formed by hydrothermal processes. These deposits may be categorized as vein or "reef" deposits, stockwork deposits, massive sulphide deposits, or disseminated deposits, and are hosted by a wide variety of rock types. In many places they are enriched by weathering and oxidation.

Gold and base metal deposits in the Cobar region are located in zones of intense deformation and exhibit a combination of massive sulphide and stockwork types of mineralization. The Peak deposit, potentially the most significant recent gold discovery, is typical of this style of deposit.

Disseminated deposits, in which gold is finely dispersed within the host rocks, commonly as a network of closely spaced veins, have become the most important exploration target in recent years. These deposits are generally substantially higher in tonnage but lower in grade than vein or reef type deposits. Technologies for large-scale extraction and treatment of such ores, particularly the carbon-in-pulp (CIP) process which has only been available since the mid 1970's, have been significant in the revival of the State's gold mining sector.

The CIP process remains profitable at lower gold prices and ore grades, and its fast production cycle generates cash flow quickly.

Other geological settings with potential for high-tonnage and mineable gold grades are being pursued, for example, skarn style replacement of host rocks close to an igneous pluton, such as occurs at the Browns Creek and Sheahan - Grants deposits.

Most of the new developments are open cut mines designed to supply on-site CIP plants.

Explorers are concentrating on locating deposits in areas adjacent to existing mines in order to keep the infrastructure of the main operation viable. Most of these additional deposits would not be mined in isolation but, in the regional context, each would provide a positive contribution to the operation's overall profitability.

In 1988/1989, Australia produced about 8% of the world's gold, with Western Australia and New South Wales producing 75% and 4%, respectively, of national production. Recent gold prices and production from New South Wales are shown on figure 2.

OPERATING MINES

Lucky Draw mine (Renison Goldfields Consolidated Ltd), (refer *Minfo 21*, p. 1) near Burraga in the Central West, opened in 1988 on a disseminated gold deposit discovered in 1985 by geophysical surveying and regional rock-chip sampling. The deposit is tabular and contains two pods of mineralization. Proved Ore Reserves in the open cut at the end of June 1989 were 1.11 million tonnes grading 3.52 g/t Au, giving a mine life of 3 years. The CIP plant has a capacity of 550 000 tonnes of oxidized ore per annum, and 400 000 tonnes of harder primary ore. Operations have kept to schedule with gold production of 832 kg in 1988/1989.

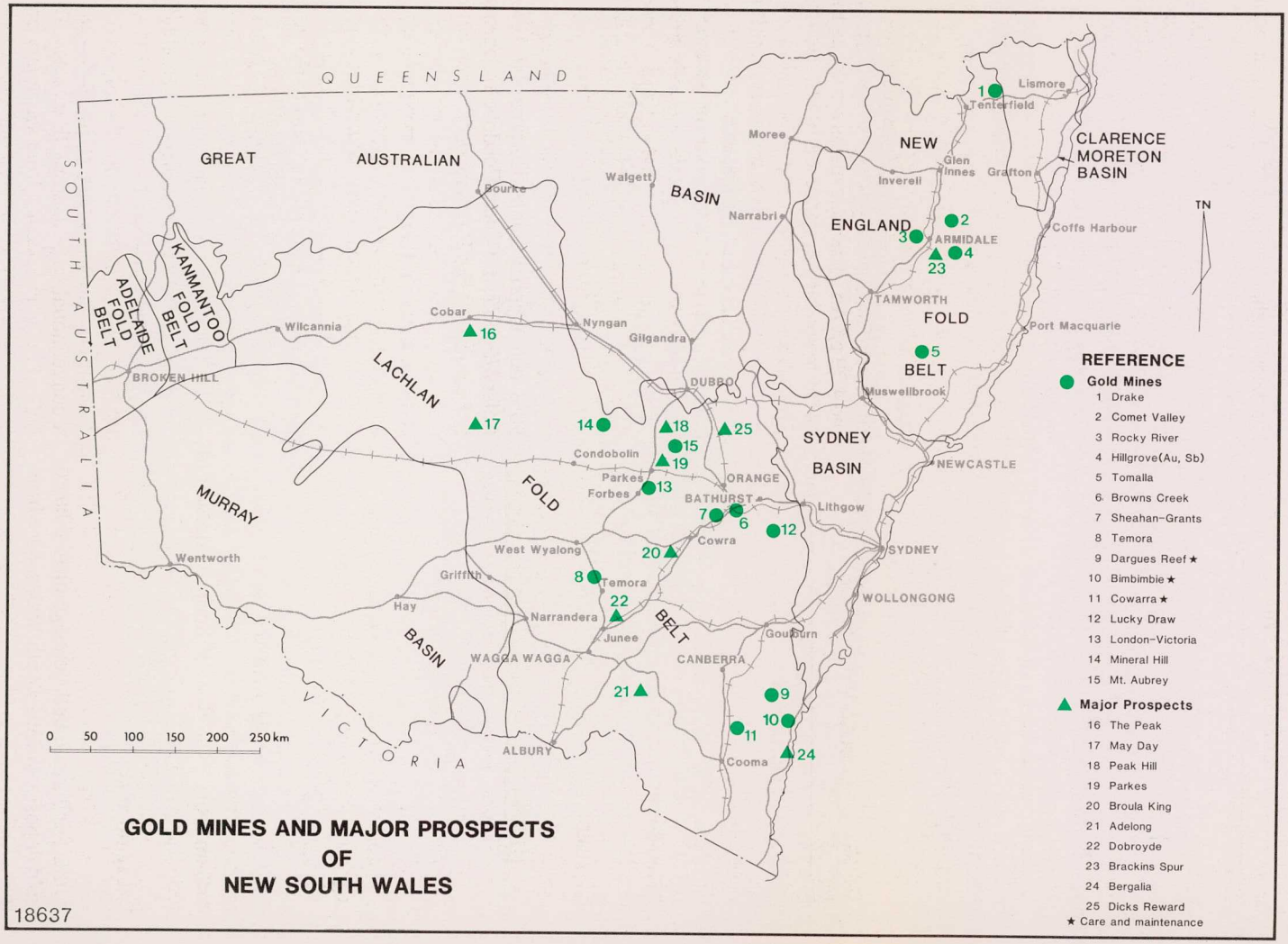


Figure 1. Locality diagram, gold mines, and major gold prospects

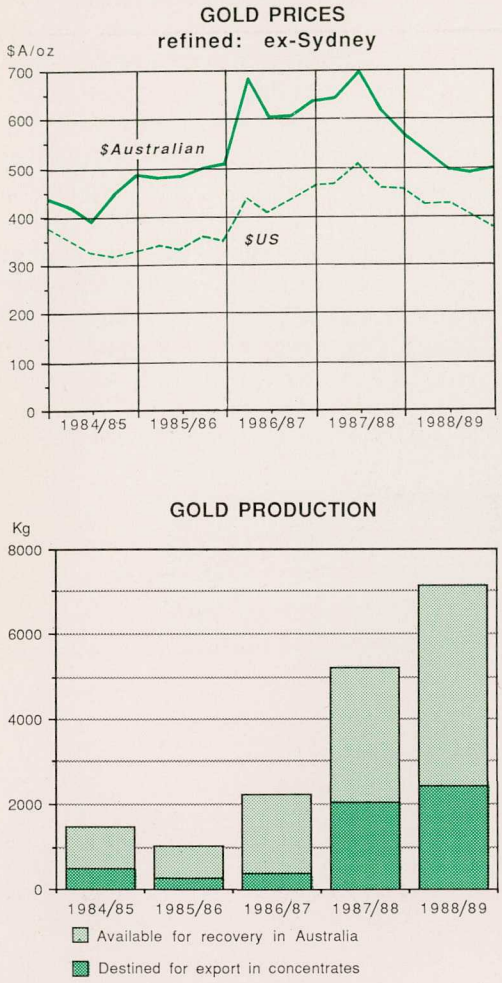


Figure 2. *Gold prices and New South Wales gold production for the period 1984/1985 to 1988/1989*

Temora mine (Paragon Resources N.L.) (refer *Minfo 12*, p. 1) opened in 1987. Pre-mining Proved Ore Reserves were 4.5 million tonnes grading 2.5 g/t Au and 5.4 g/t Ag. The deposit is a low-grade, medium to high-tonnage epithermal type. Successful mining of this type of deposit has caused a reassessment of similar low-grade bulk-tonnage disseminated gold deposits in New South Wales. Ore from the open cut is treatedint a CIP plant with a capacity of 700 000 tonnes per annum. Production in 1988/1989 totalled 1935 kg of gold and 2144 kg of silver. Gold production has been higher than planned because gold grades have been higher than expected.

Oxide ore from the open pit will be mined out by the end of 1990, but depending on gold grades obtained, processing of stockpiled material may continue for up to 6 years.

Deposits at Adelong and Cootamundra are being evaluated.

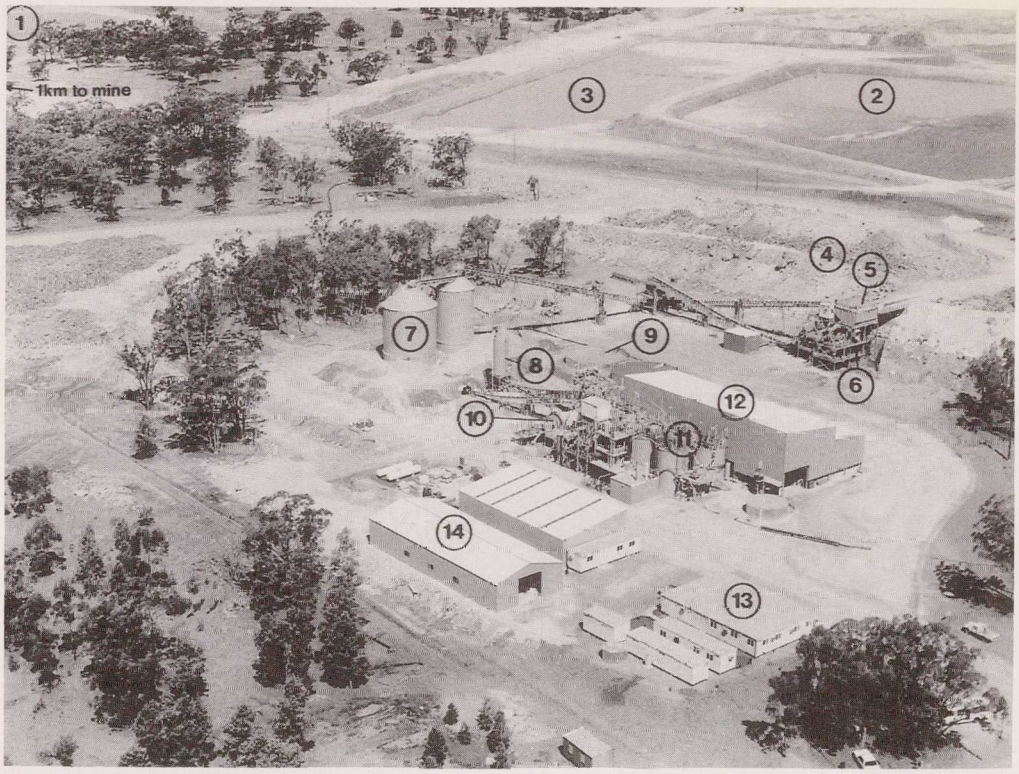
Browns Creek mine (BHP Gold Mines Ltd) (refer *Minfo 11*, p. 14), near Blayney, has been operating as an open cut mine since 1983 on a skarn-replacement type orebody. At the end of 1989 Proved Ore Reserves totalled 294 000 tonnes grading between 3.91 g/t Au and 4.79 g/t Au. The company is searching for further resources in adjacent areas to keep its CIP plant operating. Recent exploration has identified a number of small orebodies suitable for development and ore treatment at Browns Creek. Northerly extensions of structures identified in the Eastern pit are currently being assessed. Mining is expected to finish in late 1990, and processing in late 1991. In 1988/1989, gold production was 776 kg.

Mineral Hill mine (Triako Resources Ltd 90% and Cyprus Mines Corporation 10%) (refer *Minfo 11*, p. 1), near Condobolin, opened in February 1989. The main open open cut is developed on the Eastern ore zone, a southwesterly dipping vein system with a strong copper association. A second ore zone, the 5001, contains oxide ore from which copper has been leached. A third zone of mineralization known as the Western Orebody comprises two steeply dipping high-grade gold/copper lenses, and will be mined by underground methods.

Efficient metal recovery requires separation of the gold and copper ores because the treatment processes run in parallel: the copper ores in a flotation circuit, and the gold ores in a conventional cyanidation CIP circuit. The bulk of the copper comes from secondary ores present in a high grade gold and copper-rich vein system in the Eastern pit.

Metallurgical problems have significantly affected production during the first year of operation. The necessary degree of ore grade selectivity designed in pre-production modelling proved difficult to achieve. Gold values were more random than interpreted from the drilling data, and copper was found to be more closely associated with gold in ores originally designated as low in copper and suitable for cyanide leaching. Ores low in copper for gold plant feed have been less available than planned. Production for 1988/1989 was 100 kg of gold, and 1400 tonnes of copper concentrates.

Following reappraisal, a less selective bulk mining of the lower grade ores has been adopted, with the gold and copper ores being separately stockpiled. The copper flotation circuit has been improved and may be expanded to compensate for the lower ore grades and temporary gold ore shortages. Gold production is forecast to be only one-fifth of planned production at 165 kg for the year; however, copper production is forecast to be 25% above planned rates at 2060 tonnes for the year. Proved Ore Reserves, plus Indicated and Inferred Resources, in both copper and gold ores, in the Eastern pit total 631 000 tonnes grading 3.22 g/t Au and 0.60% Cu.



Mineral Hill mine processing plant (courtesy of Triako Resources Ltd)

1. Freshwater dam 2. Tailings dam 3. Collection sump 4. Ore stockpiles 5. Ore feed bin 6. Primary crusher 7. Fine ore bin 8. Lime storage bin 9. Screens 10. Ball mill 11. Carbon in pulp circuit 12. Flotation circuit building 13. Site office 14. Warehouse and workshops

Exploration adjacent to the Eastern pit, on the Jacks Hut structure, has identified an Indicated Resource of 175 000 tonnes at 2.7% Cu and 1.9 g/t Au, and, further to the north, an Inferred Resource of 425 000 tonnes lying between 20 m and 100 m below the surface.

London-Victoria mine (BHP Gold Mines Ltd) (refer *Minfo 22*, p. 1), near Parkes, began production in December 1988 . Proved and Probable Ore Reserves are 940 000 tonnes grading about 2.4 g/t Au, and indicated resources are 1.5 million tonnes grading 2.3 g/t. At current production levels, mine life is projected to 1993; however, operations may be extended if additional open cut reserves are found on the lease. There is evidence that further lenses of gold mineralization may be found below the lenses associated with the London shaft and open cut, the Shaws open cut, and below the 100 m level of the Victoria shaft. These three areas are being mined in one open cut, with another smaller open cut on the Majors prospect to the northeast of the London shaft.

The CIP plant capacity has been upgraded from 300 000 tonnes per annum to 500 000 tonnes per annum, and with it gold production from about 775 kg to 930 kg. Low-grade ore, originally planned to be heap-leached, will be treated in the CIP plant. Recovery is proving better than originally planned. Gold production in 1988/1989 was 407.7 kg.

The company began open cut mining for bulk testing the Mount Aubrey deposit in November 1989, and bulk testing is continuing. This mine is 40 km north of Parkes, near Baldry, and is on a low-grade, disseminated, epithermal type deposit with Probable Ore Reserves of 120 000 tonnes grading about 3.5 g/t Au. The ore will be trucked to the London-Victoria plant for processing.

Sheahan-Grants mine (Climax Mining Ltd 50%, Arimco N.L. 50%) (refer *Minfo 14*, p. 1), near Lyndhurst, poured its first gold in January 1988. The deposit is in an area of old workings and comprises both oxidized and sulphide ores. Proved Ore Reserves at the end of June 1989 were 1.057 million tonnes, grading 3.11 g/t Au, in twelve separate orebeds mined in a single open cut.

The CIP plant capacity is 400 000 tonnes per annum of both oxidized and sulphide ore. In 1988/1989, gold production was 776.9 kg from 366 000 tonnes of ore. Planned mine production for 1989 is 400 000 tonnes to produce 930 kg of gold.

Exploration adjacent to the existing mine operations has found four deposits comprised mainly of oxidized ore with the following reserves:

* Frenchmans (Measured Resource) 460 000 tonnes at 3.7 g/t
* Cornishmans (Measured Resource) 460 000 tonnes at 2.1 g/t
* Glendale (Measured Resource) 1.135 million tonnes at 2.0 g/t
* Glendale North (Inferred Resource) 200 000 tonnes at 2.0 g/t

An Environmental Impact Study to allow extraction is in the planning stage.

The Sheahan-Grants pit is scheduled to close in 1992 but these resources could add a further 2 years of operation to the plant.

CIP plant, Browns Creek mine (Photo by Department of Minerals and Energy)

Drake mine (Mount Carrington Mines Ltd) (refer *Minfo 19*, p. 1) was closed in February 1990. The mine was a silver and gold producer based on the former Lady Hampden mine. The area contains many old workings in high-grade gold and copper veins in oxidized zones near the surface. The first gold from the current mine was poured in July 1988. Mining was predominantly in the Carrington and Lady Hampden open cuts, with some open cut mining of the North Kylo deposit. Plans to mine the Strauss and Guy Bell deposits were abandoned after they proved uneconomic because of higher than expected copper content hampering gold and silver recovery. The original mining plan depended on these deposits producing sufficient gold to enable extensions to the Lady Hampden silver mine during periods of depressed silver prices. Overall grades were lower than expected at 2 g/t Au and 60-100 g/t Ag, and recovery rates fell as operations moved from the oxidized ore to the primary sulphide ore. The lower gold and silver prices of 1988/1989, and low grades rendered the mine uneconomic. Bullion production in 1988/1989 was 5371 kg (6.6% Au, 89.6% Ag).

Hillgrove mine (New England Antimony Mines N.L.) (refer *Minfo 8*, p. 18) is an antimony and gold mine on an extensive vein system. At depth, stibnite grades decline but gold grades increase . With antimony prices low, the company has been developing the higher grade gold areas of its orebody. Development work is concentrated on the Lady Hopetoun and Golden Gate lodes. Access has been improved to the Eleanora and Garibaldi lodes, and work is being undertaken on a gold system in the Cosmopolitan lode. Proved Ore Reserves in the Eleanora and Garibaldi lodes are 30 400 tonnes at 1.8% Sb and 11.6 g/t Au. In 1988/1989, the mine produced 190 kg of gold bullion, and significant amounts of gold in antimony and arsenopyrite concentrates.

Comet Valley (Mount Gipps Ltd) (refer *Minfo 23*, p. 12), near Rockvale, is a planned underground operation with Proved Ore Reserves of 47 000 tonnes and Probable Ore Reserves of 122 000 tonnes, grading at 7.3 g/t Au. The operation will mine a vein type deposit to a depth of 85 m (further if additional economic reserves are proved). The ore will be trucked to Hillgrove for processing at a CIP plant to be built for the purpose. The plant will also give the Hillgrove mine improved flexibility, allowing it to gain higher gold recovery rates from its feedstock. Site development has begun, and mining is planned to commence in March 1990. Mine life is estimated at 2 years.

The **Rocky River** and **Tomalla** alluvial deposits are only worked intermittently.

MAJOR PROJECTS AND PROSPECTS

The Peak Project (CRA Ltd) (refer *Minfo 18*, p. 1), near Cobar, has Probable Ore Reserves of 4.5 million tonnes grading at 6.8 g/t Au. A 510 m exploration shaft of production dimensions has been completed to allow underground bulk sampling, driving of a cross cut, and further diamond drilling. A series of orebodies from 270 m to 800 m depth has been defined. The deposit has the potential to produce 2900 kg of gold annually, which would make it the largest gold mine in New South Wales. Development consent has been granted, and a decision on development is expected in early 1990.

Parkes Project (North Broken Hill Peko Ltd) could produce 1550 kg of gold per year, with copper as a major by-product. The deposit is part of a porphyry-related copper-gold province. Proved and Probable Ore Reserves suitable for open cut mining are 1.37 million tonnes of oxidised gold ore at 2.2 g/t Au; 1.66 million tonnes of oxidised gold/copper ore at 1.1% Cu and 1.4 g/t Au; and 32.1 million tonnes of sulphide ore at 0.9% Cu and 0.5 g/t Au. Indicated and Inferred Resources for underground mining are 28.8 million tonnes at

1.8% Cu and 0.6 g/t Au. A decision on development of the project is expected in 1990

Broula King (Cluff Resources Pacific Ltd 50%, Lachlan Resources N.L. 50%) (refer *Minfo 22*, p. 7), near Bumbaldry, is a small epithermal-type orebody with a Measured Resource of 210 000 tonnes grading at 2.6 g/t Au and with a further Inferred Resource of 40 000 tonnes. The company is presently evaluating development options.

Dicks Reward (Cluff Resources Pacific Ltd), near Wellington, is a narrow quartz reef deposit with combined reserves and resources of 19 300 tonnes grading at 24.5 g/t Au. Cluff Resources is making arrangements for tribute mining of the ore by a contractor, and sale of the ore for processing in the London-Victoria mine's CIP plant. Mining will be underground at a rate of approximately 2300 tonnes per annum.

May Day (Epoch Mining N.L.), near Gilgunnia, has Proved "high-grade" Ore Reserves of 188 000 tonnes at 2.97 g/t Au and 16 g/t Ag. Proved "low-grade" Reserves are 126 000 tonnes at 1 g/t Au and 9 g/t Ag. The feasibility of mining plans and processing methods is being studied. Pending approvals, mining could begin in June 1990, with production expected to be 653 kg of gold and 778 kg of silver in a 2-year mine life.

Bergalia (Browns Creek Gold N.L.) near Moruya. Drilling at the old Donkey Hill mine has intersected structures with high gold grades. Indications are that the lode may continue, at a depth of between 10 m and 35 m, to the Francis Hill workings 800 m to the southeast. Reported resource estimates are a Measured Resource of 27 222 tonnes at 9.13 g/t Au, an Indicated Resource of 80 309 tonnes at 9.46 g/t Au, and an Inferred Resource of 210 000 tonnes at 9.4 g/t Au. Results of a 3 month drilling program beginning in February 1990 will indicate the extent, depth, and continuity of the structures, and the feasibility of an open cut operation, prior to underground mining at Donkey Hill.

Peak Hill (Alkane Exploration N.L./ Molopo Australian Ltd), is an epithermal type deposit with a Proved Ore Reserve of 1.8 million tonnes at about 2.1 g/t Au determined from drilling an area of old open cuts. The reserve comprises both oxidized and sulphide ores. Development will depend on the results of metallurgical testing, expected in August 1990.

Dobroyde (Little River Goldfields Pty Ltd), near Junee, is reported as having an Inferred Resource of 900 000 tonnes grading at 2.7 g/t Au. Gold mineralization appears to be very finely disseminated. Metallurgical testing to find the most efficient means of gold recovery is continuing. Preliminary testing indicates grinding prior to flotation may produce suitable concentrates. The results of these tests will be crucial in determining development of the deposit. There are indications of high-grade shoots in the deposit which may be developed first if testing is successful.

Adelong (Pan Australia Mining Ltd) is based on the old Challenger mine. Probable Ore Reserves are 300 000 tonnes grading at 5.4 g/t Au, including a higher grade gold zone of 144 000 grading at 8.5 g/t Au. A decline to allow bulk sampling has been completed; however, the project's future is uncertain.

Brackins Spur (Mount Gipps Ltd), near Hillgrove, is an Inferred Resource of more than 500 000 tonnes grading about 6 g/t Au. The deposit is being evaluated as a potential satellite for the Mount Gipps Ltd operations in the area, although there are land use constraints to be overcome.

Several former mines are currently on care-and-maintenance, awaiting improved gold prices or favourable exploration results. These include Cowarra, Dargues Reef, and Bimbimbie (all in the Southern Highlands area), and Eagle Hawk, Kirkconnel Creek, and Wallaby Rocks (all in the Central West between Bathurst and Mudgee)

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TALLAWANG MAGNETITE– BEYOND 2000*

Doral Magnetite Pty Ltd's open cut on the Tallawang magnetite deposit, 18 km north of Gulgong (figure 3) has been developed to provide a local high-quality product for coal washing in New South Wales and Queensland, into the next century.

Mining of the deposit has continued intermittently by open cut methods since 1901, when the magnetite was used as iron ore for the Lithgow Smelter. A total of approximately 500 000 tonnes of ore was mined for this use, but the mine closed in 1955 and subsequently filled with water.

Earlier this decade, interest in the Tallawang deposit was rekindled and it became part of the assets of Lydgate Holdings Ltd. Lydgate commenced plant construction at Tallawang and pumped out the flooded mine. In mid-1986 the Swan Resources Group and associates acquired the titles and in June 1987 commenced production. Doral Magnetite Pty Ltd, a wholly owned subsidiary of Doral Resources N.L., purchased the project from the Swan Resources Group in April 1989.

