Minfo

New South Wales Mining and Exploration Quarterly

No. 60 JULY 1998

FEATURE :
Petroleum in New South Wales

PRINT POST APPROVED: PP224987/00004

DEPARTMENT OF MINERAL RESOURCES

Minfo®

New South Wales Mining and Exploration Quarterly
No. 60

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COVER PHOTO:
Night time drilling west of Narrabri in the Surat Basin, part of the exploration program for conventional and coal seam methane on the PEL held by Petroleum Securities Pty Ltd and Great Southland Petroleum Pty Ltd.

July 1998 Issue
ISSN 0812-0293

Published under the authority of the Minister for Mineral Resources
1998

MINERAL RESOURCES

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PETROLEUM IN NEW SOUTH WALES — AUSTRALIA'S FRONTIER ZONE

The size of the New South Wales oil and gas market and the prospectivity of its sedimentary basins are anomalous set against the lack of modern exploration within the State, the only one in mainland Australia not yet to have hydrocarbon production.

INTRODUCTION

New South Wales is Australia's largest potential market for oil and natural gas. The six million residents in the State consume about 32% of the nation's energy output. The State's energy consumption is estimated at approximately 800 petajoules (PJ) per annum. Of this, the industrial sector uses 47.3%, transport 37.4%, domestic consumption 9.6%, and the commercial sector 5.7%.

Energy supply to New South Wales is dominated by coal, which supplies 51 % of the State's energy needs. Oil contributes a further 37%, used mainly in the transport industry, while gas supplies only about 8%, and renewables (mainly hydroelectric power) about 4%.

New South Wales has significant resources of high quality black coal which are used for electricity generation, steel making, industrial processes and heat generation. Coal fired power stations generate 94% of the State's electricity, with hydroelectric facilities accounting for the majority of the remaining capacity. But apart from some coal seam methane production, all of New South Wales oil and gas supplies are imported from interstate or overseas. Potentially, reliance on imported oil and gas and the dominance of coal in New South Wales energy supply may become a strategic weakness for the State.

THE NEED FOR EXPLORATION

New South Wales is unique among the mainland states of Australia in having no identified commercial reserves of natural gas or oil within its borders or in adjacent waters.

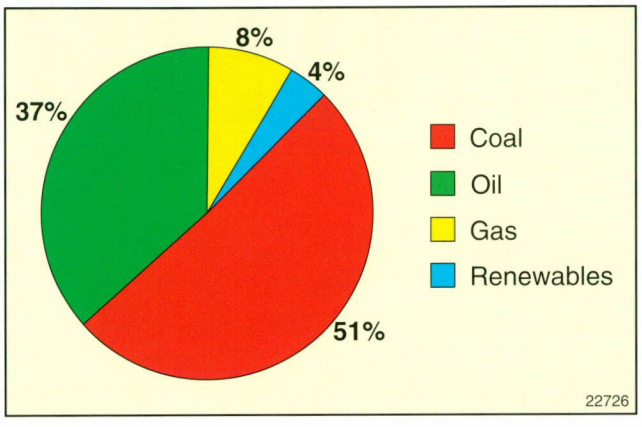


Figure 1. Sources of energy used in New South Wales

In the 1950s and 1960s, exploration was relatively evenly spread between the states. However, early petroleum discoveries in Western Australia, Victoria and Queensland attracted petroleum exploration away from New South Wales. More recently, exploration in Australia has concentrated on offshore areas. As a consequence, not only is New South Wales sparsely explored but the limited exploration that has been carried out is quite old and based on outdated exploration concepts.

The paradoxical lack of exploration is emphasised when it is understood that the geological formations and sedimentary basins that contain economic gas and oil production in South Australia and Queensland extend into New South Wales.

There are almost 500 000 km^2 of sedimentary basins in New South Wales, although only 250 wells have been drilled

Drilling for hydrocarbons through the eastern Surat Basin to exploration targets in the underlying Gunnedah Basin

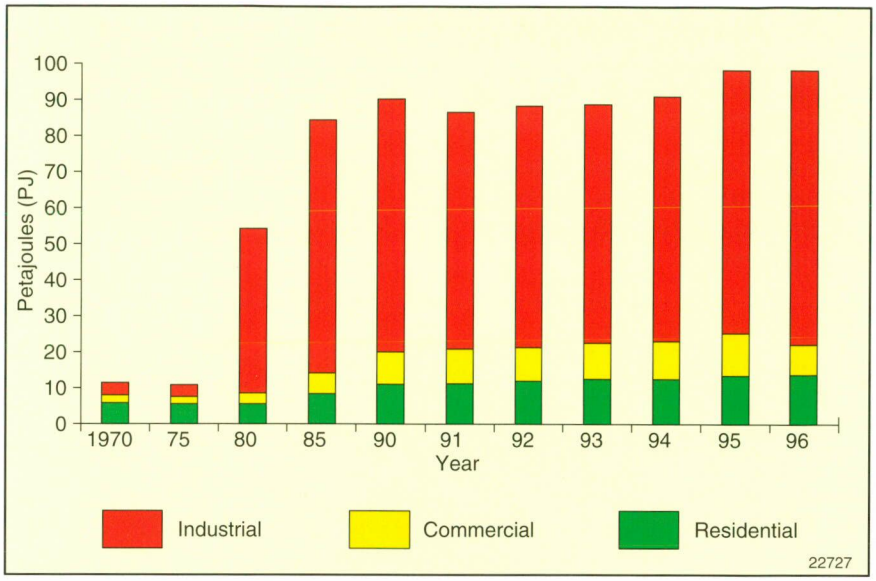


Figure 2. New South Wales reticulated gas sales by sector, 1970–1996

Natural gas was first supplied to New South Wales from South Australia in 1976. Demand for natural gas grew rapidly until the early 1980s, as it replaced other energy feedstocks in many industries. However, over the past decade demand has been constrained by supply and sales of gas have shown little growth since the mid 1980s (figure 2).

Currently New South Wales consumes about 100 PJ of gas per year. The lack of growth of in the State's gas consumption is in contrast to strong growth in gas usage nationally, where it has expanded more strongly than Gross Domestic Product over the past decade, and has also grown at a faster rate than any other primary fuel. Per capita use of gas in New South Wales is one of the lowest in Australia (figure 3).

Further, it is the only State to have developed natural gas markets and a distribution system based on supplies from outside the State. To supply the market in New South Wales, gas is piped from Moomba to Sydney, Wollongong, Newcastle and several country centres. AGL Gas Companies (New South Wales) Ltd and its subsidiaries currently supply more than 95% of natural gas requirements for New South Wales.

to date in this vast area. The more recent limited exploration that has been conducted has demonstrated that these sedimentary basins have suitable reservoir, source and seal rocks. It has also indicated that the source rocks are of suitable maturity for the generation of oil and gas. Significantly, there have been shows of oil and gas in most of the sedimentary basins in the State, with significant gas flows recorded in the Gunnedah/Surat, Sydney and Clarence–Moreton Basins.

The petroleum exploration program carried out under the State Government's successful Discovery 2000 initiative has targeted areas in the State which have had limited exploration but are considered prospective for petroleum. Using the latest petroleum evaluation technology, large areas of the State's sedimentary basins have been covered with high resolution airborne magnetic, and gravity, surveys followed up with seismic surveys and stratigraphic drilling.

NATURAL GAS BENEFITS

The energy sector, and in particular the power industry, is under increasing pressure to reduce or contain greenhouse gas emissions. The Kyoto climate summit late in 1997 resulted in 159 nations accepting legally binding targets for greenhouse gas emissions for the first time.

Natural gas is the cleanest of fossil fuels and has the potential to make a significant contribution to reducing greenhouse gas emissions from energy production, provided there are sufficient gas reserves to meet market demand.

In 1970, a 30 year agreement was made between the Australian Gas Light Company Ltd and the South Australian Cooper Basin gas consortium to supply gas to New South Wales, and the 1300 km, 152 PJ per annum, fully compressed capacity Moomba, South Australia, to Sydney pipeline was built.

GAS INDUSTRY GROWTH FACTORS

The Australian gas industry is expected to grow at between 3% and 5% annually over the next 5 years. In New South Wales, a number of factors will contribute to strong growth over the next decade. Key aspects include:

- The contracted supply of natural gas to New South Wales is scheduled to begin to decline after the turn of the century. The contracts are due for renewal in 2006. There is some possibility that supplies to Sydney from Moomba could be reduced. Even if there is no shortage of gas nationally, there is likely to be increased competition

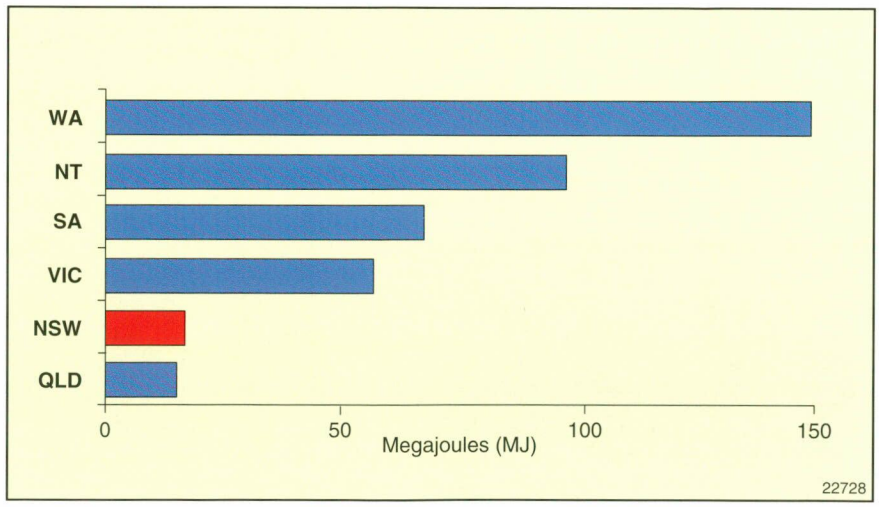


Figure 3. Per capita gas consumption, by State, 1995–1996

between the eastern states for more accessible and economic gas reserves.

- Governments and industry have made significant progress in implementing free and fair trade in natural gas. In 1996 New South Wales became the first state to have its Third Party Access code for distribution networks certified as effective under the Trade Practices Act. This code allows third party access to the New South Wales reticulation network. Owners of reticulation networks are required to provide an access undertaking, giving terms and conditions for access to their distribution network to the State's Independent Pricing and Regulatory Tribunal.
- Competition between gas producers for the New South Wales market is likely as a result of two proposals for pipelines for the supply of natural gas to and from Victoria. Permits were granted for a proposed pipeline from Longford in Victoria to Sydney and for a link between Wodonga on the New South Wales–Victoria border and Wagga Wagga in New South Wales.
- The need to contain the environmental consequences of energy use.

FUTURE MARKET GROWTH

Gas is essential to the manufacture of many of the State's major commodity and manufactured exports, such as iron and steel, glass, cement, brick making and the food and beverage industries.

Natural gas is expected to penetrate markets for electricity generation fuels, which in New South Wales have been dominated by coal, and for road transport fuels where oil is now the principal energy form. One of the major factors which has limited its penetration into the power industry in New South Wales to date has been the lack of assured long term supplies of large quantities of gas.

Potential exists for secondary processing of many of the State's mineral products. Western New South Wales and central Australia are proximal to a number of Australia's major metallic mineral production areas. Secondary processing to smelt or transform these minerals into high value products requires access to low cost intensive energy.

A market sector that has been almost nonexistent in New South Wales to date is gas fired power generation. Power generation is the fastest growing gas application worldwide. A major reason for this is the environmental advantage of gas over alternatives. Applications range from small (10 MW) to large (200 MW) cogeneration plants that combine the production of useable heat and electricity, to large independent power production plants.

In May 1997, the first stage of a national wholesale electricity market was implemented, with power generating companies in New South Wales and Victoria for the first time being able to bid against each other to supply power to energy retailers in these states and the Australian Capital Territory. The operation of the market has seen a dramatic fall in the price of electricity as a result of an oversupply in base load generating capacity.

At present, although there is an oversupply of base load capacity, there are indications that during peak periods electricity demand can approach generating capacity. Coal fired power stations are not as flexible in ramping up power output to meet peak and intermediate electricity demand. However, gas is ideally placed to supply peak and intermediate demand.

Advances in gas turbine technology have resulted in the efficiency of gas turbines increasing to that of coal fired power stations. Further, combined cycle plants which use waste heat from gas turbine exhausts have the highest efficiency ratings of non-renewable generating plant (40–45%). Gas turbines also have a major advantage in their low capital cost, about half the cost on a kilowatt basis compared to coal fired plants.

CONCLUSION

As a result of the Discovery 2000 program and legislative changes that have occurred in access to infrastructure, New South Wales is increasingly recognised as an attractive target for petroleum exploration.

This recognition resulted in a surge of petroleum title applications in the State during 1997, with exploration proposals valued at $30 to $50 million. However, large areas of prospective basins (the Darling, Eromanga and Murray Basins) remain vacant and available for exploration licence application. New South Wales represents a unique opportunity because a ready market exists in close proximity to virtually unexplored basins with significant petroleum prospectivity. Very few frontier areas provide these sort of opportunities.

For further information contact Brad Mullard, Chief Geologist, Coal and Petroleum, on (02) 9901 8505, fax (02) 9901 8520, e-mail mullardb@minerals.nsw.gov.au

NEW SOUTH WALES PETROLEUM POTENTIAL

New data and the re-evaluation of existing data are overturning beliefs that the sedimentary basins of New South Wales lack petroleum prospectivity.

INTRODUCTION

When thinking about exploration and mining in New South Wales, most people think of it in terms of its hard rock mineral deposits. Most fail to realise that over 60% of New South Wales is covered by sedimentary basins representing an area of over 500 000 km^2 in seven basins, all of which, to varying degrees, have petroleum potential. Petroleum systems in these basins vary from the Cambrian through to the Jurassic with numerous oil and gas shows being recorded in all basins.

This article concentrates on the basins shown in figure 4.

In the Darling, Eromanga and Surat Basins, oil and gas production occurs from equivalent formations in adjacent States. In addition, the large black coal resources of New South Wales provide a substantial source for both coal seam methane and conventional gas.

DARLING BASIN

The Darling Basin contains a very thick sedimentary sequence, much of which has never been penetrated. The basin is underexplored and, although little is known, available data indicate the presence of the major ingredients for a successful exploration venture. Both large anticlines and faulted anticlines are evident on available seismic data and these should contain reservoir rocks, both clastic and carbonate, and have access to adequate mature hydrocarbon source rocks and sealing units. Structural timing preceded, or was contemporaneous with, hydrocarbon generation and migration. Recent work by the Department has confirmed the presence of oil within drill core and in surface outcrops in the Basin.

Because of its potential to contain large structures that may contain gas, the Darling Basin is attracting considerable interest from international oil companies. This has resulted in recent separate exploration licence applications by First Sourcenergy Group Inc (US), Go Resources Ltd (Canada) and Otto Oil NL (Australia). In addition to these companies, Maple Oil NL (Australia) is an existing exploration licence holder in the Darling Basin.

SURAT AND GUNNEDAH BASINS

The New South Wales part of the Surat Basin contains the same petroleum producing formations that occur in Queensland and from recent investigations is considered to have excellent prospects for oil and gas discoveries. Already two wells, Wilga Park and Coonarah, have obtained, on test, significant gas flows from Permian rocks of the underlying Gunnedah Basin. The wells were drilled in separate structures several kilometres apart. The Coonarah prospect is estimated to contain between 15 and 40 billion cubic feet (BCF) of gas. An unusual aspect of these discoveries is their high helium content (about 1%). They are likely to be further evaluated during 1998.

The limited number of petroleum wells in New South Wales has resulted in considerable innovation by Departmental geologists in assessing the State's petroleum potential. The sampling and analysis of deep waterbores is one example of this (refer *Minfo* **49**, pp 29–31). The sampling program has identified numerous bores which flow methane. Significant quantities of gas flowing from waterbores have been identified from wells in the New South Wales' portions of the Surat and Eromanga Basins. In some cases gas quantities have been sufficient to enable the waterbores to be ignited. Isotopic analysis of the gases from various regions of the State has allowed some conclusions to be drawn about their likely origins.

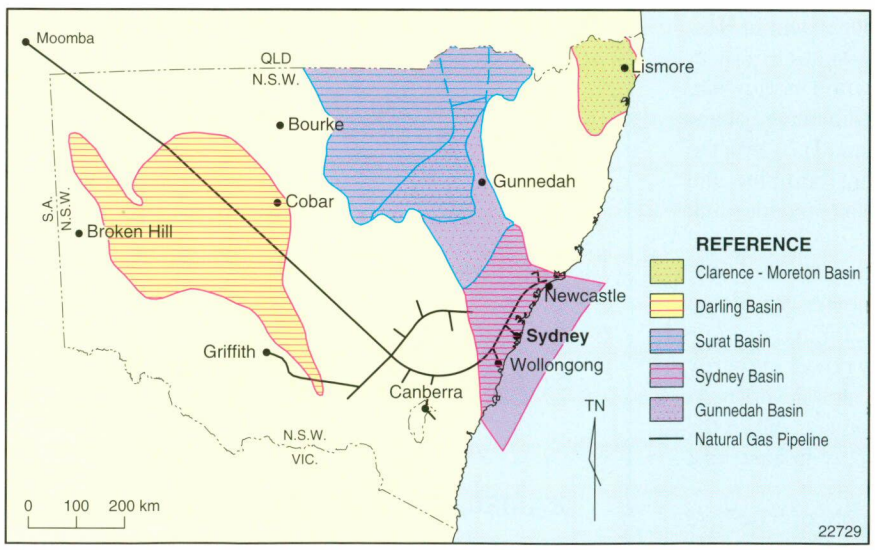


Figure 4. Sedimentary basins in New South Wales with petroleum potential

OFFSHORE SYDNEY BASIN

The number and spread of gas and oil occurrences in the Sydney Basin demonstrate that the basin contains an active petroleum system. However, the major problem for

onshore exploration in the Sydney Basin has been the poor quality of potential reservoirs. Previous interpretations assumed that the absence of good quality reservoirs would extend to the offshore part of the basin. As a consequence no wells have been drilled in the offshore part of the basin. New South Wales is the only state in Australia which has not had a petroleum well drilled off its coast.

Previous offshore exploration has been restricted to aeromagnetic and seismic data acquisition. Santos Ltd recorded the most recent seismic data in 1991. In 1996 an examination by Departmental geologists of all previous information available on the Sydney Basin resulted in a revised assessment of the offshore petroleum potential of New South Wales. This revised assessment resulted from the development of a new structural model of the Sydney Basin (see pp 20-22, this issue).

On the basis of the revised structural model, the New South Wales and Commonwealth Governments released the Offshore Sydney Basin as part of the Commonwealth Government's 1997 acreage release program. A decision on the allocation of the area is expected to be made during 1998.

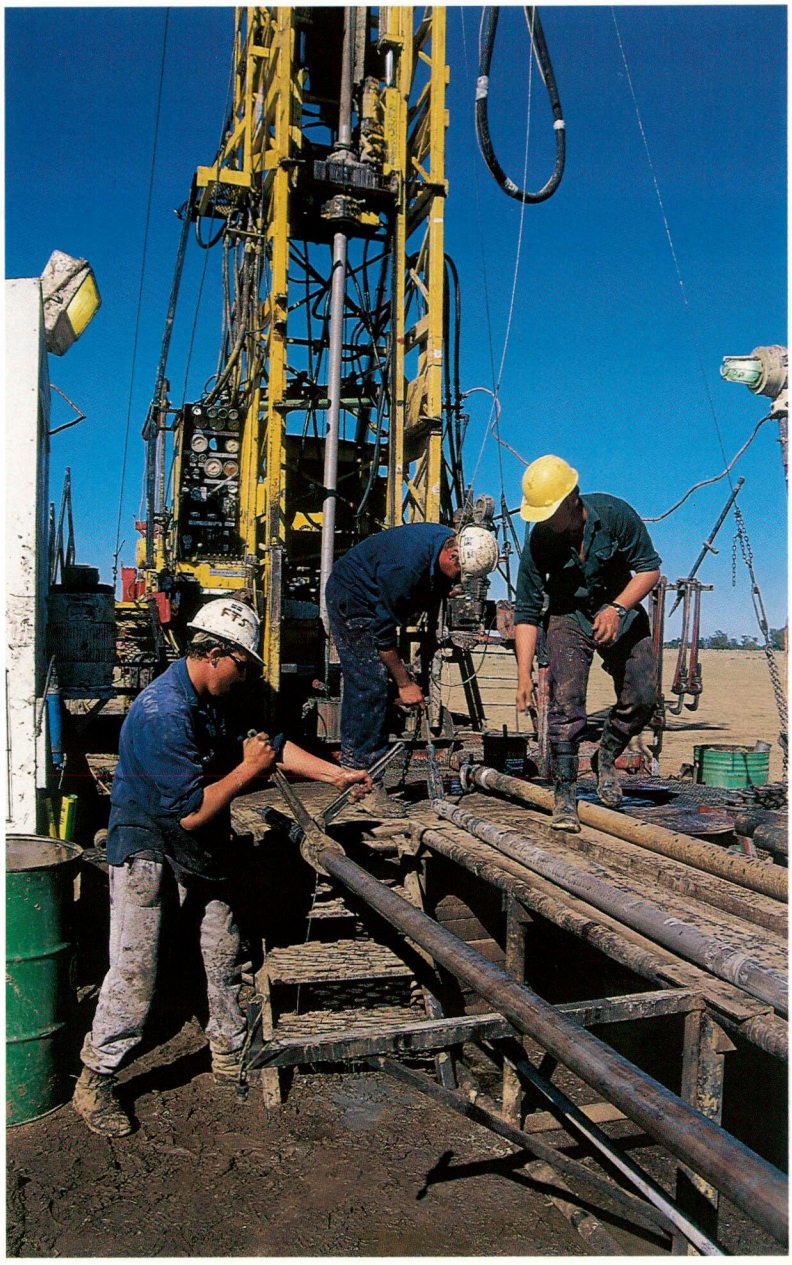
COAL SEAM METHANE

The State contains enormous resources of coal which have the potential to supply significant quantities of coal seam methane These coal seams are ideally located beneath, and adjacent to, the major gas markets and population centres of Sydney and the industrial cities of Newcastle and Wollongong.