Magnetite is a member of the spinel group of minerals with a formula Fe_3O_4, corresponding to 72.4% of iron. It is a black opaque mineral with a metallic lustre, a high specific gravity (between 4.9 and 5.2), and is highly magnetic. In eastern Australia, its major commercial application is in the dense-medium washing process used in the majority of the coal washeries. This requires a suspension of a finely milled heavy mineral in water. Magnetite is particularly well suited to this operation, because of its high density and recoverability by magnets for recycling. Magnetite is also used in the SIROFLOC water treatment process, developed by the Commonwealth Scientific and Industrial Research Organization, but tonnages currently used are small.

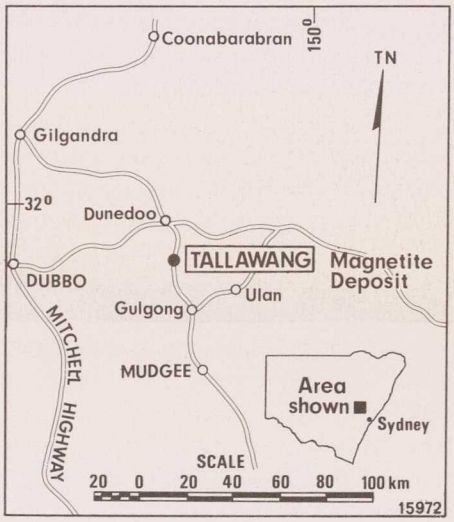
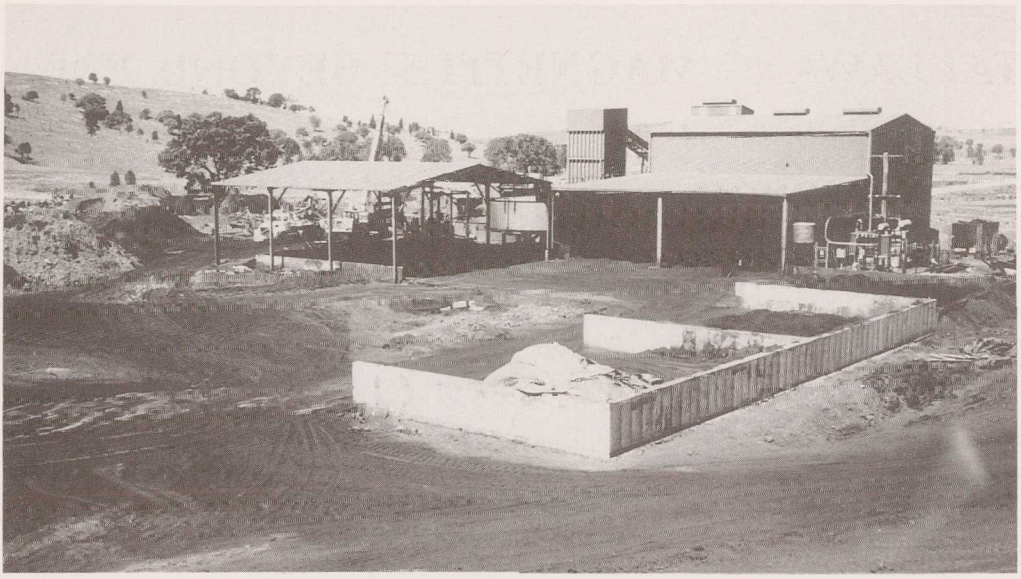


Figure 3. Locality diagram, Tallawang magnetite deposit

The magnetite orebody comprises near-vertical tabular bodies 1.2 km long and varying in width from 1.8 m to 11.0 m in a hornblende - biotite - magnetite metasomatic host rocks close to the Gulgong Granite. Prior to recent studies the Proven and Probable Ore Reserves extractable by open pit mining in the northern deposit were 371 000 tonnes, equivalent to 3.9 years of production at 50 000 tonnes per annum. In addition the southern deposit contained 690 000 tonnes of Proven and Probable Ore Reserves extractable by open pit mining methods which are equivalent to 7 years production. Further substantial tonnages are considered to be extractable from the northern and southern deposits by underground mining, giving an estimated life for the operation of 16.5 years. A recent drilling program in the northern deposit has demonstrated the availability of an additional

* Article prepared from material supplied by Doral Resources N.L.



Tallawang mine treatment plant (courtesy Doral Resources N.L.)

219 000 tonnes considered to be extractable by open pit mining, giving a further 2.2 years of operation and so delaying the requirement to open up the southern pit.

The production process is relatively simple. Ore mined from the pit is transported to a beneficiation plant where it is upgraded by crushing, grinding, and magnetic separation. Considerable capital improvements were undertaken during a shut down in July/August 1989 to:

* increase plant availability, resulting in higher annual production rates and lower operating costs;

* produce a higher quality product with higher magnetics content, lower moisture content, and reduced contaminants.

Productivity was improved by modifications to the dump hopper and ramp, the installation of a weightometer, the commissioning of a second disc filter, the provision of covered storage and additional concrete storage pads, and construction of a loading ramp at the weighbridge. The extensive area of concrete storage and loading facilities enables a front-end loader to load trucks without contaminating the product.

Additional magnetic separators and disc filters, coupled with improvements to thickeners and an improved water supply, have ensured greater magnetics content whilst minimizing moisture content. These are the primary factors that determine the magnetite usage rates at the coal washeries. Ulan and Charbon Coal Washeries have been able to quantify substantial reductions in magnetite consumption as a direct result of using the high-quality Tallawang magnetite product.

The mining and crushing contractor has installed a new crushing plant to increase crushing availability and to greatly improve the overall standard of the material fed to the processing plant.

The magnetite is trucked from the mine to the coal washeries usually using 25 tonne capacity semi-trailers.

New South Wales coal production during 1988/1989 was 6.3% greater than the previous year, whilst a 12.6% increase was experienced

in Queensland. With the exception of most coals used in domestic power stations and cement plants, almost all Australian coals require washing. Currently most new washing plants use the dense-medium separation process which requires magnetite. With several new washing plants being proposed and the expected growth in coal production, the demand for magnetite is expected to increase.

Tallawang is the only current commercial source of magnetite in New South Wales.

To displace material imported into New South Wales and to penetrate the even larger market in Queensland, action has been taken to improve:

* product consistency and quality;
* plant availability to reduce operating costs and increase production capacity;
* market perception of product quality; and
* transportation efficiency to the user.

The Tallawang mine is well placed to satisfy greater magnetite demand beyond the year 2000.

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COBAR FIELD WORKSHOP – NEW CHALLENGES FOR EXPLORATION

The Cobar region (figure 4) has been mined for base and precious metals since 1869. It has probably the highest potential for the discovery of new base and precious metal deposits of any area in the Lachlan Fold Belt. To examine current mining and exploration projects, and to discuss new challenges for future exploration, the Specialist Group in Economic Geology of the Geological Society of Australia held a field workshop at Cobar in October 1989. Several keynote speakers from industry, government, and universities attended.

Cobar has the State's newest major base-metal mine at Elura, the State's biggest gold tailings retreatment operation at the New Occidental (recently closed), and a major new gold prospect being developed at The Peak. The attractiveness of the area for exploration has also increased as a result of the completion of a major mapping project by the Geological Survey of New South Wales. This project has produced an integrated synthesis of the whole region and provided an up-to-date geological framework for company exploration.

Geological mapping essential to regional interpretations is made difficult in the area by the:

* paucity and weathering of surface outcrops
* lack of topographical relief; and
* monotonous nature of lithological units.

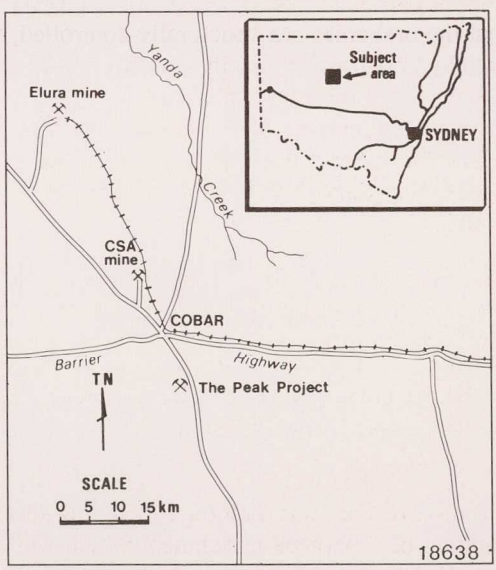


Figure 4. Locality diagram, Cobar area

The area has been subject to extensive geophysical and geochemical surveys to locate orebodies with poor or no surface expression. With increasing depth orebodies become "blind" to many geophysical and geochemical techniques. Some deep orebodies, immediately adjacent to known deposits, have been located by surface and subsurface drilling programs, but other exploration techniques are needed to locate more isolated deep orebodies.

COBAR OVERVIEW

The Cobar Field Workshop was very well organized. It was opened with a brief introduction by John Angus, committee member of the Specialist Group. Richard Glen, of the New South Wales Geological Survey, then presented an overview of the geology of the Cobar area. He discussed the evolution of the Devonian Cobar Basin in terms of opening by oblique extension in the latest Silurian-Early Devonian, and subsequent closing in the late Early Devonian by oblique shortening. This closing led to reactivation of syn-depositional faults and to formation of thrusts, some with strike-slip movement. Work done to date (refer *New South Wales Geological Survey Quarterly Notes 73*, p. 21) suggests that the orebodies are structurally controlled, metahydrothermal in origin, and localized by "short-cut" thrusts. Major faults controlling opening and closing of the Cobar Basin are inferred to be splays off the Gilmore Suture, one of the master faults in western New South Wales.

The workshop also comprised various sessions developed around the main mines of the Cobar district.

Elura mine (Ian Kelso, Elura mine; Ken Lawrie, James Cook University)

The geometry, ore mineralogy, and zonation of the main orebody, including the capping of supergene enrichment which was not discovered by early exploration, were detailed. At least a further five adjacent orebodies, at depths below 350 m, have recently been discovered during underground drilling programs. The relationship of these new orebodies and the main orebody to areas of relatively high and low strain, together with the influence of brecciation at all levels of scale, is the subject of current research work.

CSA mine (John Carswell, Cobar Mines Pty Ltd; Bettina Brill, University of Melbourne)

The history of the mine, including the derivation of the name, CSA, from the original discoverers: a Cornishman, a Scotsman, and an Australian, was presented as introduction. Discussion included the geometry, mineralogy, and spatial relationships of the various orebodies and their genesis which was consistent with ore deposition in dilation areas of shear zones. The short strike length of the orebodies increases costs for underground diamond drilling programs which have again discovered adjacent orebodies at considerable depth below the surface.

Research workers at the CSA mine have used trace elements, stable isotopes, and fluid inclusions formed during ore deposition to provide indicators of temperature and pressure. They have developed a model for the mine which favours mineralization during deformation. Ore-bearing fluids were channelled along regional and local structures, with ore deposition resulting from continued hydraulic fracturing in high strain zones.

The Peak Project (Mark Hinman, James Cook University)

An extensive surface drilling program has enabled a three dimensional model of the orebody, and its host rocks and structures, to be conceived. Future exploration at the project will be based on this model.

The presence of more competent volcanics within the host rocks has resulted in a partitioning of strain, with the formation of

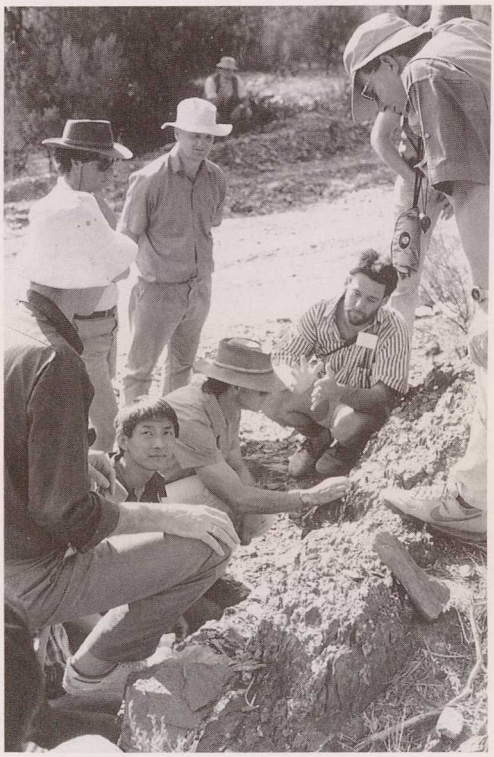
high strain zones in the sediments flanking the more competent volcanics. Much of the mineralization is localized in these high strain zones. Several periods of fault movement associated with late-stage activity on the Peak and Blue Shears post-date early mineralization. An interesting observation was that pre-ore deposition pyrrhotite in the volcanics is responsible for local magnetic anomalies which do not indicate the actual ore lenses. This situation could also apply for other magnetic anomalies in the general Cobar area

FIELD EXCURSIONS

Field excursions, both surface and underground, enabled participants to examine features described during the workshop discussion.

OUTLOOK FOR EXPLORATION

During the evening discussions and the workshop conclusion session, many intriguing problems were raised and discussed. It has become increasingly evident that the new challenge for exploration is to develop techniques to locate deeper orebodies which are blind to most current techniques, and which undoubtedly exist further away from known orebodies. Structural geology is a powerful tool in this regard.



Workshop participants discuss quartz vein relationships in a "short-cut" splay thrust adjacent to the Great Chesney Fault, 1 km southeast of Cobar

Exploration at Cobar is entering a more sophisticated stage in which orebody search will be based on the integration of geophysical and geochemical input with structural geology. This approach will enable a more thorough investigation of potential orebody locations.

Greater levels of co-operation between companies, government, and tertiary institutions to minimize cost and maximize efficiency will be essential for continued growth in the Cobar mining industry. This trend is already evident and the Australian Consortium for Reflection Profiling's (ACORP) project (refer *Minfo 26*, p. 7) is an example of action in this area.

The new challenge for exploration is to apply a more sophisticated and integrated approach to locate new orebodies.

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OPENING OF THE TRURO SAPPHIRE MINE*

The Minister for Minerals and Energy, the Hon. Neil Pickard M.P., opened the Truro sapphire mine near Glen Innes on 10th November, 1989 (figure 5). The mine is the newest operation by the State's largest sapphire producer, T.J. and P.V. Nunan Pty Ltd. The company has mined in the New England region since its small beginnings in 1977, and is now the largest and most successful sapphire miner in Australia. The New England region dominates the New South Wales sapphire industry with an estimated value of $13.6 million in 1988/1989.

The company has established a reputation for its responsible approach to mining and rehabilitation of agricultural lands. This approach has helped overcome landowner concern about sapphire mining, and enabled access to resources that would otherwise be sterilized.

T.J. and P.V. Nunan Pty Ltd has four mines in the region, with a fifth (on Wellingrove Creek) planned to begin in June 1990 (figure 5). Three of the mines are of marginal grade, but development is possible because of the high-grade sapphire deposits mined at Kings Plains.

The Truro mine, on Back Plains Creek, was discovered by systematic test pitting in 1988. A feasibility study established that the resource could be mined even though grades are marginal. However, the mine will make a positive contribution to the company's overall operations in the area.

Probable Reserves are 250 000 loose cubic metres of sapphire-bearing wash, giving an estimated mine life of 4 years. There is a further Inferred Resource of 140 000 loose cubic metres, which may give an extra 2 years of mine life.

The area will be mined using open cut strip mining techniques, with progressive rehabilitation ensuring a minimum of open ground. The mining operations will employ ten people.

The company is extremely active in the search for new sapphire deposits. The company's discovery of rich sapphire-bearing wash in deeper ground at Kings Plains provided, at least in part, the stimulus for the Department of Minerals and Energy's comprehensive research into the origin of sapphire in the Inverell region. The concepts developed from this research have substantially increased the potential for the discovery of rich primary sapphire deposits containing significantly higher concentrations of sapphire than the traditional alluvial deposits (refer *Minfo 17*, p. 12). Four companies, including T.J. and P.V. Nunan Pty Ltd, are systematically exploring for these sources in twenty-three exploration licence areas in the Inverell-Glen Innes area.

As well as applying innovative exploration concepts, the company (via a separate division known as Nunan Sapphire) is embarking on a program of adding value to its mined sapphire by applying advanced processing techniques. At present, most Australian sapphires are exported for processing, mainly to Thailand.

* Article prepared from information supplied by T.J. and P.V. Nunan Pty Ltd.

The company aims to make Inverell the sapphire processing centre of New South Wales and eventually Australia. The program includes:

* Purchase of an automatic colour sorting machine valued at $250,000 – the first of its kind in the local sapphire industry.

* A $300,000 program of research into heat treatment of sapphire, conducted with the Commonwealth Scientific and Industrial Research Organization and the University of Technology, Sydney. Heat treatment is an essential step in onward processing prior to cutting and polishing. It is a permanent process to "clear" the stone of "silk" (internal cloudiness). T.J. and P.V. Nunan Pty Ltd will be heat-treating sapphires on a production basis from 1990 when two furnaces will be commissioned in Inverell.

* A new grading system for rough stone.

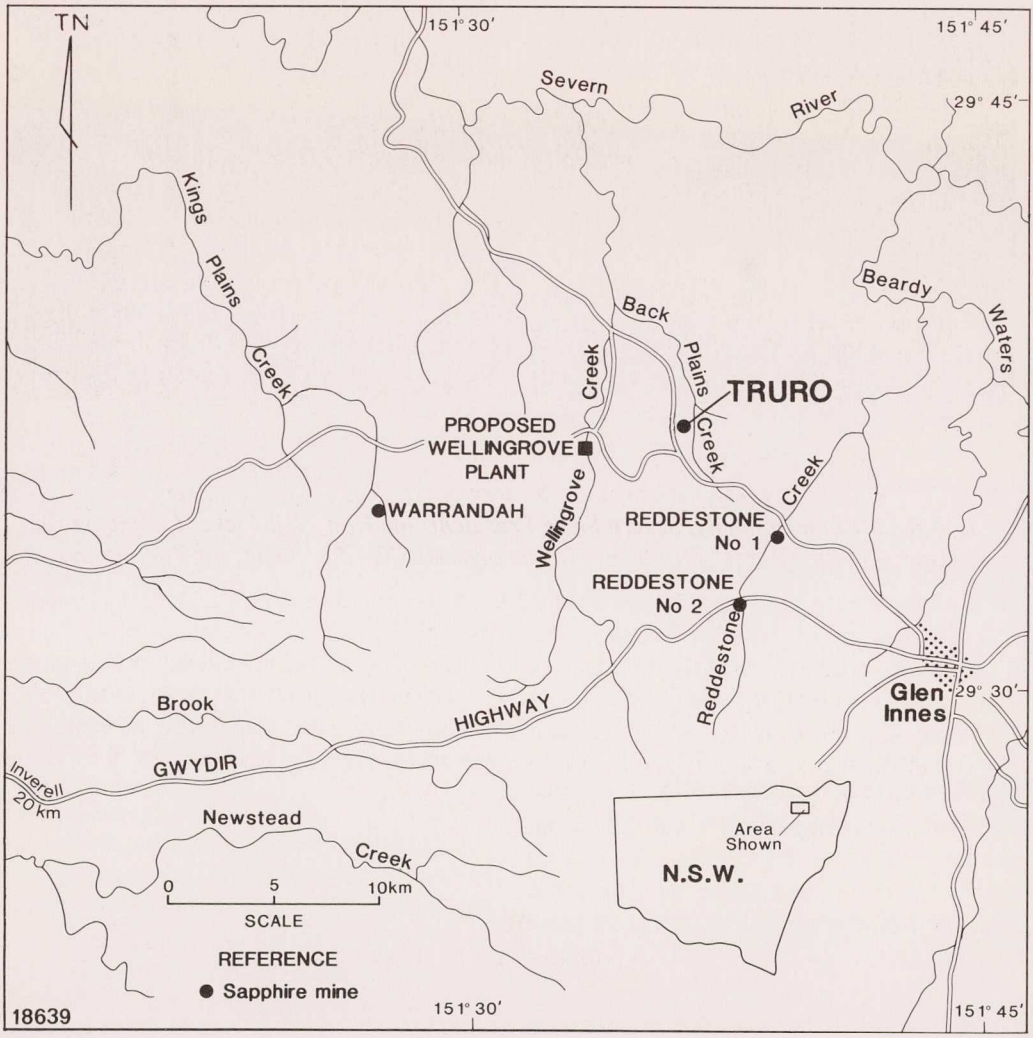

Figure 5. Locality diagram, Truro sapphire mine

The Minister for Minerals and Energy, the Hon. Neil Pickard, M.P., opening the Truro sapphire mine (courtesy of the Glen Innes Examiner)
L to R : Mr Len Donnelly, Severn Shire President; the Hon. Neil Pickard, Minister for Minerals and Energy; Mrs Mavis Tozer, Inverell Shire President; Mr Tom Nunan, Truro mine owner.

* After 2 years of investigations, the company is setting up a lapidary to cut a proportion of its production using the best combination of manual and automatic methods. Eight cutters will be employed in the first stage of the project beginning in mid-1990. The smaller, less valuable stones that cannot be economically cut in Australia will be cut in company premises in Sri Lanka, with value-added benefits returning to New South Wales.

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HEAVY MINERAL SANDS — AN OFFSHORE RESOURCE?*

Rutile and Zircon Mines (Newcastle) Pty Ltd (RZM) has lodged twenty exploration licence applications with the Department of Minerals and Energy to explore for heavy mineral sands in New South Wales territorial waters (figure 6). The exploration programs will be in joint venture with Picon Explorations Pty Ltd (Picon). Both companies are wholly owned subsidiaries of Pioneer International.

The companies have provided an outline of an 8-year exploration and assessment project to determine the presence of economic deposits offshore.

To date, the companies have been granted four exploration licences between them, with the condition that exploration begin within 12 months.

The interest in offshore exploration for mineral sands is undoubtedly stimulated by the high prices of zircon, rutile, and ilmenite. An equally important factor is the need to find alternative sources of these vital minerals. Accessible economic reserves of heavy minerals from traditional sources along the coastal strip are nearing exhaustion, possibly within 15 years at current production levels. Many potentially mineable deposits are not available for mining because of other land uses.

Since the late 1950's, the east coast of Australia has supplied much of the world's premium-quality rutile and zircon. A significant proportion of that production has been from the New South Wales coastline between Broken Bay and Tweed Heads (see *Minfo* 26, p. 23). There is now interest in inland areas such as the Murray Basin in the State's southwest, following the discovery of large low-grade deposits in northwestern Victoria, and the Pilliga in the State's north. However, exploration in the 1960's and up to 1972, by Planet Metals N.L., indicated there is potential for the discovery of substantial deposits offshore. The size, grade, and geological features of these offshore deposits have yet to be determined. Picon and RZM are proposing a systematic exploration project to determine the economic potential of these occurrences.

The exploration program involves:

* development of suitable geophysical exploration technology;
* trial geophysical exploration and drilling;
* analysis and interpretation.

The presence of rutile and zircon is not directly detectable using geophysical techniques. Data must be obtained indirectly, using a range of ship-borne geophysical sensing methods to find relic geological features likely to contain heavy mineral sands. These methods include:

* bathymetric sounding;
* sidescan sonar profiling;
* seismic reflection profiling; and
* magnetometer profiling.

* Article prepared from material supplied by Picon Explorations Pty Ltd

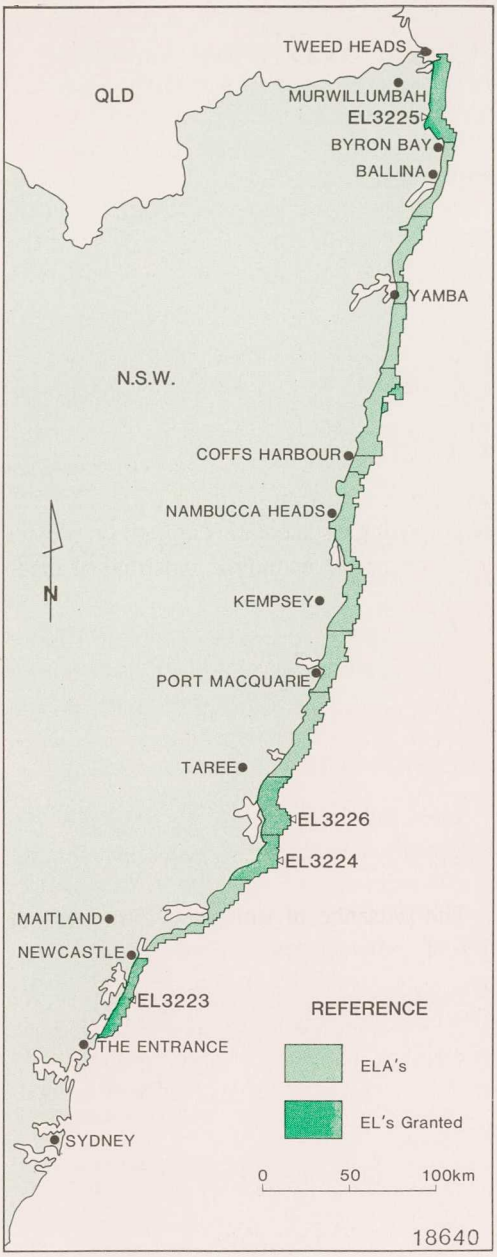

Figure 6. Locality diagram, exploration licences and applications

A multi-channel digital data logging system has been developed to acquire and store data from each of the above systems simultaneously. New video mass storage systems will provide storage of up to 40 hours of survey data per video tape, a significant improvement on existing technology.