The Sydney Basin may contain up to 67 000 PJ of energy within coal seam methane.

Exploitation of coal seam methane resources in New South Wales is at an early stage of development. Significant technical problems associated with production and economic extraction of the gas remain to be overcome. Most coal seam methane activity in the State is still at the exploration stage, with efforts concentrated on the Sydney (including Gloucester Sub-basin), Gunnedah and Clarence–Moreton Basins.

Coal seam methane production and use has already commenced in New South Wales in association with coal mining in the State's Southern Coalfield. At the BHP Ltd colliery at Appin, methane produced from the mine workings is used to generate electricity. BHP Steel Collieries Division entered into an agreement with Energy Development Limited to supply gas to generate 94 MW of electricity per year to be sold to Prospect Electricity. Appin Colliery supplies methane gas to generate 54 MW of the electricity and nearby Tower Colliery methane for 40 MW. (Methane from Appin Colliery is also being assessed as a fuel for road transport.)



Drillers at work, exploring for gas at Coonarah near Narrabri in the Gunnedah Basin

The potential exists to develop similar scale projects in other coalfields, particularly in the Newcastle and Hunter Valley regions. It is likely that coal seam methane will make a small but significant contribution to New South Wales' energy supply in the future.

CONCLUSION

Historically, New South Wales gained a reputation for not being prospective for petroleum or natural gas. However, recent work by the Department has shown that this appears not to be based on fact. Opportunities exist for both small and large exploration companies to take up acreage in a highly strategic area of the Australian continent.

For further information contact Brad Mullard, Chief Geologist, Coal & Petroleum, on (02) 9901 8505, fax (02) 9901 8520, or e-mail mullardb@minerals.nsw.gov.au

NEW GAS PIPELINES

The extensive pipeline infrastructure to the gas markets in New South Wales is an important adjunct to hydrocarbon exploration and discovery.

A major research report released in February 1998 by The Australian Gas Association identifies up to $6 billion of potential investment in Australia's natural gas transmission pipelines over the next few years. Projects could involve the construction of up to 11 000 km of new pipelines across Australia. The need for gas in value adding to Australia's minerals processing industries is driving a significant proportion of the development.

New South Wales is set to benefit from the boom in pipeline construction. One of the most important developments is the start of construction of the Wodonga (near the New South Wales and Victorian borders) to Wagga Wagga (in New South Wales) gas pipeline (figure 5).

This project involves the construction of a 146 km pipeline between Barnawartha (near Albury) and Wagga Wagga, which for the first time will allow the interconnection of the

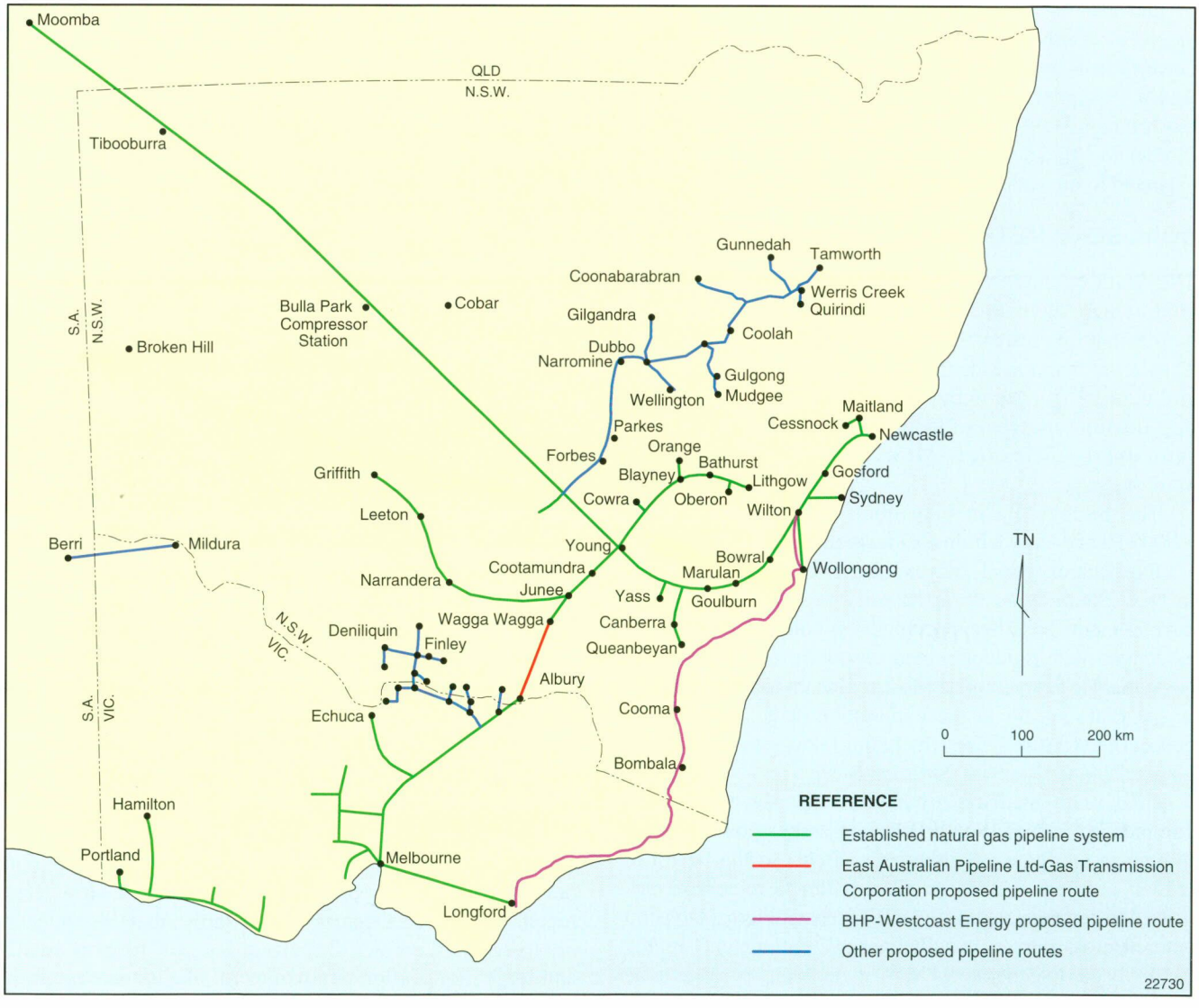


Figure 5. Existing gas pipeline systems and proposed pipeline routes in New South Wales

Victorian and New South Wales high pressure gas transmission systems. The link will have an initial capacity of at least 20 petajoules (PJ) which can be expanded in stages to 90 PJ to meet future growth in the New South Wales market. The cost of the initial stage of the connection between the two systems will be approximately $130 million.

The link will allow trading of gas in both directions. Bass Strait gas may be sold to New South Wales and the Australian Capital Territory markets, and Cooper Basin (in South Australia) gas may be sold to the Victorian market. In conjunction with deregulation, this will achieve a key element of the gas reform process being implemented by Federal and State Governments. The reforms will create competition by enabling interstate trade in gas, and offering gas customers a choice of supply.

A second pipeline project – the eastern gas pipeline project – will also bring Victorian gas to New South Wales. The construction of a 730 km, 450 mm diameter gas pipeline is planned, from Longford in Victoria to Wilton in New South Wales via the the towns of Cann River in Victoria, and Bombala, Cooma, Nowra, Port Kembla and Wollongong in New South Wales. The gas line proponents are BHP Petroleum Ltd and Westcoast Energy Inc.

In addition to these major connections between New South Wales and Victoria, there are plans to extend the New South Wales pipeline network to a number of other centres.

Construction has begun on the 283 km pipeline extension from the Moomba–Sydney pipeline to supply the regional centres of Forbes, Parkes, Narromine, Dubbo and Wellington. A pipeline is also proposed to supply areas in the Murray Valley region. This would include Rutherglen to Cobram in Victoria, and Corowa, Barooga, Deniliquin, Finley and Berrigan in New South Wales.

The expansion of the gas pipeline network can act as a stimulus to exploration in New South Wales. The expanded network will provide new and larger market opportunities for gas sales. It also provides the transport infrastructure in areas of petroleum potential to take gas to major markets, reducing the cost and risk of developing new petroleum discoveries.

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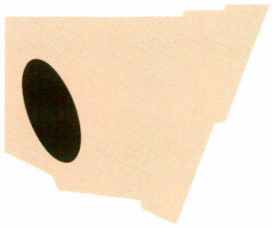
DARLING BASIN STRATIGRAPHY



Review of Darling Basin stratigraphy using new and reprocessed existing data has led to a better understanding of the basin and its hydrocarbon potential.

INTRODUCTION

The Darling Basin dominates the geology of central western New South Wales (figure 6). Across much of the basin, its sediments are obscured by a thin veneer of regolith. Historically, geological descriptions of the main basin sequence have been derived from outcrops, particularly in the eastern part of the basin towards Cobar, and in the west, the Broken Hill Block west of the Bancannia Trough. In order to understand better the Devonian stratigraphy of the Darling Basin, the Department has correlated and re-evaluated all the available data. It is hoped that the review will provide new insights into petroleum prospectivity within the region.

ESTABLISHING AND REPROCESSING DATA

New seismic data have been acquired under the Discovery 2000 program, and data from analogue lines in the Bancannia and Nelyambo Troughs have been reprocessed. Data has also been obtained from a new stratigraphic bore, Kewell East DDH 1, drilled in the Darling Basin. Other available cores and cuttings have been resampled – largely for geochemical analysis, but also for biostratigraphic and petrological information and isotope dating.

The biostratigraphic and petrophysical information has been compiled into a stratigraphic inventory, based largely on lithological correlation, with biostratigraphic information being limited to the largely Early Devonian non red-bed facies. It is proposed to add data from seismic surveys to establish a tectono-stratigraphic framework appropriate for describing petroleum systems. Already some results, including isotope dating and some reservoir data, have been integrated.

RESULTS TO DATE

The stratigraphic review has identified a number of significant breaks in sedimentation in the basin. Seismic data indicate that some were accompanied by varying amounts of structural movement and erosion within the sequence. Several regionally significant horizons, originally identified in seismic data as reflectors A, B and C, have been correlated, although their tectono-stratigraphic significance remains unclear. They have been positively identified in a number of wells and have been followed across the basin by wireline log correlation and seismic interpretation. Currently, horizon A is believed to represent a latest Silurian (Bowning) event, horizon B an Early Devonian (Bindian) event, and horizon C a late Middle Devonian (Tabberabberan) event (Table 1).

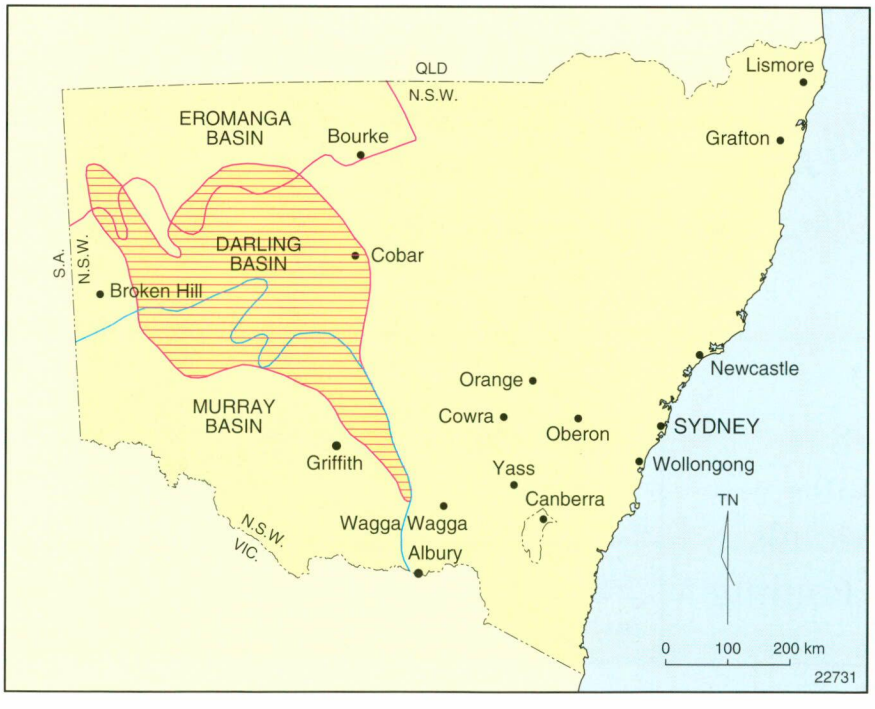


Figure 6. Location of the Darling Basin in western New SouthWales

Preliminary framework

Using these major sequence boundaries, a preliminary working seismo-stratigraphic framework has been established as a basis for describing the Devonian strata within this sparsely drilled basin with little outcrop. The (largely subsurface) sequence stratigraphic terms proposed in this report are (in order of decreasing age) the Winduck Interval, the Snake Cave Interval and the Ravendale Interval.

Through the review, it has been possible to extend a number of previously recognised marine intervals. Marine influences may have enhanced the source potential of some parts of the sequence, and this needs to be followed up with further work. A considerable number of depositional environments with source potential have been identified.

TABLE 1

WORKING SEQUENCE STRATIGRAPHY - DARLING BASIN

Late Devonian	Ravendale Interval	Upper part of the Mulga Downs Group red bed facies including Nundooka Sandstone & Ravendale Formation & equivalents, plus Bundycoola Formation & Crowl Creek Formation
Tabberabberan event ~ regional unconformity ~ Horizon "C"		
early Middle to late Early Devonian	Snake Cave Interval	Lower part of the Mulga Downs Group red bed facies including Coco Range Sandstone & Snake Cave Sandstone, plus Bulgoo Formation, Merrimerriwa Formation & Meadows Tank Formation
Bindian event ~ regional unconformity ~ Horizon "B"		
Early Devonian and latest Silurian	Winduck Interval	Mt Daubeny Formation [west], the Winduck Group [central & east], plus the upper Amphitheatre Group [east]
Bowning event ~ angular unconformity ~ Horizon "A"		

The Late Devonian Ravendale Interval reservoirs identified are generally of good to very good quality and a small body of quantitative data exists for them. Locally developed seals have been noted for the best reservoir units within the basin. There are, in places, very thick and extensive sealing lithologies near the top of the sequence.

Valid comparisons can and have been made between the prospectivity of the Darling Basin and that of the Adavale Basin of south-western Queensland, 570 km to the north (figure 7). These comparisons will become more useful as a detailed biostratigraphy for the Darling Basin becomes available and a fuller understanding is gained of the basin's tectonics and structural history.

The results of the stratigraphic review have been prepared as an unpublished geological report, GS 1997/214, which is available for loan from the Information Counter, Head Office, St Leonards.

For further technical information on the Darling Basin contact Dave Alder, Principal Geologist – Petroleum, on (02) 9901 8512, fax (02) 9901 8520, e-mail alderd@minerals.nsw.gov.au

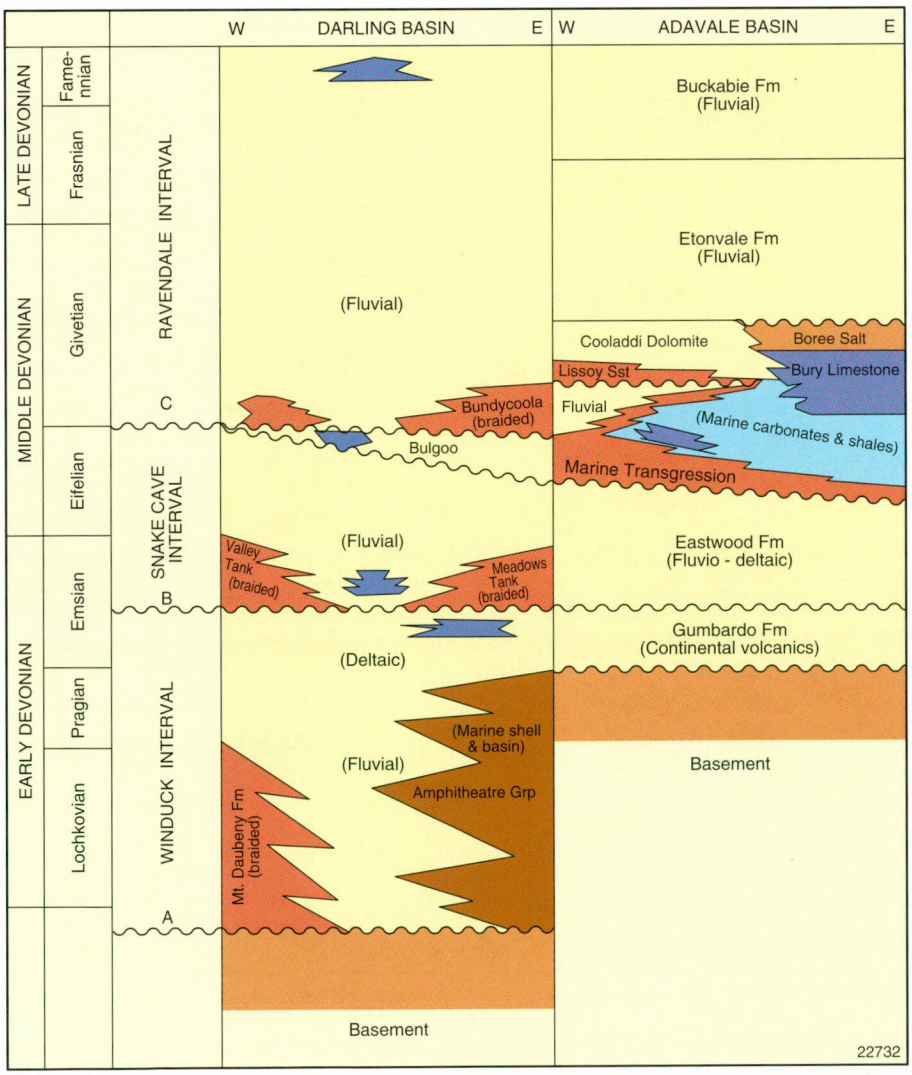
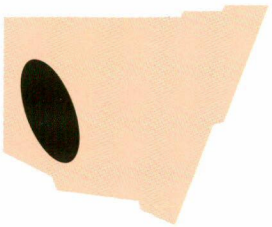


Figure 7. Comparison of the stratigraphy of the Darling Basin in New South Wales and the Adavale Basin in Queensland

GEOCHEMICAL ANALYSIS OF THE DARLING BASIN, STAGE 2



Following assessment of available geochemical data, oil seep material from the Darling Basin has been analysed in an effort to to trace regional petroleum source rocks.

INTRODUCTION

Stage 1 of the Department's petroleum geochemistry study of New South Wales sedimentary basins (*Minfo* **53**, p 34) showed that the geochemical data available for the Darling Basin were very limited. Stage 2, now completed, was undertaken to identify potential source rocks in the pre-Cretaceous section of the basin, to assess their thermal maturity, and to investigate the nature of the minor oil shows recorded in various wells and in outcrop.