The system will be tested within each of the four current exploration licence areas over small areas which previous exploration has indicated are prospective. Traverses will be at right angles to the shoreline, spaced at 250 m intervals, and extend to the territorial sea limit of 5 km. Exploration drilling will provide information on geological features, refine knowledge acquired via the geophysical techniques, and establish heavy mineral concentration.

This first stage of research and development will develop the best system for locating offshore heavy mineral deposits. Should a suitable system prove unattainable, the project would be abandoned.

Should a viable exploration system be developed, a more detailed exploration program, within selected areas, will be undertaken to identify target sites likely to contain heavy minerals. Providing appropriate targets are located, drilling to define the geological features and heavy mineral concentrations will be undertaken.

ENVIRONMENTAL ASPECTS

The company's investigations indicate that the planned offshore geophysical techniques would pose no threat to marine biota. The trial geophysical cruises will collect data on Cetacean behaviour on behalf of the Organisation for the Rescue and Research of

Cetaceans in Australia (ORRCA). (The Cetacean family is a class of marine mammals including whales, dolphins, and porpoises).

There is a comprehensive series of reviews built into the project, including several prime consultation points with relevant government authorities. A review of environmental factors and constraints will form a vital part of Picon's study. The data for this environmental review will be collected simultaneously with the geophysical data.

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MINERAL RESOURCES DEVELOPMENT COMMITTEE

The **Mineral Resources Development Committee** (MRDC) was established in 1983 as a Ministerial advisory body. It provides a forum for discussion and co-operation between the mining industry, unions, farmers, and State and Commonwealth Departments.

The terms of reference of the committee encompass issues relating to:

* responsible environmental management and land use policies;
* Government legislation;
* project approval and taxation reviews;
* financing options; and
* promotion of research and development programs in mining exploration and mineral processing.

The Mineral Resources Development Committee has at present eighteen members, with the Director Minerals, Mr Don Pinkstone, as Chairman. The membership comprises representatives of the following State Government agencie: Minerals and Energy, Agriculture and Fisheries, Lands, Planning, Treasury; State Rail, and the Cabinet Office; the Commonwealth Department of Primary Industry and Energy; the Barrier Industrial Council and the Australian Workers Union; the New South Wales Farmers Association; the New South Wales Chamber of Mines, Metals and Extractive Industries, and the New South Wales Quarrymasters Association.

Since the inception of the committee, a number of working parties have been formed to consider various issues and to develop reports to advise the Minister. Some recent working party reports of importance include:

* access to agricultural land (which resulted in the Mining Act (Access to Lands) Amendment Bill);
* rare earths production waste disposal; and
* resource assessment procedures.

Current working parties have nearly completed their research on the greenhouse effect and on multiple land use. Future work will include a review of the grouping and inclusion of minerals proclaimed under the Mining Act.

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EXPLORATION LICENCES

Exploration Licences granted October - December 1989

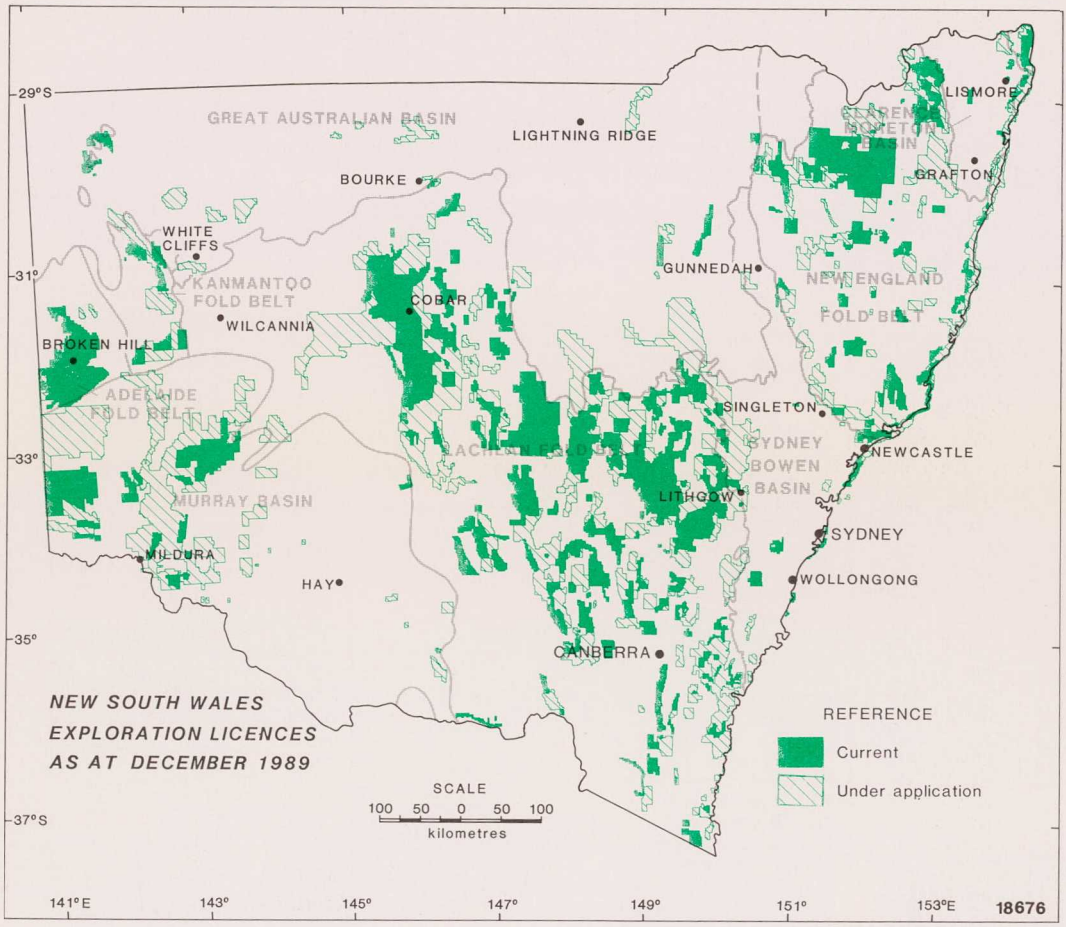
No.	Mining Division*	Holder	Area $	Expiry date	Mineral group#
3366	BH	CRA Exploration Pty Ltd	7 U	08.10.91	1
3367	CB	CRA Exploration Pty Ltd	71 U	08.10.91	1
3368	CB	CRA Exploration Pty Ltd	55 U	08.10.91	1
3369	DU	CRA Exploration Pty Ltd	100 U	11.10.91	1
3370	BH	CRA Exploration Pty Ltd	97 U	11.10.91	1
3371	BH	CRA Exploration Pty Ltd	98 U	11.10.91	1
3372	BH	CRA Exploration Pty Ltd	91 U	11.10.91	1
3373	DU	Compass Resources N.L.	13 U	11.10.91	1
3374	CB	Epoch Mining N.L.	100 U	11.10.91	1
3375	BH	Southern Ventures N.L.	93 U	11.10.90	1
3376	BH	Southern Ventures N.L.	100 U	11.10.90	1
3377	BH	Southern Ventures N.L.	100 U	11.10.90	1
3378	OR	Peko-Wallsend Operations Ltd	24 U	11.10.91	1
3379	CB	Peko-Wallsend Operations Ltd	100 U	11.10.91	1
3380	CB	Platinum Search N.L.	99 U	17.10.91	1
3381	CB	Platinum Search N.L.	26 U	17.10.91	1
3382	CB	Platinum Search N.L.	55 U	17.10.91	1
3383	OR	Pancontinental Gold (Operations) Pty Ltd	14 U	17.10.91	1
3384	OR	Climax Mining Ltd	58 U	18.10.91	1
3385	OR	Climax Mining Ltd	58 U	18.10.91	1
3386	OR	Renison Ltd	18 U	18.10.91	1
3387	DU	BHP Minerals Ltd	100 U	11.09.91	1
3388	BH	CRA Exploration Pty Ltd	81 U	22.11.91	1
3389	BH	CRA Exploration Pty Ltd	90 U	22.11.91	1
3390	BH	CRA Exploration Pty Ltd	86 U	22.11.91	1
3391	BH	CRA Exploration Pty Ltd	74 U	22.11.91	1
3392	DU	Peko-Wallsend Operations Ltd	78 U	22.11.91	1
3393	GB	Red Anchor Investments Pty Ltd	100 U	22.11.91	1
3394	IN	Melocco Pty Ltd	6 U	05.12.90	4
3395	WW	Lachlan Valley Granite Supplies Pty Ltd	10 U	06.12.91	4
3396	BH	Aberfoyle Resources Ltd	42 U	07.12.90	1
3397	BH	Aberfoyle Resources Ltd	72 U	07.12.90	1
3398	BH	Aberfoyle Resources Ltd	98 U	07.12.90	1
3399	BH	Aberfoyle Resources Ltd	83 U	07.12.90	1
3400	CB	Peko Exploration Ltd	100 U	10.12.90	1
3401	CB	Peko Exploration Ltd	100 U	10.12.90	1
3402	CB	Peko Exploration Ltd	100 U	10.12.90	1
3403	CB	Peko Exploration Ltd	100 U	10.12.90	1
3404	CB	Peko Exploration Ltd	100 U	10.12.90	1
3405	CB	Peko Exploration Ltd	100 U	10.12.90	1
3406	WW	CRA Exploration Pty Ltd	100 U	07.12.91	1
3407	BH	BHP Minerals Ltd	6 U	12.12.91	1
3408	CB	Peko Exploration Pty Ltd	100 U	03.01.91	1
3409	CB	Peko Exploration Pty Ltd	100 U	03.01.91	1
3410	CB	Peko Exploration Pty Ltd	100 U	03.01.91	1
3411	CB	Peko Exploration Pty Ltd	100 U	03.01.91	1
3412	CB	Peko Exploration Pty Ltd	100 U	03.01.91	1
3413	CB	Peko Exploration Pty Ltd	100 U	03.01.91	1

* BH Broken Hill
CB Cobar
DU Dubbo
GB Goulburn
IN Inverell
OR Orange
WW Wagga Wagga

$ U = Graticular system units

\# Group 1 - Elemental minerals (metallics)
Group 4 - Hard rock minerals

Exploration Licences in force December 1989



Exploration Licences cancelled/expired October - December 1989

Reports on EL's that have terminated during the quarter and have been placed on open file include the following:

EL 2532 South of Walcha Balgold Nominees Pty Ltd

This licence was taken out to re-examine the Glen Morrison gold workings. A seven-hole drilling program defined a small zone of low-grade gold mineralization of insufficient size to warrant continued exploration.

EL 2602 Southwest of Broken Hill CRA Exploration Pty Ltd

Exploration for gold and base metals associated with "iron-rich" Adelaidean sediments led to a small percussion drilling program. Hole HK3 intersected 2 m at 0.9 g/t Au. A follow-up diamond drill hole failed to intersect any significant mineralization.

EL 2730 Mudgee Western Granites Ltd

The area was inspected for granitoids suitable for dimension stone. Although rocks of potentially desirable colour are abundant, quarrying would be severely constrained by numerous small rural holdings.

Minfo 27, 1990

EL 2733 Rylstone Western Granites Ltd

The area was inspected for granitoids suitable for dimension stone, but no rocks of desirable colour were found.

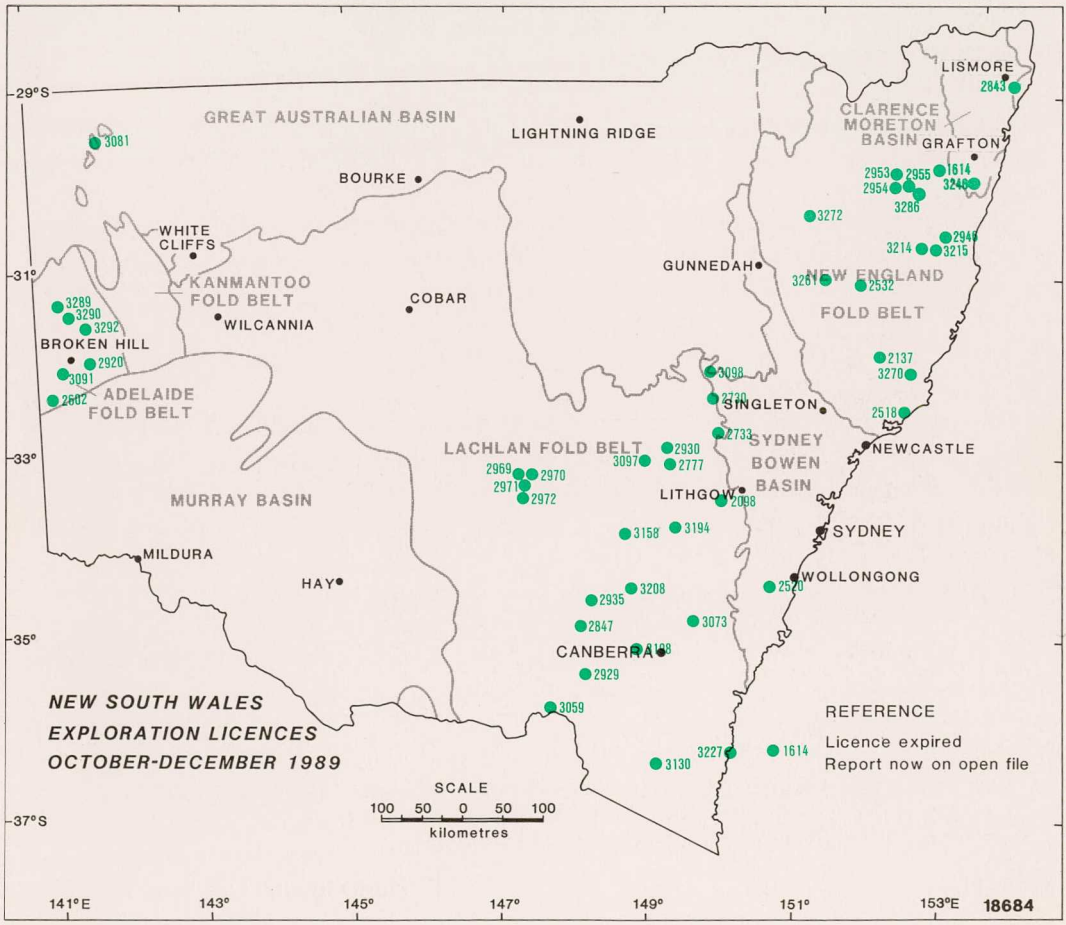
EL 2777 Northeast of Orange BHP Gold Mines Ltd

Exploration was focussed on the search for hydrothermal gold mineralization related to quartz stockworks or shear zones, and for epithermal gold in subaerial acid or andesitic volcanics.

Reconnaissance stream sediment sampling and rock chip geochemistry were carried out over the licence area, and more detailed gridded soil geochemistry was carried out over the old Mount Lindsay Au/Cu mine area. Some anomalous stream sediment results appear to be related to alluvial gold concentration. They were located close to Orange and its water supply. No significant gold mineralization was found at Mount Lindsay.

EL 2843 North of Woodburn Mineral Deposits Ltd

Drilling established a deposit of mineralized sand averaging 0.25% heavy minerals, composed of 11.8% rutile and 11.6% zircon. The low grade, small grain size, and difficulties associated with mining the area made further investigations unwarranted.



EL 2847 Northwest of Gundagai Goldrim Mining Australia Ltd

Initial stream sediment sampling, and mapping and rock chip sampling of old workings in the northern part of the Gundagai Extended Gold Field focussed attention on the old Prince of Wales and Sybil mines. A sixteen hole RAB (rotary air blast) program to test for shallow gold mineralization gave disappointing results as most of the near-surface vein material had been worked out. Subsequent to the drilling, an old mine plan was located in Gundagai showing potential for unstoped ore blocks at greater depth. Financial restructuring and rationalization of Goldrim's interests prevented drill testing of this target.

EL 2929 Batlow Alkane Exploration N.L.

This area was chosen to explore for intrusive-related precious metals associated with Silurian granitoids or the Nacka Nacka Metabasic Igneous Complex. Stream sediment sampling, and reconnaissance inspection and sampling of previously known deposits and prospects were carried out. No new prospects were generated. The Walshs Dyke, Mutoroo, and Sesame mines remain untested, being covered by a prior mining lease application.

EL 2930 North of Orange BHP Minerals Ltd

Exploration was aimed at discovery of a large bulk tonnage open cut gold deposit within the Ordovician to Siluro-Devonian volcano-sedimentary rocks of the area.

Reconnaissance stream sediment sampling over the licence area and rock chip sampling over old gold workings were followed by soil geochemistry over anomalous areas. No worthwhile prospects were located and the licence was relinquished.

EL 2935 Coolac Freeport Aust. Minerals Ltd

This licence lies south of the Cullinga gold field, and was considered prospective for mineralization associated with the contact between the Jindalee Group and the Blowering Formation, similar to that at Cullinga. Stream sediment and rock chip geochemical surveys did not indicate gold mineralization.

EL's 2953-2955 Southeast of Glen Innes Saracen Minerals N.L.

Exploration was for gold mineralization, particularly disseminated mineralization hosted by granitic rocks. A large rock chip sampling program identified an aplite body with anomalous Au-As-Mo mineralization but the anomaly is of limited extent. Trenching and sampling of two quartz reef gold deposits did not give encouraging results, and an assessment of alluvial gold and tin in the licence areas suggested some potential for large deposits, but grades would most likely be uneconomic.

EL 3073 Southeast of Goulburn Norgold Ltd

Stream sediment geochemistry in the search for gold mineralization identified an area of patchy multi-element anomaly associated with complexly faulted and folded rocks. Pyrite and silica-altered sedimentary rocks anomalous in Pb-As-Au were located by follow-up work, but these were not considered to have significant mineralization potential.

EL 3091 Southwest of Broken Hill BP Australia Gold Pty Ltd

Geochemical sampling was undertaken in the search for extensions or repetitions of previously defined gold mineralization (viz. Windy Ridge gold prospect in adjacent EL's). All samples assayed <= 1 ppb Au.

EL 3098 Gulgong Commercial Minerals Ltd

An extensive RAB drilling program was carried out to explore for primary and transported kaolin deposits. Although an economic resource was not proven, three interesting deposits on EL 2434 were located.

EL 3130 South of Cooma Target Mineral Exploration Pty Ltd

Several inliers of ?Ordovician metasedimentary rocks and Silurian granitoids, in the Tertiary Monaro Basalt, were considered prospective for Cowarra-type vein gold deposits. An evaluation of the Rock Lodge prospect showed that subeconomic gold is sporadically distributed in quartz-sulphide veins and gossans which have little or no geophysical expression. Geochemical sampling and geological mapping of the remaining Palaeozoic outcrop did not yield any encouraging results.

EL 3158 South of Cowra BHP Minerals Ltd

Thorough stream sediment sampling failed to indicate anomalous values for gold.

EL 3194 Abercrombie River BHP Gold Mines Ltd

Several earlier found gold and zinc geochemical anomalies were not followed up due to the licence holder's other commitments in the area.

EL 3198 West of Canberra BHP Gold Mines Ltd

This licence was taken up to explore for epithermal gold-silver deposits within Devonian volcanics. Stream sediment and rock chip sampling indicated the old Mount Blundell mine area to have the best potential for gold mineralization. However, the lodes are of limited width and strike, and offer no good grade or tonnage potential. Several extensive areas of quartz veining in the Mountain Creek Volcanics do not contain significant gold values, and would appear to be deeper epithermal to possibly mesothermal in character.

ELs 3214, 3215 West of Nambucca CRA Exploration Pty Ltd

Stream sediment sampling was carried out in the search for large-tonnage gold deposits. No significant gold anomalies were found.

EL 3246 South of Grafton CRA Exploration Pty Ltd

This licence was taken out to explore for gold deposits associated with altered sedimentary rocks of Carboniferous and Jurassic age. A reconnaissance stream sediment sampling program yielded generally discouraging results. Extensive testing in the area of a 5 ppb gold anomaly failed to locate the source.

EL 3270 Southeast of Gloucester Placer Exploration Ltd

The area was considered favourable for sediment-hosted fine-grained gold mineralization, similar to Carlin type deposits. A regional drainage sampling program involving fifty-one bulk stream sediment samples identified only three anomalous drainages, two of which could be related to old mine workings.

EL 3272 East of Barraba CRA Exploration Pty Ltd

A stream sediment geochemical survey for base and precious metals returned no anomalous results.

EL's 3289, 3290, 3292 North of Broken Hill BP Australia Gold Pty Ltd

A program of reconnaissance BLEG (bulk leach extractable gold) stream silt and rock chip sampling was conducted in the search for gold associated with calcareous/carbonaceous Adelaidean sediments. A few BLEG samples from areas draining the partly calcareous Euriowie beds contained anomalous gold (maximum of 2.6 ppb Au).

No follow-up work was undertaken because the company will not be continuing exploration in Australia.

Other cancelled or expired Exploration Licences

At the time of compilation, final reports had not been received for the following licences: 2098, 2137, 2518, 2520, 2920, 2946, 2969, 2970, 2971, 2972, 3059, 3081, 3097, 3208, 3227, 3261, 3286

Exploration Licence 1614 has terminated but is subject to flow-on title applications and reports remain confidential.

EXPLORATION LICENCES TERMINATED PRIOR TO OCTOBER 1989

EL 2467 Gulgong Triad Minerals N.L.

The objective of exploration within the licence area was to locate the primary source of diamonds found in deep lead material in the Wyaldra - Cudgegong area. From the apparent lack of wear displayed by the diamonds, it would appear that the primary source must have been proximal; however, geophysical surveys and heavy mineral sampling failed to detect it.

EL 2759 South of Wellington International Mining Corp. N.L.

The exploration target for this licence was gold, as primary mineralization in Ordovician and Devonian volcanics and sediments or as alluvial deposits in derived sediments.

A BLEG drainage geochemistry program obtained two anomalies. The Stabbs Creek anomaly was tested fully, the maximum BLEG values being 6.5 ppb in soil over the derived sediments and the maximum assay value of ferruginous material being 0.07 ppm gold. Time and weather conditions did not permit a full evaluation of the Turrawonga anomaly.

ELs 3063, 3064 Southwest of Nyngan Helix Resources N.L.

Several aeromagnetic anomalies north of the platiniferous Honeybugle Intrusive Complex were thought to have potential for platinum group metals and associated alluvial platinum and gold. RAB drilling of the anomalies did not intersect anomalous platinum, but weakly anomalous gold values (up to 0.11 ppm Au) were found. No palaeochannels draining the Honeybugle Intrusive Complex were detected.

EL 3192 Northwest of Wentworth Peregrine Mineral Sands N.L.

Heavy minerals were sought in the Parilla Sand of the Murray Basin. Three reconnaissance air core holes were drilled, but none intersected the Parilla Sand and virtually no heavy mineral was reported.

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MINES INSPECTION BRANCH – PAST TO PRESENT

The "new" Mines Inspection Branch of the Department of Minerals and Energy (refer *Minfo 25*, p. 20) provides safety, health, and welfare assistance, and direction, together with environmental controls, to the metallic and industrial minerals industry which employs over 8000 people. The value of minerals (excluding coal and shale) extracted in New South Wales in 1987/1988 was approximately $1 billion.

CHIEF INSPECTOR OF MINES BRANCH

The evolution of the branch to its present form commenced when John Hardman Australia Lister and William Tom found the first payable gold at Ophir on 12th April, 1851.

In June 1851 the Governor, Sir C.A. Fitzroy, stated in a dispatch, it was essential that:

"the Government lose no time in framing and publishing regulations for placing all persons desirous of searching for gold under proper licence and control";

and

"the workings at present are conducted in the most wasteful manner from the cupidity and ignorance of the people, which cannot be remedied till some officer is appointed acquainted with the proper mode of working and with power to enforce it."

The first Act of Council relating to mining came into operation on 1st February, 1853. It was Act 16 Victoria No. 43* and dealt with regulating management of goldfields, the raising of revenue, and the preservation of order. This Act was so autocratic that pressure by miners forced amendments very quickly, with new Acts being introduced (i.e. Act 17 Victoria No. 23 1st October, 1853, Act 20 Victoria No. 29 March, 1857) and previous Acts being repealed. Further Acts followed in 1861 and 1866, the latter forming the basis of the current system of Warden's Courts.