HYDROCARBON GENERATION

For hydrocarbons to be generated, there needs to be sufficient organic material within rocks, and for this material to be buried to sufficent depths to achieve appropriate levels of maturity. Generally the level of total organic carbon (TOC) required for this process needs to be at least about 1.0% in clastic rocks and 0.5% in carbonate rocks. Rocks with a TOC of less than 1.0% are considered unlikely to constitute viable source rock sequences. TOC determinations can be made

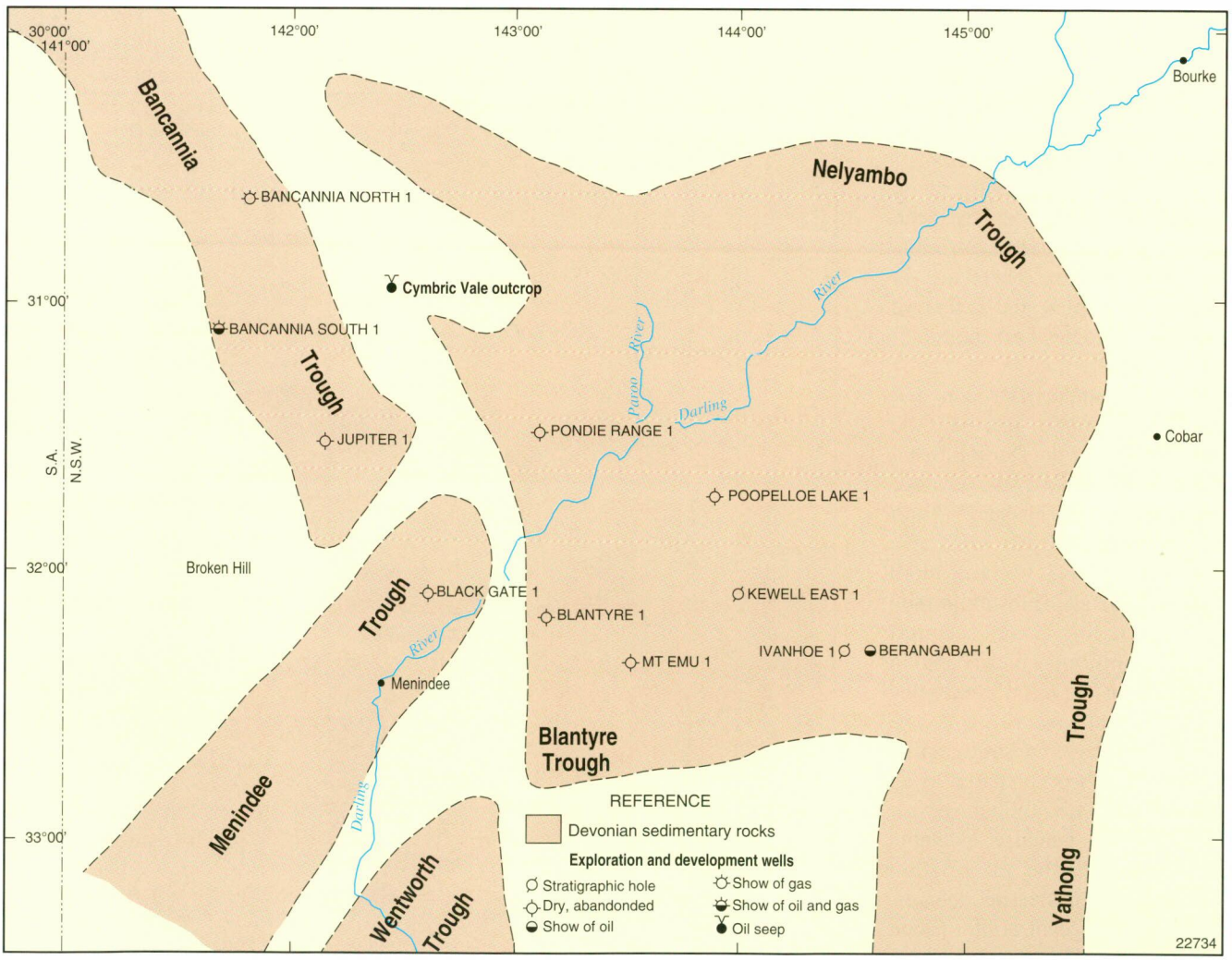


Figure 8. Location of wells drilled within Devonian sediments of the Darling Basin, which were sampled for geochemical testing

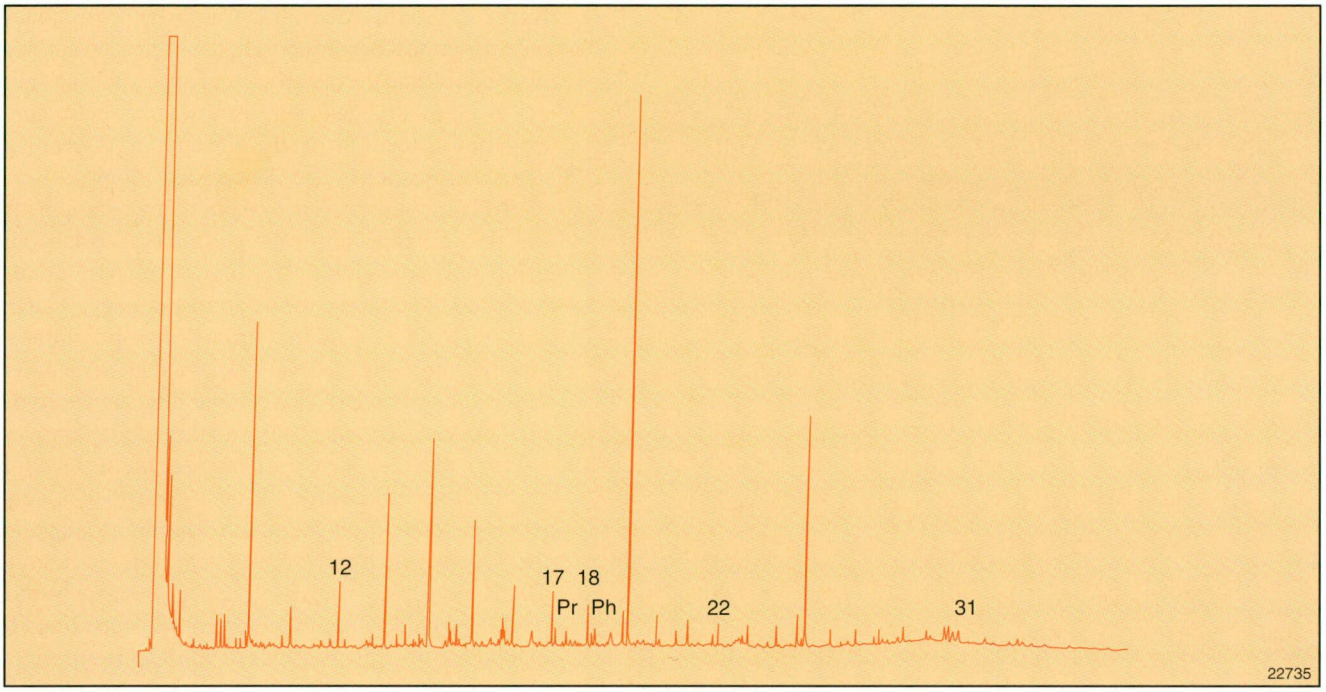


Figure 9. Analysis of an oil seep at Cymbric Vale (figure 8). The gas chromatograph traces the presence of hydrocarbons, particularly in the low molecular weight region, with a predominance of C_{14}. There is a slight odd over even predominance in the high molecular weight range, possibly indicating some higher plant input. The pristine/phytane ratio of 1.63 is consistent with a reducing depositional environment. C_{27}/C_{29} diasterane and sterane ratios are 1.75 and 1.24 respectively and indicate mainly marine (algal/bacterial) source material. The C_{29} 20S/20R ratio and the methyl phenanthrene index of 0.59 suggest that the extract is moderately mature.

from drilling cuttings and core samples. Geochemical analysis of the composition of the organic constituents can also provide estimates of whether the source rocks will generate oil or gas preferentially, and at what levels of maturity. Conversely, oil shows encountered on the surface or in cuttings can be geochemically analysed to ascertain the likely nature of the source rock. Although relatively rare in Australia, in some tectonically active basins surface oil seeps may be commonplace, whereas the source rock sequences may or may not have been ascertained.

THE SEARCH FOR SOURCE ROCKS

Until recently, attempts at ascertaining source rock sequences in the Darling Basin focused on sampling TOC content in the finer grained argillaceous lithologies, as these are expected to be the best candidates for source rocks. In 1996, following earlier reports of a surface occurrence of a bitumen-like material, the Department analysed samples from limestone outcrops and cuttings from wells in the Darling Basin where 'live' (that is, not biodegraded) hydrocarbon shows were reported. Although none of the wells encountered any obvious source rock sequences, minor quantities of oil extract were obtained, and now the hunt is on for locating the source rock sequences.

Cuttings from several wells with reported minor oil shows were analysed using gas chromatograph (GC) and gas chromatograph mass spectrometry (GCMS). Hydrocarbon extracts were also obtained and analysed from an area where a petroliferous seep had been recorded in outcrop. Although only minor, they provide the first definite signs that a viable source rock sequence exists and that it has attained levels of maturity compatible with oil generation within the Darling Basin (figure 9).

Samples from the shows indicate the presence of possibly two sub-families of oil — one possibly derived from the Cambrian and the other wholly or partly from the Devonian. However, due to the lack of intersection of suitable source rock candidates the exact origin of these shows remains unknown. One line of investigation being pursued is that each of the three wells drilled within the region (all within the Bancannia Trough [figure 8]), did not penetrate the entire sedimentary section. That is, the lack of source rocks penetrated in these wells (Bancannia South-1, Bancannia North-1 and Jupiter-1) is not truly reflective of the source potential of the Trough and adjacent regions. Some support for this contention comes from the interpretation of reprocessed seismic lines recorded originally during the 1960s.

These seismic lines indicate substantial thickening in the Trough towards the east, in the direction of the Koonenberry High. Considerable onlap is observed in basal sequences westwards as basement shallows and it is towards the western portion of the Trough that each of these three wells was located. It is uncertain what the relationship is between the Bancannia Trough and the Koonenberry High, but it is on the

View of the Darling Basin looking north from the Broken Hill region

Koonenberry High that bituminous shows were previously recorded in Cambrian limestone outcrops. The High may have acted as a foreland load during at least part of the Trough's development. The very limited available seismic data suggest that part of the boundary between these two features is compressional, and the attitude of the reflectors is not inconsistent with some foreland loading. If foreland loading did occur, then lateral facies changes are to be expected from west to east within the Trough's sedimentary rocks. Alternatively, if the present structural relationship reflects later overthrusting, a considerable amount of the Bancannia Trough may have been overridden and shielded from view.

Extensive analysis (fingerprinting) of the minor oil shows suggests that the oil source material could be derived from sequences deposited in a carbonate/evaporitic environment. Such environments have not been encountered within the Devonian in the western Darling Basin, although these types of environment occur in the Middle Devonian of Central Queensland's Adavale Basin — as shown by the occurrence there of the Boree Salt and Cooladdi Dolomite.

However, the Middle Devonian has yet to be categorically recognised in the Darling Basin succession. An alternative to the theory that preserved Middle Devonian sequences might be the source of the minor oil shows in the eastern portion of the Bancannia Trough is that they originated from carbonate–evaporitic sequences of Cambro-Ordovician age, similar to those occurring west of the Broken Hill Block in the Warburton Basin in South Australia. Cambrian carbonates outcrop on the Koonenberry High, but their subsurface distribution and the occurrence of any evaporites has yet to be ascertained, because previous petroleum exploration focused on the surrounding Devonian depocentres, such as the Bancannia Trough.

Although the presence of possible contaminants (eg drilling pipe lubricants) cannot be ruled out completely, particularly for shows in some of the wells, contamination seems a most unlikely source for the extracts gathered from outcrop samples. Another intriguing aspect to emerge is that the maturity of the shows is relatively low and they appear to be non-biodegraded, suggesting, for the outcrop samples at least, that they have not been near the surface for any length of time. These attributes point to relatively recent generation and migration. There is no apparent mechanism which may have triggered this generation. The Koonenberry High itself appears to have been a relatively stable structural element for some time. It exhibits no obvious evidence of uplift and unroofing. Higher Cainozoic heatflow might provide a mechanism but no studies have been conducted in this region to confirm this.

In the east of the Darling Basin, Early Devonian marine sequences traditionally have been thought most likely to contain the best potential source rocks. The Department drilled Kewell East 1, a fully cored stratigraphic well, to test the Early Devonian at a location where, on the basis of seismic data, it was thought feasible to penetrate to the base of the section.

Unfortunately the seismic velocities proved to be higher than estimated, resulting in the well having to terminate above the base of the Winduck Interval. The penetrated sequences, although outwardly dark and fine grained, proved in detailed geochemical analysis to contain only limited TOC, at levels generally thought too low to constitute valid source rock sequences. Further studies are continuing. Kewell East 1, being located on a relative structural high, may not have penetrated a sufficiently representative section. With this in mind, detailed stratigraphic and geochemical data are being cross referenced with boreholes drilled further to the east, some of which contain significant quantities of organic material.

CONCLUSIONS

Identification of regional source rock sequences remains the most vexing issue for petroleum exploration in the Darling Basin. Over the next twelve months the Department will be continuing to identify possible source rock material, to fingerprint extracts and other minor reported shows in an attempt to resolve their origin. Already the results have been surprising, raising as they do the distinct possibility that Cambro-Ordovician sequences, in addition to the marine Early Devonian, constitute regional source rock targets.

For further information contact Dave Alder, Principal Geologist — Petroleum, on (02) 9901 8512, fax (02) 9901 8520, or e-mail alderd@minerals.nsw.gov.au

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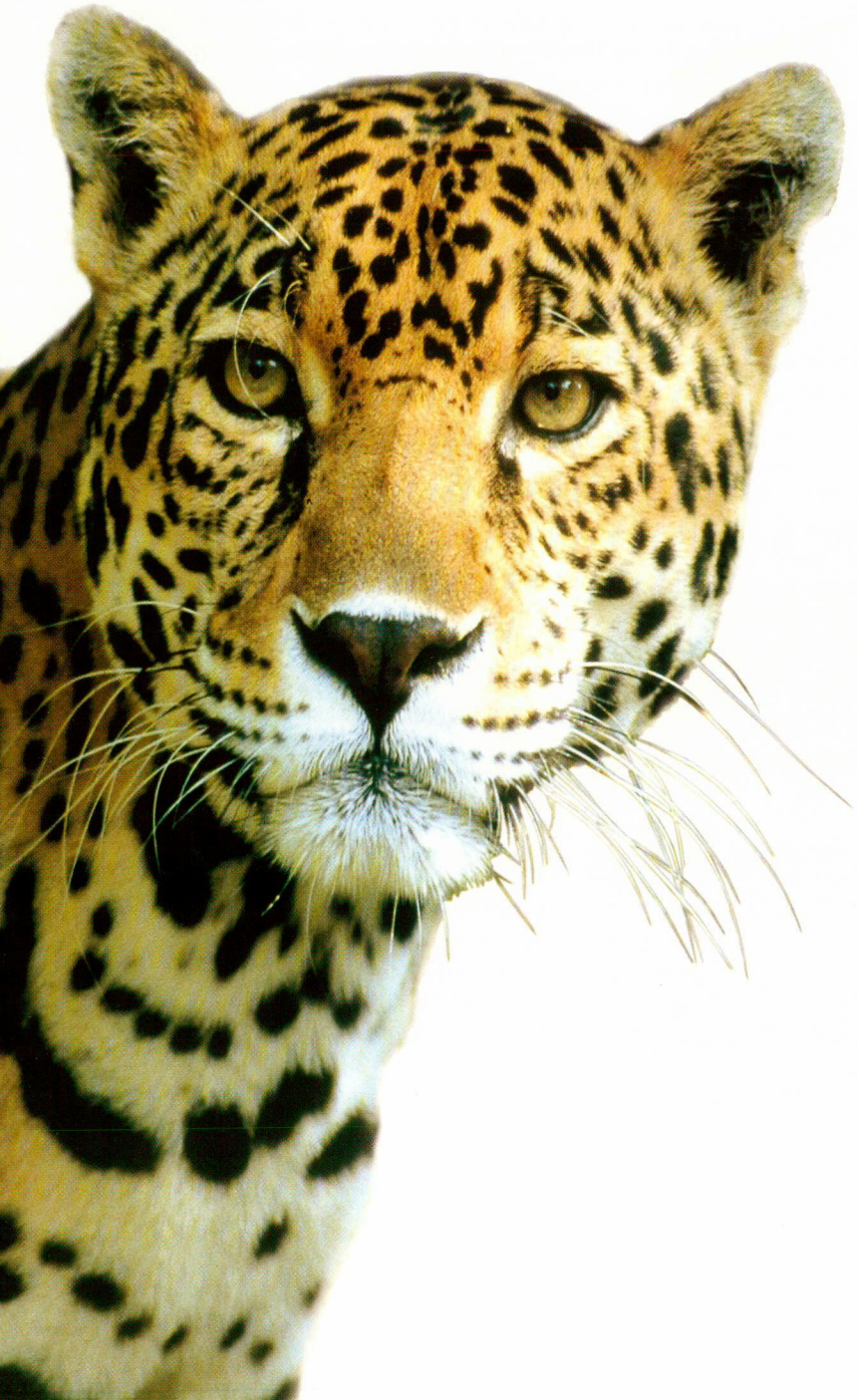

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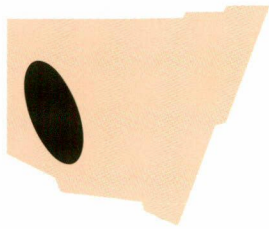

Through the preservation, reprocessing and acquisition of seismic data, the Department is encouraging petroleum exploration in the Darling Basin.

The Darling Basin in western New South Wales is one of the State's most prospective and least explored regions for petroleum. Over the past three years, to encourage petroleum exploration, the Department has undertaken a program designed to enhance the Darling Basin's seismic database.

The Basin covers an area of approximately 87 000 km^2 and has only approximately 1 550 km of modern multifold seismic coverage. By comparison, other similar sized mature exploration basins may contain 100 000 – 200 000 km of seismic coverage.

The Department's program to enhance the limited existing seismic coverage has included:

- Preservation of existing data – conversion of original field tape information to a more stable medium, exabyte format, and where original data were in analogue format, conversion to digital format.
- Reprocessing of old data – selected old survey data have been reprocessed to enhance their quality.
- Acquisition of new data – a limited amount of new high quality data has been acquired in areas where previously data quality were poor.

PRESERVATION OF EXISTING DATA

Since the first seismic reflection data were recorded in 1962, 18 seismic surveys have been conducted in the Darling Basin. Of the 2 100 km of data, only the 1 450 km recorded by BHP Ltd during 1983-84 were considered to be of both sufficient regional coverage and quality to be of genuine interest to the petroleum industry in its existing form. The balance of the data was acquired during the early 1960s or 1970s. The earlier single analogue data potentially provided the most interest because they represented long traverses across many of the major structural boundaries and depocentres.

Guardian Data Pty Ltd of Sydney transcribed all analogue field tapes to digital (SEGY) format and now store them on a more stable and durable medium (exabyte tape). This material now forms part of the open file system and is available for the cost of duplication.

REPROCESSING OF OLD SURVEY DATA

Any significant improvement in the quality of existing data, particularly in areas devoid of modern seismic coverage, is seen as a cost effective way of enhancing the seismic database. The location of four seismic surveys acquired in the 1960s in various portions of the Darling Basin are shown in figure 10.

The original seismic data were typically displayed in exaggerated vertical and horizontal scales using variable density/wiggle trace format, a sample of which is shown in figure 11(a).

By present day standards relatively large (3 x 25 lb [10 kg]) dynamite charges used as energy sources in these surveys gave rise to relatively low frequencies, which in turn reduced sub surface resolution. Low frequencies are compounded by use of 'tight' band-pass filters applied in the field to reduce deleterious effects of ground roll and air blast, both enhanced by use of large charges. Band-limited reflections seen on the original data typically produce a 'ringing' character to the section.

By applying deconvolution during reprocessing much of this 'ringing' has been reduced. During reprocessing,

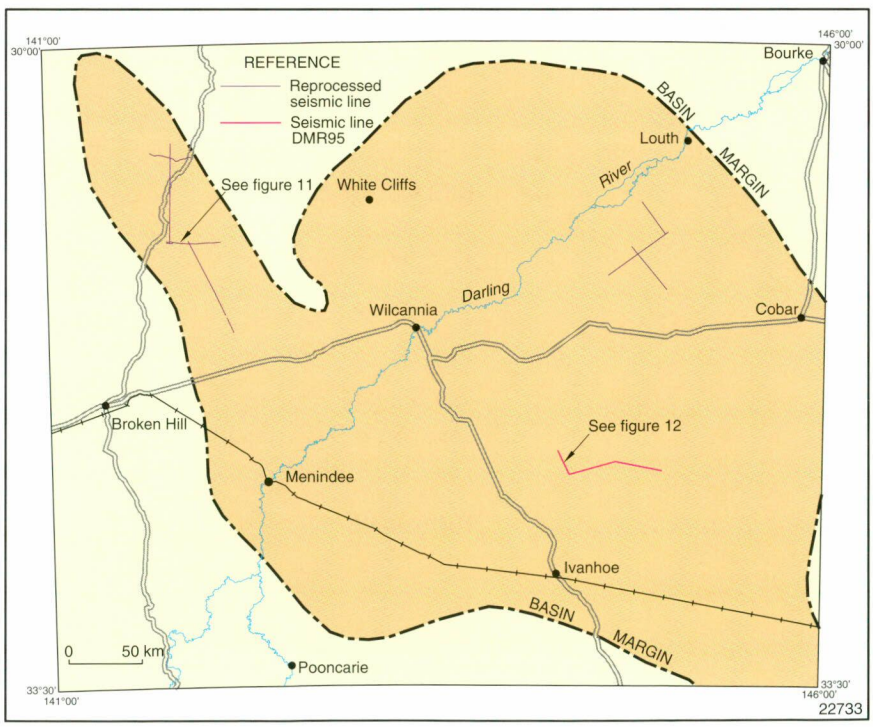

Figure 10. Location of recently reprocessed seismic lines, and newly acquired seismic line in the Darling Basin

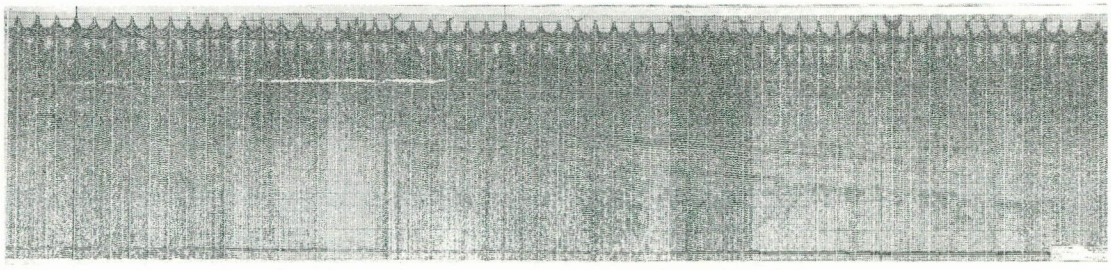

Figure 11(a). Seismic data obtained about 30 years ago, as they appeared before reprocessing

Figure 11(b). The same seismic data, after recent reprocessing using current techniques

particular attention was also paid to application of state-of-the-art statics software, better velocity control, and re-display of the final sections, using more appropriate plotting scales.

Figures 11 (a) and (b) show a comparison of one of the lines before and after reprocessing. Enhancement in data quality is obvious, and the compression of 'ringing' events to a simple reflector – representative of a geological marker – is quite apparent, for example, at 1.2 seconds near the end of the line in figure 11 (b). Most reprocessed lines showed similar improvement. Reprocessing has demonstrated that even though the data are 30 years old or more, they are still valuable and provide important information in regions of the basin where there are no other available seismic data.

NEW SEISMIC DATA ACQUISITION

The Berangabah seismic survey was recorded in November 1995, as part of the Discovery 2000 program. It comprised 76.89 km of high fold seismic reflection data recorded along three lines (figure 10). The survey area is located in the south-eastern part of the Darling Basin, 70 km north of the town of Ivanhoe.

The survey was designed to investigate the structural and stratigraphic relationships of the Palaeozoic to Recent sedimentary sequences on the south-eastern edge of the Neckarboo Trough, adjacent to the Neckarboo High. The region was targeted because at the time of the survey, limited seismic and potential field data indicated the presence of thick sedimentary section, for which there was no subsurface data.

The lines were located to avoid, as far as possible, surface outcrops, laterite and silcrete, which are extensively developed in the structurally prone areas. To obtain as complete a coverage as possible, and at the same time, retain straight line geometry, the traverse was divided into three straight line segments. These have been described as DMR95-01, DMR95-02 and DMR95-03.

The primary geological objective of the survey was to obtain subsurface information from within the Devonian section, including the major intra-Devonian unconformities, as well as the earliest Devonian, to help understand the history of deposition and structural development along the eastern portion of the Darling Basin.

From a geophysical standpoint there were a number of additional aims. The first was to ascertain the efficacy of very high (~275) fold seismic acquisition techniques, particularly as to whether superior seismic quality could be obtained, sufficient to enable reliable correlation across zones previously yielding noncoherent reflection data. Previously, only 12-fold data had been recorded in the region. The second aim was to ascertain what level of improvement in data quality was provided by the much higher fold coverage. A third objective was the degree of improvement in data quality from processing with modern software, and whether this warranted any reprocessing of the 1983-84 vintage BHP data.

The data acquired during the Berangabah survey were of variable quality. The best data were recorded along line DMR95-01 (figure 12), where a thick Devonian sequence is interpreted to thin onto the Neckarboo High. Data on lines DMR95-02 and DMR95-03, which are located on the Neckarboo High, were disappointing in quality, there being little coherent energy evident on either line.

Greatest differences between the new and existing BHP acquired data are in the shallower levels, less than 300 msec, where better signal to noise ratios are achieved on the new data because of a much higher fold coverage. The new data also have better resolution, enabling stratigraphic relationships to be delineated.

Nevertheless, some areas recorded with the high fold coverage still resulted in no coherent reflections. In several places these areas coincide with, or are close to outcrops of, Late Silurian to Early Devonian Amphitheatre Group sedimentary rocks and highly silicified Mulga Downs Group. It is suggested that these outcrops may also coincide with structurally complex areas across which the depositional fabric has been intensely deformed. The deformation may have led to a loss of reflector coherency and hence the recording of no obvious reflections even on the high fold data.

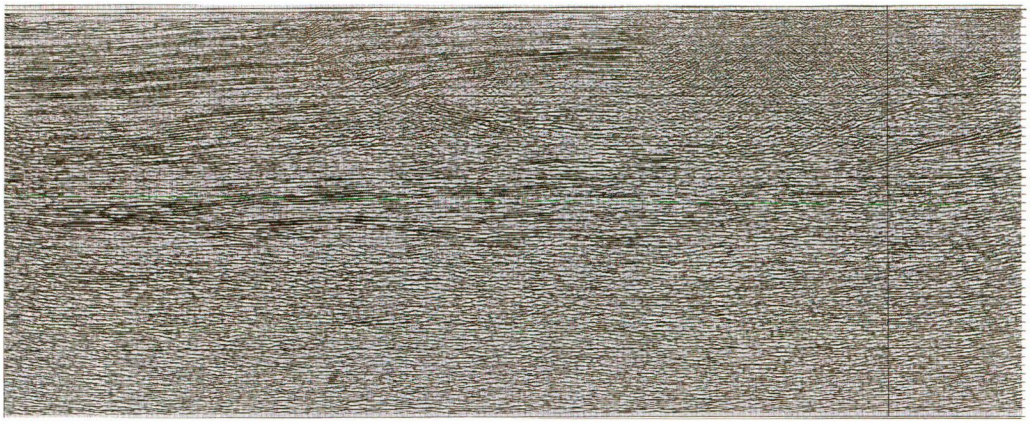

Figure 12. The first of the three straight line segments, DMR95-01, shot as part of the Berangabah seismic survey in the south-east of the Darling Basin in 1995

New seismic acquisition has established that very high fold data, and selection of line location to avoid obvious near surface problems such as silcrete and laterites, do not significantly improve the data quality in those areas previously known to have poor data quality. Those areas which are still characterised by poor data quality probably coincide with intense deformation, and as such are an indication of likely areas of poor porosity and permeability preservation, unsuitable for petroleum exploration.

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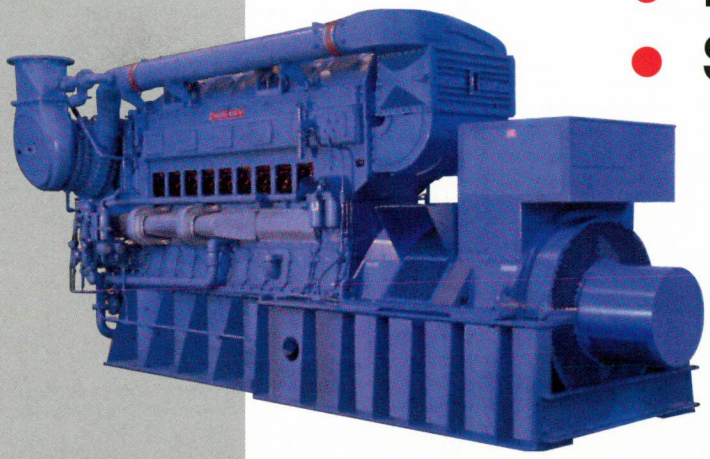

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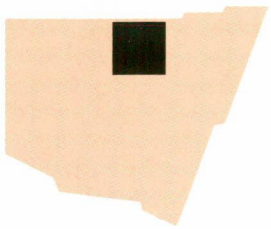
THE SURAT BASIN — A NEW SOUTH WALES GAS PROVINCE



Exploration for hydrocarbons in the Surat Basin is gathering pace. At the same time, data are being collected to assist the exploration industry.

Over the last four years the Department has been investigating gas occurrences within the New South Wales portion of the Surat Basin and the underlying Gunnedah Basin (figure 4, p 4). The Surat has long been known as a productive petroleum province in Queensland, but in New South Wales industry for many years considered it too shallow to generate hydrocarbons and therefore unprospective.

Exploration by Hartogen Energy Ltd in 1986 and Petroleum Securities Pty Ltd in 1994 identified the Wilga Park and Coonarah gas accumulations near the town of Narrabri in New South Wales (figure 13), but at the time they were considered sub economic. These gas deposits are located in Triassic and Permian sedimentary rocks of the Gunnedah Basin underlying the Surat Basin. The finds were encouraging, and they are now being actively investigated to ascertain if sufficient gas resources exist for commercial exploitation. Gas in these fields consists of approximately 87% methane, 11% nitrogen, 1% helium and 1% carbon dioxide. There are both local and regional markets ready to use the methane, nitrogen and helium for electricity generation, domestic gas use, fertiliser production and other uses.

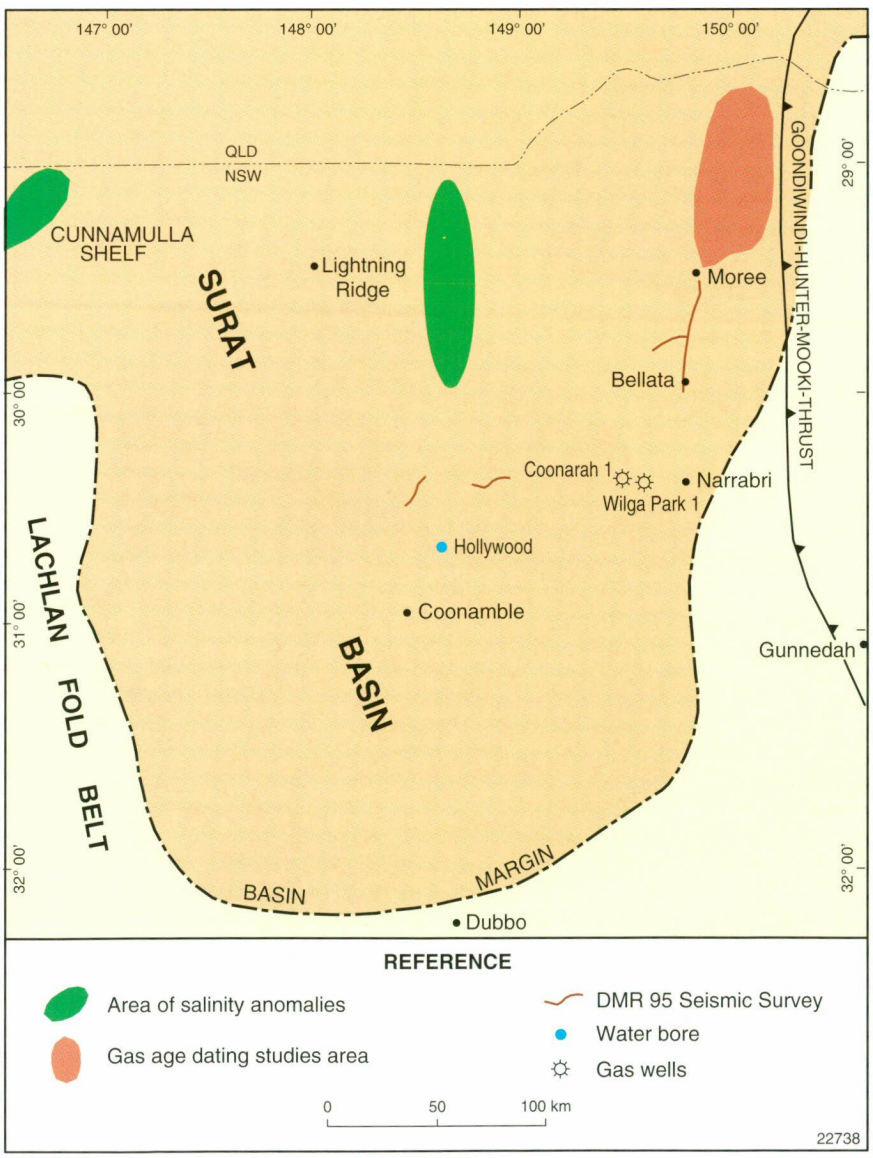


Figure 13. Area covered by the Surat Basin in northern New South Wales, showing the locations of Departmental studies and some exploration wells

HYDROCARBON OCCURRENCE AND COMPOSITION

The occurrence of gas accumulations was the basis for regional studies by the Department, under the Discovery 2000 program, to ascertain the existence of other gas bearing structures within the Basin. The studies have indicated that many of the waterbores in the basin contain quite significant volumes of dissolved gases (refer Minfo 49, pp 29-31). Samples collected from the basin show that methane is the main gaseous hydrocarbon and is accompanied by varying amounts of carbon dioxide.

Hydrocarbon gases may be derived from a number of natural sources such as biogenic decomposition of organic matter at shallow levels, or from commercially more important and deeper thermogenic sources. Nearly all the waterbore analyses record predominantly methane ('dry' gas), although gases from one bore, Hollywood, west of the town of Gunnedah, approach wet gas composition. Wet gas, that is gas containing butane and pentane, is regarded as an indicator of oil generation. Stable carbon isotope analysis showed the ^{13}C composition of

methane to be outside the compositional range for thermogenic gas (that is, gas generated as part of the process of oil generation or the break-down thereof) but similar to that of coal seam gas.

The Department is continuing to map waterbore salinity and trace elements. Initial results show quite strong trends, with high amounts of bicarbonate and boron indicating the presence of older marine rocks within the deeper sedimentary rocks of underlying grabens. The Department is also investigating the age of gases in the bores to understand better their origins and migration system. Results of these studies were due in early July 1998.

SEISMIC SURVEY DATA

Although the Surat Basin has been the subject of several phases of petroleum exploration, like many basins within the State it is relatively large and has only sparse seismic coverage. Existing coverage is largely of older seismic data, with many of the regional lines having been recorded using analogue techniques during the 1960s. Shallow intrusions and limited processing capabilities in the 1960s severely limited the depth of penetration and resolution of earlier seismic data, seismic imaging being restricted to the upper few hundred metres. The depth to economic basement remained uncertain.

In 1996 a seismic line was acquired by the Department across the Surat Basin between Bellata and Moree (a distance of 75 km) to investigate the depth of sedimentary rocks in the underlying Bellata Trough. The interpretation of pre-existing seismic and potential field data indicated that the Trough might be a regional depocentre. The new high quality data indicate that Permian sequences are much more extensive, and more deeply buried than previously interpreted. The section is now interpreted to thicken northwards, in the direction of Moree, where over 1.4 seconds of sediment (approximately 2 200 m) is mapped above economic basement. Such thicknesses are compatible with depths for the thermogenic maturation of source rocks, raising the possibility that at least some of the gas entering the overlying aquifers may indeed come from thermogenic, as well as coal seam, sources.

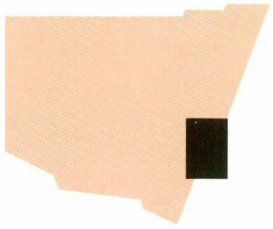
OUTCOMES

As a result of these studies and continued corporate interest in potential gas resources and in opening up market opportunities, three companies have recently applied for exploration licences in the area. Applications have been made for both coal seam methane as well as for conventional petroleum. Initial coal seam methane studies have been very encouraging. Exploration will include on-going investigation and evaluation of the Wilga Park and Coonarah gas accumulations and the drilling of exploration wells to test both conventional petroleum plays and structural traps, as well as for coal seam methane potential.

For further information contact Dave Alder, Principal Geologist — Petroleum, on (02) 9901 8512, fax (02) 9901 8520, or e-mail alderd@minerals.nsw.gov.au

Flying a geophysical survey over the Surat Basin, part of the Discovery 2000 program

A NEW STRUCTURAL MODEL OF THE SYDNEY BASIN



A recent review of the structural geology of the Offshore Sydney Basin has led to different concepts of the origins of the Basin. The proposed model has implications for the Basin's petroleum prospectivity.

The Sydney Basin forms part of a major longitudinal Permo-Triassic basinal complex stretching 1500 km along the eastern margin of Australia. The beginning of the Basin's development may have been extensional, although reinterpretation of seismic and other geophysical data also highlight the important role played in its early development by easterly directed compression of what has been known as the 'Currarong Orogen' (which includes the Dampier Ridge and Lord Howe Rise). The offshore area is made up of four structural components, the Offshore Uplift, the Newcastle Syncline, the Offshore Syncline and the New England Fold Belt (figure 14).

OFFSHORE UPLIFT

The most conspicuous structural element is the Offshore Uplift. The Offshore Uplift is bound on its western side by a low angle thrust complex which may steepen in dip southwards. This fault boundary also marks the western margin of a region of high magnetic intensity. The Offshore Uplift is extensively partitioned by reverse, thrust and down-to-the-east normal faults that formed during rifting which preceded breakup and the formation of the Tasman Sea Basin. The northern boundary of the Offshore Uplift trends west-north-west and dips below the Newcastle

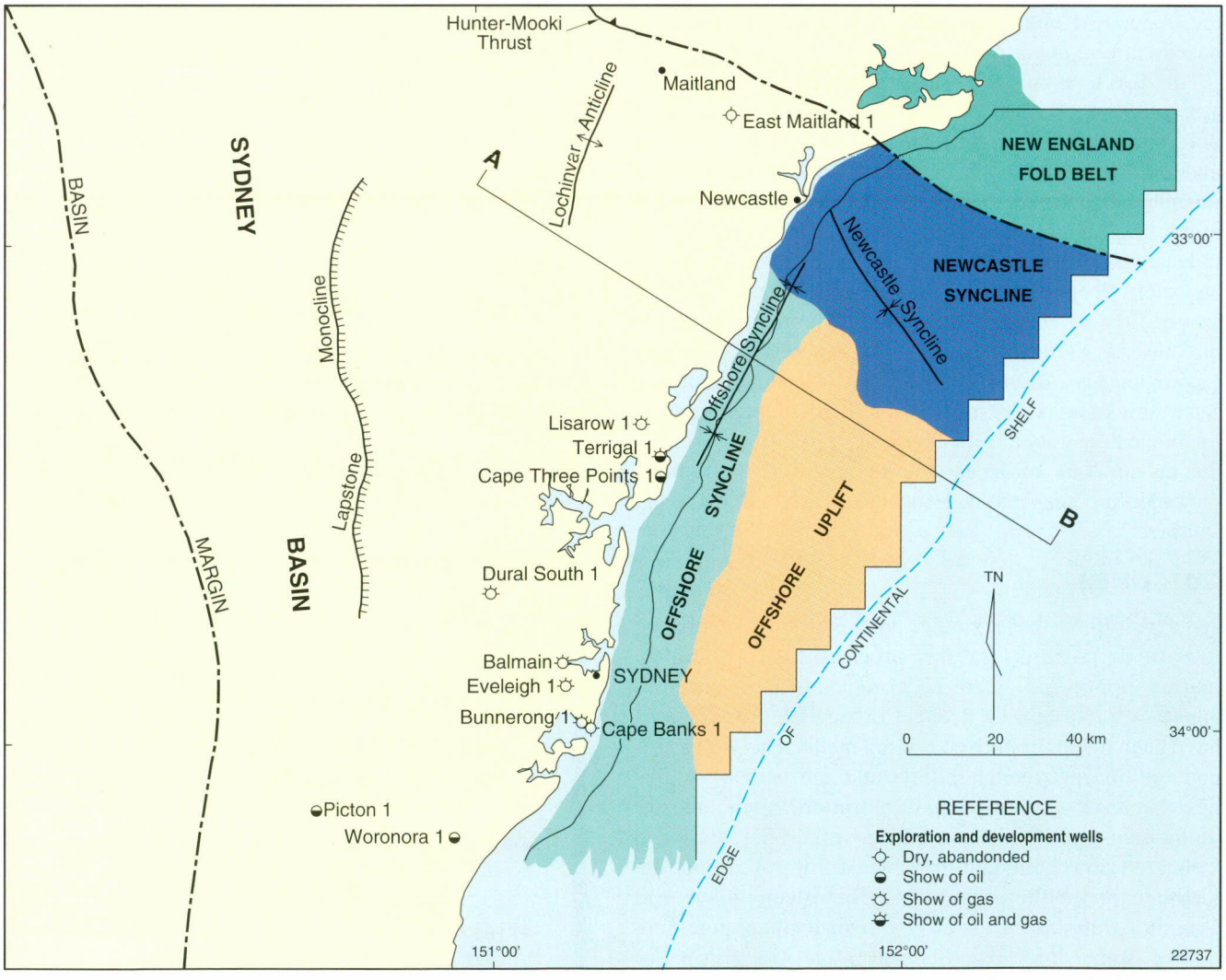


Figure 14. Structural elements of the Offshore Sydney Basin

Syncline. To the south, the Offshore Uplift extends at least to Wollongong. It is difficult to identify further to the south because of poor seismic data and interference from shallow volcanic rocks.

The Offshore Uplift shares key similarities with the Lochinvar Anticline located in the northern onshore Sydney Basin. Both are underlain by Late Carboniferous volcanic rocks, both are bound by reverse and/or thrust faults on their western flanks and both experienced Early Permian structural growth. Similarities in seismic character and aeromagnetic response have led to the conclusion that the Offshore Uplift contains Carboniferous volcanic rocks similar to those of the New England Fold Belt. The Offshore Uplift comprises the western margin of the 'Currarong Orogen' and is interpreted to have acted not only as a provenance for epiclastic rocks but also as a centre for latite flows. More importantly, and as a result of westerly directed compression, the Currarong Orogen provided thrust loading onto the eastern margin of the Lachlan Fold Belt, thereby controlling deposition and overall development of the central and southern parts of the Sydney Basin from the earliest Permian.

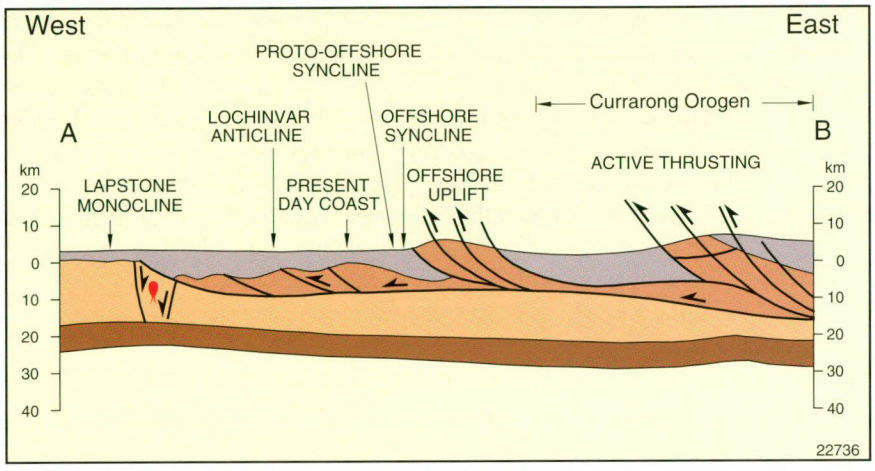


Figure 15. Section through the Offshore Sydney Basin (refer A–B in figure 14)

NEWCASTLE SYNCLINE

The Newcastle Syncline, covering an area of approximately 650 km^2 between the Offshore Uplift and the New England Fold Belt, is inferred to be an offshore extension of the onshore Newcastle Syncline. The syncline is located between the offshore extension of the New England Fold Belt and the Offshore Uplift. Originally the sedimentary rocks that form the syncline were much more extensively distributed. Their current distribution is remnant, and follows removal of extensive sequences by uplift of the offshore New England Fold Belt, and erosional truncation which has superimposed, or reinforced, the now conspicuous east-south-east synclinal axial trend of the Newcastle Syncline. Present synclinal geometry may date from the Late Permian or Early Triassic.

A northerly continuation of the thrust fault forming the western boundary of the Offshore Uplift divides the Newcastle Syncline into western and eastern segments. The western segment is shallower and coincident with the northern extension of the Offshore Syncline. The oldest sedimentary rocks (interpreted at the base of a seismic section) are considered to be of Early Permian age, offshore equivalents of the lower Dalwood Group, which unconformably overlie volcaniclastics of Late Carboniferous age.