The years passed, and in 1874, the Mining Act of 1874, No. 37 Victoria 13, established the Department of Mines. The granting of leases was transferred from the Lands Department to the Department of Mines, Wardens were appointed, and Warden's Courts were instituted.

In August 1876 Mr William Henry John Slee was appointed as the first Inspector of Mines. In the same month the "Regulations for the Inspection of Mines" (other than Coal and Shale) was passed by Parliament. This set of regulations was the forerunner of today's Mines Inspection Act. There were eleven regulations (today eighty-one) and twenty-two General Rules (today seventy-six). Mr Slee reported that:

"The regulation(s) ensures safety to the health and life of the working miner, they strengthen the hands of the Mining Manager against the false economy of directors, they protect the shareholder in having his mine kept in a secure state for future development and they compel tributors to keep the mine under their charge in a secure and workable state".

During 1880 Mr Slee made Hill End his headquarters and travelled 6326 miles by horse and buggy to inspect a total of 385 mines.

* Victoria refers to the reign of Queen Victoria I

By 1888 there were 17,000 men (growing to 32,000 in 1899) working in metalliferous mines and in that year there were twelve fatalities. Mr Slee was still the only inspector and was also a member of the Prospecting Board and Superintendent of Drills, supervising diamond drilling and water augering. He was promoted to Chief Inspector of Mines in January 1890 and in May 1890 two additional inspectors were appointed, one stationed in Broken Hill and the other subsequently, in the Albert Mining District. Mr Slee retired in August 1904.

In 1894 the Branch was listed in the New South Wales Public Board List as the "Chief Inspector of Mines Branch". The main lode at Broken Hill had five operating mines, and the number employed in metallic mines in New South Wales had increased to 24,000. That year there were twenty-eight fatal accidents. Regulations relating to lead poisoning were passed, and in 1895 Inspector James Hebbard (Broken Hill) reported that:

"Since the enforcement of Clause 3 of the Lead Poisoning Act, the names of 88 men have been recorded as having suffered from lead poisoning from 1st May to 31st December. In a great many cases the illness lasted only a day or a few days; twenty-seven were unaffected".

During 1897 a Royal commission, with Judge Murray as sole commissioner, was appointed to inquire into the alleged high accident fequency occurring in the Broken Hill mines. Among other findings the Commissioner decided that the regulations needed some amendment and alteration, and that the rules and powers of inspectors should cover open cuts.

Mining districts with resident inspectors were established in Cobar, Broken Hill, Orange, and Sydney in 1898.

Considerable assistance in the framing of a bill was gained from the Commission's report and enactments of other States, and the **Mines Inspection Act 1901** came into operation on 1st February, 1902.

This was an act "to make better provision for the regulation and inspection of mines other than coal and shale mines; to regulate the treatment of the products of such mines and for purposes incidental to or consequential on those objects".

As the years passed many amendments were made to the Act. Some of these amendments were influenced by the recommendations of a Technical Commission which investigated the occurrence of Industrial Diseases in Broken Hill.

The **Mining Act 1906** came into operation on 15th July, 1907. It consolidated, amended, and liberalized the law, and also repealed thirteen earlier Acts, including the 1874 Act. Rights and titles under the repealed Acts were preserved. It provided in general that all lands were open to mining, even in the case of alienated lands.

In March 1907 a set of rules regulating the use of electrical power in metalliferous mines came into operation, but it was not until 1959 that Mr Ken Robertson was appointed the first Electrical Inspector of Mines.

Changes in regulation were ongoing and influenced mainly by the technological and social changes which occurred during the next few decades.

MINES INSPECTION BRANCH

In 1946 the name of the branch was changed from the Chief Inspector of Mines to the Mines Inspection Branch. The Diamond Drill Branch was abandoned in 1956 after 80 years of operation.

The first Mechanical Inspector, Mr Ken Hunt, was appointed in 1962 as a result of a report submitted by the Chief Inspector of Mines to the Public Service Board. At the same time, approval was given for the appointment of a Deputy Chief Inspector of Mines, a Senior Inspector to be stationed at Broken Hill, a Special Duties Officer, an additional Inspector of Mines, and a Technical Officer - Petroleum.

During 1966 the Minister for Mines approved that only persons holding a degree or diploma in Mining Engineering from a recognized School of Mines or University could be examined for the Mine Managers Certificate of Competency. Also in this year a Cadet recruitment system was introduced.

The Mining Act 1906 was completely revised and subsequently replaced by the **Mining Act 1973**. Until the early 1960's little regard was paid to the incorporation of conditions to protect the environment and to ensure the rehabilitation of mined areas. However after the early 1960's the Department commenced to place conditions and controls but without statutory obligation. This was particularly so in respect of the heavy mineral sands industry and it set the standard of rehabilitation required now in all mining areas. The need for the protection of the environment is contained in this Act. It made the lodgement of security deposits mandatory to ensure that required rehabilitation conditions were met and gave power to require environmental impact statements.

In November 1981, as a result of the Williams Inquiry, the Mines Inspection Branch was transferred from the Department of Mineral Resources to the Department of Industrial Relations and Technology, and was no longer responsible for the administration of the Mining Act 1973. The **Occupational Health and Safety Act 1983** as it relates to mines became their responsibility as "umbrella" legislation for the Mines Inspection Act 1901. The Mining Act 1973 responsibilities became a function of the Mining Engineering Branch of the then Department of Mineral Resources.

The Mines Inspection Branch was transferred back to the Department of Mineral Resources in April 1988 and was complementary to the Mining Engineering Branch. A further change took place in July 1989 when the functional responsibilities of the Mines Inspection and Mining Engineering Branches were combined and some districts adjusted accordingly.

Since mid 1989 the Branch's responsibilities have included promoting the development of mining projects and minerals processing, mainly through the Development Section. Also, in conjunction with the Soil Conservation Service, the Branch organizes and supervises the rehabilitation of the Derelict Mined Land Program.

The new Mines Inspection Branch now administers the **Mines Inspection Act 1901** as amended, the **Occupational Health and Safety Act 1983**, the **Mining Act 1973**, and the relevant Sections and Regulations of the **Petroleum Act 1955** as amended, the **Petroleum (Submerged Lands) Act 1967**, and the **Dangerous Goods Act 1975** in so far as they affect mines and associated industries, other industries, and the general public.

The Branch has a staff of forty-three located in eleven offices throughout the State (refer *Minfo 25*, p. 20) and comprises:

* sixteen mining engineer inspectors (thirteen of these are regional);
* two specialist mining engineers;
* six specialist engineers (mechanical, electrical, petroleum, and rock mechanics);
* six mining officers (regionally based and whose primary functions are connected with the Mining Act 1973);
* four development officers (mining and minerals processing), and
* seven full-time and two part-time support staff.

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STRATEGIES FOR DEVELOPING MINERALS PROCESSING

The Government is formulating a **Strategy for the Economic Development of New South Wales** to address the State's competitiveness both nationally and internationally.

In late 1988, consultants to the State Government identified fourteen different industry sectors as having the greatest potential for increasing the State's competitiveness and economic growth. These sectors include Minerals Processing, Tourism, Pulp and Paper, Information Technology, Agriculture/Food Processing, Metallic Minerals, Non-Metallic Minerals, and Coal.

Industry-based task forces are being convened to prepare appropriate development strategies for these various industry sectors. Not all task forces will run concurrently. Tourism, Pulp and Paper, Information Technology, and Minerals Processing will start first, followed by Coal, Agriculture/Food Processing, and others.

The Department of Minerals and Energy is responsible for initiating and providing a Secretariat to the **Task Force on Minerals Processing Development Strategies.**

The Task Force is chaired by Mr Reg Fraser, Managing Director, Pasminco Mining, Pasminco Ltd, and comprises:

* four other senior industry representatives;
* the Executive Director, New South Wales Chamber of Mines, Metals and Extractive Industries;
* a representative from the Labor Council of New South Wales; and
* one senior officer each from the Departments of Minerals and Energy, Business and Consumer Affairs, and State Development.

This Task Force has been meeting regularly since September 1989.

The Task Force is required to develop a **strategic plan** to increase the level of minerals processing in New South Wales and will:

* profile world minerals processing industries, and identify market opportunities;
* evaluate the New South Wales competitive position, and identify opportunities for investment; and
* formulate appropriate strategic options by which the Government can attract and facilitate further minerals processing development in New South Wales.

A draft report, available for public comment, will be prepared by mid 1990.

Following review and assessment of the draft Task Force report, a final **Strategy Report for Minerals Processing** will be submitted to Cabinet for consideration and implementation if approved. A similar process will apply for the other industry sectors.

For further information, contact Garth Holmes, Principal Adviser, Minerals Processing, on (02) 240 4699.

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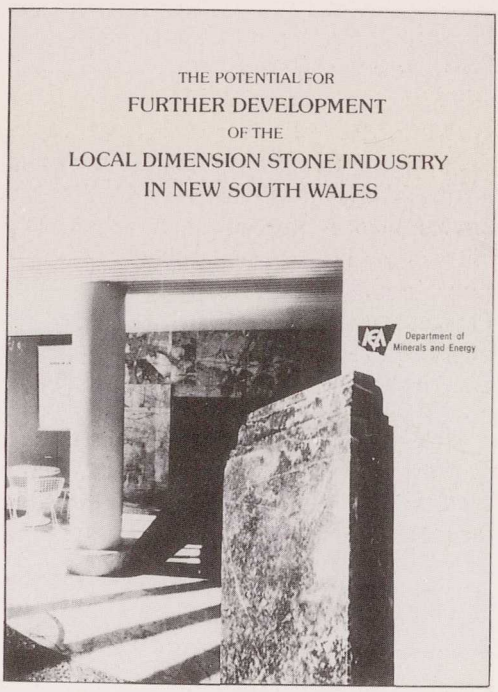
GRANITE AND MARBLE INDUSTRY REPORT AVAILABLE

A comprehensive report "**Potential for Further Development of the Local Dimension Stone Industry in New South Wales**" has recently been released by the Department of Minerals and Energy. In the report, prepared by Polymex Consultants for the Department , the potential for local granites and marbles to replace imports is examined. The Department is eager to encourage further development of the State's dimension stone industry, and greater use of dimension stone products.

In recent years, Australia has followed the international trend favouring the use of natural stone in building applications, particularly in architectural facades, counter tops, internal walls and floors, and external paving. There is considerable potential for expansion of the local dimension stone industry using the State's excellent resources of granite and marble.



In the report strategies are discussed for:

* expanding local demand for dimension stone;
* increasing the market share held by New South Wales quarried stone;
* increasing the primary and secondary processing of stone in New South Wales; and
* increasing dimension stone exports.

For both granite and marble building applications, the report presents information on aspects of the:

* market structure;
* distribution systems;
* market participants;
* market sizes and trends;
* competing products and prices; and
* purchase processes.

Copies of the report (140 pp.) are available (cost $200.00 + handling) from the Central Enquiry Counter (see page 72).

For further information concerning dimension stone processing in New South Wales, contact David Barnard, Development Officer Minerals Processing, on (02) 240 4579 or Helen Ray, Geologist, on (02) 240 4318.

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NEW COAL MINE AT RIXS CREEK

Development consent for the **Rixs Creek coal mine** was granted by the Minister for Planning on 19th October, 1989, enabling the grant of a coal lease to Bloomfield Collieries Pty Ltd on the following day. The proposed Rixs Creek open cut mine is located 5 km northwest of Singleton township (figure 7).

Development consent conditions for this project are very stringent. They follow the recommendations made by the Commissioners folowing a major environmental inquiry, held in May 1989, under Section 119 of the Environmental Planning and Assessment Act, 1979. The proposed mine generated considerable concern due to its proximity to Singleton. The inquiry established that the mine could operate with minimal environmental impact on Singleton and surrounding areas provided the recommendations were followed. These included land acquisitions by the company to establish an adequate buffer between the mine and Singleton Heights.

Apart from its importance to this particular project, the inquiry is of general interest because of the comprehensive examination in the report of major environmental issues.

The company proposes to develop and operate an open cut coal mine with supporting surface facilities for handling, preparing, and transporting the coal in a program to be implemented in two stages. The mine will have a production of about 18 million tonnes of saleable coal over the initial 21-year lease period. Coals with coking and steaming properties will be produced. The products will be blended with high-sulphur coal from Bloomfield Colliery, East Maitland, to satisfy market specifications for lower sulphur coals.

Production in Stage 1 over the first 5 years will average about 300 000 tonnes per year run-of-mine (ROM) coal, and will then be increased in Stage 2, from year 6, to about 1.5 million tonnes per year ROM coal, or about 1 million tonnes per year of product coal.

Raw coal will be ripped by bulldozer and hauled by scraper to a rotary breaker for size reduction, prior to transport to the coal preparation plant at the Bloomfield Colliery, East Maitland. In the first 2 years, while a rail loop and associated facilities are being constructed, coal will be hauled by road direct to East Maitland. The rotary breaker will not be used during this 2-year period. From year 3 in Stage 1 of the project, coal will be loaded into railway wagons on the site for transport to the Company's rail siding at Thornton and, from there, hauled by truck to Bloomfield Colliery.

Upgraded surface facilities, including a coal preparation plant, will be constructed prior to Stage 2 to allow full processing of the increased coal production on the Rixs Creek site.

In Stage 2 a bench mining method, employing an electric shovel and trucks for the removal of blasted overburden, will be introduced in year 6 to expand production from the pit on the northern side of the New England Highway.

Mining on the southern side of the highway will commence in year 7. Overburden will be removed by bulldozers and scrapers, although some blasting of the overburden will be required. Coal will be ripped and loaded into trucks for transport to the surface facilities via an underpass to be constructed below a re-routed section of the highway.

Rixs Creek is to be diverted to a new channel over a length of approximately 1 km to allow for maximum coal recovery in the southern area (figure 8).

The Company expects only a minimal requirement for out-of-pit overburden disposal from the initial mining operation. Spoil will be used for the construction of haul roads and bunds along boundaries of the site to shield the operations, and a small surplus will be incorporated in the final stages of the shaping of the Stage 1 backfill area.

The Company's mining methods, as proposed, allow for the progressive rehabilitation of the backfilled areas. Should the project end in 21 years, the final cuts will be filled and no void is expected to remain.

There will be thirteen permanent employees on the site in Stage 1 initially, and this will increase to twenty-two by year 5. The total permanent workforce in Stage 2 will be 115.

Initial work on the site is expected to commence early in 1990.

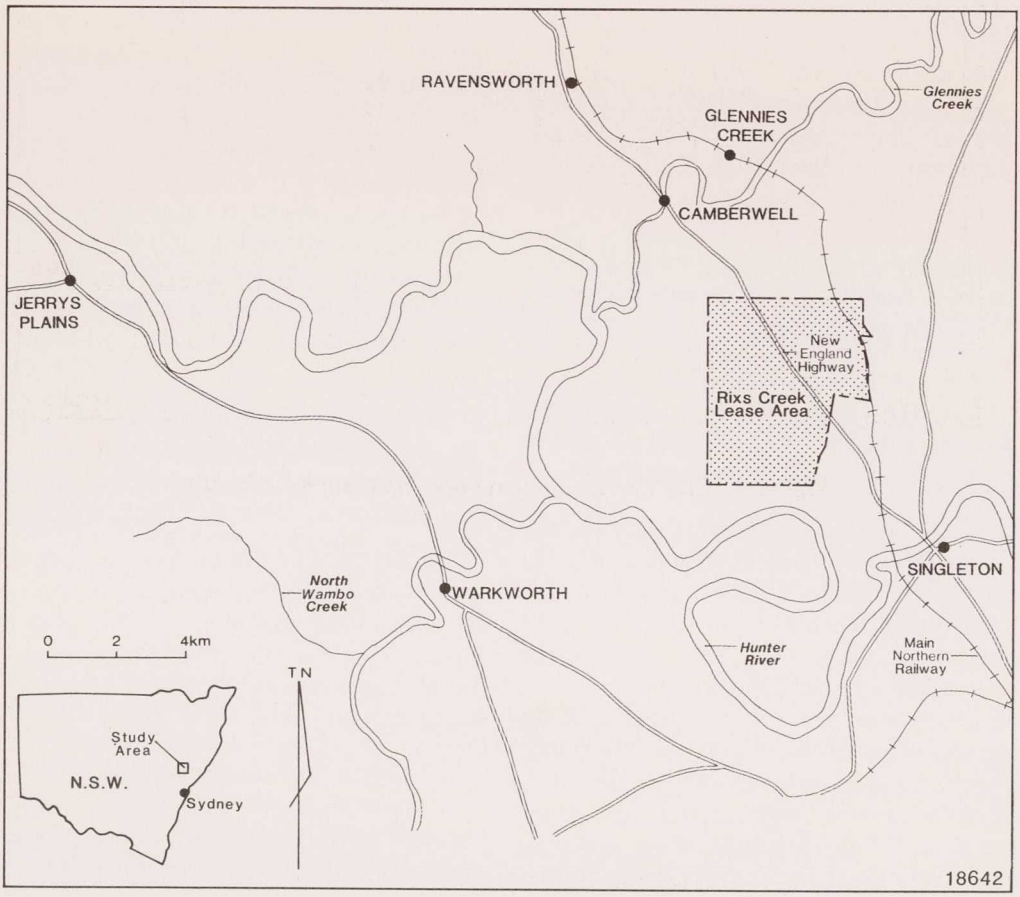

Figure 7. Locality diagram, Rixs Creek coal lease

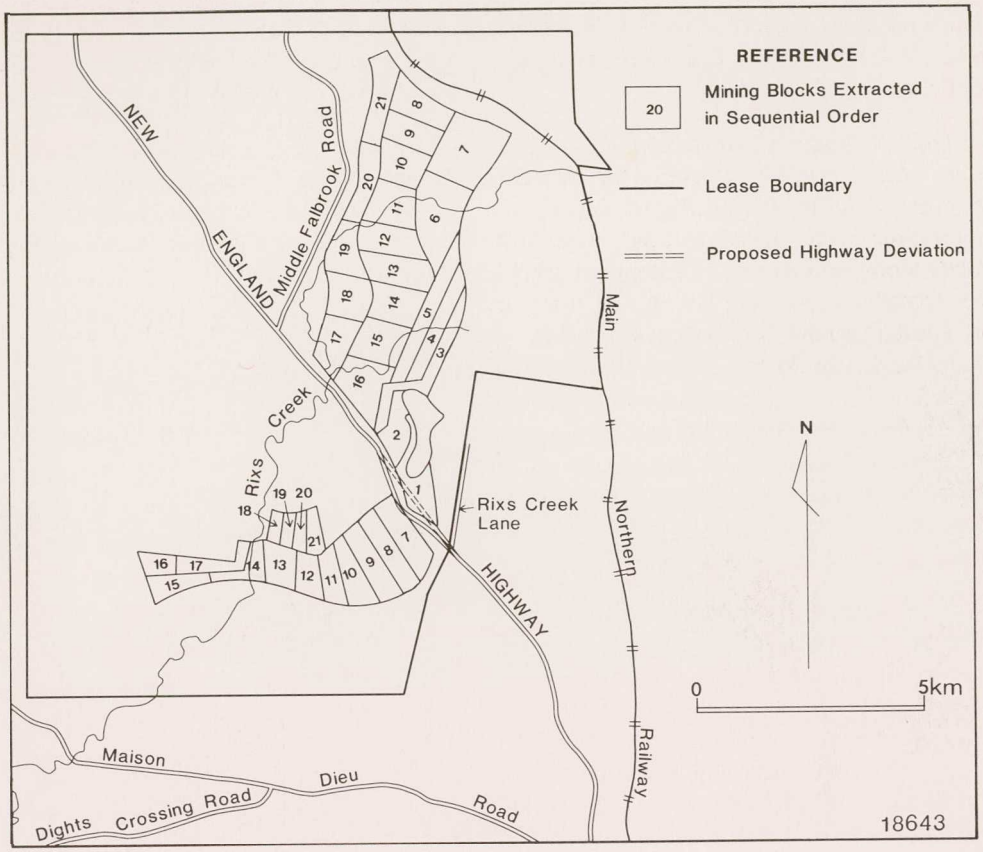

Figure 8. Rixs Creek coal lease area and mining schedule

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SMALLER COMPANIES PURCHASE NORTHERN COAL MINES

In 1989 smaller companies have bought two mines from Coal and Allied Operations Ltd. Most other recent investment in the industry has been by major Australian companies, such as Oakbridge Ltd and Pacific Copper Ltd, and a number of significant Japanese energy and trading companies. This investment by major companies was a feature of the recent widespread restructuring of the coal industry ownership (refer *Minfo 25*, p. 40).

Liddell Colliery, 25 km northwest of Singleton (figure 9), was sold to a consortium including Savage Resources Ltd and Marion Mining Pty Ltd. Yieldex Pty Ltd has become the registered holder of the titles on behalf of the consortium. Key figures in the Yieldex consortium include Messrs George Edwards and David Archer.

The output of Liddell Colliery was 673 000 tonnes in 1987/1988 but then fell sharply to 481 000 tonnes in 1988/1989, due to geological problems with a new longwall unit. The new consortium believes Liddell has the potential to eventually reach an annual output of 2 million tonnes per annum, based on two shortwall units. Since taking over in May 1989, the consortium has based production on pillar extraction using continuous miners, and is aiming for a 1989/1990 raw coal production of 750 000 tonnes. The mine has large reserves of soft coking coal and all production is exported. Total employment at the mine and associated washery is now 195, compared with 390 under the former management.

The mine has already achieved a significant feat; a team of thirty miners carried out "mission impossible" over an 8-month period, namely the recovery of over 10 million dollars-worth of buried longwall equipment in extremely wet conditions.

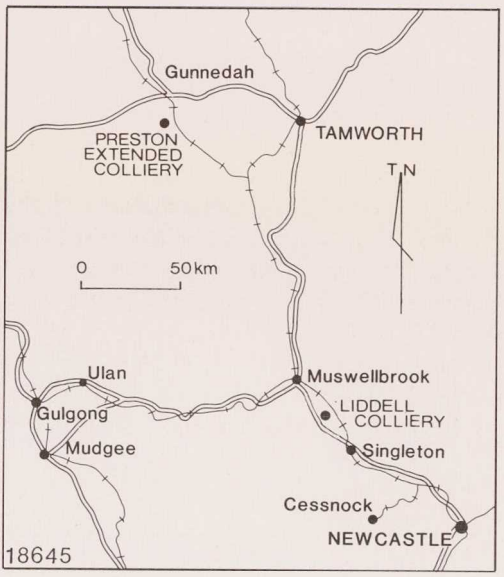

Figure 9. Locality diagram, Liddell and Preston Extended Collieries

Preston Extended Colliery, 12 km south of Gunnedah (figure 9), was also sold this year by Coal and Allied Operations Ltd to a consortium (Preston Coal Holdings Pty Ltd) headed by Messrs Bob Cameron and Brian Kirkpatrick. A half interest in the consortium is held by the Europa Minerals Group, a British mining finance company. This mine has small reserves of export steaming coal and a workforce of seventy-eight. Production for 1988/1989 was 321 000 tonnes and scheduled production for 1989/1990 is 367 500 tonnes.

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RICHMOND MAIN HISTORIC PARK

The Richmond Main Historic Park project, 5 km south of Kurri Kurri (figure 10) and within easy reach of Sydney, is one of the most significant examples of preservation and restoration of mining heritage in New South Wales. With outstanding potential as a mining heritage theme park, this project could become as significant to New South Wales as Ballarat's Sovereign Hill is to Victoria. The Park comprises the surface workings of the Richmond Main Colliery and Power Station, the Richmond Vale Railway, and over 40 ha of surrounding eucalypt forest.

HISTORY OF THE AREA

Richmond Vale Estate

The Richmond Vale Estate, which later became a part of the Richmond Main Colliery Holding, is directly linked to the First Fleet. Lieutenant John Palmer was purser on HMS Sirius in 1788 and later became Commissary General of New South Wales. In 1823 he selected a 260 ha grant in the Valley of Wallis Creek, 1.6 km east of property purchased in 1840 by Charles William Roemer, on which the Richmond Main Colliery was eventually established. The Richmond Vale Estate was probably named after HMS Richmond on which John Palmer was captured off Chesapeake Bay during the American War of Independence.