The onshore Newcastle Syncline is considered a foredeep with respect to the southern New England Fold Belt which overthrusts it from the north and north-east, west of the town of Maitland. In the coastal and offshore areas seismic data show no clear evidence of similar thrust relationships. Moreover, the overall synclinal geometry is not consistent with foreland loading because the synclinal axis lies in a mid basinal position rather than in an asymmetrical position adjacent to, and parallel with, the overthrust front.

OFFSHORE SYNCLINE

The Offshore Syncline is a well defined north-north-east trending syncline running the length of the offshore basin, although the shallow Gerringong Volcanics impede the seismic imaging of this feature in the south. At its deepest point, near the intersection of the western segment of the Newcastle Syncline, the top of the basal Carboniferous volcanic sediments lies at a depth of approximately 3.0 seconds (TWT) or ~6000 m, which indicates a very good depth of sediment for the generation of petroleum. The fold axis of the Offshore Syncline parallels major onshore structural fold axes, including the Macquarie Syncline.

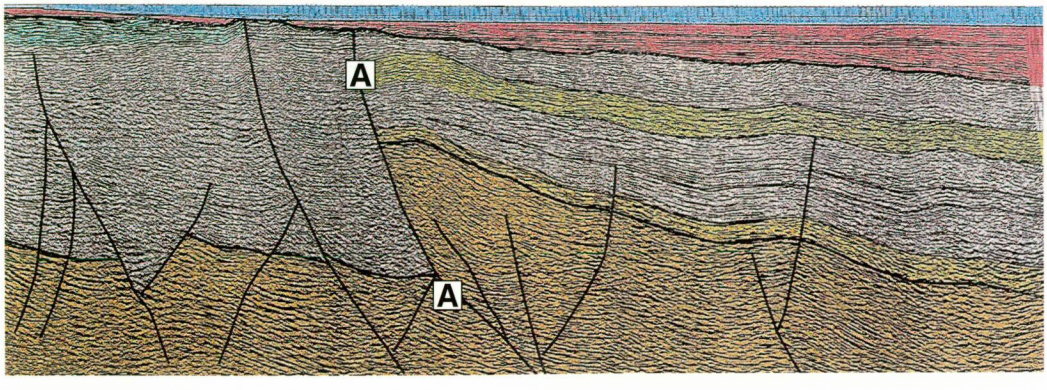


Figure 16. Seismic section showing the thrust (A-A) forming the Offshore Uplift

Increasingly steep westerly dips are observed towards the Offshore Syncline's eastern margin and its boundary with the Offshore Uplift.

The present structure of the Offshore Syncline appears to be Late Permian or younger. No obvious thickening towards the synclinal axis is interpreted, and using the Macquarie Syncline as a model, synclinal growth is interpreted as Late Permian. Prior to that, the nascent Offshore Syncline may have been a foreland deep with respect to the adjacent Offshore Uplift. Like the Newcastle Syncline, the present day structure of the Offshore Syncline is interpreted to have been largely formed during the Late Permian to Early Triassic as a result of westerly directed compression and overthrusting along the western edge of the 'Currarong Orogen' — the Offshore Uplift. Transverse components of this compression were probably manifest as wrench reactivations of meridionally trending faults, such as the major fault sub-paralleling the Offshore Uplift and Offshore Syncline.

NEW ENGLAND FOLD BELT

The New England Fold Belt bounds the Sydney Basin north of the Hunter–Mooki Thrust System. The bulk of the southern part of the fold belt lies onshore, although it also extends into the adjacent offshore. Limited seismic and aeromagnetic data indicate that it coincides with shallow 'basement' across the continental shelf. A major unconformity separates a thin, easterly prograding Cainozoic cover from the underlying 'basement' — Late Carboniferous volcaniclastic and volcanic rocks. Across the flank forming the boundary with the adjacent Newcastle Syncline, remnant Permian sedimentary rocks are present, indicating that the offshore portion of the New England Fold Belt had previously been the site of Permian deposition. The structural relationship between the New England Fold Belt and the adjacent Newcastle Syncline is unclear. No obvious overthrusting is apparent, although a detachment surface, suggestive of underthrusting, has been interpreted from seismic reflection data on several north-south lines, with the thrust front re-emerging on the shallowing flank of the Offshore Uplift.

PETROLEUM POTENTIAL

Early structural growth of the Offshore Uplift, particularly Early Permian, has important implications for petroleum exploration. The emerging Offshore Uplift provided a major sediment provenance area and formed a barrier behind which restricted anoxic conditions flourished, conditions favouring the preservation of organic matter. Late Permian and Triassic sequences are absent across the crestal portions of the Uplift. However, the emerging seaward facing flank of the Uplift would have been subject to marginal and shallow marine, wave-base, barrier and strand bar deposition during the Early Permian, conditions known to favour petroleum reservoir development.

Cretaceous Tasman Sea rift-related structuring is subordinate to that of the earlier compressional and wrench related features, and several new structural targets have now been added to known prospects and leads. These include some that are considered to be well placed with regard to source rock and reservoir development.

For further information contact Dave Alder, Principal Geologist — Petroleum, on (02) 9901 8512, fax (02) 9901 8520, or e-mail alderd@minerals.nsw.gov.au

This article, 'A New Structural Model of the Sydney Basin' is based on two papers. The first, entitled 'Prospectivity of the Offshore Sydney Basin: A New Perspective' was presented by David Alder at the APPEA '98 Conference, 8–11 March 1998, Canberra. The paper was prepared by D.A. Alder, S. Hawley, T. Maung, J. Scott, R.D.Shaw, A. Sinelnikov and G. Kouzmina.

The second paper, 'Origin of the Sydney Basin: A New Structural Model', was presented by David Alder at the Thirty Third Newcastle Symposium on Advances in the Study of the Sydney Basin, April 3–5 April, 1998, Newcastle. The paper was prepared by D.A. Alder, S. Hawley, B. Mullard and R.D. Shaw.

For further information and other models refer to:

BRADLEY G.M. 1993. Evolution and Hydrocarbon Prospectivity of Offshore Sydney Basin, Permit NSW P/10. Proceedings, NSW Petroleum Symposium, Sydney, June, 25–58, unnumbered.

BRADLEY G.M. 1993. A new tectonic and depositional model for the offshore Sydney Basin (NSW P/10). Newcastle Symposium on advances in the study of the Sydney Basin, University of Newcastle, Department of Geology, 27, 19–26.

GLEN R.A. and BECKETT J. 1997. Structure and tectonics along the inner edge of a foreland basin: The Hunter Coalfield in the northern Sydney Basin, New South Wales. *Australian Journal of Earth Sciences* (1997) **44**, 853–877.

SANTOS, March 1990. Geological and geophysical interpretation report for activities in Permit Year 1 of Permit NSW P/10. D.A. Grybowski. New South Wales Department of Mineral Resources Open File Report, PG 1990/02.

SANTOS, March 1993. The 1991 Seaspray Seismic Survey Report. Permit NSW P/10. Final Report by David Grybowski.

from the Director–General

Alan Coutts
Director-General

This issue of Minfo features an article on native title aimed at assisting industry to better understand the issues and some of the processes involved in gaining title for mining and exploration.

The State Government is constrained by the Commonwealth Government's responsibility for native title, however, the Department of Mineral Resources is pursuing all avenues to ensure that investment in the State is maintained.

The grant and renewal of exploration titles has been excluded from the 'right to negotiate' provisions of the Commonwealth Native Title Act on the condition that the process is pursued if and when an explorer seeks to access potential native title land.

Because of its complexity and lack of a simple arbitral process, pursuing the 'right to negotiate' process before grant or renewal of exploration titles can involve significant cost and delays to Government, explorers and potential native title claimants. However, this process will need to be pursued more frequently in the future as on-ground access progressively becomes more critical.

The Department has recently produced a set of negotiation protocols and a 'How To' brochure which is intended to help explorers and miners with the complexities of native title. The Department will continue to monitor and update these protocols in the light of recent decisions by the Commonwealth Government on native title legislation.

□ □ □

The Department is determined to win exploration investment for the State, despite the difficulties brought on by uncertainties of native title dealings or from the downturn in Asian economies.

The New South Wales State budget has continued the commitment by the Government to encourage minerals exploration through further funding of the $35 million six year Discovery 2000 Exploration Initiative. Discovery 2000 has been an outstanding success to date, with exploration expenditure in New South Wales reaching $101.8 million for the calendar year 1997. This is a 21% increase on the expenditure of $83.9 million for 1996.

Of particular note is the success in attracting companies interested in petroleum exploration to this State. The Department's promotion of the State's petroleum potential to investors in the United States in particular has been fully repaid, with levels of investment – and optimism – at an all time high.

I am keenly aware that a major aspect of the exploration attraction of New South Wales lies in the quality of information available to explorers. Better delivery of information by the Department enhances the explorer's ability to select the most prospective areas or to identify prospectivity that others have failed to recognise.

We are actively consulting with the exploration industry to develop the most appropriate program to succeed the Discovery 2000 initiative, to ensure that New South Wales continues to attract exploration.

□ □ □

The death in April of the owner of an opencut colliery near Lithgow and two recent fatalities at underground mines in the Newcastle coalfield reminds us again of the risks of mining, and underlines the need for the whole industry and workforce to pay more attention to safety.

The Government, through the Department of Mineral Resources, is about to begin large scale administrative changes that will, over the next three to five years, create a climate for better management of safety. I am sure that the continued three-way co-operation between industry, unions and government will add greater emphasis to the safety of miners.

DISCOVERY 2000

STREAM SEDIMENT DATABASE NEARS COMPLETION

The development of an important exploration tool, a digital stream sediment database of the State, will be completed within twelve months.

The task of building a digital stream sediment database of New South Wales is nearing completion. The project began early in 1995 (*Minfo* **47**, p 28), and a stream sediment database of 110 000 samples, which covered 20 of the State's 1:250 000 map sheet areas, was released on CD-Rom in 1996 (*Minfo* **51**, p 36).

A total of about 260 000 records has now been entered into the database (figure 17). There are still some gaps in information on the New England region, and recently found information on central New South Wales has yet to be added. The program of data collection for 1998–99 will capture most of the outstanding material, estimated to be over 15 000 samples, from these two areas.

Most of the work has been carried out under contract by Terra Search Pty Ltd, with an early contribution by Technical and Field Surveys Pty Limited, although in the far west of the State, the database has been been compiled by staff from the Department's Broken Hill office.

In compiling the information, emphasis has been on ensuring spatial accuracy and acquiring as much information as possible from records. Dubious data have been discarded. The contractors have searched past exploration records and recovered missing data where possible and in some cases companies have been able to provide digital copies of data or replacements for lost information. It is estimated that only around 5% of the old data cannot be recovered.

When complete, the dataset will hold almost 300 000 records on stream sediment geochemistry over basement outcrop, covering roughly 60% of the State.

The Department uses the data for landuse investigations and mineral potential assessment work. The information, which is sold by Terra Search Pty Ltd under licence, is also proving very popular with explorers. Purchasers can obtain extracts for project areas or a complete coverage of the State in a variety of formats, including in Explorer 3 exploration database.

For further technical information contact Peter Lewis, Manager Discovery 2000 (Minerals), on (02) 9901 8372, fax (02) 9901 8753, or e-mail lewisp@minerals.nsw.gov.au

For further information on the purchase of database information contact Terra Search Pty Ltd on (07) 4728 6851, fax (07) 4728 6854 or e-mail terrasch@ultra.net.au

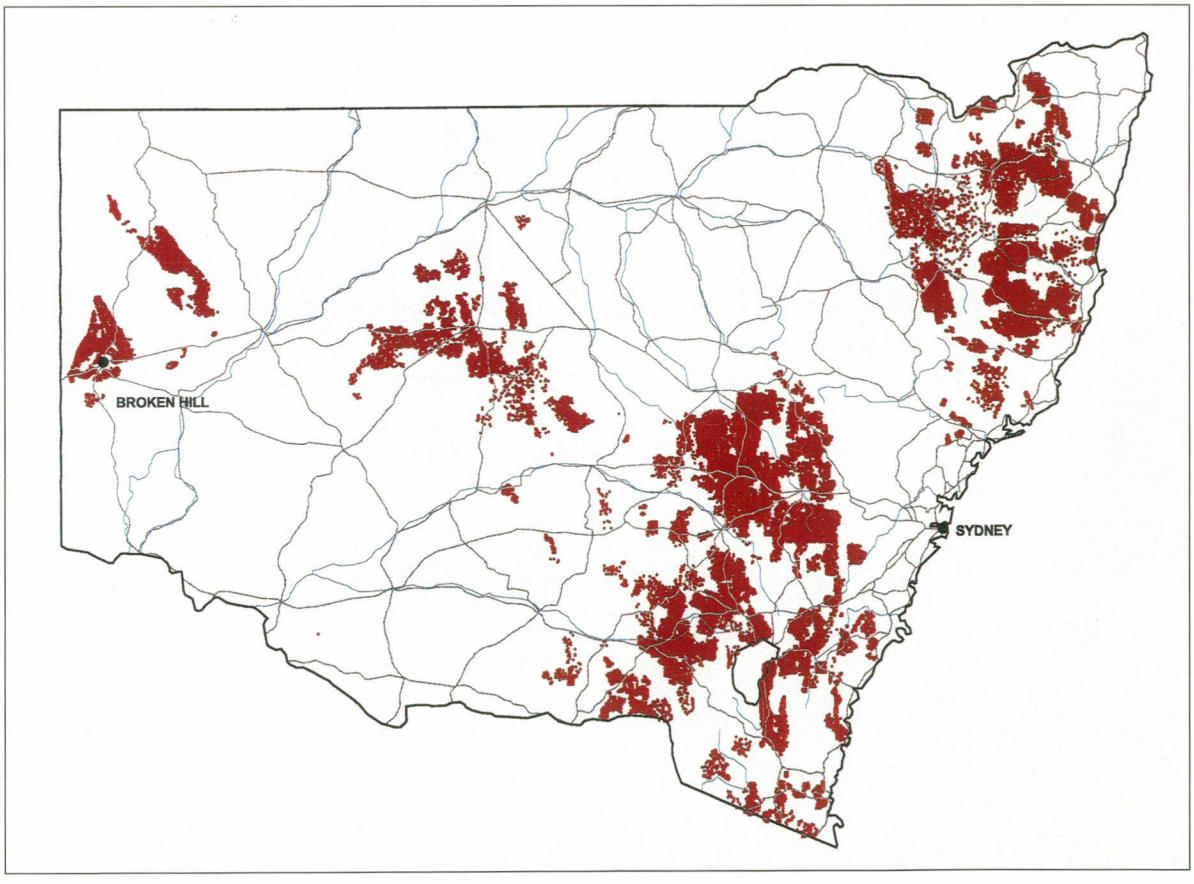


Figure 17. Location of samples that have been included in the digital stream sediment database of New South Wales

DISCOVERY 2000

BROKEN HILL EXPLORATION INITIATIVE CONFERENCE

The fourth annual conference of the Broken Hill Exploration Initiative (BHEI) takes place in Broken Hill from 19-23 October 1998. The program includes two days of technical talks, a regolith workshop, and several field excursions which will be run both before and after the technical sessions. The conference will be held in the Entertainment Centre near the city centre and within easy walking distance of several motels and hotels.

Leading representatives of industry, the Broken Hill Exploration Initiative partners (Primary Industries and Resources South Australia, New South Wales Department of Mineral Resources, Australian Geological Survey Organisation), academia, CRCLEME, and the Australian Geodynamics CRC will give presentations. These will cover a wide range of topics and views, and delegates can look forward to lively debate. Among the highlights will be talks on recent discoveries in the Curnamona Province (including Portia and White Dam) and a keynote address on Pb–Zn deposits through time. The main themes of the conference are:

- Exploration and mineral deposits in Broken Hill/Olary region
- Metallogenesis and geochemistry
- Regional structure and new mapping results
- Regolith and geomorphology (CRCLEME workshop 18-19 October)
- Geochronology
- Geophysics and petrophysics
- Ore genesis
- Databases and future directions

Posters and computer modelling displays are included in the program. Drill core from several mineral deposits will also be available for inspection.

Places available on the field trips and regolith workshop are limited, so early registration for these activities is advisable. Transport will be by minibus wherever possible, but some travel by four wheel drive vehicles is inevitable in more remote areas. Delegates wishing to bring their own four wheel drive vehicles on field trips should advise the conference organisers accordingly. Accommodation on the field trips will be in shearing quarters, and delegates should bring a sleeping bag. Meals will be provided and their cost included in the excursion fee.

Registration fees for the meeting are $160 (students $80). They cover the cost of the abstracts volume, lunches, morning and afternoon teas, and the ice breaker on the evening of Monday, 19 October. The conference dinner, regolith workshop, and field excursions have been costed separately.

For further information contact Peter Lewis, Manager Discovery 2000 (Minerals) on (02) 9901 8372, fax (02) 9901 8753, e-mail lewisp@minerals.nsw.gov.au

NEW SOUTH WALES EXPLORATION ON SHOW IN CANADA

The Prospectors and Developers Association of Canada (PDAC) held its 66th Annual Convention and Trade Show in Toronto from 8 to 11 March 1998. PDAC has become the world's major minerals exploration conference and Toronto is the pre-eminent capital market for exploration and mining. PDAC 98 attracted about 6800 delegates and exhibitors, with about 30 nations represented. There were over 300 trade displays including many by national, provincial and state governments.

The New South Wales Department of Mineral Resources participated in PDAC 98 as part of a substantial Australian minerals industry presence. The Commonwealth (represented by the Australian Geological Survey Organisation and the Coal and Mineral Industries Division of the Commonwealth Department of Primary Industries and Energy) plus New South Wales, Victoria, South Australia and Western Australia joined with fourteen Australian mineral exploration and mineral sector service companies to present a combined 'pavilion' at the trade display in the Metro Toronto Convention Centre. Australia's presence was second only to the Canadian in size. This government–industry promotion was endorsed by ANZMEC (Australia and New Zealand Minerals and Energy Council) and was supported by the Association of Mining and Exploration Companies. AUSTRADE facilitated the trade display and provided local on-ground support. The State displays attracted substantial exploration investor interest and much praise for the standard of presentation.

Interest centred on particularly prospective mineral provinces:

• *New South Wales*	*Lachlan Fold Belt porphyry copper-gold*
• *Victoria*	*Victorian gold province*
• *South Australia*	*Gawler Craton*
• *Western Australia*	*Yilgarn Province*

The New South Wales display emphasised the attractiveness of the Ordovician porphyry copper–gold province in the Lachlan Fold Belt, highlighting current mining development, the potential size of the mineralised systems (eg Cadia) and the high grade associated mineralisation (eg Cadia–Ridgeway).

A half-day minerals investment symposium also focused on Australia. Speakers came from Australian exploration companies including Great Central Mines Ltd, Acacia Resources, Straits Resources Ltd, Platsearch NL and Perseverance Corporation Ltd. Specific New South Wales presentations included Garry Lowder on recent discoveries and gold–copper potential in the State, and Bob Richardson on developments and opportunities in exploration in the Broken Hill–Olary region. John Cramsie, Director of the Geological Survey of New South Wales, gave a summary of Australia's competitive position.

At the Australian stand at PDAC'98: Lindsay Gilligan, Assistant Director (Minerals) of the Geological Survey of New South Wales, discusses the prospectivity of the Lachlan Fold Belt

John Cramsie and Lindsay Gilligan, Assistant Director (Minerals) represented New South Wales. Their principal objective was to promote exploration opportunities in the State. They also investigated developments and trends in the international minerals industry, and in government policies and progress in support of the industry.

Another objective was benchmarking with other government geological organisations, particularly in North America. To this end the delegation met with the Ontario Ministry of Northern Development and Mines. They then visited Denver, USA, for meetings with mining company representatives and staff of the United States Geological Survey.

For further information contact John Cramsie, Director, Geological Survey of New South Wales, on (02) 9901 8300, e-mail cramsiej@minerals.nsw.gov.au, or Lindsay Gilligan (02) 9901 8301, e-mail gilligal@minerals.nsw.gov.au or fax (02) 9901 8256.

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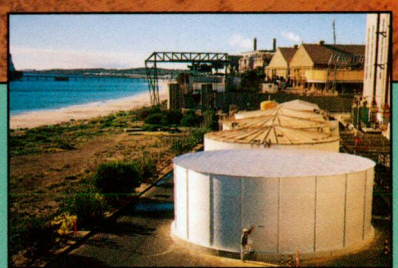

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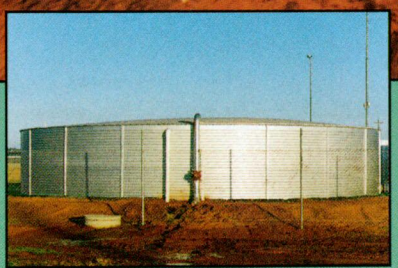

Fleetwash, Kalgoorlie, Western Australia.
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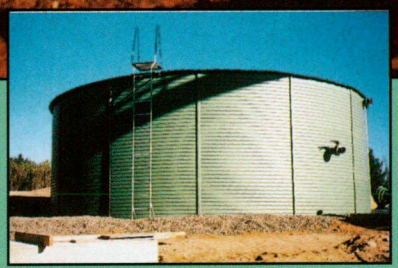

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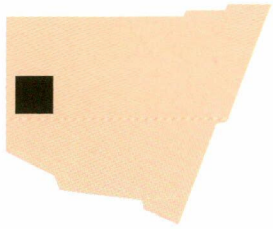
TRAILBLAZING IN GEOLOGICAL MAPPING —THE BROKEN HILL EXPERIENCE



Over the last 25 years, the Geological Survey of New South Wales has completed a world class geological and metallogenic mapping project in the Broken Hill region.

INTRODUCTION

The Broken Hill geological and metallogenic mapping conducted by the Geological Survey of New South Wales over the last 25 years has produced not only an outstanding dataset, but has caused a quantum change in the understanding of the stratigraphy, structure and metallogenesis of the area which hosts the world's richest silver–lead–zinc orebody.

START OF THE TRAIL

The mapping project followed from earlier important Geological Survey contributions to the regional geology of the Broken Hill area. The first major effort to understand the regional geology of Broken Hill was that of J.B.Jacquet, who produced the first geological map of the Barrier Ranges in 1884. E.C. Andrews, over the period 1919–21, was assisted by E.J. Kenny and W.R. Browne in detailed geological mapping of the Broken Hill lode and environs, plus regional geology of the Barrier Ranges. This work stands as a magnificent contribution — in Haddon King's words 'excellent'!

In subsequent years much of the understanding of Broken Hill geology flowed from the great contributions of the geologists of the Barrier companies. Notable in this time was the collaborative companies' work in the 1930s and 1940s of the Central Geological Survey with contributions from such distinguished geologists as Gustafson, Burrell and Garretty.

Government regional geological mapping came to the fore in the 1960s with the Geological Survey of New South Wales 1:250 000 geological mapping program and the contributions by Toby Rose and Rowley Brunker. The late sixties saw a focus by the Geological Survey on the Adelaidean sedimentary rocks in the Broken Hill region. The publication of three 1:100 000 maps covering mainly younger rocks overlying the Willyama Supergroup presaged a rapid growth in Broken Hill geological work on the Willyama rocks. The commencement of the detailed geological and metallogenic mapping in the 1970s marked Australia's entry into the modern phase of mineral exploration and mining.

Industry recognises that the Broken Hill mapping project, carried out between 1973 and 1998, was a result of the professionalism and committment of the geologists and cartographers who contributed to it over 25 years.

They have ensured that the district containing one of the world's great mineral deposits has been covered by world class geological mapping. The current Broken Hill Exploration Initiative is building on this great database and, indeed, would not have been possible without it.

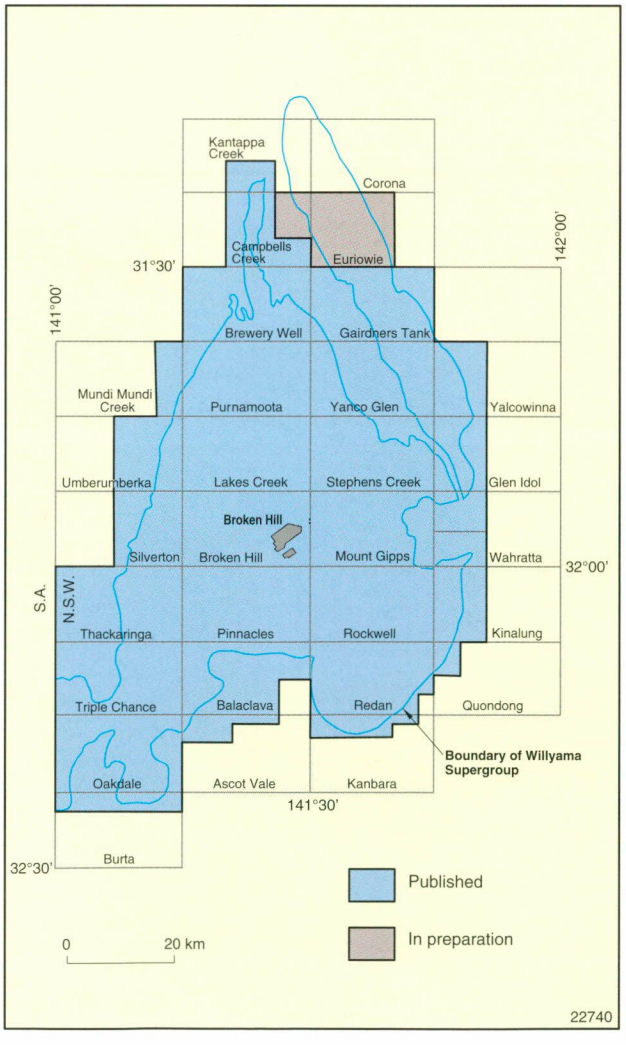


Figure 18. Publication status of the 1:25 000 map sheet areas of the Broken Hill Mapping Project

ELEPHANT COUNTRY

The origin and setting of this huge orebody has provided one of the great challenges in ore deposit geology, and the origin of this fabulous orebody will surely be debated for many years to come.

> So, oft in theologic wars
> The disputants, I ween,
> Rail on in utter ignorance
> of what each other mean
> And prate about an elephant
> Not one of them has seen.
> (from *The Blind Man and the Elephant,* a Hindu fable)

Completion of geological mapping of the Corona 1:25 000 sheet, the twenty third and last of the 1:25 000 geological map sheets, is an opportune time to reflect on the whole Broken Hill mapping project.

The Geological Survey of New South Wales, in the then Department of Mines, began the Broken Hill mapping project in the early 1970s. The project involved the production of a set of high quality geological maps, metallogenic maps and associated notes for the Broken Hill area. The major impetus for the project was the declining reserves in the Broken Hill lead–zinc–silver orebody, and the need to promote exploration for new orebodies.

The Broken Hill orebody is in the high grade metamorphic terrain of the Proterozoic Broken Hill Block (Willyama Supergroup). Geologically, it is considered very likely that other orebodies exist in the region, but prior to the mapping project, exploration was hampered by the lack of consistent, detailed geological mapping. It was considered that the possibility of finding new orebodies would be enhanced by producing a set of systematic geological maps of the Broken Hill and Euriowie Blocks. The preparation of metallogenic maps and the associated database, in parallel with the geological mapping, was designed to delineate the types of mineral occurrences present, and their distribution patterns, which would also assist in identification of prospective areas.

The most obvious problems at the start of the project were the compexity of the geology of the region, the limited understanding of its range of mineral occurrence types, the variable quality of existing geological map coverage, and the lack of appropriate scale base maps.

PROJECT HISTORY

Preliminary work on the project in 1972-73, was carried out by staff based in Sydney, but by 1974 a team of geologists was based at Broken Hill.

The first set of 1:12 000 map sheets was compiled for cartographic assembly to 1:25 000 (Mt Gipps and Broken Hill) in late 1978, and publication followed in 1984. Over the next 20 years a total of 23 separate 1:25 000 map sheets were completed and all but one is published (figure 18).

GEOLOGICAL MAPPING

The original project concept was to compile at 1:12 000 scale the previous detailed geological mapping by Broken Hill South Ltd, The Zinc Corporation Ltd, North Broken Hill Ltd and New Consolidated Goldfields Ltd. The Geological Survey team would complete the mapping of areas not already covered. The 1:12 000 compilation scale was chosen because of the complexity of the geology (a good deal of the company mapping was at 1:4 800), and because aerial photographs were available through the then CRA Exploration Ltd (CRAE) at that scale.

The initial mapping soon encountered two major problems. The available base maps had been prepared for use at 1:100 000 scale and were almost unuseable to compile very

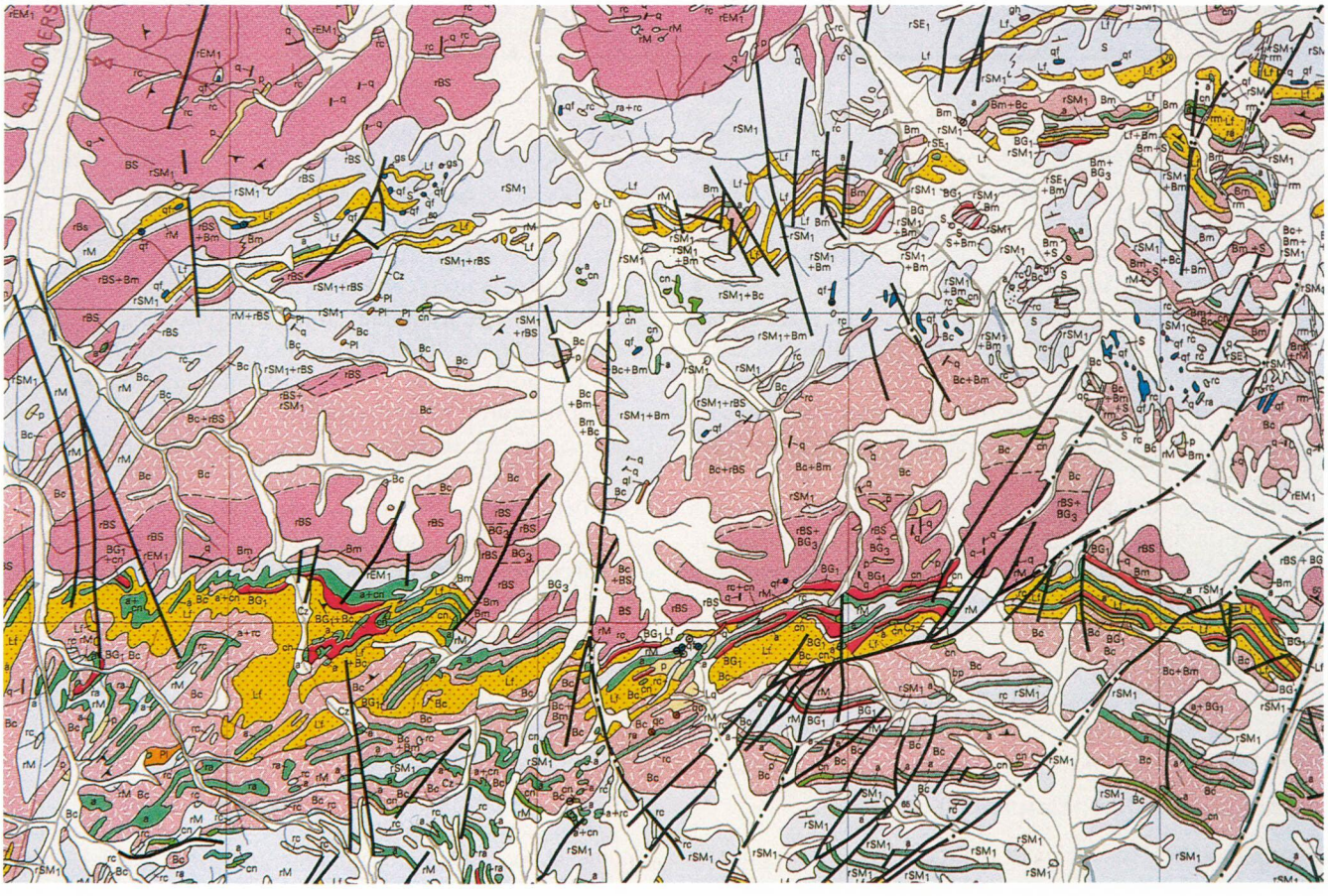


Figure 19. The complexity of the geological mapping is clear in this detail from the Gairdners Tank 1:25 000 map

Mapping project geologists in Broken Hill in the 1970s. From left (at rear) are Ian Willis, Paul Millstead (technical assistant) and Bob Brown. In the front are Barney Stevens, Jim Stroud and Rob Barnes

In 1974 the mapping group comprised geologists Barney Stevens, Ian Willis, Graham Bradley, Jenny Thomson, Anne Felton and David Edkins (technical assistant). By 1976, Thompson and Felton had transferred to other projects, and geologists Jim Stroud, Rob Barnes and Bob Brown, and cartographer the late Neil Swinbourne joined the group in Broken Hill.

Geologists Willis, Bradley, Stroud and Brown were fully engaged in geological mapping, and Barnes in metallogenic mapping, while Stevens co-ordinated the project and also took part in the geological mapping.

The group remained together until Graham Bradley was transferred to another project in 1979. In late 1983 all of the remaining Broken Hill project geologists, except for Barney Stevens, transferred to Armidale to commence work on a New England project. The remaining geological mapping was completed by Barney Stevens and Gary Burton. The metallogenic mapping was completed by Neil Raphael, Michael Bartholomaeus and Gary Burton.

Over the years many cartographers made substantial contributions to production of the very complex and demanding maps. These included John Fryer, Jim West, Neil Swinbourne, Karen Lawson, Andrew Valja, Peter Bliss, Cheryl Verardo, Sue Parker, Megan James, Brian Millett, Peter Clarke and Mohammad Aresh.

detailed Broken Hill geology at 1:12 000 scale. To remedy this, the Cartography Section of the Geological Survey produced a new series of base maps at 1:12 000, using the CRAE aerial photographs.

The second major problem was the variability of the previous geological mapping. For instance, New Consolidated Goldfields Ltd (NCGL) had used a team of geologists dedicated to the task of delineating the rock types of greatest interest to them, 'Potosi-type' gneiss, amphibolite, and quartz-gahnite rock, etc, and had produced high quality work in this regard, but did not attempt to make meaningful subdivisions of the metasediments. The work of other companies varied from place to place and also in treatment of particular rock types. This variability, together with differing nomenclature developed from area to area, led to the recognition that it would be necessary to start again to develop consistent nomenclature systems and to map or remap almost all of the Broken Hill and Euriowie Blocks.

Now, virtually the whole of the Broken Hill and Euriowie Blocks has been remapped at 1:12 000 scale and published with very little loss of detail at 1:25 000 scale.

Lithological nomenclature

During the first two years of mapping it became apparent that some of the existing rock nomenclature was not particularly useful for regional mapping. This was especially apparent with metasedimentary rocks. Terminology applied by structural and metamorphic geologists emphasised deformation features (eg gneiss, schist) and mineralogy. Names such as 'variably retrogressed garnet-staurolite-biotite-muscovite-sillimanite-quartz-feldspar schist' are impractical to use in the field! When mapping unmetamorphosed siliciclastic sedimentary sequences, the primary mapping criterion is the proportion of shale, siltstone, sandstone and conglomerate. Metamorphism changes the original grainsizes, but the chemical composition, as reflected by mineralogy, preserves differences between originally shaly and originally sandy sediments.

So a nomenclature was developed for Broken Hill metasediments, based on the proportions of psammite (metamorphosed sandstone or siliceous siltstone), pelite (metamorphosed shale) and psammopelite (metamorphosed clayey sandstone or siltstone). This system allows original sedimentary facies to be traced across areas of different metamorphic grade and structural history. Other features of the metasediments, including metamorphic grade, were used as lower level classifiers for the metasediments.

A consistent and reproducible system of lithological nomenclature for all of the Willyama rock types was developed and tested in the field. This system was an important factor in developing the group's first stratigraphic interpretations in

1976-79. The stratigraphic interpretation, together with the work of many researchers, fed into interpretations of pre-metamorphic rock types. The various interpretations formed the basis for a number of substantial publications between 1980 and 1983.

METALLOGENIC MAPPING

Metallogenic studies began in the Purnamoota area in the northern part of the Broken Hill Block in 1975, where some of the initial lithological mapping had been carried out. At the time there was a poor understanding of the regional lithological, stratigraphic and structural controls on mineral deposits and recognition of only a limited number of mineral deposit styles.

Work initially comprised visiting the many hundreds, and ultimately thousands, of discrete mineral occurrences which had been documented during the detailed lithological mapping. The early stages of this work were mainly based on field observations as there was no established descriptive or conceptual framework within which many of the deposits could be classified.

Ultimately, a deposit classification was developed based on assessment of thousands of deposits. The work was undertaken in close collaboration with the lithological mappers, whose detailed geological traversing enabled the location of virtually every prospecting pit and old mine shaft in the region, and the creation of a very extensive and relatively detailed mineral occurrences database.

Among the associations recognised were many variants of essentially stratigraphically constrained mineral deposit types including Broken Hill type and various iron and copper-rich stratiform types. A classification scheme for mineral deposit styles was established in the northern part of the Broken Hill Block, and this has since been applied to deposits throughout the Willyama Supergroup with only minor modification.

Considerable benefit derived from conducting the metallogenic studies at the same time as lithological mapping. In many instances the distribution of mineral deposit styles could assist in recognising litho-stratigraphic rock packages. Indeed, the metallogenic mapping program could not have proceeded as it did without the identification of the mineral deposit localities during the mapping. In many instances Broken Hill type 'lode rocks', such as quartz–gahnite–garnet rocks were painstakingly traced out by the lithological mappers.

One of the main outcomes of the metallogenic mapping program was the systematic delineation of the spatial and temporal distribution of various mineral occurrence types containing a wide range of metals, including Ag, Pb, Zn, Cu, Au, W, Sn, U, Th, Platinum Group Elements (PGE), Ni and various non-metallic minerals.

Mineral deposit provinces were outlined and spatially related to lithologies, stratigraphic units and structures. Results of the mapping have led to an understanding of the association of mineral deposits with discrete mineralising events, such as those associated with:

- sedimentation of the sequence
- prograde metamorphism
- retrograde metamorphism and shearing
- the intrusion of granites/pegmatites and ultrabasics
- the Cambro-Ordovician Delamerian Orogeny.

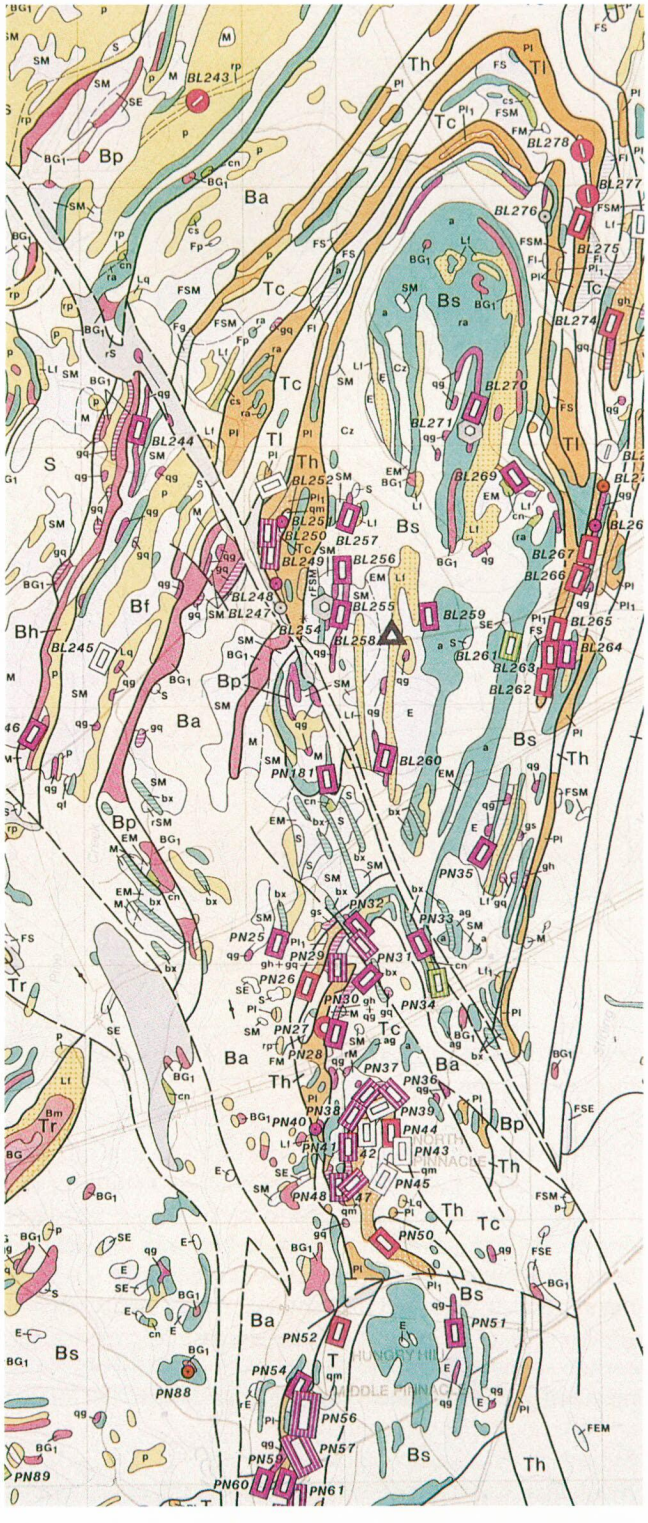


Figure 20. An example of the metallogenic mapping, taken from the Broken Hill Block Southwest map, 1: 50 000 scale

The first metallogenic map and accompanying notes (Broken Hill Block Southwest [figure 20]) were published in 1988- 89). Work on the 1:50 000 Broken Hill Block

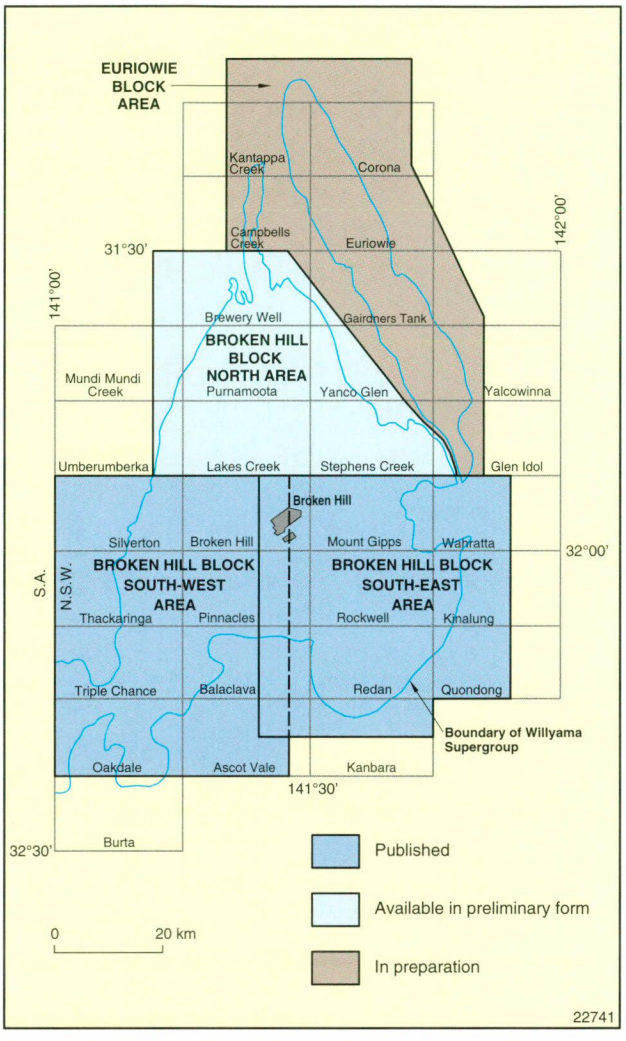


Figure 21. The Broken Hill metallogenic map sheets and their publication status

Southeast metallogenic map area followed and the map and notes were published in 1994 and 1995 (figure 21).