In time, the Palmer and Roemer properties became part of a much larger Richmond Vale Estate of 1863 ha. In 1888, 2 years after T.W. Edgeworth David proved the Greta seam, the Estate was purchased by a Melbourne syndicate from John Scholey of Waratah, and

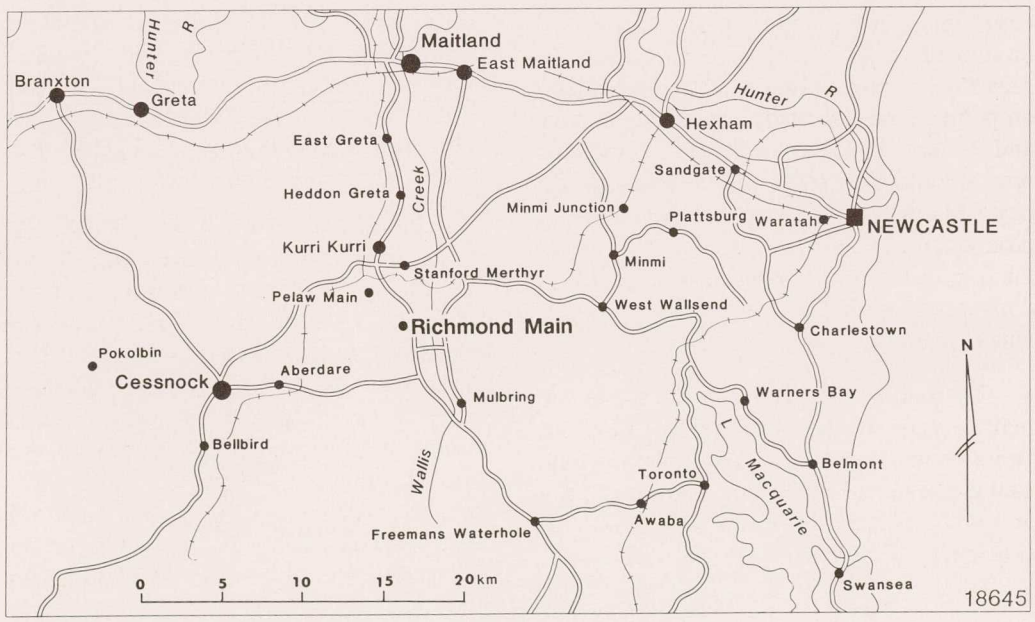


Figure 10. Locality diagram, Richmond Main

a shaft of nearly 244 m was sunk. The venture failed due to both a lack of adequate capital and a railway to transport the coal from its site in virgin forest.

In 1896 the Estate was purchased by the J. and A. Brown Mining Co., founded in 1844 by brothers James and Alexander Brown who had emigrated 2 years earlier. Soon after their arrival they acquired an interest in coal transport, and opened a small coal mine at Four Mile Creek near East Maitland. James Brown's son John, a mine surveyor in the company, became General Manager in 1893. His foresight was evidenced when, in 1896, he purchased the Richmond Vale Estate.

About this time the East Greta Co. developed the Stanford Greta No. 2 and Stanford Merthyr coal mines to the immediate north, on the Homeville seam. At the turn of the century the East Greta Co. sold the former mine to the J. and A. Brown Mining Co., and John Brown, who had a well-known dislike of anything of a Welsh nature, promptly changed the name to Pelaw Main.

Richmond Vale Railway

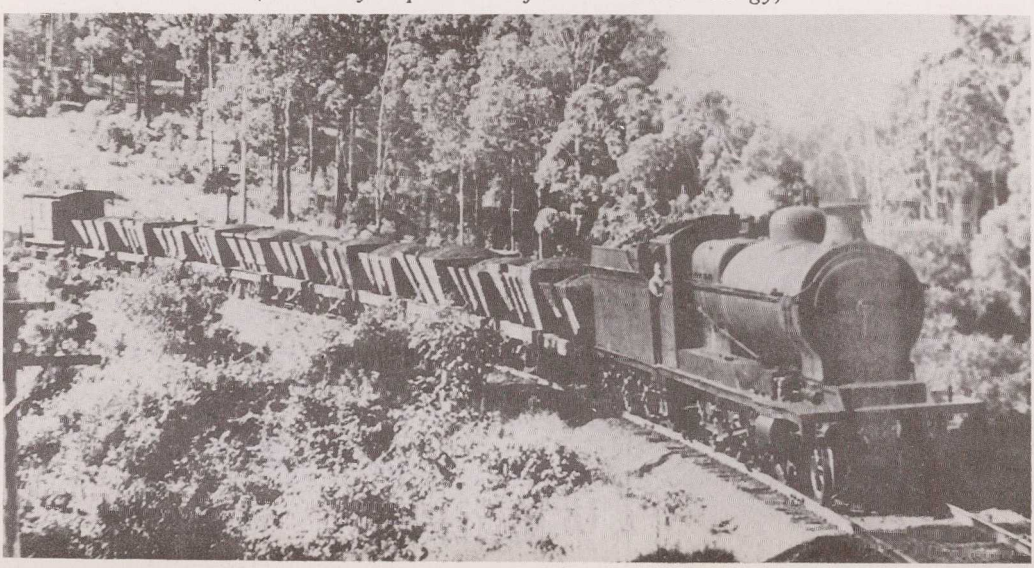
In 1890 an Act of Parliament was passed to allow the J. and A. Brown Mining Co. to build the Richmond Vale Railway. The track between Minmi Junction and Pelaw Main included three tunnels and two trestle bridges, and was completed in 3 years. It was then extended to provide company-owned rail access to the Richmond Main Colliery (renamed from Richmond Vale by John Brown).

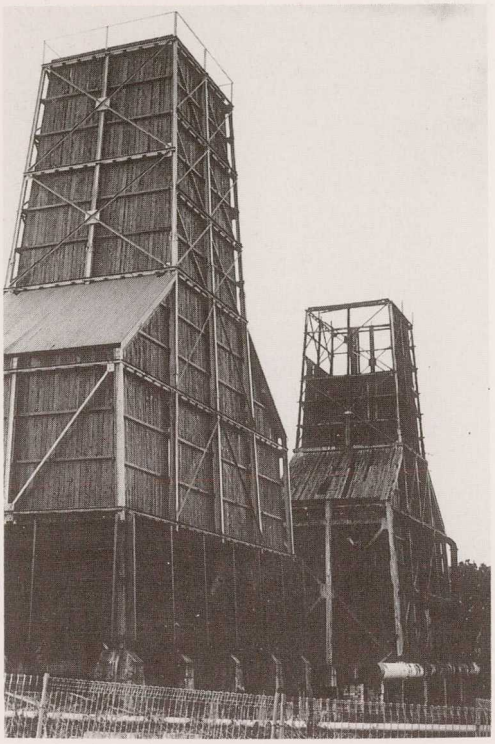
Richmond Main Power Station

The first priority at the Richmond Main site was the construction, in 1908, of a power house to supply the Pelaw Main Colliery. After the completion of the power house in 1912, the powering of equipment at Pelaw Main was gradually converted by 1929, from steam to electricity. John Brown's foresight was again evidenced in the siting of the power house at Richmond Main, contrary to his engineers' preferred site at Hexham where there was an adequate supply of cooling water. A pondage and cooling towers were constructed at Richmond Main. Modern practice has affirmed John Brown's concept of siting the power station where the coal to fire it is mined.

The original generating equipment at Richmond Main consisted of two Siemens 1000 kW alternators, and a 3000 kW unit was added in 1923. In 1927 rapid expansion of the mines, especially the Richmond Main, required the addition of a higher pressure 6000 kW unit and the 1000 kW and 3000 kW units were modified to operate at this higher pressure to provide a total generating capacity of 10 000 kW. New mechanically stoked boilers

Locomotive No. 17 approaching No.1 tunnel on the Richmond Vale Railway
(Photo by Department of Minerals and Energy)





Cooling towers, restored unit in foreground

also required the installation of a mechanical coal storage and handling system. The original brick chimney stack was superceded by a steel chimney and eventually demolished.

Richmond Main Colliery

The Administration Building was built in 1910 and the sinking of the 6.7 m diameter main shaft (No. 1 Shaft) at the Richmond Main Colliery commenced in 1912. The Homeville seam was intersected at a depth of 241 m and was 4.1 m thick. Production commenced in July 1914 with the establishment of the pit bottom and a production of 1000 tonnes for the month.

Despite his reputation for industrial toughness, John "Barron" Brown, the most powerful industrialist in Australia in the first quarter of this century, ensured that the miners in Richmond Main and Pelaw Main had the best working conditions in the field and the most up-to-date equipment. In 1926 Richmond Main set a world record for a shaft mine with 3454 tonnes of coal being wound up a single shaft in an 8-hour shift. The mine reached its peak production of 515 112 tonnes of saleable coal in the year 1928, when it employed a work force of 1200. Richmond Main Colliery was, at that time, the largest coal mine in Australia and a technological showpiece.

In 1967 Richmond Main was closed, the shafts sealed, and the headframes taken down. The track of the Richmond Vale Railway was also taken up for scrap and re-use.

The power station continued to generate power, supplying the company's other mines in the area, until 1976.

Restored headframe, Richmond Main No. 1 shaft

South Maitland Coalfield

In 1903 the few established mines in the South Maitland Coalfield produced 580 234 tonnes or 13% of the Northern District's output. By 1907 the ten collieries on the field produced 1 901 570 tonnes or 31% of the Northern District's output. The peak was reached in 1923 when the field produced 5 352 053 tonnes or 69% of the State's output.

In a hectic quarter of a century the South Maitland field grew, became the centre of coal production for the Australia's expanding heavy industries, and then went into a decline from which it never recovered. The terms South Maitland Coalfield and Northern District are no longer used; the former is now within the Newcastle Coalfield.

RECENT DEVELOPMENTS

Preservation of the South Maitland Coalfield's Heritage

In the early 1970's, a policy of the then Department of Mines required owners of derelict mines to rehabilitate sites by demolishing structures and mine waste dumps. However, by 1975, the Cessnock City Council was concerned that this policy was too extreme and would obliterate noteworthy buildings and structures so vital to Australia's mining and industrial heritage. Discussions between the Department of Mines, the Cessnock City Council, the National Trust, and the Richmond Main owners, Coal and Allied Industries Ltd, established a policy which allowed significant buildings and structures in the South Maitland Coalfield to be preserved. In 1976 Coal and Allied Industries Ltd donated the 19 ha site to the Council which now holds the freehold title.

The Minister for Planning and Environment directed that an interim development order be made to protect structures at Richmond Main. This was later converted to a Conservation order under the Heritage Act when introduced in 1979.

Between 1977 and 1979, $130,000 from National Estate grants, donations, and the Cessnock City Council were used to secure the site from vandals, to partly restore the Administration Building as accommodation for an on-site caretaker, and to salvage equipment from other mine sites.

Richmond Vale Preservation Co-operative (R.V.P.C.)

The Richmond Vale Railway Museum was inaugurated in 1979 as a club to re-establish the Richmond Vale Railway, and has now been incorporated as a registered co-operative, "The Richmond Vale Preservation Co-operative Society." Members have since laid 2 km of track and have materials on site for 3 km; R.W. Miller and Co. Pty Ltd has donated a further 5 km of track, yet to be lifted and transported to Richmond Main. Rolling stock collected includes the original Richmond Vale Kitson steam locomotives; two British ROD (Railways Operations Department) locomotives, 1908 and 1911, purchased after the Second World War; two industrial steam locomotives from Lysaghts Newcastle; and two steam crane locomotives which were used in the construction of The Broken Hill Proprietary Co. Ltd's Newcastle Steelworks in 1915.

Richmond Main Board of Management

The Richmond Main Board of Management was formed by the Cessnock City Council in 1980. It is chaired by Mr A.J. Frame, retired Deputy Mayor. Leading executives of major mining companies in the Hunter Valley have accepted positions as Board members. Mr J.G. Bailey, Chief Inspector of Coal Mines, is the Department of Minerals and Energy's representative on the Board, and two directors of the R.V.P.C. are also Board members.

In 1982 the Board developed a detailed concept for the restoration and development of Richmond Main as a major tourist attraction. The goals are to:

* preserve and restore the Richmond Main pit top as a Heritage Project of national significance;

* create a viable tourist attraction for the economic benefit of the Hunter Valley Region; and
* provide an educational interface between the public and the mining industry.

The concept envisaged an expenditure of $5 million for the complete project from 1983 to 1988.

Feasibility Study

A meeting, chaired by the Minister for Industrial Relations, determined that consultants should undertake a full feasibility study of the Board's concept, and in June 1983 the Minister accepted the consultants' findings. Richmond Main is an authentic part of the nation's heritage with original buildings and structures existing, albeit in need of maintenance and restoration, a position supported by the Minister.

Task Force Review

In late 1983, an independent task force reviewing the Board's preliminary application for funding under the Steel Regions Assistance Program (S.R.A.P.) recommended commencement with a minimum level of capital expenditure which would increase when justified by improved visitation levels.

In 1984 a tourism strategy plan for the Lower Hunter Region, formulated various types of tourist "trails" with Richmond Main as an example of an important "node" on the Heritage Trail.

Master Plan

Responding to the task force and tourist strategy plan, in mid 1984 the Board accepted, in principle, a six-stage Master Plan prepared by consultants and formally applied for S.R.A.P. funding. In 1986, $898,000 (equivalent to Stage 3 of the Master Plan) was granted as the minimum of funds to:

* make the site safe for the public;
* halt deterioration of structural members and building fabric in critical areas;
* provide basic visitor facilities; and
* enhance tourist potential.

Also in 1984 Coal and Allied Industries Ltd wished to dispose of its land surrounding Richmond Main. The Board, fearing that sale and clearing of the land would destroy both the original historic landscape of the isolated colliery surrounded by its pit prop forest, and the future growth potential, arranged with Coal and Allied Industries Ltd to withold the land from sale. Part of the Council's Bicentennial Grant was then used to purchase 40 ha of additional land.

Restoration projects were undertaken in 1984 and 1985 by the Hunter Development Board, through the Trades Apprentice Training Scheme.

The Centenary of the discovery of the Greta coal seam by T.W. Edgeworth David, which led to the establishment of the South Maitland Coalfield, was celebrated at Richmond Main in August 1986. The Joint Coal Board made a grant of $100,000 for the establishment of a small museum to mark the event.

During 1986 and 1987 a considerable amount of work was carried out through the S.R.A.P. grant.

Administration Building

The Bicentennial

The principal Bicentennial events in 1988 at Richmond Main were the opening of a small steam museum in the former locomotive shed stores and the formal opening of the first stage of the Richmond Vale Railway. A S.R.A.P. grant of $200,000 was made to the R.V.P.C. towards rebuilding the railway between Richmond Main and Pelaw Main. This work is proceeding using the volunteer labour force of the R.V.P.C.

The Future

In 1989 the Board recommended that the Cessnock City Council seek expressions of interest from private enterprise to operate the Richmond Main Historic Park Complex in partnership with the Richmond Vale Preservation Co-operative Society.

For further information about the project contact Graham Smith, Cessnock City Council, on (049) 90 2044.

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COAL RESOURCES DEVELOPMENT COMMITTEE

The **Coal Resources Development Committee** (CRDC) was established in 1979 by the New South Wales Government to provide it with advice on coal resources development, particularly relating to co-ordinating the planning of the State's rapidly expanding coal industry.

The terms of reference of the CRDC encompass the State and regional issues of:

* land use;
* exploration;
* resource allocation and recovery;
* infrastructure and transport systems;
* industry finance and government revenue;
* administrative procedures and regulation.

There are twenty-two members of the CRDC, the current Chairman being Mr Tony Galligan, Director Coal Division, Department of Minerals and Energy. The membership comprises representatives from State Government departments and authorities, coal producers, mining unions, and the Association of Coal Related Councils. Government organizations represented on the CRDC are the Departments of Planning, Minerals and Energy, and Public Works, The Treasury, the Premier's Department, the Department of Transport, the State Rail Authority, and the Roads and Traffic Authority.

The CRDC has produced a number of reports on major issues in the coal industry. Included is the 1986 report on rationalization of conflict between coal mining and urban development particularly in the Macarthur Region, and a review of this report in 1988. The most recently completed report prepared by a study group from the CRDC is "**A Strategic Study of the NSW Southern Coalfield**". It contains coal production forecasts for the Southern and Western Coalfields and an assessment of the capacity of the existing infrastructure to cope with anticipated production. Subcommittees are now studying a number of problems identified by the strategic study. A strategic study of the northern coalfields is now in progress, with a final report expected by the end of 1990.

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INVESTIGATION INTO SUBSURFACE EFFECTS OF MINING

In New South Wales, large reserves of coal lie under tidal lakes, stored waters, rivers, estuaries, and the Pacific Ocean. Many collieries also have more than one seam with economic potential. A comprehensive project on aspects of subsurface subsidence has just been completed by the Subsidence Engineering Section of the Department of Minerals and Energy. The results of this investigation will be useful in assessing the effects on a higher seam of mining a lower seam, and will help the Department process applications for mining under water bodies. The project was financed by the Commonwealth Department of Resources and Energy, Canberra, under a National Energy Research Development and Demonstration Council (NERDDC) grant of $490,260 (refer *Minfo 14*, p. 40).

The main objectives of the investigation were:

* to collect information on strata behaviour above caved longwall faces,
* to study the variation of subsurface subsidence and the associated vertical strains; and
* to measure mining-induced strata fracturing and permeability.

The work program measured bulk permeability of strata before and after mining, and monitored the movement of anchors installed in a vertical borehole.

The investigation was successfully carried out in four collieries reflecting different geological and mining environments: Ellalong and Wyee Collieries in the Newcastle Coalfield, Invincible Colliery in the Western Coalfield, and Tahmoor Colliery in the Southern Coalfield.

In the past Australian research undertaken to understand the mechanism of subsurface subsidence has yielded only limited results. The multi-wire borehole instrumentation system was successfully used in this investigation to monitor large displacements within the overburden associated with caved longwall faces.

MAIN FINDINGS AND CONCLUSIONS

Caving Behaviour

As longwall roof supports are advanced, the unsupported roof strata break and collapse, under the influence of gravity, into the cavity formed by the extraction of the coal seam. The process of collapse of roof strata is referred to as caving, and the height to which it extends above the extracted seam roof is called the caving height.

Because solid strata break into fragments, the volume after collapse increases. The ratio of the volume of broken strata to the original pre-mining volume of the same strata is referred to as the bulking factor. The bulking factor varies with rock type, shape, and size of the caved rock fragments, the way in which the rock fragments are piled up, and the pressure exerted on them. The more disorderly the arrangement of fragments, the larger the bulking factor. The size and the uniformity of arrangement of caved fragments influence caving height.

The zone of caving and bed separation monitored in two cases was nine and thirteen times the extracted seam thickness. The average overall bulking factor in the caving zone was less than 1.06. These caving heights are significantly larger than the caving height

of two to five times the extracted seam thickness reported in the British coalfields. The difference appears to be due to the more competent seam roof strata in New South Wales caving with much smaller bulking factors than the weak seam roof strata generally found in the United Kingdom.

Subsurface Subsidence and Vertical Strains

The magnitude and distribution of subsidence and strains were established in all cases. Figures 11 and 12 show typical subsidence and strain contours within the overburden.

If tensile strain in excess of 2.5 mm/m represents fractured rock which has deformed non-elastically, then the indications are that the overburden of at least 110 m at the Tahmoor borehole and 75 m at the Ellalong borehole would be free from inelastic deformation, and that the strata would maintain their structural integrity even after undermining.

The regions of larger dilations were separated by regions of compression or low tensile strains. This means that even if the strata undergoing relatively larger dilations fractured, these fractured beds would be sandwiched between beds undergoing small dilations or beds which were in compression. In this situation, vertical continuous hydraulic connections extending from the surface to mine workings are unlikely to develop in the overburden.

Geology Dependence of Subsidence

The strain contours were layered in all boreholes (figure12), and indicate a correlation between strata dilation and geology. At the Invincible borehole, larger strains were associated with layers of sandstone, siltstone, and conglomerate, whilst smaller strains were indicated by layers of mudstone, claystone, and coal which subsided in blocks.

Generalizing the above observation, overburden consisting of competent strata, such as massive sandstone and conglomerate, capable of accommodating large vertical strains is likely to subside less and result in less surface subsidence. Conversely, overburden consisting of weak mudstone and claystone is likely to develop larger surface subsidence.

Mining-Induced Strata Fracturing and Permeability

Fracturing expressed as a Rock Quality Designation (RQD) factor and/or number of fractures per metre length was more in cores of the after-mining borehole compared with that in cores of the before-mining borehole. Mining under deep cover caused only a slight increase in near-surface strata fracturing.

There was a general increase in permeability after mining throughout the overburden in the three cases investigated. However, no correlation was observed between increase in fracturing and increase in permeability. Both the RQD fracture quantification method and the frequency of fractures per unit length were found to be lacking as a means of establishing correlation between fracturing and changes in permeability.

POTENTIAL FOR APPLICATION

Application of the investigation results is likely to improve coal recovery in the situations specified earlier, and lead to the development of more reliable models for predicting the extent of subsurface subsidence.

The End of Grant Report was submitted to the Commonwealth Department of Primary Industry and Energy in November 1989.

For further information, contact Dr Lax Holla, Principal Subsidence Engineer, on (02) 240-4456. Copies of the reports can be obtained from the Department of Primary Industry and Energy, Canberra City, ACT.

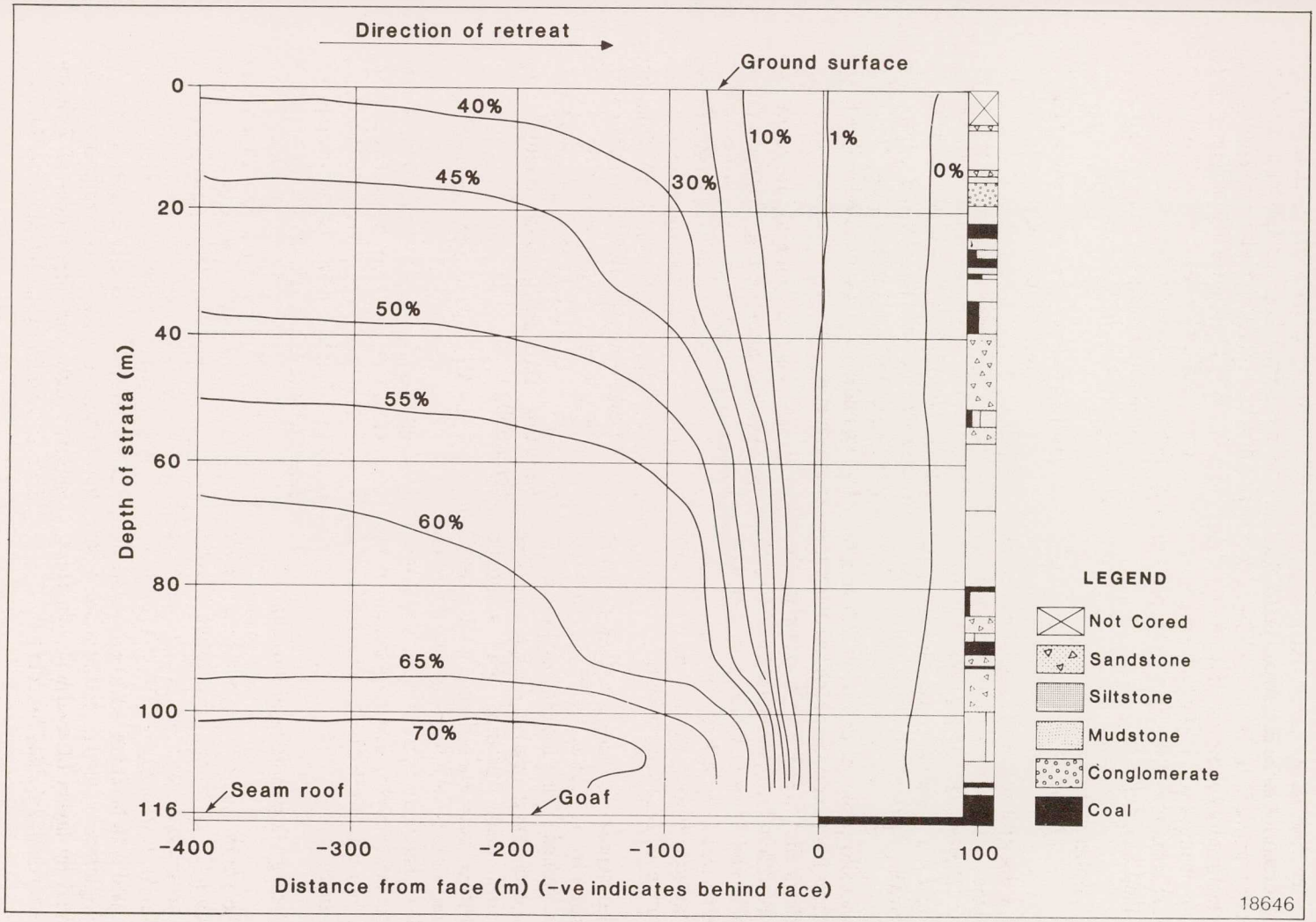

Figure 11. Vertical movement in the overburden as a percentage of the extracted seam thickness