The Broken Hill Block North metallogenic map was originally compiled in 1980 but its publication was delayed because of continuing lithological map upgrades. The upgraded mapping identified several hundred mostly small mineral occurrences in addition to those already described in an earlier series of reports. The Broken Hill Block North metallogenic map is due for publication shortly.

Field checking of locations and sampling for the northern Euriowie area was not completed until mid 1997. The Euriowie Block area was mapped and mineral occurrences described after most of the work on the Broken Hill Block was finished. The Euriowie Block metallogenic map will be published in 1999.

The much clearer understanding of the metallogenesis of the Broken Hill and Euriowie Blocks which resulted from this project has greatly assisted both new and established explorers in the area. The work has led to the area being seen as not just an Ag–Pb–Zn province, but also prospective for other commodities, including copper–gold. This regional view has extended to include the rocks and mineral occurrences of the Olary Province in South Australia. The Department's systematic work has also meant that the mineral occurrence styles developed in the Broken Hill region can be more readily compared with those elsewhere in the world.

Broken Hill is a major attraction for economic geologists worldwide and the long term presence of Departmental geologists in Broken Hill has allowed a number of co-operative studies to be undertaken on mineralisation. Among these have been studies of sulphur and lead isotopes and the tourmaline-rich rocks. Studies on individual deposits and deposit styles have also been carried out.

The mineral occurrence datasheets which were prepared during metallogenic mapping are now being added to a digital geoscience dataset for the Broken Hill region.

Recent extensive detailed geophysical coverages resulting from the Broken Hill Exploration Initiative will cause a re-evaluation of the conclusions of some of the metallogenic studies. Genetic concepts for the many mineral occurrence types were developed to only a limited degree, and deserve re-evaluation in the light of ongoing mineral deposit studies worldwide. It is now more readily accepted, for example, that Broken Hill is an example of a massive sedimentary exhalative (sedex) style deposit, with more in common with Mount Isa and McArthur River than with volcanogenic massive sulphide deposits.

The role of metamorphism and re-mobilisation continues, however, to be controversial. The regional descriptive framework established by the Broken Hill metallogenic mapping program will be invaluable in mineral exploration and metallogenic research.

CONCLUSION

The Broken Hill Mapping Project resulted in the development and publication of a series of 23 detailed geological outcrop maps at 1:25 000 scale, emphasising lithology; the preparation of 4 metallogenic maps at 1:50 000 scale; a lithostratigraphic map at 1:100 000 scale; and numerous published papers and unpublished map notes. There are few places in the world where such a large area of metamorphosed and deformed rocks has been mapped in such detail.

This information will continue to be a cornerstone for ongoing and future exploration programs in the Broken Hill region.

For further information contact Barney Stevens, Principal Research Scientist, Broken Hill Office, on (08) 8080 0629, fax (08) 8087 8005, e-mail minres@ruralnet.net.au

THE BROKEN HILL CARTOGRAPHIC CHALLENGE

The Cartography Section of the Department has been a significant contributor to the Broken Hill Mapping Project. The project presented major cartographic challenges which led to the development of innovative geological mapping and cartographic techniques resulting in a world class product.

It became apparent in the very early stages of the project that the existing 1:50 000 scale base maps provided insufficient control for geological information collected at 1:12 000 scale. The drainage patterns, for example, so obvious on air photos, were too generalised. It was therefore necessary to produce a new 1:25 000 scale series of base maps to allow for the detail of mapping to be accurately presented. To this end, a cartographer was based at the Broken Hill office to prepare base maps and geological compilations, working closely with the geologists.

Field mapping was compiled onto 1:12 000 segments of the new base maps. To enable reproduction of geological data at 1:25 000, a minimum outcrop width of 1 mm was adopted at the 1:12 000 compilation stage. A 1 mm increment on a field sheet at 1:12 000 scale (ie 12 metres on the ground) represents the portrayal of a great degree of geological detail. Because of time constraints, overall spatial accuracy priority focused on maintenance of the relative positional accuracy between the detailed geology and base map features.

The standard of detail tested the limit of cartographic technology and is a tribute to the many Departmental cartographers and tracers who contributed to this major mapping project.

Among the cartographic innovations developed during the project was a system of standard geological letter symbols, specifically designed because of the amount of detail on the maps. Another innovation, a new colour design for the entire Willyama Supergroup, maximised contrast between the stratigraphically significant quartzo-feldspathic rocks and the metasediments and composite gneisses. The design departs from the Australian standard colour scheme in not using a range of browns for Precambrian age rocks. The rationale for this departure was that the 1:25 000 series of sheets would not be required to join other maps, whereas the maps at 1:250 000 and 500 000 are part of a national coverage, requiring standardisation.

Although the earlier Broken Hill maps were prepared by manual cartographic methods, the more recent maps have been produced using GIS technology. All of the older 1:25 000 scale maps have also been converted to GIS format.

NEW MINERALS INDUSTRY ANNUAL PUBLICATION

The Department has produced a new flagship publication, the *1998 New South Wales Minerals Industry Annual*, which is due for release in August 1998. The new publication replaces both the old *Mineral Industry Review* and the *Mining Industry Directory*, while retaining some of their features.

The annual will be the vehicle for publishing New South Wales minerals statistics, the 1998 edition providing figures for 1995-96 (previously unpublished) and 1996-97. It will be a companion volume to the comprehensive *New South Wales Coal Industry Profile*, while also being a stand alone publication for the State's whole industry.

The *New South Wales Minerals Industry Annual* should prove a popular reference for most people and companies with an interest in the New South Wales minerals industry. It will also help to promote mineral development investment in New South Wales.

The contents of the annual include:

- A New South Wales minerals industry overview, including summary data on industry trends and outlook, production, minerals exports, new mines and projects, exploration, mine safety, environmental management and minerals processing,
- Energy minerals information, including summary data on coal and petroleum,
- Metallic minerals and metals, including summary data on major commodities, new developments and outlook,
- Industrial minerals, including summary data on major commodities, new developments and outlook,
- Dossiers on significant mines (metallic and industrial minerals),
- Minerals statistics for 1996-97 (and 1995-96),
- Extractive industries' overview and summary of top 50 producers by quantity ,
- Suppliers' index,
- Reference information, including government and industry organisations and general index.

The *1998 New South Wales Minerals Industry Annual* will be available in August for $45.00 from the Information Counter at the Department's Head Office on (02) 9901 8269, fax (02) 9901 8247, e-mail martusca@minerals.nsw.gov.au

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

For information about advertising and publication contact Peter Walker, Manager, Publishing and Marketing, on (02) 9901 8230, fax (02) 9901 8246, e-mail: walkerp@minerals.nsw.gov.au

TIMBARRA UPDATE

Ross Mining NL was granted a mining lease to extend the Timbarra gold project in March this year. The mine is located 29 km north-east of Tenterfield. The lease, which covers the RMT Prospect, was granted following the Land and Environment Court's dismissal of challenges to the development consent issued by Tenterfield Shire Council.

Sustained opposition by opponents has delayed commencement of the project. The granting of the second lease has allowed Ross Mining to start work. The company has begun upgrading the access road, and construction work at the site is expected to be completed in September. The first gold pour is expected in October this year.

The Timbarra gold mine will be one of the most highly regulated mines in the State. Consent has been granted with stringent development and mining conditions to minimise environmental impact and to protect fauna and flora. The project has been subject to comprehensive environmental assessment, with all results indicating that the impact would be limited to the minesite itself.

The Timbarra gold mine is expected to produce 50 000 ounces of gold annually. The mine has the potential to create up to 90 jobs during the construction phase, 60 direct jobs during the five to six year life of the mine and indirect employment for a further 150 people.

For further information contact Vince Fallico, Project Officer (see below).

COWAL GOLD PROJECT

A new development application for the Cowal gold project was submitted by North (Gold) WA Ltd during March 1998. The development application and associated Environmental Impact Statement and Species Impact Statement were placed on exhibit between 7 April and 19 May.

State Environmental Planning Policy No. 34 – Major Employment Generating Industrial Development applies to the proposal. The Minister for Urban Affairs and Planning will be the consent authority. Following review and reporting by the Department of Urban Affairs and Planning on submissions made about the proposal, the Minister will make a decision on the application, or may direct a Commission of Inquiry to be held.

For further information contact Vince Fallico, Project Officer, on (02) 9901 8325, fax (02) 9901 8493, or e-mail fallicov@minerals.nsw.gov.au

DIARY NOTE

The Department of Mineral Resources will hold its biennial 'NSW Mineral Exploration and Investment Conference,' at the Regent of Sydney, on 20-21 May, 1999. See next issue of *Minfo* for further information.

MAJOR PROJECT TO STUDY ORDOVICIAN VOLCANICS

A new regional co-operative study focuses on the setting of mineralised Ordovician volcanics in the Lachlan Fold Belt (Orogen) of New South Wales.

Gold–copper deposits in Ordovician volcanics and intrusions in the Lachlan Fold Belt (Orogen) of New South Wales are one of the main targets of intensive company exploration in the State. Major discoveries at Northparkes, Cadia–Ridgeway and Lake Cowal point to the presence of a world class mineral province.

Ordovician volcanics, intrusions and volcaniclastics occur in four main (structural) belts in the Lachlan Orogen. Mapping and interpretation of the northern three belts, in the central and eastern part of the State, were carried out by the Geological Survey of New South Wales and the Australian Geological Survey Organisation under the National Geoscience Mapping Accord. This information, together with data from the Department's Discovery 2000 program, has provided new information on how the volcanics formed (their lithology, stratigraphy, ages and geochemistry), their structural setting, and controls on the location of mineral deposits. (A brief synthesis of the new data and presentation of models for the tectonic and metallogenic development of the rocks of the main volcanic belts was included in *Minfo* **56**, 1997, pp 4–6, 8).

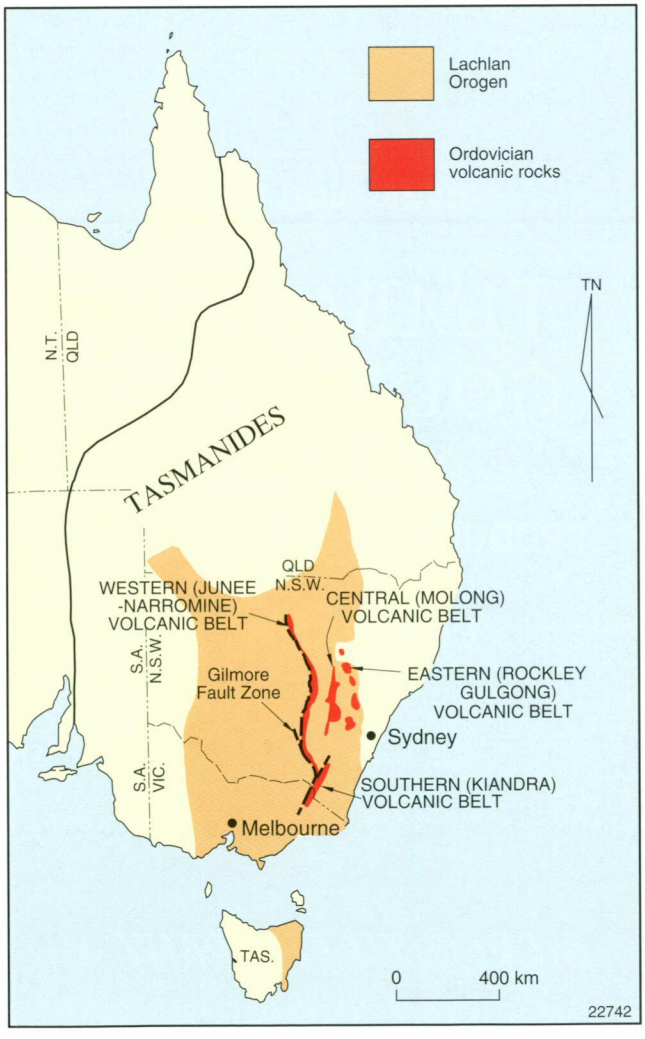


Figure 22. Ordovician volcanic rocks within the Lachlan Fold Belt (Orogen) in south-eastern Australia

Despite these advances, databases are incomplete and there is still much not understood. A review of the work carried out in 1997 concluded that more information was needed on many aspects of these prospective rocks. This perceived need has led to the setting up of a new Ordovician project that builds on the existing data.

The Department, through the Geological Survey, is a partner in a collaborative project called 'Origin and Metallogenesis of Ordovician Volcanics in New South Wales: a $10 billion resource'. The other partners are The Centre for Ore Deposit Research (CODES) at the Department of Geology, University of Tasmania, and five exploration and/or mining companies (Alkane Exploration NL, Hargraves Resources NL, Newcrest Mining Ltd, North Ltd and RGC Ltd). Chief co-ordinators are Tony Crawford and David Cooke of CODES, and Dick Glen from the Geological Survey of New South Wales. The three year project is designed to produce a more refined model for the tectonic significance and settings of belts of mineralised Ordovician volcanics in the Lachlan Orogen. To do this the project will study:

- the distribution of Ordovician volcanic, intrusive and volcaniclastic units within and across belts, interpreted from outcrop, geophysical and drillhole data.
- facies variations within and between belts, and location of volcanic centres.
- melt sources and tectonic settings of volcanics from chemical/isotope work, and changes in space and time.
- the deformational history of the volcanics in response to postulated Early Silurian deformation, rifting during middle Palaeozoic, and shortening during later basin inversion.

The project has received $218 000 in Federal Government funding over three years under a SPIRT (Strategic partnerships with industry: research and training) grant.

The project began in February 1998 with a short period of work on the Kiandra Volcanic Belt in the New South Wales Snowy Mountains. Most of the first year's activities will focus on the western (Junee–Narromine) Volcanic Belt which hosts the Cowal and Northparkes gold–copper deposits. In later years, attention will switch to the central (Molong) and eastern (Rockley–Gulgong) Volcanic Belts.

For further information contact Dr Richard Glen on (02) 9901 8346, fax (02) 9901 8256.

HOT DRY ROCK

The Department has modified the definition of geothermal substances under the Mining Act to allow exploration for a new type of mineral known as 'Hot Dry Rock'.

It is well known that the temperature of the earth's crust becomes hotter with increasing depth. Most of the heat is thought to be derived from natural radioactive decay in the earth's crust. Since this heat liberation is not evenly distributed across the surface of the earth, geothermal anomalies at relatively shallow depths can lend themselves to economic use. Such anomalies are found mainly, but not exclusively, in areas of current or recent volcanic activity.

Traditionally, geothermal energy resources can be divided into three main types, based on the temperature of the heat discharge:

1. Hot steam reservoirs (eg Landerello, Italy)
2. Hot water reservoirs (eg Wairakei, New Zealand)
3. Warm water reservoirs (eg Birdsville, Queensland)

More recently, a new concept for the generation of geothermal energy has been developed, based on what is know as 'Hot Dry Rock'. This is hot rock (typically a granite) at depth, that does not have a natural system of permeable water-filled fractures. While hot dry rock occurs almost everywhere, realistically it can only be exploited where it occurs at relatively shallow depths.

Hot dry rock stores by far the most energy of geothermal reservoirs. However, to extract the energy from the rock, the resource needs to be developed by the creation of artificial fractures in the rock and the insertion of water as a heat carrier. To extract energy from it, bores are drilled into the hot dry rock and a system of fractures are produced by hydrofracturing technology. Water is then circulated to extract the heat, using injection and production wells.

While hot dry rock technology is still at an experimental stage, it is considered to be a very promising and potentially abundant renewable energy resource.

For further information contact Brad Mullard, Chief Geologist, Coal and Petroleum, on (02) 9901 8505, fax (02) 9901 8520, e-mail mullardb@minerals.nsw.gov.au

The Minister for Mineral Resources has called for tenders to award an exploration licence to explore for hot dry rock geothermal resources in the Jerrys Plain area, south of Muswellbrook.

Tenders close on 30 September 1998.

THE SEARCH FOR HERITAGE QUALITY SANDSTONE

The New South Wales Government is searching for first quality, yellowblock-compatible sandstone for its restoration program for Sydney's heritage buildings.

BACKGROUND

'Yellowblock' sandstone is the freestone used in many of Sydney's public buildings and churches constructed between the mid 19th century and the early 20th century.

Yellowblock was the name given to the sandstone extracted from quarries between Sydney's eastern suburbs and the inner suburb of Pyrmont in the last century. After quarrying, the pale grey stone turned a bright yellow colour as it dried out, before it changed to the warm buff colour that has long been associated with the historic government buildings in the city.

All the original yellowblock quarries in Pyrmont and the eastern suburbs closed long ago, and it is highly unlikely that significant quantities will become available in future. Although a number of development sites in Pyrmont and Sydney's central business district have been identified as having some good quality stone, recovery has been limited by time constraints on developers, the comparatively small amount of recoverable material, or the cost of removing large quantities of overburden.

Sandstone from a number of operating quarries around the Sydney Basin has been investigated and while suitable for most purposes, it does not generally meet the stringent requirements for replacement of yellowblock in heritage buildings.

The Department of Public Works and Services is looking further afield for long term supplies of high quality sandstone as close as possible in appearance and properties to genuine yellowblock. Only small quantities of suitable local stone have been available in recent years, and compatible material has been brought from as far as Western Australia and North Queensland for restoration work on the Australian Museum and on the former Museum of Applied Arts and Sciences in Harris Street, Ultimo, in Sydney.

NEED FOR STONE

The Department of Public Works and Services has approached the Department of Mineral Resources to ask for assistance from the mining industry and the geological profession in searching for resources and potential resources of yellowblock-compatible sandstone in New South Wales.

The Department of Public Works and Services requires up to 500 m^3 of quarry blocks of yellowblock sandstone each year and demand is expected to continue at this rate for at least the next twenty years on major buildings alone. (Other owners of heritage yellowblock buildings, including the Commonwealth Government and churches, also use yellowblock sandstone.) It is currently being sought to complete work at the Australian Museum and to begin work at the Sydney Observatory and other key city buildings.

(Courtesy of Department of Public Works & Services)

A detail from the upper part of the facade of the Australian Museum in Sydney, before restoration

As the Department's specifications are very strict, it will only purchase material after:

- exhaustive testing procedures to ensure the highest quality and durability,
- establishing compatibility in colour, texture and weathering characteristics,
- showing cost competitiveness,
- following established procedures to ensure value for money, fairness and impartiality.

GEOLOGICAL QUALITIES

The distinguishing feature of yellowblock sandstone is its ability to change colour from grey when freshly quarried to an attractive buff or pale gold within months or even weeks of exposure to the weather.

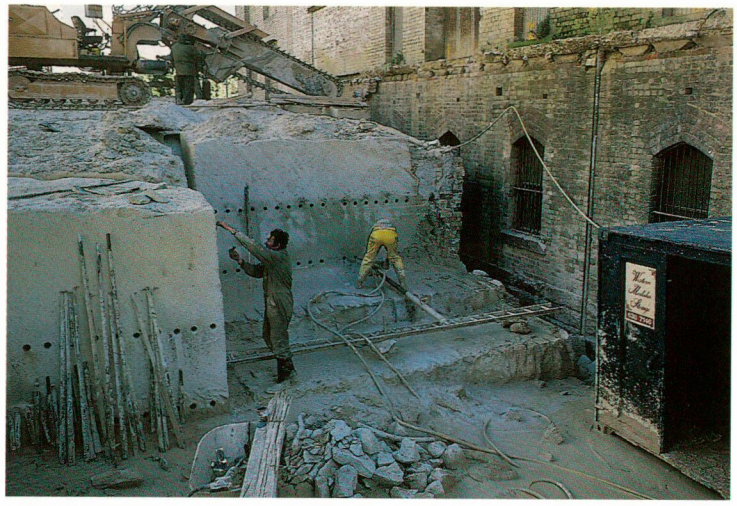
It occurs within the Hawkesbury Sandstone as lenses or stringers surrounded by crossbedded, colour banded or

otherwise unsuitable sandstone. It is a fine to medium grained quartz sandstone with an argillaceous (clay) matrix, and is compact, tough, and highly durable in most situations. It is uniform in texture, dresses well, and is suitable for complex mouldings and carvings.

There are no specific methods for searching for dimension stone apart from careful observation of sandstone outcrop, followed by a program of detailed mapping, drilling and testing. Good yellowblock-compatible sandstone generally outcrops well, has few visible joints, is massive, consistent in colour, grainsize and texture, and shows no sedimentary structures.

Yellowblock sandstone is used to replace stone that may be carved and has been in relatively aggressive weathering environments. Minerals such as calcite and swelling clays may be deleterious to the durability of a stone in the weathering environment, therefore it is essential to undertake detailed petrographic and mineralogical examination of samples.

It is of utmost importance to keep the historic fabric of a building and to ensure that the new stone will be durable. Hence any stone that is submitted as a replacement for yellowblock in a heritage building will be subject to stringent examination, including geological assessment of the resource as a whole, examination and testing of workability by stonemasons, and physical and durability testing.