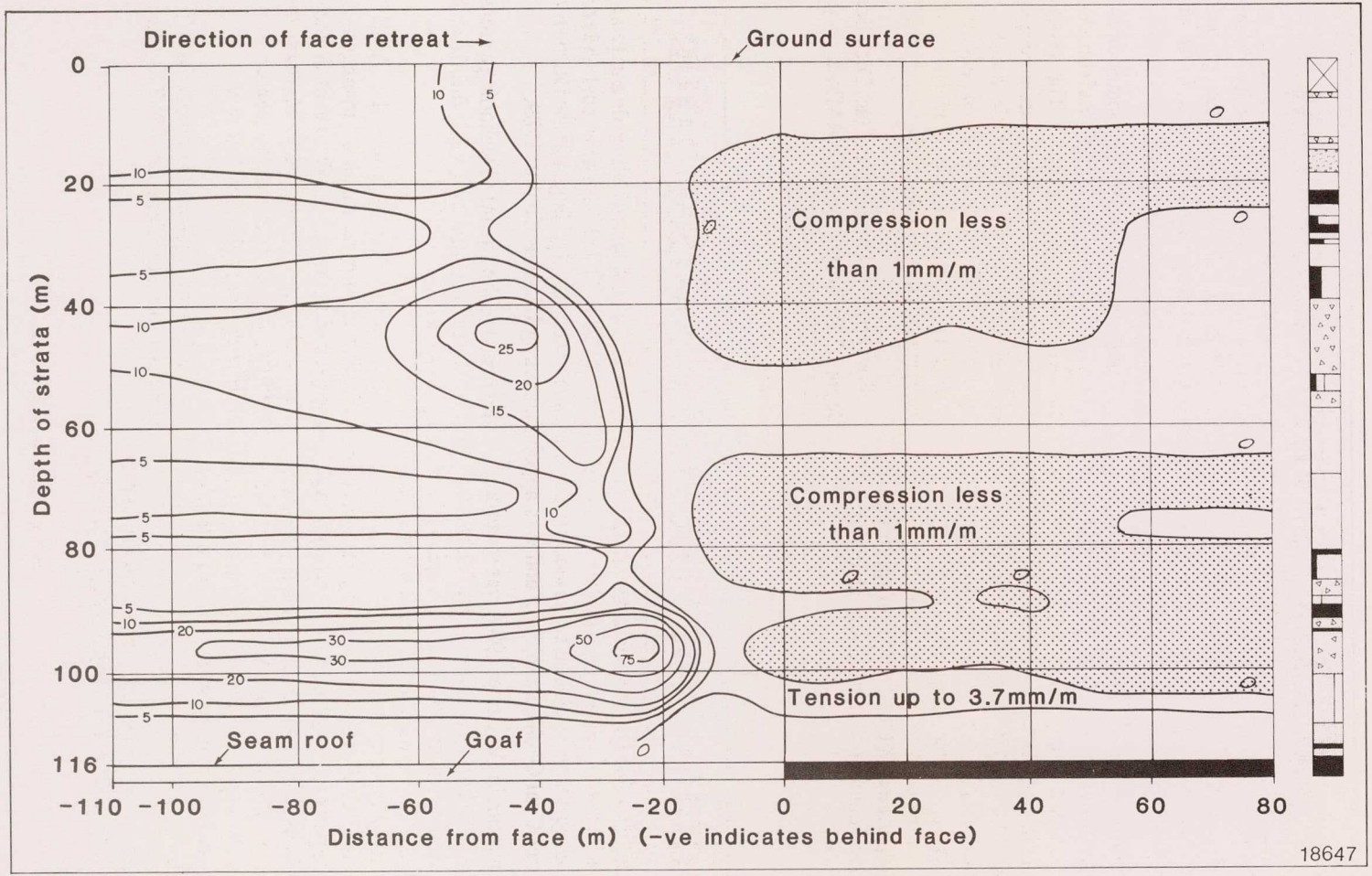

Figure 12. Contours of vertical dilution (mm/m) in the overburden

COLLIERY SAFETY SYMPOSIUM

The 11th Annual Colliery Safety Symposium was held at the Macquarie University Union on Tuesday, 24th October, 1989, with 257 delegates attending. The delegates consisted of safety specialists from operating collieries as well as Inspectors and representatives from mine management.

Mr John Cramsie, the then Acting Deputy Director-General (Minerals), Department of Minerals and Energy, opened the symposium on behalf of the Director-General, Mr G. Rose. In his address Mr Cramsie pointed out that "Good Safety is Good Business" and that where there is good management there is good safety. Mr Cramsie also spoke of the involvement of the Department's Coal Mining Inspectorate in the development of computerized analysis of accidents.

The theme of the 1989 Symposium was "**A safe and healthy working environment–learning through sharing**". The program included papers from the operations, research, medical, training, and academic areas. An **Open Forum** was held, with mining equipment suppliers giving short presentations on their contribution to operator safety.

For further information contact Dick Scott, Deputy Chief Inspector of Coal Mines, on (02) 240 4350.

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DIRECTOR COAL ON JAPANESE TOUR

Mr Tony Galligan, the then Acting Director Coal of the Department of Minerals and Energy, was selected as the special invitee for a 10 day study tour of the Japanese coal industry. Mr Galligan who has broad experience in the Australian coal industry, began in the Department as Chief Coal Geologist in 1983 and was appointed Acting Director Coal in 1989.

The tour, in December 1989, was sponsored by the New Energy and Industrial Technology Development Organization (NEDO), a Japanese Government organization which has previously co-ordinated study tours of the Australian coal industry by representatives of the Japanese coal sector. NEDO has established the Australian Coal Industry Trainee (AUSCIT) Program to introduce Australians to the Japanese coal industry, and the December tour was the inaugural tour of Japan.

The tour schedule was varied and comprehensive. Mr Galligan was particularly interested in the advanced technology areas of coal-water mixtures and coal fluidized bed combustion.

The tour also enabled the AUSCIT participants to meet Japanese managers who are preparing for a NEDO tour of Australia. The exchange of knowledge between these two groups will promote greater mutual understanding of the coal industry.

For further information contact Mr Tony Galligan, Director Coal, on (02) 240 4122.

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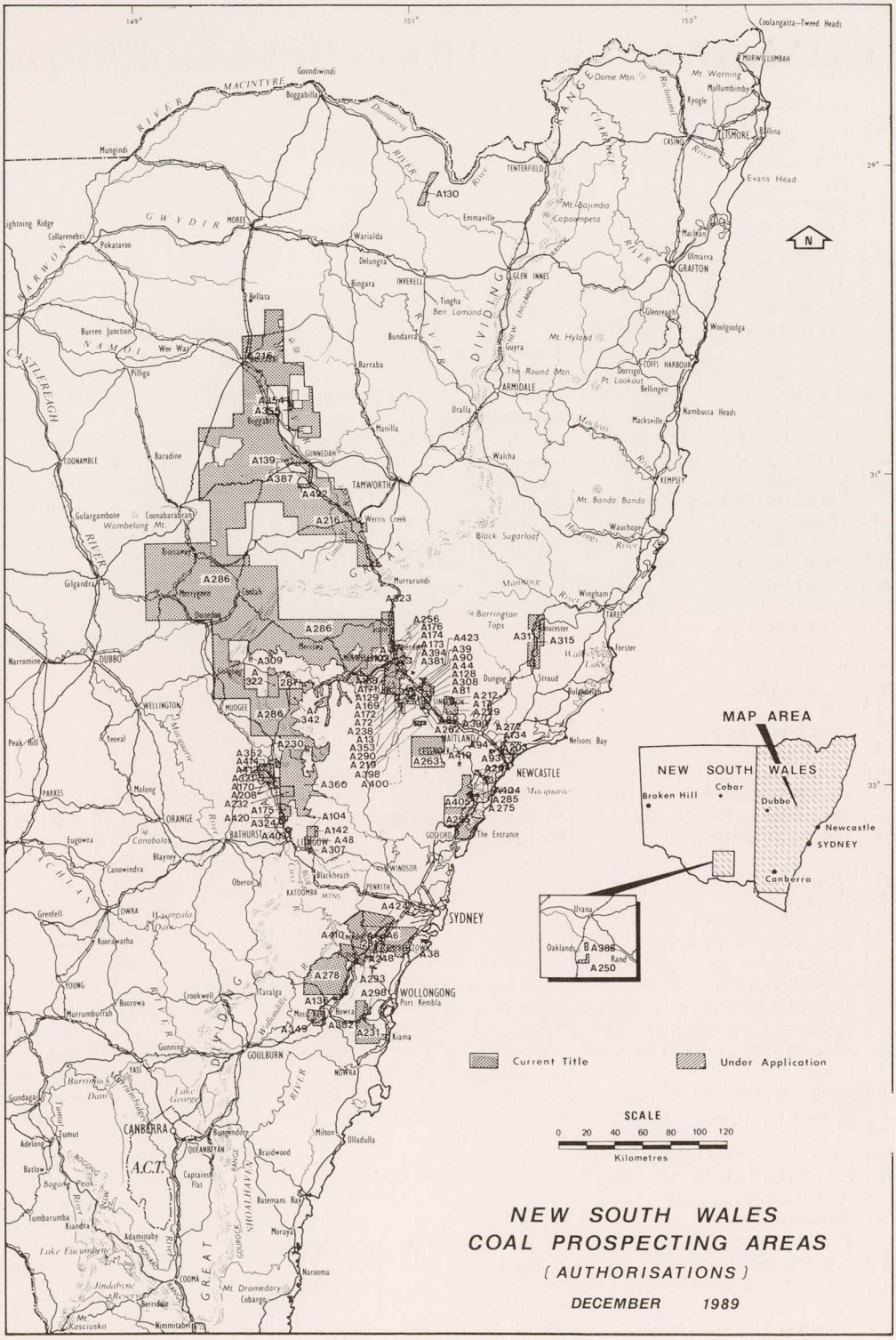
COAL AUTHORISATIONS DECEMBER 1989

No.	Holders	Nearest town
A6	Dep. Mineral Resources	Campbelltown
A13	Coal & Allied Operations P/L	Warkworth
A17	Barix P/L	Singleton
A30	Macdonald Bros P/L	*
A39	Consolidated Goldfields Aust. Ltd	Ravensworth
A44	Australian Mining Investments Ltd	Camberwell
A48	Austen & Butta Ltd	Lithgow
A72	BP Coal Development Aust.	Jerrys Plains
A81	Southland Coal P/L	Camberwell
	Toyota Tsyho Corp.	
A89	Bloomfield Collieries P/L	Singleton
A90	Consolidated Goldfields Aust. Ltd	Ravensworth
A93	R.W. Miller & Co. P/L	Beresfield
A94	R.W. Miller & Co. P/L	Beresfield
A102	Dep. Mineral Resources	Muswellbrook
A104	Electricity Commission of N.S.W.	Lithgow
A128	Gunnedah Coal Co. Ltd	Camberwell
A129	Carpentaria Exploration Co. P/L	Denman
A130	White Industries Ltd	Ashford
A134	R.W. Miller & Co. P/L	Beresfield
A136	Macdonald Brothers P/L	Mittagong
A139	Gunnedah Coal Co. Ltd	Gunnedah
A142	Electricity Commission of N.S.W.	Lithgow
A149	Electricity Commission of N.S.W.	*
A168	Electricity Commission of N.S.W.	Muswellbrook
A169	Electricity Commission of N.S.W.	Muswellbrook
A170	Genders Mining P/L	Capertee
A171	Bayswater Colliery Co. P/L	Muswellbrook
A172	Bayswater Colliery Co. P/L	Jerrys Plains
A173	Thiess Bros. P/L	Muswellbrook
A174	Mount Sugarloaf Collieries P/L	Muswellbrook
A175	Electricity Commission of N.S.W.	Ben Bullen
A176	Muswellbrook Coal Co. Ltd	Muswellbrook
A203	Dep. Mineral Resources	Raymond Terrace
A204	Dep. Mineral Resources	Toronto
A208	Genders Mining P/L	Capertee
A212	Barix P/L	Singleton
A216	Dep. Mineral Resources	Gunnedah
A219	Newcastle Wallsend Coal Co.	Bulga
A229	Dep. Mineral Resources	Singleton
A230	Dep. Mineral Resources	Rylstone
A231	Electricity Commission of N.S.W.	Robertson
A232	Western Main Collieries P/L	Capertee
A238	Electricity Commission of N.S.W.	Ravensworth
A248	Australian Iron & Steel P/L	Menangle
A250	Mitsubishi Development P/L	Oaklands
A255	Electricity Commission of N.S.W.	Wyong
A256	The Bellambi Coal Co. Ltd	Aberdeen
A261	Esso Exploration & Production Aust. Inc.	*
A262	Esso Exploration & Production Aust. Inc.	Warkworth
A263	Dep. Mineral Resources	Wollombi
A272	R.W. Miller & Co. N.L.	Beresfield
A275	Electricity Commission of N.S.W.	Toronto
A278	Dep. Mineral Resources	Mittagong
A281	Dep. Mineral Resources	Camden
A285	Dep. Mineral Resources	Toronto
A286	Dep. Mineral Resources	Gulgong
A287	Austen & Butta Ltd	Bylong
A290	The Nardell Colliery P/L	Ravensworth
A293	Australian Iron & Steel P/L	Appin
A298	Electricity Commission of N.S.W.	Robertson
A307	Hartley Valley Coal Co. P/L	Lithgow
A308	Southland Coal P/L	Camberwell
A309	Ulan Coal Mines Ltd	Ulan
A311	B.M.I. Mining P/L	Gloucester
A315	B.M.I. Mining P/L	Gloucester
A321	Genders Mining P/L	Capertee
A322	Electricity Commission of N.S.W.	Bylong
A323	Electricity Commission of N.S.W.	Murrurundi
A324	Clutha Coal P/L	Ben Bullen
A342	Austen & Butta Ltd	Bylong
A349	Austen & Butta Ltd	Sutton Forest
A352	The Kandos Coomber Mining Co. P/L	Clandulla
A353	Carpentaria Exploration Co. P/L	Jerrys Plains
A354	Coal Cliff Collieries P/L	Boggabri
A355	BHP Minerals Ltd	Boggabri
	Agip Coal Australia P/L	
	Idemitsu Boggabri Coal P/L	
A360	Dep. Mineral Resources	Rylstone
A373	Wambo Mining Corporation P/L	*
A381	Coal & Allied Operations P/L	Jerrys Plains
A382	Southern Portland Cement P/L	Moss Vale
A387	Gunnedah Coal Co. Ltd	Gunnedah
A388	The Coal Cliff Collieries P/L	Oaklands
	Mitsubishi Development P/L	
A390	Dep. Mineral Resources	Singleton
A394	BP Coal Development Australia P/L	Muswellbrook
A398	Wambo Mining Corporation P/L	Warkworth
A400	Dep. Mineral Resources	Jerrys Plains
A404	Newcom Collieries P/L	Morisset
A405	Dep. Mineral Resources	Cooranbong
A409	Clutha Coal P/L	Wallerawang
A410	B.P. Coal Development Pty Ltd	Lithgow
A412	Genders Mining P/L	Ilford
A414	Kandos Coomber Mining Co. P/L	Kandos
A419	Newcastle Wallsend Coal Co. P/L	Cessnock
A423	Hunter Valley Coal Corporation	Ravensworth

AUTHORISATION APPLICATIONS

No.	Applicant	Nearest town
38	Bulli Main Colliery P/L	Heathcote
420	Clutha Coal P/L	Ben Bullen
422	Preston Coal Co. P/L	Gunnedah
424	Department of Minerals & Energy	Campbelltown

Note: Section 21A Authorisations are not listed.
* Section 20 Authorisations over colliery holdings (not shown in diagram)



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CURRENT COAL MINING PROPOSALS

Company	Location	Coal type	Mine type	Development stage
Barix Pty Ltd	Mitchells Flat, 12 km northeast of Singleton	Thermal/ Coking	Underground	A
Bloomfield Collieries Pty Ltd	Rixs Creek, 3 km northwest of Singleton	Thermal/ Coking	Open cut	D*
Boggabri Joint Venture Venture	15 km northeast of Boggabri	Thermal	Open cut & underground	C*
Camberwell Joint Venture	Camberwell, 10 km northwest of Singleton	Thermal/ Coking	Open cut	B*
Coal & Allied Industries Ltd	Hunter Valley No. 2, 17 km west of Singleton	Thermal/ Coking	Open cut	E
Coal Cliff Collieries Pty Ltd	Maules Creek, 20 km northeast of Boggabri	Thermal	Open cut	B*
Dartbrook Joint Venture	Dartbrook, near Aberdeen north of Muswellbrook	Thermal	Underground	A
Electricity Commission of New South Wales	Mount Arthur North, 6 km southwest of Muswellbrook	Thermal	Open cut	A
Renison Gold Fields Australia Ltd	Glendell, 17 km northwest of Singleton	Thermal/ Coking	Open cut	C
Gloucester Joint Venture	Stratford & Wards River, 12-24 km south of Gloucester	Thermal	Open cut	A
Maitland Main Collieries Pty Ltd	Glennies Creek, 12 km northwest of Singleton	Coking	Underground	A
MIM Holdings Ltd	Denman, 17 km south of Muswellbrook	Thermal/ Coking	Underground	A
Mount Arthur South Joint Venture	Mount Arthur South, 12 km south of Muswellbrook	Thermal	Open cut	D*
Newcastle Wallsend Coal Co. Pty Ltd	Bulga, 15 km southwest of Singleton	Thermal/ Coking	Open cut	A
Novacoal Australia Pty Ltd (KCC)	Howick, Southern Extension, 20 km northwest of Singleton	Thermal/ Coking	Open cut	B*
Oaklands Joint Venture	Oaklands, 100 km northwest of Albury	Thermal/ Conversion	Open cut	A
Pacific Copper Ltd	Westside, near Killingworth	Thermal	Open cut	A
Pacific Copper Ltd	Wakefield, near Wakefield	Thermal/ Coking	Underground	A
Southland Coal Pty Ltd	Bellbird South, 5 km southwest of Cessnock	Thermal/ Coking	Underground	A
Wambo Mining Corporation Pty Ltd	Wambo, Homestead area, 15 km west of Singleton	Thermal/ Coking	Underground	B*

* Development stage has advanced since publication of the previous schedule (1st July,1989)

BOGGABRI JOINT VENTURE:	BHP Minerals Ltd (50%), Agip Coal Australia Pty Ltd (25%) Idemitsu Boggabri Coal Pty Ltd (25%)
CAMBERWELL JOINT VENTURE:	Southland Coal Pty Ltd (50%) Toyota Tsusho Corp. of Japan (50%)
DARTBROOK JOINT VENTURE:	Austen & Butta Ltd (50%) Shell Co. of Aust. Ltd (50%)
GLOUCESTER JOINT VENTURE:	BMI Mining Pty Ltd (51%) Esso Exploration & Production Australia Inc. (49%)
MT ARTHUR SOUTH JOINT VENTURE:	Elcom Collieries Pty Ltd (50%) Ampol Ltd (17.5%) Pioneer Concrete Services Ltd (17.5%) Unallocated (15%)
OAKLANDS JOINT VENTURE:	CRA Ltd (60%) Mitsubishi Development Pty Ltd (40%)

Notes: 1. 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.

2. This table excludes other projects which are either still in the exploration or very preliminary assessment stage.

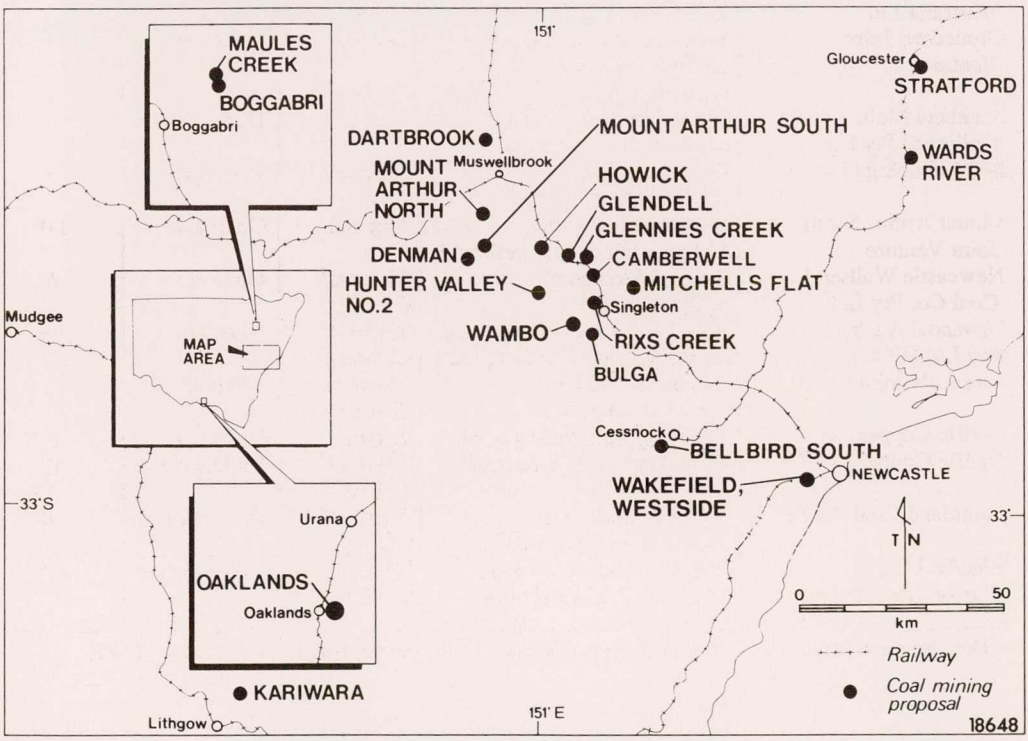

Figure 13. Current coal mining proposals

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CHANGES TO COAL MINE OWNERSHIP

The ownership of New South Wales coal mines continues to undergo change as part of the rationalization brought about by a period of financial losses. Table 1 lists the more important changes to ownership of coal mines since 31st July, 1989. The table is correct as at 31st December, 1989.

TABLE 1

RECENT AND PROPOSED CHANGES TO COAL MINE OWNERSHIP IN NEW SOUTH WALES

Colliery/ Project name	Previous interests		New interests	
Airly Mountain	BP Coal Development Australia Ltd	100%	CRA Ltd	100%
Clarence	Oakbridge Ltd	51%	Oakbridge Ltd	100%
	BP Coal Development Australia Ltd	49%		
Glendell	Dalgety Australia Operations Ltd	50%	Renison Goldfields Consolidated Ltd	100%
	Renison Goldfields Consolidated Ltd	50%		
Howick	BP Coal Development Australia Ltd	100%	CRA Ltd	60%
			Mitsubishi Development P/L	40%
Muswellbrook No. 2	Muswellbrook Energy and Minerals Ltd	100%	Idemitsu Kosan Co Ltd	100%
Tahmoor	BP Coal Development Australia Ltd	100%	CRA Ltd	100%
Western Main	BP Coal Development Australia Ltd	100%	CRA Ltd	100%
Warkworth	Costain Australia Ltd	25%	Costain Australia Ltd	28.75%
	T&G Mutual Life Society	20%	Mitsubishi Development P/L	22.75%
	Mitsubishi Development P/L	19%	Minproc Holdings Ltd	20%
	H.C. Sleigh Resources Ltd	15%	Wales Resources Fund	15%
	Wales Resources Fund	15%	Nippon Steel Australia P/L	7.5%
	Mitsubishi Mining and Cement (Aust.) P/L	6%	Mitsubishi Mining and Cement (Aust.) P/L	6%
Preston Extended	R.W. Miller and Co.	100%	Europa Minerals Group	50%
			Private interests	50%

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MINI SOSIE SEISMIC SURVEY AT JERRYS PLAINS

The Mini Sosie seismic technique, although using conventional geophones, uses a portable modified tamper as an energy source instead of shot holes and explosives. The frequency of the Mini Sosie seismic source can be adjusted to obtain optimal performance for specific survey areas. As a consequence of not requiring explosives and the drilling of shot holes, the technique is faster, less costly, and more environmentally acceptable than shot-fired techniques.

In August 1989, the Coal Geology Branch surveyed three lines using the Mini Sosie Seismic technique in the Jerrys Plains area in the Hunter Coalfield (figure 14). The survey aimed to define more precisely the location and attitudes of faults inferred from drilling during 1988. The subsurface structure interpretations based on the drilling and the seismic survey will assist in determining the economic potential of coal resources in the area.

The drilling program was designed principally to test the open cut coal resource potential of the Whybrow and Redbank Creek seams and possible underground resources in the Wambo and Whynot seams in an area close to Jerrys Plains village. Three fully cored holes (DM Jerrys Plains DDH 9, 10, and 11) were drilled to depths of between 100 and 350 m in the Department's Authorisation 400.

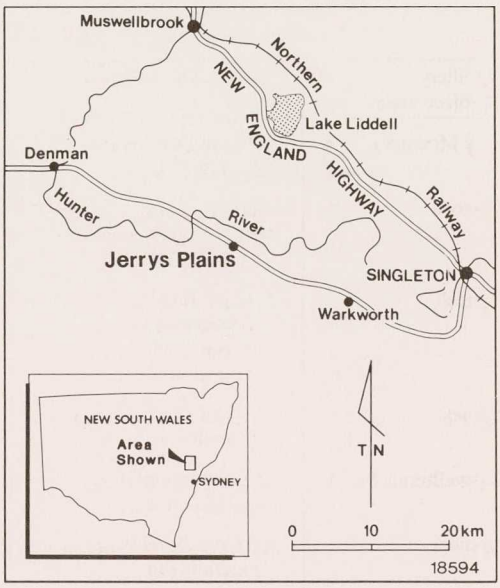

Figure 14. Locality diagram, Jerrys Plains area

Correlation of the coal seams intersected during the drilling program and in previous boreholes in the area indicated the presence of major structural features. The Doyles Creek 1:25,000 Geological Sheet shows three inferred faults crossing the area in a northeast-southwest direction. The 1988 exploration program indicated the presence of an additional major fault striking northwest-southeast.

Approximately 6.5 km of Mini Sosie profiling were conducted on three lines – A, B, and C (figure 15). The lines were designed to intersect the inferred faults at right angles in order to obtain the highest definition. The ramming, or shot, interval was 10 m, and was designed to identify coal seam reflectors at depths of between 100 to 350 m.

Preliminary results of the survey indicate high-quality data showing clear reflectors. The presence of a fault on line B in the order of 100-150 m is indicated. On line C a series of graben-like faults is clearly indicated (figure 16).

The interpretation of the seismic lines is continuing. For further information contact Julie Moloney, Geologist (Hunter), on (065) 72 4200.

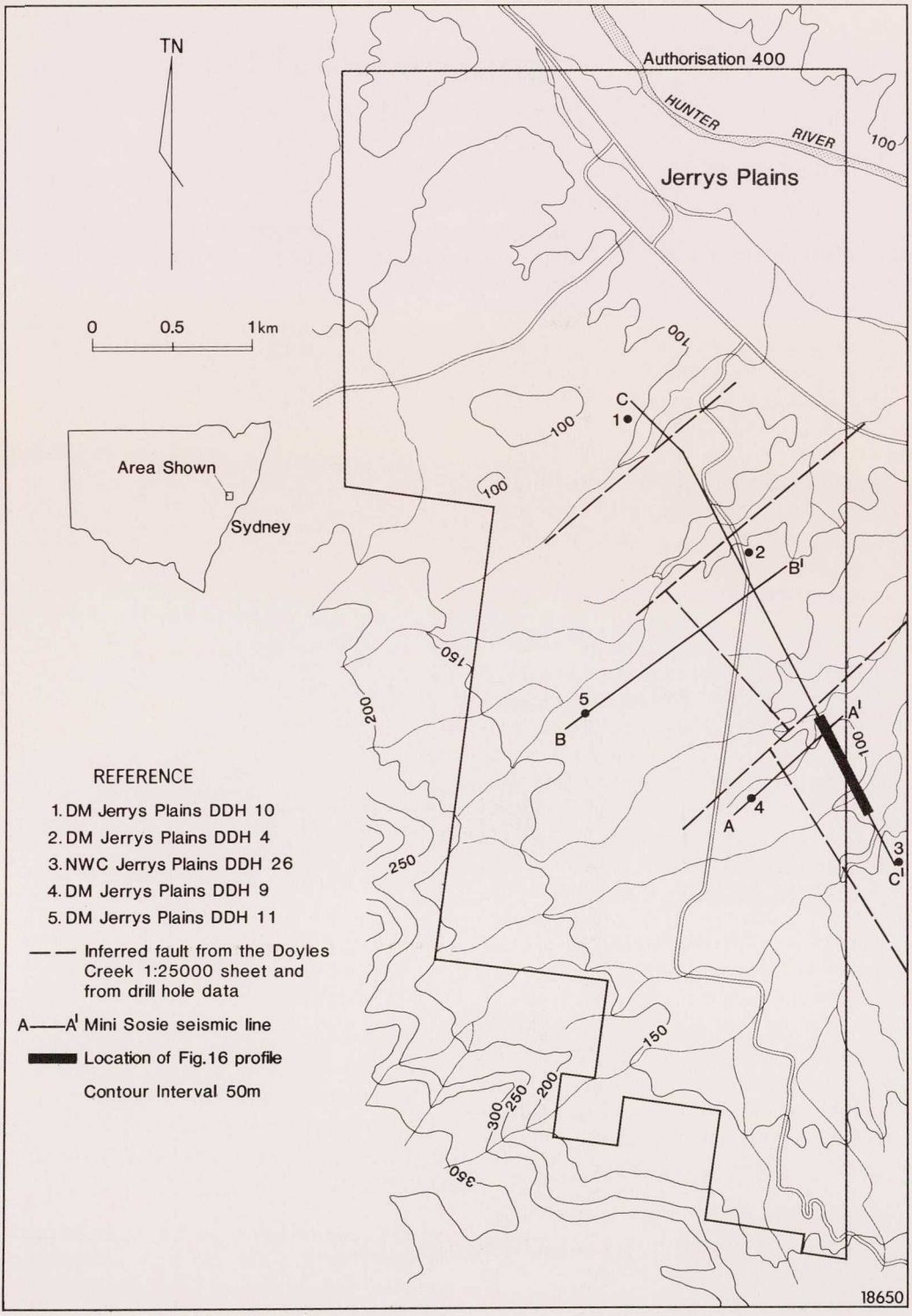

Figure 15. *Location of Jerrys Plains study area, boreholes, and mini Sosie seismic survey*

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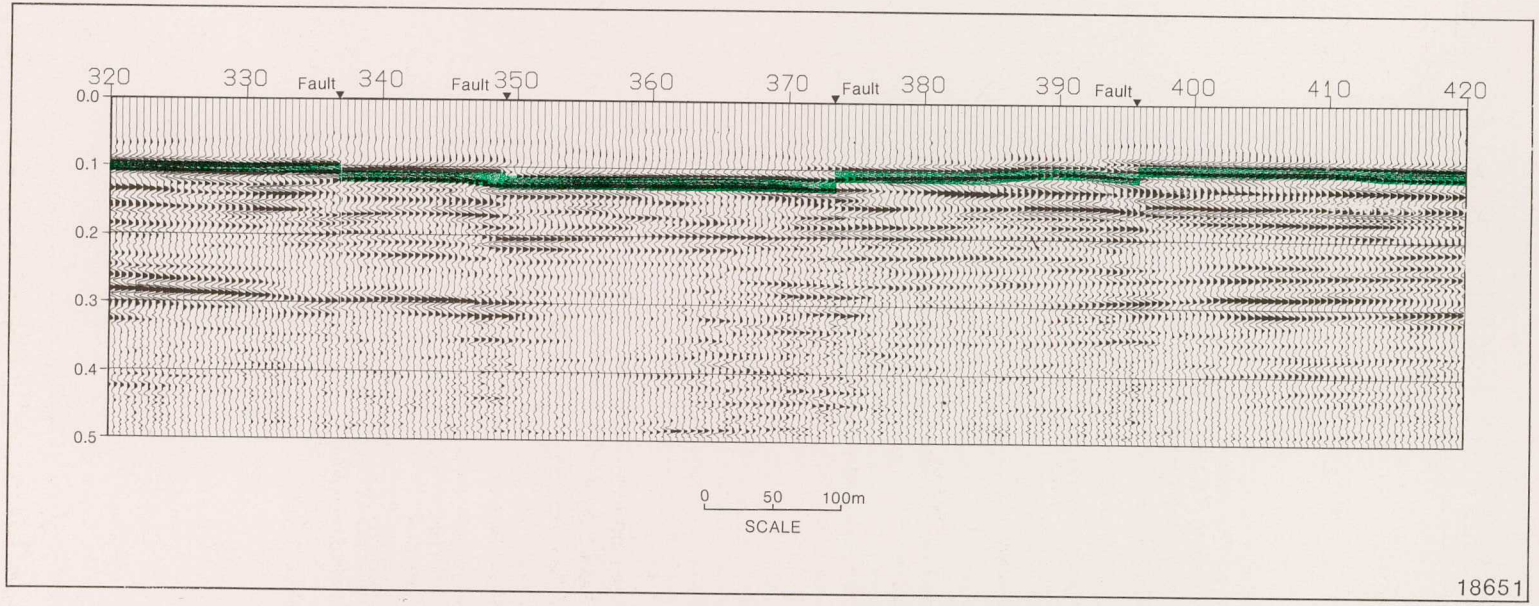


Figure 16. *Seismic survey data set. Part of line C showing graben-like faults. Looking northeast*

PETROLEUM EXPLORATION LICENCES DECEMBER 1989

PETROLEUM EXPLORATION LICENCES

No.	Holder	Area (km²) *	Expiry date
PEL 182	Gel Oil P/L, Oil Co. of Australia N.L., Ampol Exploration Ltd, Tennscourt Oil P/L, Winton Oil N.L., Poseidon Oil P/L	9 700	14.3.1990
PEL 221	Consolidated Petroleum (Aust.) N.L., The Australian Gas Light Co.	2 650	16.3.1990
PEL 238	"	9 900	31.8.1990
PEL 239	"	3 072	31.8.1990
PEL 246	Comserv (No. 779) P/L	9 550	14.11.1990
PEL 247	"	9 550	14.11.1990
PEL 250	"	9 660	14.11.1990
PEL 251	"	10 000	14.11.1990
PEL 253	"	9 450	14.11.1990
PEL 254	"	10 000	14.11.1990
PEL 255	The Australian Gas Light Co. Sydney Ltd	3 710	8.3.1990
PEL 258	Endeavour Resources Ltd, Claremont Petroleum N.L., Basco Energy Inc., Charterhall Oil Aust. P/L	2 950	6.1.1991
PEL 259	The Australian Gas Light Co. Consolidated Petroleum (Aust.) N.L.	8 297	6.1.1991
PEL 260	The Australian Gas Light Co. Sydney Ltd	7 660	8.3.1990
PEL 267	Sydney Oil Co. (N.S.W.) P/L, Manvane P/L, Base Resources Ltd, Seahawk Oil Aust. N.L., Reading and Bates Petroleum Co.	7 000	19.1.1990
PEL 276	Petroleum Resources Pty Ltd	1 350	16.4.1991

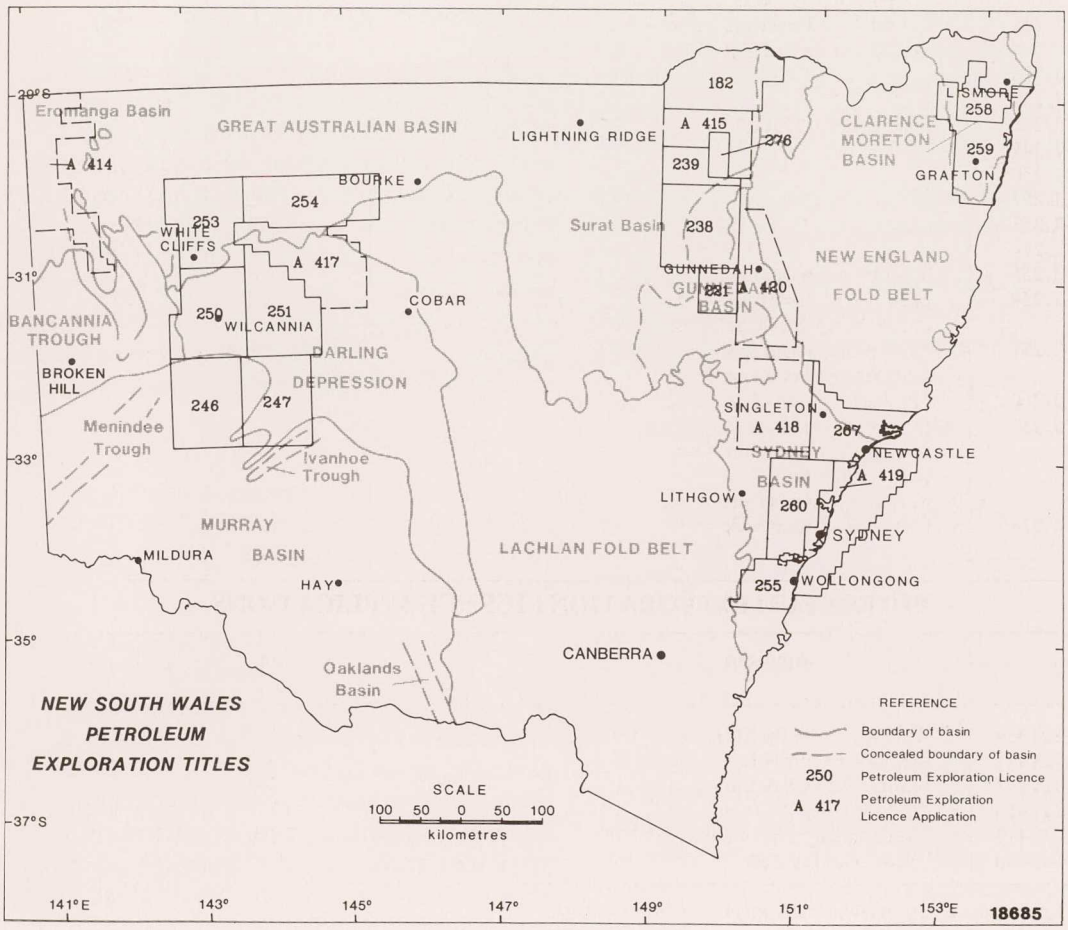
PETROLEUM EXPLORATION LICENCE APPLICATIONS

No.	Applicant	Area (km²)*	Application date
PELA 414	Cluff Resources Pacific Ltd	10 000	6. 8.1987
PELA 415	Beach Petroleum N.L.	7 012	26. 8.1987
PELA 417	Western Gulf Oil & Mining Ltd	10 000	6. 7.1988
PELA 418	The Electricity Commission of N.S.W.	9 900	20. 9.1988
PELA 419	The Electricity Commission of N.S.W.	2 300	20. 9.1988
PELA 420	Tasman Gas Pty. Ltd.	9975	17.2.1989

* Total area, i.e. area available plus exclusions where relevant

PETROLEUM EXPLORATION PERMITS

No.	Applicant	Area	Issue date
P10	Santos Ltd, Ampol Exploration Ltd	148 graticular blocks	25.1.1995



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NATURAL GAS FOR POWER GENERATION*

Natural gas (methane, CH_4) is an inherently clean burning fuel. It has a high ratio of hydrogen to carbon and, on combustion, produces less carbon dioxide (CO_2) and other pollutants than a thermally equivalent amount of oil or coal. Considering the contribution of CO_2 emissions to the greenhouse effect, natural gas could play an increasingly important role in the area of power generation.

Gas turbines have been used for electricity generation since the 1930's, and modern gas turbines have demonstrated a high reliability when operated on clean fuels such as natural gas. Several types of gas turbines can be used:

* simple-cycle gas turbine plants in which the hot exhaust gases drive the turbine;
* combined-cycle gas turbine plants in which the hot exhaust gases from a simple gas turbine generator are further used to make steam in a steam turbine generator.

SIMPLE-CYCLE GAS TURBINE PLANT

Industrial Gas Turbine Plant

Simple-cycle gas turbine plants generate electricity at lower capital cost but consume more fuel than gas-fired steam cycle plant because of the lower thermal efficiencies (up to 30% compared with up to 39% for the steam cycle). The plants are relatively cheap, come in small unit sizes, and can be installed quickly. Their fast start-up capability makes them useful for electricity generation during periods of high demand (peak loads), but their smaller unit size limits their suitability for satisfying large base-load demands.

Aero-Derivative Gas Turbine Plant

Aero-derivative gas turbine generators are adapted aircraft engines capable of generating 25-35 MW. These generators generally have a fuel comsumption about 10% better than industrial gas turbine plants of the same capacity, however, the savings in fuel costs are offset by increased replacement costs for more highly loaded components. It is possible to do the more specialized maintenance required on a changeover engine basis using commercial aircraft servicing facilities.

COMBINED-CYCLE PLANT

In a combined-cycle power station some of the waste heat of the gas turbine is used in a steam turbine to increase overall cycle efficiency.

Gas turbine exhaust gas is typically at about 500°C and heat recovery boilers have been developed to generate steam from gases at this temperature. The heat recovery steam generator, or waste heat boiler, can produce steam for other uses or power a conventional steam turbine driving a separate generator, the plant then being called a "combined-cycle plant". The steam leaving the turbine is condensed and recycled to the boiler in the normal way. Steam temperatures and pressures

* Article adapted from Keynote Address, "Natural Gas and Combined-Cycle Power Generation" by Mr M.H. Thomas, Chairman Electricity Council, and Member of State Energy Advisory Council. Address presented at The Australasian Institute of Mining and Metallurgy Seminar "Mineral Fuels and the Greenhouse Effect" on 26th July, 1989.

in combined-cycle plant are low in comparison with those of conventional steam-cycle plant and the boiler is considerably less complex and physically smaller.

The combination of two or three gas turbines with one steam turbine results in overall plant thermal efficiencies of about 42%, though efficiencies of 44% and more have recently been reported or predicted. About one-third of the electrical output from combined-cycle plant is generated by the steam turbine. Separate boilers for each gas turbine are used so that the steam turbine can still operate when one gas turbine is out of service.

GAS TURBINES IN POWER GENERATION

Combined-cycle plants are creating considerable interest at present. They are thermally more efficient than coal-fired plants, produce less pollution, and require less capital per unit of output. However, at present, natural gas is considerably more expensive than coal. There is likely to be, nevertheless, a considerable role for combined-cycle stations in the future, and here Australia will be following the lead given in the United States and increasingly in Europe.

Developments in gas turbine plants in the last 10 years have increased efficiencies from about 25% to 30%, and outputs to more than 100 MW. The improved performance has been achieved by the use of higher pressure ratios, improved materials for the hot components, and additional cooling of the blades.

It is expected that gas turbine plants will continue to be improved during the next decade, with consequent further reductions in cost per unit of output. One major manufacturer predicts the development of gas turbine generators of 260 MW capacity and 33% simple cycle thermal efficiency within this period. These technical developments, particularly the increase in unit size, are expected to give a price advantage to gas turbine plants, particularly in combined-cycle configuration, over conventional steam plants.

The electricity generating capacity of gas turbine generators is dependent on the mass flow of air which is ingested, and the maximum allowable turbine inlet temperature. The capacity decreases significantly with increase in ambient air temperature and altitude. On the other hand, the capacity is increased significantly when the ambient temperature is reduced, such as on cold mornings and evenings when demand peaks often occur. Thermal efficiency also changes with ambient conditions but to a lesser extent.

Natural gas fired combined cycle-plants would emit only 40% as much CO_2 per kWh as coal-fired power plants. However, to replace all our coal-fired power stations with combined-cycle plants, even if the necessary gas was available at an economic price, would be unreasonable.

Benefits in alleviating the greenhouse effect alone are not likely to bring about the immediate adoption of gas turbines. However, combined-cycle plants are strong candidates for future stationary power generation because:

* Advanced gas turbine combined-cycle units can generate electricity using natural gas at up to 44% efficiency at an installed cost as low as $500/kW, compared with conventional coal-fired plant with a maximum efficiency of 39% and an installed cost of around $1200/kW.

* Further improvements in gas turbine technology are likely.

In coalfields supplying coal-fired generating plants, gas turbines fueled by methane drained from coal seams could play a supporting role during periods of high generating demand, or as units in industrial systems such as those in operation at Appin Colliery

(refer *Minfo 11*, p. 30) and at West Cliff Colliery (refer *Minfo 10*, p. 55).

Methane is released from coal seams during mining and creates an operational hazard. Techniques for coal seam methane drainage are being developed for integrated pre-drainage and post-drainage operations. Hydraulic stimulation of coals (hydrofraccing or "fraccing") from vertical wells can be used to extract gas from deeper seams, thin seams, or seams not of sufficiently high quality to be considered mineable, as well as from seams proposed to be worked prior to mining (refer *Minfo 24*, p. 40).

It must also be recognized that further advances in coal technology are being made, for example with fluidized bed combustion.

CONCLUSION

Natural gas can be used effectively for power generation. Gas turbines, particularly in combined-cycle configuration, have the potential to reduce greenhouse gas emissions. Their competitiveness however, depends on the relative prices, measured in thermal terms, of natural gas and its competitors oil and coal. At the present time in Australia, coal is the most economical. However, if the lower greenhouse gas emission benefits of natural gas fired power generation are to be realized, it may involve a premium in the price of electricity.

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PETROLEUM EXPLORATION UPDATE

GUNNEDAH – SURAT BASINS

Oil Co. of Australia N.L. completed the S89 Seismic Survey in PEL 182. The dynamite survey acquired 71.5 km of twelve-fold records between 11th and 18th October, 1989.

SYDNEY BASIN

Command Petroleum N.L., the operator of PEL 267, completed the drilling of the Shearman 1 well near Fullerton Cove on 1st November, 1989. The well, designed to evaluate the methane content of the Tomago Coal Measures, was drilled to a depth of 739.15 m, and has been left open to permit further testing. Gas desorbtion testing is being carried out on thirteen coal seams.

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DEPARTMENT OF MINERALS AND ENERGY 'ON THE MOVE' IN 1990

The Minister for Minerals and Energy, the Hon. Neil Pickard, M.P., announced recently that the main city offices of the New South Wales Department of Minerals and Energy would move to St Leonards in June this year.

It is estimated the relocation will save the Government and the taxpayer $33.5 million over the next 10 years in lower rents and other savings. The move to new premises will also allow greatly improved service to industry, the public, and other Departmental clients.

The Department will be the major tenant occupying five floors of an attractive modern office building located at 50 Christie Street, St Leonards (figure 17). The building is to be named **Minerals and Energy House.**

The ground floor of the new building will be a major focal point for the Department's servicing of its customers' needs. Included on this floor will be an information desk, displays, publications and map sales, titles information, and comprehensive library facilities. Experienced staff will be on hand to advise and assist with any enquiries.

MRLIS workstations will also be online in the ground floor of the new offices. MRLIS (Minerals Resources Land Information System) is the innovative database system developed by the Department to streamline mining and landuse planning within the State.

Floors 3-6 will house the rest of the Department's Headquarters staff. This will include the Administration Branches for Minerals Resources (MRAB) and Coal Resources (CRAB), to be located on floors 3 and 4 respectively.

The Department's Geological Survey Branch will also be accommodated on floor 3. The branch's role includes gathering and compiling geological and geophysical data to enable effective mineral resource assessment, exploration, and development.

The Government is also examining greater regionalization of the Department's functions which could bring significant improvements in service. A recent survey of the mining and energy industries indicated that most of the Department's clients would welcome increased services in country areas, in addition to substantial metropolitan services. The Department has almost one hundred staff presently located in thirteen country centres which could form the basis of a regionalization program in future years.

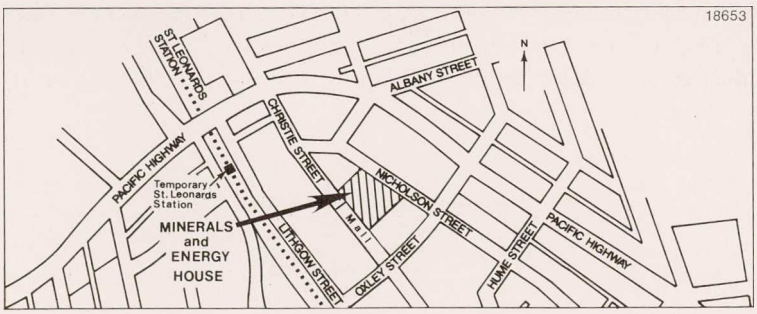

Figure 17. Locality diagram, Minerals and Energy House, St. Leonards

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INTRODUCING *TITLEFINDER*, A NEW ONLINE DATABASE

The Department is creating a computerized database which will be available online through the Info-one International network. The database, to be called TITLEFINDER, will contain data on exploration licences (EL's), and on other mining and exploration-related titles granted in the State.

The bulk of the initial data for TITLEFINDER,which includes historical information on EL's, comes from a register of all exploration licences granted in New South Wales. This register, compiled from Departmental files, is kept as part of the maintenance of the GS system (the Department's information system for internal and company unpublished reports). The database will contain fields for the following information:

* EL number
* Application number
* Holder's name
* Locality name
* Map sheet down to 1:50,000 scale
* Related titles
* Expiry date
* Mineral group for which the licence was granted.

Information on other titles, such as PEL's, ML's, PL's, and Authorisations, will be derived from the Mineral Resources Land Information System (MRLIS) and re-formatted for addition to TITLEFINDER, so that it will be immediately accessible online to the industry and general public.

TITLEFINDER will be the Department's third online database. The other two are MINFINDER (bibliographic references to unpublished reports) and COREFINDER (reference to core stored at the Department's Core Library). These three separate databases, together with the Australian Earth Science Information System (AESIS) and the South Australian Department of Mines and Energy's SAMREF, make up the GEOPAC package on the Info-one International network (refer *Minfo 24*, p. 50).

A full database profile for TITLEFINDER will be published as soon as it is available, but in the meantime Rahmat Khaiami, Manager Library Services Section, can be contacted on (02) 240 4297 for further information.

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LIBRARY USE OF *INMAGIC* SOFTWARE

INMAGIC is a text indexing and retrieval software which is particularly powerful and efficient at organizing and rapidly searching text records of varying lengths. The software has been installed in the Department's Library, and all ordering, accounting, accession, and loans are now computer controlled.

The computerized library management system consists of five databases:

* **LIBCAT** Library monograph holdings; used for cataloguing, loans management, bibliographies, and accession lists
* **SERCHECK** Library serials holdings; contains fields for serials accessioning, missing issues, loans management, circulation, and contents names
* **SERIALS** Library serials holdings; contains fields for financial management of serials, ordering subscription renewals, expenditure, reports, etc.
* **ORDERS** New order records; used for entering details of new orders, ongoing orders, and management and expenditure reports
* **ILL** Record of inter-library loans.

The Library holds some 4000 monographs and some 1200 serial titles. A monthly bulletin which contains accession lists for monographs and serials, and photocopies of the contents pages of serials received in the previous month, is produced and circulated within the Department.

It is proposed to make the bulletin available for sale by subscription to industry clients.

Inquiries about the Library should be directed to Al Bashford, Librarian, on (02) 240 4688 or Rahmat Khaiami, Manager Library Services Section, on (02) 240 4297.

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GUIDELINES FOR GEOSCIENCE DATABASES

The Standards Subcommittee of the Australian Geoscience Information Association (AGIA) has recently developed a set of guidelines for geoscience bibliographic (or reference) databases. The guidelines apply to the style, format, and/or usage of the following data items:

* map sheet numbering
* geoscience indexing terms
* company names
* stratigraphic names
* geographic names
* well names
* tenement nomenclature
* authors
* serial titles
* collation
* chemical data

The guidelines are contained in a paper by Lorraine Gerdes (South Australian Department of Mines and Energy) and Kerry Smith (Cultus Resources N.L.) which is to be published as the *AGIA Occasional Paper 4*. Until the paper is published, further information about the guidelines and a copy of the Subcommittee's recommendations can be obtained from Rahmat Khaiami, Manager Library Services Section, on (02) 240 4297.

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NEW TRUST AND MARKETING IMAGE FOR MUSEUM

INDUSTRY LEADERS WELCOME *THE EARTH EXCHANGE*

More than 200 mining industry leaders recently attended a function at State Parliament to hear the Minister for Minerals and Energy, the Hon. Neil Pickard, M.P., announce that the Geological and Mining Museum, at the Rocks, will reopen early next year as **The Earth Exchange.**

The Government has decided to fast-track the redevelopment so that the museum can be re-opened as soon as possible.

Mr Pickard said that the new museum would be the mining and energy industries' own "Hall of Fame", and that with the involvement of the private sector in funding the exhibits it could become the best geoscience museum in the world.

NEW TRUST

Mr Pickard also announced the membership of a new Trust of senior Australian business identities to administer The Earth Exchange.

Renison Goldfields Consolidated Ltd Deputy Managing Director, Mark Bethwaite as Chairman,will be assisted by Sir Bruce Watson (Chairman, MIM Holdings Ltd), Paul Isherwood (National Chairman, Coopers and Lybrand), Gilles Kryger (Executive Chairman, Ord Minnet), Peter Barnett (Chief Executive, Pasminco Ltd), John Doherty (Chief Executive, Clutha Ltd), Toby Rose (Director-General, Department of Minerals and Energy), Fred Caterson M.P., and Lady Carmen Carnegie.

The budget for the new museum has been doubled to nearly $14 million so it can incorporate major energy exhibits and a

The Hon. Neil Pickard M.P., Minister for Minerals and Energy, with Trust Chairman, Mark Bethwaite (left), and Museum Director, Angus M. Robinson, at the public launch of the Earth Exchange, held on the same day as the Parliament House function

The Premier, the Hon. Nick Greiner, M.P., with Trust Chairman Mark Bethwaite (centre), and Trust Member Paul Isherwood at the Parliament House function

State Treasures Floor which will house the **Albert Chapman Mineral Collection.**

At the dinner, the Minister launched an appeal for corporate sponsorship of the major exhibits in the Museum.

Sponsor companies will be entitled to a range of benefits, details of which can be obtained through the Museum Director, Angus M. Robinson. More than $2 million has already been committed by major companies towards a target of $5.9 million.

The Earth Exchange will become a major public attraction drawing an estimated 820,000 visitors a year.

NEW NAME

The new name, **The Earth Exchange**, has been adopted, after market research, to give the new museum a more exciting image as a place to exchange knowledge about the Earth. The re-naming marks a turning point in the communication of the industry's vital role in the national economy and in the daily life of every Australian.

While the term the *Geological and Mining Museum* is retained, and is an integral part of the logo and formal name, the museum will be simply referred to as **The Earth Exchange.**

MARKETING IMAGE

The theme of **The Earth Exchange** is **Formation and Transformation** — formation of the Earth, its minerals and ores, and transformation of its mineral resources into items of everyday use.

The imagery is powerful, exciting and guaranteed to promote discussion of the "raison d'etre" for the museum project. Recent market research has indicated that this new approach will capture the public imagination.

Exciting "hands on" exhibits will include a walk-through Hawaiian volcano, a simulated earthquake and realistic scenes of mining operations. They will employ a wide range of special effects using videos, computer games, audio visuals, touch specimens, do-it-yourself experiments, fibre optics, and even special aromas.

A **Minerals and Energy Information Centre** will provide literature on the mining and energy industries and there will be an **Education Centre** for school and other groups.

GRAPHIC IMAGERY

The new imagery, as featured on the front cover of this issue of *Minfo*, embodies the theme of **The Earth Exchange** — Formation and Transformation. Around a central globe, the logo moves from raw materials, transformed through mining, to high technology products.

The Geological and Mining Museum Trust is confident that **The Earth Exchange** will quickly become one of the great attractions of Sydney.

For further information contact Angus M. Robinson, Museum Director, on (02) 251 2422.

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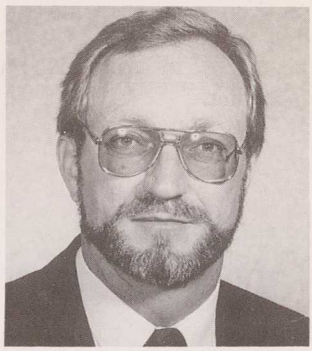
DEPARTMENT OF MINERALS AND ENERGY UPDATE

Further appointments have been made following the restructuring of the Department of Minerals and Energy (refer *Minfo 22*, p. 59, *23*, p. 63, *24*, p. 46, *26*, p. 70).

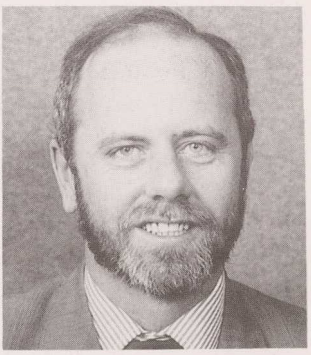
(Photos by Department of Minerals and Energy)

DEPUTY DIRECTOR-GENERAL (MINERALS)



Ian Campbell has a Law Degree and an Honours Degree in Government and Public Administration. He has had legal experience both in Australia and overseas. He had exposure to development issues as Director of Policy and Planning in the Chief Minister's Department in the Northern Territory. He also has had wide experience in the resource sector as Deputy Secretary of the Department of Mines and Energy in the Northern Territory, as Deputy Director-General of the Department of Industry, Technology and Resources in Victoria, and as Chairman of the Victorian Solar Energy Council. He left the Judicial Commission of New South Wales where he was the Deputy Chief Executive to join the Department of Minerals and Energy in February 1990.

DIRECTOR COAL DIVISION

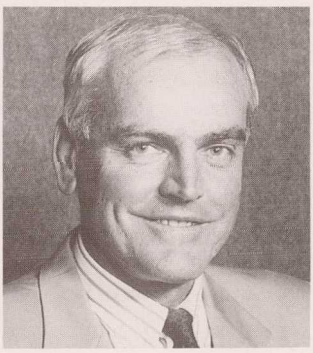


Tony Galligan has had 20 years experience in the coal industry, both with Government and industry. A graduate in geology from the University of Queensland, he worked on a variety of coal projects as an exploration geologist with industry and the Queensland Mines Department. In 1979 he became Coal Exploration Manager with Agip Australia Ltd, and was appointed as Chief Coal Geologist with the New South Wales Department of Minerals and Energy in 1983.

DIRECTOR MINERALS DIVISION

After graduating from Sydney University with a Bachelor of Science Degree and a Diploma in Education, Don Pinkstone commenced his career by teaching mathematics for 2 years. He transferred to the then Department of Mines during the first uranium boom in 1953 and worked as a field geologist within the Geological Survey until 1960 when he was appointed as Petrologist. Subsequently, he became Deputy Curator, and then Curator of the Mining Museum, was appointed Assistant Director (Common Services) in 1970, and became Assistant Secretary (Minerals) in 1980. He has been involved in a number of State and Commonwealth Committees and Working Parties. His main interest lie in minerals exploration, mining, and mineral processing.

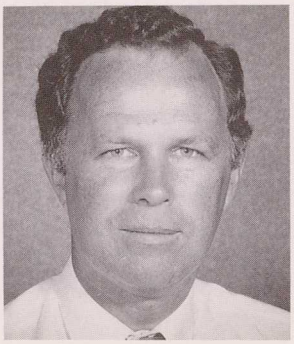
DIRECTOR GEOLOGICAL SURVEY OF NEW SOUTH WALES



John Cramsie has had extensive experience in management, and in mineral resources and geological investigations with the New South Wales, Victorian, and South Australian Governments. Following completion of his Master of Science Degree at the University of Sydney, he spent 5 years as a Geologist with the South Australian Department of Mines. He joined the Geological Survey of New South Wales in 1968, working in a number of positions including Principal Geologist (Operations) and Principal Geologist (Regional Mapping). When the Department of Mineral Resources established a Coal Division in 1979, John was appointed as Chief Coal Geologist.

In 1983, John joined the Victorian Department of Minerals and Energy as Director of the Geological Survey. In 1986 he returned to the New South Wales Department of Mineral Resources as Assistant Secretary (Coal). John acted in the position of Deputy Director-General (Minerals) from the time of formation of the Department of Minerals and Energy until his appointment as Director of the Geological Survey.

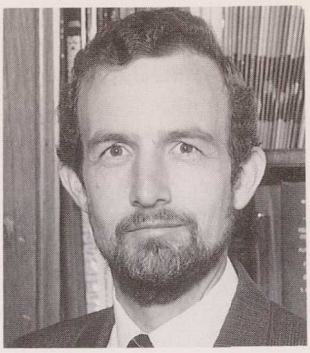
CHIEF INSPECTOR OF MINES



Graham Terrey joined the Department in the Mines Inspection Branch at Lismore in 1975, during an active period in the heavy mineral and mining sector. He had previously gained underground and surface operations experience with Mount Isa Mines Ltd. A 2-year period as District Inspector at Armidale was followed by 5 years as Senior Inspector at Broken Hill, and 2 years in the Special Duties area at Sydney, before being promoted to Deputy Chief Inspector. In 1988 he was appointed as Chief Inspector of Mines.

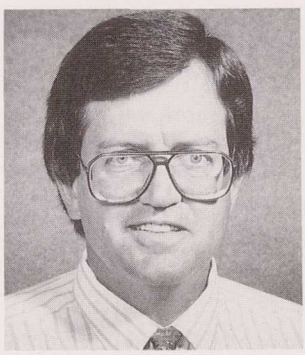
Graham has a Masters degree in rock mechanics, teaches the shot-firer's course at several centres, and is interested in the development of mining law.

DIRECTOR GEOLOGICAL AND MINING MUSEUM



Originally appointed to the position of Museum Director in December 1987, Angus M. Robinson has subsequently led the new museum project through its formative development period. A 1968 graduate in geology from the University of Melbourne, he has developed a career, initially in mineral exploration and then in project management, in both the private sector and Government. Angus joined the Department in 1980. In various positions he has pursued a particular interest in coal mine development and in the "Planning Focus" process. Angus is a Fellow and Councillor of The Australasian Institute of Mining and Metallurgy as well as a Member of various other professional associations. Angus has contributed to *Minfo* as an inaugural and continuing Editorial Board Member and is regularly involved as an organizer and author for mining industry symposia.

MANAGER COAL RESOURCES ADMINISTRATION BRANCH



Jon Hawke joined the Department of Mines in 1968 as a trainee, subsequently graduating in 1970 with honours in Geology from the University of New England. In 1984 Jon obtained a Graduate Diploma in Engineering Developments from the University of New South Wales.

He worked in the Geological Survey of New South Wales until 1983, including 7 years as Senior Geologist (Engineering Geology) and a 6 months exchange with The Zinc Corporation Pty Ltd.

He was a Development Officer (Minerals) in 1984, a Ministerial Adviser from 1985 to mid 1987, then Executive Officer of the Power Station Coal Supplies Steering Committee until March 1988 in the former Department of Energy.

Since April 1988 he has been Regional Manager (Northern) in the Coal Resources Administration Branch.

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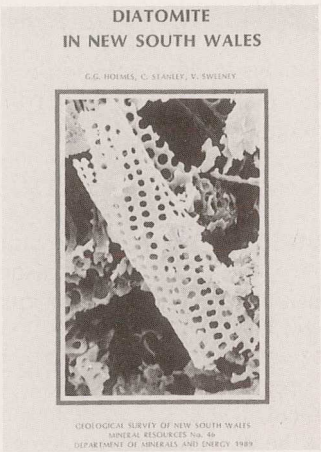
NEW GEOLOGICAL PUBLICATIONS

Mineral Resources No. 46: Diatomite in New South Wales, by G.G. Holmes, C. Stanley, and V. Sweeney

This comprehensive report (161 pages) summarizes available geological information on the known diatomite deposits of New South Wales, and includes detailed results of laboratory tests on diatomite samples. Also included are chapters on nature and occurrence, uses and specifications, alternative materials, mining and processing, production and consumption, prices, world diatomite deposits, other Australian deposits, and the potential of Australian diatomite as a filter media.



The main diatomite deposits in New South Wales are located near Barraba, Coonabarabran, Cooma, Lismore, Ballina, Orange, and Comboyne. Several much smaller deposits are scattered throughout the State. In 1984/1985 New South Wales diatomite production was 6632 tonnes, all from Bells Mountain, Barraba. Currently this material is mainly used as an absorbent for pet litters and oil and industrial liquid spillages.

Numbla 1:100,000 Geological Sheet, by A.J.R. White, B.W. Chappell, I.S. Williams, and R.A. Glen

Geology of the Numbla 1:100,000 Sheet 8624, by A.J.R. White and B.W. Chappell

The Numbla sheet is located in the southernmost part of the Southern Tablelands of New South Wales near the town of Delegate.

Sedimentary units occurring in the sheet area are the Ordovician Adaminaby beds and Warbisco Shale, the Silurian Yalmy Group, Tombong beds, Merriangaah Siltstone, and Quidong Limestone, and Cainozoic sands, gravels, and clays.

Silurian granitoids of the Berridale and Kosciusko Batholiths dominate the sheet area, and petrological and chemical descriptions of the units are given. Jurassic breccia pipes and a plug, plus Cainozoic basalts are also present.

Key features of the Numbla sheet are:

* the definition of the I-S line defined on the basis of granitoid geochemistry;
* the interpretation that large areas, previously regarded as Ordovician Adaminaby beds, actually comprise an imbricate stack of Silurian Yalmy Group sediments interleaved with Late Ordovician black shales of the Warbisco Group; and
* the recognition of thin-skinned tectonics in this part of the Lachlan Fold Belt.

****

AMIRA AND GROUND PENETRATING RADAR – APPLIED RESEARCH IN ACTION*

The **Australian Mineral Industries Research Association Ltd (AMIRA)** promotes exploration and mining research on behalf of its member companies. Although AMIRA does not have research facilities of its own, it initiates and co-ordinates projects through a small permanent secretariat which seeks support for projects from members. If sufficient support is forthcoming, a contract is let to a relevant research group either in Australia or overseas. The sponsoring companies are encouraged to participate with AMIRA staff in monitoring the contract's progress. The research reports arising from the contract are initially confidential to the companies who support the work.

At the end of June 1989 there were seventy-one projects current with a total value of $26 million. **Contract Research** spending during 1988/1989 was $8 million, with almost all of these funds coming from industry sponsorship and the remainder coming from National Energy Research Development and Demonstration Council (NERDDC) grants (refer *Minfo 25*, p. 30). Just over half of the Contract Research funds were used by tertiary institutions, while the Commonwealth Scientific and Industrial Research Organization used about one-quarter.

Research projects have included:

* exploration techniques for iron ore and platinum,
* rock magnetism,
* seismic techniques,
* remote sensing for gold and petroleum,
* radar techniques, and
* basin studies for petroleum exploration.

Considerable effort has been devoted to improving both formal and informal communication networks with the members. Extensive discussions held between Research Co-ordinators and their technical networks, both in companies and research groups, have resulted in many companies joining existing projects.

An interesting example of AMIRA's operation is provided by **Project P297 - Acquisition and Signal Processing of Ground Penetrating Radar for Shallow Exploration and Open-Pit Mining.** This project is being sponsored by eight Australian mining companies (Aberfoyle Resources Ltd, Comalco Aluminium Ltd, CRA Exploration Pty Ltd, Geopeko, Mount Isa Mines Ltd, BHP Melbourne Research Laboratories, Picon Explorations Pty Ltd, and Westralian Sands Ltd). The research for AMIRA is being conducted by Mr P. L. Baker and Dr J. P. Cull of Monash University, Melbourne.

Ground penetrating radar is a geophysical method offering rapid, high-resolution investigation of shallow geological features (0-30 m deep) such as diamond, sapphire, or gold-bearing alluvial deposits; heavy mineral placer deposits; and opal and bauxite environments. Such deposits are often hidden under surface cover that can be penetrated by ground radar. The method is also being tested in the drill hole investigation of base metal deposits.

Ground penetrating radar has potential economic benefits to open pit mining by providing data from which cross sections can be constructed to aid mine design, planning, and scheduling. Detailed sections can be obtained for better mapping between drill holes,

* Article compiled from information supplied by AMIRA

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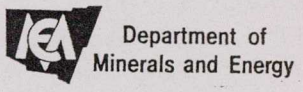
(available from the Department of Minerals and Energy)



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Pumps and Pumping Systems (1983)		
Structure and Mechanics of Fault Zones in Relation to Fault-Hosted Mineralization (1989)		

Ground penetrating radar unit in a sled configuration for towing by a vehicle (courtesy of Paul Baker, Monash University)

detection of problem zones (for example: high ash content and fireholes in coal, clay zones in mineral sands, dykes in overburden), and geotechnical and slope stability investigations.

The project has three specific objectives:

* To acquire high-quality ground-penetrating radar data sets for shallow exploration and surface mining applications under a variety of geological conditions.

* To develop signal processing techniques to convert radar time profiles to depth sections and correct for artifacts prior to detailed interpretation.

* To assess the accuracy of ground-penetrating radar and associated processing techniques through comparison with independent measurements.

Rapid progress has been made over the last few years in ground radar techniques. Improved hardware has increased the depth of investigation and gives digital records of high precision. Signal processing is now receiving increased attention as different levels of signal processing sophistication are required for target identification, classification, and mapping, as distinct from image presentation. Techniques tailored for specific applications are being developed.

Since analogous signal-producing techniques have been extensively applied to seismic data and medical ultrasonic imagery, rapid progress in ground radar signal interpretation is expected.

A typical ground penetrating radar data set with features indicated by an overlay is shown in figure 18.

The variety of applications will undoubtedly generate wide interest in this State, and AMIRA is seeking further sponsors to the project.

For further information contact: AMIRA - John Kennedy, Public Relations Consultant, (03) 696-2750; Ground Radar Project - Joe Cucuzza, Research Co-ordinator - Exploration, (03) 654 8844; Fax (03) 654 8661.

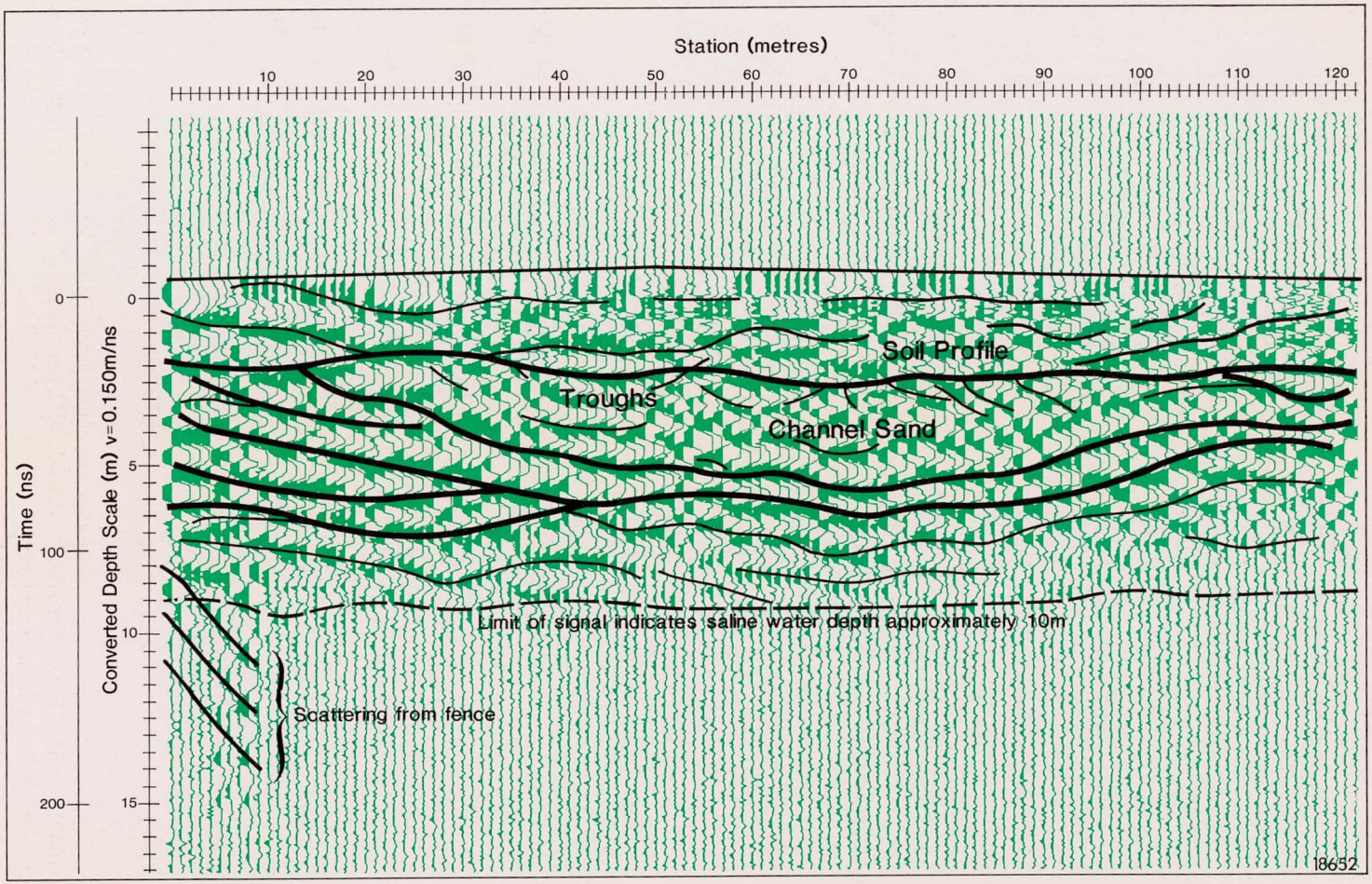

Figure 18. *A typical ground penetrating radar data set with features indicated by an overlay*

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Borah PL's 871, 872, 919	Getty Oil Development Co. Ltd SJL Mining Development Co. Ltd	Diamond whole core 9 holes
*Mount Allen EL 1199 (Ext) PL's 525, 530	Billiton Australia Ltd	Diamond whole core 2 holes
*Noo-Noora	Department of Minerals and Energy	Diamond whole core 4 holes
Cockatoo Creek EL 3140	Billiton Australia Ltd	Diamond whole core 6 holes
*Oran Park	Department of Minerals and Energy	Diamond whole core 5 holes
Mulloon	Kratos Minerals N.L. Preussag Australia Pty Ltd	Diamond whole core 3 holes
*Cobbitty	Department of Minerals and Energy	Diamond whole core 1 hole
*Maryland	Department of Minerals and Energy	Diamond and Auger, core + cuttings 5 holes
*Gum Flat EL 2372	Billiton Australia Ltd	Diamond whole core 9 holes

*Confidential

For further information and to arrange inspection contact Stan Kaluza, Core Library Manager, on (047) 77 4316. For core marked as confidential, permission of the company must be obtained before inspection can be arranged.

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