(Photography by Helen Ray)

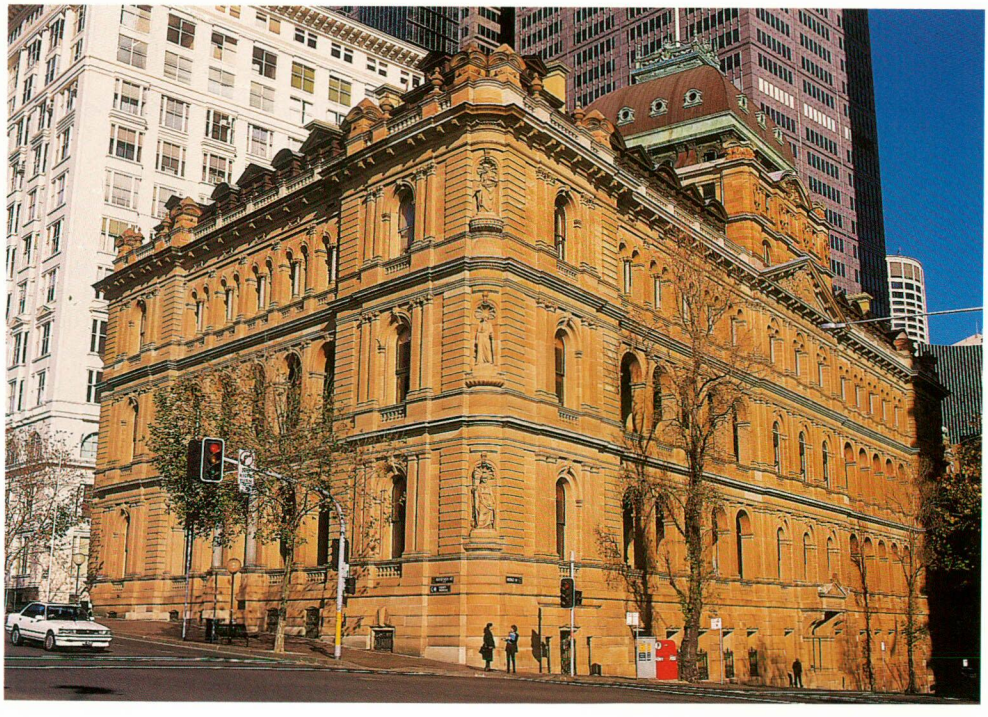
Quarrying for yellowblock compatible sandstone in Kent Street, Sydney, adjacent to the historic Grafton Wharf quarry, on the site of the present Maritime Services building

IN SITU, QUARRY AND TEST MEASURES

Dimension sandstone is usually extracted in blocks up to 5 m^3 in volume from lifts of about 1.5 m. Any potential quarry resource therefore has to be largely free of jointing or fractures. Joints, particularly those at an oblique angle to the quarry benches, may severely reduce yield. Blasting may cause significant macro and micro fracturing for a considerable distance from the blast site, so stone will not be accepted from quarries in which there has been any blasting.

During quarrying, each block of stone to be used in heritage restoration projects is closely examined by stonemasons and/or other technical officers or consultants. Specifications relate to the amount of shale or clay inclusions, 'tea leaf', lines, marks, pebbles, iron stains, or concretions, 'sand balls', any sign of weathering or variation in appearance or composition.

Physical tests, including apparent porosity and wet and dry compressive and tensile strength tests, are used to indicate both strength and durability. A 15 cycle sodium sulphate durability test gives some indication of the durability of sandstone. In addition, test methods such as ultrasonic velocity and the Schmidt Hammer test can be used to measure both the uniformity of the material and to detect the presence of defects such as cracks and voids in the body of the stone.



The Chief Secretary's building on the corner of Maquarie and Bridge Streets, Sydney: is a fine example of colonial architecture using Sydney yellowblock sandstone

CONCLUSION

While there are good local sources of quality sandstone for most dimension stone applications, the search for yellowblock compatible sandstone for the heritage building restoration program remains a high priority.

For further information contact Peter Wilkins, Manager, Stone Program, Department of Public Works and Services, on phone (02) 9372 8834, or fax (02) 9372 8999.

IMPORTANT NEW SOUTH WALES MINERAL PROJECTS

Name	Commoditie	Location	Resource
GOLD			
Cadia Hill (Cadia Project)	Gold, copper	21 km SSW of Orange	202 Mt at 0.73 g/t Au, 0.17% Cu (1995)
Cadia East (Cadia Project)	Gold, copper	21 km SSW of Orange	150 Mt at 0.44 g/t Au, 0.43% Cu (1996)
Cadia Ridgeway (Cadia Project)	Gold, copper	20 km SW of Orange (3 km NW of Cadia Hill)	Just released: 44 Mt at 2.6 g/t Au, 0.82% Cu (1998)
Cobar Central Project (New Cobar, New Occidental)	Gold, copper	3 km SE of Cobar	Not publicly released
Cowal Project (Lake Cowal, Endeavour 42)	Gold	40 km NE of West Wyalong	49.6 Mt at 1.53 g/t Au (1995)
Lewis Ponds prospect	Gold, lead, zinc, silver (copper)	13 km E of Orange	Main Zone: 2.7 Mt at 3.6 g/t Au, 0.21% Cu, 2.56% Pb, 4.17% Zn, 123 g/t Ag. Tom's Zone: 1.0 Mt at 1.95 g/t Au, 0.30% Cu 5.36% Pb, 7.9% Zn, 214 g/t Ag (1995)
Timbarra Project (Poverty Point, Big Hill, RMT)	Gold	30 km SE of Tenterfield	9.9 Mt at 0.89 g/t Au (1995), plus 2.85 Mt at 0.73 g/t Au (RMT deposit - 1996)
SILVER & BASE METALS			
Bowdens prospect (Bowdens Gift)	Silver (lead, zinc)	25 km ESE of Mudgee	18.8 Mt at 99 g/t Ag, 0.32% Pb, 0.37% Zn (1995)
Hillgrove Extension	Antimony, gold	25 km E of Armidale	1.843 Mt at 1.89% Sb, 5.8 g/t Au (1997)
Lake Innes prospect (Hurlls Hill, Pacific Hwy	Nickel, cobalt (chromium, scandium)	7 km SW of Port Macquarie	Hurlls Hill + Pacific Hwy combined: Lower Zone: 9.3 Mt at 0.81% Ni, 0.11% Co, 35.7 ppm Sc Upper Zone: 3.1 Mt at 0.26% Ni, 0.02% Co, 57.2 ppm Sc (1997)
Syerston prospect (Fifield laterite)	Nickel, cobalt (platinum, chromium)	6 km NW of Fifield	33.0 Mt at 1.0% Ni, 0.15% Co, 0.36 g/t Pt, 1.01% Cr (1997)
Tritton Copper prospect (Bonnie Dundee project area)	Copper (gold, silver)	22 km SW of Girilambone	10.23 Mt at 3.00% Cu, 0.23 g/t Au, 11.4 g/t Ag, 316 ppm Co (1997)
INDUSTRIAL MINERALS			
Cowra Project (includes Glenella)	High purity silica for silicon metal	16 km SE of Cowra	5 Mt of recoverable quartz pebbles
Oberon Project	Feldspar, mica (silica)	6 km E of Oberon	3.3 Mt at 57% feldspar, 11% mica (1996). Very large additional resources available.
Twelve Mile Project (Birthday Gift)	Rutile, zircon, ilmenite (leucoxene)	210 km SE of Broken Hill (Murray Basin)	61 Mt at 3.6% HM containing 19% rutile, 11% zircon, 49% ilmenite, 8% leucoxene (1997)

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

The information is updated as developments arise. New projects will be added to the list, and others deleted. For information contact John Chapman, on (02) 9901 8347, fax (02) 9901 8256 or Garth Holmes on (02) 9901 8480, fax (02) 9901 8468.

Resource Status	Proposed Mine Type	Operator	Project Status
Reserve - mineable (Proved + Probable)	Opencut	Newcrest Mining Ltd	Trials of the SAG mill expected to commence early June with commissioning expected by the end of September 1998.
Resource - in situ (Inferred)	Opencut & underground	Newcrest Mining Ltd	Exploration drilling is continuing.
Resource - in situ (Indicated + Inferred)	Underground	Newcrest Mining Ltd	Exploration decline for underground drilling and bulk sampling is being sunk. Planning focus held in May 1998.
	Opencut & underground	Peak Gold Mines P/L	Resource evaluation complete and initial mining studies underway.
Resource - in situ (Measured + Indicated + Inferred)	Opencut	North Ltd	Fresh development application lodged in April 1998.
Resource - in situ (Indicated + Inferred)	Underground	Tri Origin Australia NL	Exploration is continuing. Further drilling is planned to test for resource extensions.
Reserve - mineable (Proved + Probable)	Opencut (heap leach)	Ross Mining NL	Additional mining lease to include the RMT resource granted in March 1998. Start up planned for mid to late 1998.
Resource - in situ (Indicated + Inferred)	Opencut and possible u/ground	Silver Standard Resources Inc	Feasibility studies commenced. Further drilling to test for resource extensions is continuing.
Resource in situ (Measured + Indicated)	Underground	Hillgrove Gold Ltd	Planning focus held in March 1998. Development application to be lodged shortly.
Resource - in situ (Measured + Indicated)	Opencut	Jervois Mining NL	Exploration is continuing. Preliminary results of metallurgical work are encouraging.
Resource - in situ (Measured + Indicated)	Opencut	Uranium Australia NL	Prefeasibility studies underway. Revised resource estimates expected mid 1998.
Resource - in situ (Measured + Indicated + Inferred)	Underground	Nord Resources (Pacific) P/L (JV with Straits Resources Ltd)	Draft EIS and feasibility study completed. Development application expected mid to late 1998.
Resource - in situ (Indicated + Inferred)	Shallow opencut	Doral Mineral Industries Ltd	Feasibility studies based on a Lithgow plant location are well advanced.
Resource - in situ (Measured)	Opencut	Minerals Corporation Ltd	EIS and feasibility studies in progress.
Resource - in situ (Indicated + Inferred)	Opencut	RZM Pty Ltd (JV with Aberfoyle Ltd)	Mining lease applications lodged. EIS and feasibility studies in progress. Earliest time frame for mining is 2-3 years.

FOSSICKERS GUIDE RELEASED

The Department has just released an attractively illustrated field guide on fossicking which should prove a valuable tool for beginners and experienced fossickers.

The *Fossickers Guide* is full of practical information, such as how to plan a fossicking trip, where to look, how to use maps, gold panning, selecting and using metal detectors, fossicking equipment, the 'dos and don'ts' of fossicking safely, and the ethics of fossicking.

Fossickers often have trouble identifying the specimens that they have found. To help overcome this problem, the guide contains over 70 coloured photos of minerals and gemstones and includes where these may be found. It also discusses major fossicking regions and centres, and lists such places as mines and museums.

The book focuses on New South Wales, although some of the information may be applicable to other parts of Australia. A useful chapter on a wide range of sources of information is included.

The recommended retail price of the guide is $20.00. It is available from the Information Counter of the Head Office of the Department on (02) 9901 8269, fax (02) 9901 8247, or through e-mail martusca@minerals.nsw.gov.au

REGISTER OF MINERAL DEVELOPMENT OPPORTUNITIES

The Department of Mineral Resources maintains a *Register of Mineral Development Opportunities* to assist minerals investors and project developers in New South Wales.

The register was updated in June 1998. It gives details of exploration, mining and minerals processing projects in New South Wales in which companies are seeking investment and/or joint venture participation.

There are currently 16 listed ventures, covering diverse exploration, mining and value-added minerals processing projects.

Mining and exploration projects include gold, copper, antimony and other metals, diamonds, vermiculite, bentonite, olivine (dunite), coalbed methane and petroleum.

Value-added minerals processing projects include high purity quartz and dimension stone.

Copies of the register are distributed in Australia and internationally and are available free of charge on application.

Companies and project proponents who would like to register specific minerals based opportunites, or those interested in obtaining data and contact details on investment opportunities should contact Dave Barnard, Development Officer, on (02) 9901 8463, fax (02) 9901 8493.

EXPLORATION LICENCES GRANTED MARCH — MAY 1998

No	Mining Div'n*	Holder	Area$	Expiry date+	Min grp#
5444	BH	Golden Cross Operations P/L	14.0 U	01.03.00	1
5445	IN	Topalite Resources P/L	35.0 U	01.03.00	1,2,6
5446	IN	Walburn, Robert John	1.0 U	04.03.00	6
5447	OR	Dunford, Wayne Edward	1.0 U	08.03.99	2
5448	OR	Golden Cross Operations P/L	14.0 U	23.11.99	1
5449	SI	BHP Titanium Minerals P/L	3.0 U	18.03.00	1
5450	WA	Imperial Mining (Aust) NL	102.0 U	19.03.00	1
5451	OR	Michelago Resources NL	18.0 U	19.03.00	1
5452	SY	Michelago Resources NL	98.0 U	23.03.00	1
5453	SY	Michelago Resources NL	100.0 U	23.03.00	1
5454	OR	Acapulco Mining NL	8.0 U	24.03.00	6
5455	IN	Diamond Ventures Exploration P/L	32.0 U	29.03.00	6
5456	IN	Diamond Ventures Exploration P/L	16.0 U	29.03.00	6
5457	IN	Diamond Ventures Exploration P/L	17.0 U	29.03.00	6
5458	IN	Diamond Ventures Exploration P/L	28.0 U	29.03.00	6
5459	IN	Diamond Ventures Exploration P/L	24.0 U	29.03.00	6
5462	SI	Sirocco Resources NL	10.0 U	13.04.00	1
5463	BH	Helix Resources NL	318.0 U	15.04.00	1
5464	BH	Helix Resources NL	688.0 U	15.04.00	1
5465	BH	Helix Resources NL	170.0 U	15.04.00	1
5466	BH	Helix Resources NL	116.0 U	15.04.00	1
5467	BH	Helix Resources NL	303.0 U	15.04.00	1
5468	OR	North Mining Ltd	100.0 U	16.04.00	1
5469	OR	North Mining Ltd	32.0 U	16.04.00	1
5471	OR	Golden Cross Operations P/L	2.0 U	20.04.00	1
5472	OR	Michelago Resources NL	22.0 U	22.04.00	1
5473	BH	Probo Mining P/L Imperial Mining (Aust) NL Peregrine Mineral Sands NL	554.0 U	22.04.00	1
5474	BH	Probo Mining P/L Imperial Mining (Aust) NL Peregrine Mineral Sands NL	763.0 U	22.04.00	1
5476	CO	Polymetals P/L	46.0 U	28.04.00	1
5477	BH	Morton, Peter James Morton, Suzanne Esther	4.0 U	30.04.00	2
5478	BH	Platsearch NL	218.0 U	13.05.00	1
5479	BH	Platsearch NL	29.0 U	13.05.00	1
5480	BH	Platsearch NL	42.0 U	13.05.00	1
5481	SY	Millennium Minerals (Operations) P/L	9.0 U	17.05.00	1
5482	OR	Newcrest Operations Ltd	65.0 U	18.05.00	1
5483	BH	Probo Mining P/L Imperial Mining (Aust) NL Peregrine Mineral Sands NL	574.0 U	20.05.00	1
5484	OR	Acapulco Mining NL	45.0 U	25.05.00	6
5485	CO	Plumbum P/L Kannateal P/L	35.0 U	25.05.00	1
5487	CO	Imperial Mining (Aust) NL	45.0 U	28.05.00	1

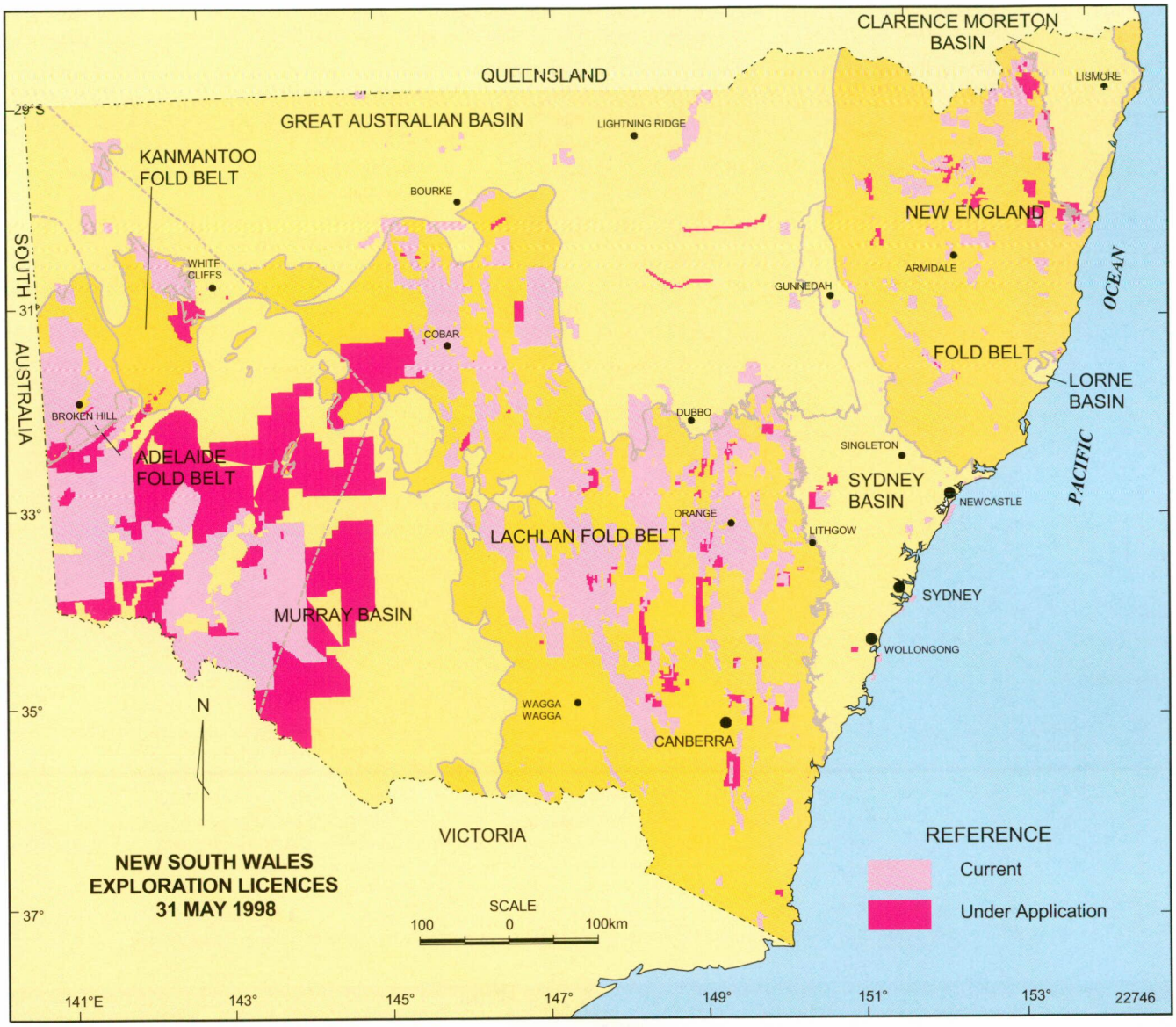
REFERENCE

* AL Albury
AR Armidale
BH Broken Hill
CH Coffs Harbour
CM Cooma
CO Cobar
DU Dubbo
GO Goulburn
IN Inverell
LM Lismore
LR Lightning Ridge
NE Newcastle
OR Orange
SI Singleton
SY Sydney
WA Wagga Wagga
WO Wollongong

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

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

EXPLORATION LICENCES IN FORCE JUNE 1998



SUMMARIES OF TERMINATED EXPLORATION LICENCES

EXPLORATION LICENCES CANCELLED/EXPIRED JANUARY — MARCH 1998

EL 3858 — **Metallic Resources P/L**

Location: 35 km S of Blayney

Objective: Gold

This licence covered the historic Mount Dudley, Scabben Flat and Golden Wattle workings. Soil and rock chip sampling, followed by reverse circulation drilling by Plutonic Resources Ltd concentrated on a 600 m strike length of vein mineralisation north of Mount Dudley Mine. Drilling confirmed gold mineralisation in Ordovician black shales but Plutonic concluded there was only potential for low tonnage/grade resources. The best drill intersection was 3 m at 4.18 g/t Au but most intersections were in the 1–2 g/t Au range.

EL 3969 — **J. & J. Manuel**

Location: 21 km ENE of Inverell

Objective: Sapphires

Pitting and bulk sampling were undertaken but results suggested these sapphire deposits are not viable.

EL 4125 — **Rio Tinto Exploration P/L**

Location: 5 km E of Wellington

Objectives: Gold and copper

The licence was acquired to explore for porphyry systems but data compilation also revealed potential for volcanogenic massive sulphide style deposits within Silurian felsic volcanics. Work was limited to data compilation followed by field checking and sampling of mineral occurrences.

EL 4128 — **Rio Tinto Exploration P/L**

Location: Molong

Objective: Porphyry copper–gold

The licence covered Ordovician volcanics and intrusives. The potential for a porphry related deposit was downgraded following rock chip and soil sampling which yielded a best result of 0.39 g/t Au from silicified volcaniclastic rock.

EL 4159 **Desertstone NL**

Location: 150 km NW of Bourke

Objective: Opal

This licence covered Cretaceous Rolling Downs Group, and included old opal working at Clarkes Bore. Lineament analysis and high resolution topographic modelling was followed by a 57 hole drilling program. This established a correlation between frequency of opal traces and alteration intensity but did not intersect any significant occurrrence of opal. Precious opal and potch occur as fracture fillings, slickenside veneers and as small nodular masses in the old workings.

EL 4174 **Homestake Australia Ltd**

Location: 80 km ENE of Canberra

Objectives: Gold and base metals

This licence covered shallow marine volcanics and sediments intruded by the Early Devonian Boro Granite. Comprehensive work by Homestake Australia Ltd and joint venture partners Denehurst Ltd included aeromagnetic surveys, geochemistry mapping, ground geophysics and drilling. Thirty-two percussion and diamond holes were drilled at 4 prospects. An inferred resource of 1.5 Mt at 1.04 ppm Au, 0.3% Cu, 0.1% Pb, 0.5% Zn and 7 ppm Ag was calculated for the Mayfield prospect. The mineralisation is oxidised but has primary skarn characteristics.

EL 4199 **Rio Tinto Exploration P/L**

Location: 8 km S of Wellington

Objective: Porphyry copper–gold

The licence area was considered prospective for porphyry related copper–gold deposits in Ordovician volcanics. Stream sediment anomalies were followed up by geological mapping and rock and soil sampling. No significant assay results were obtained.

EL 4214 **Alphadale P/L**

Location: 5 km N of Boggabri

Objective: Gold

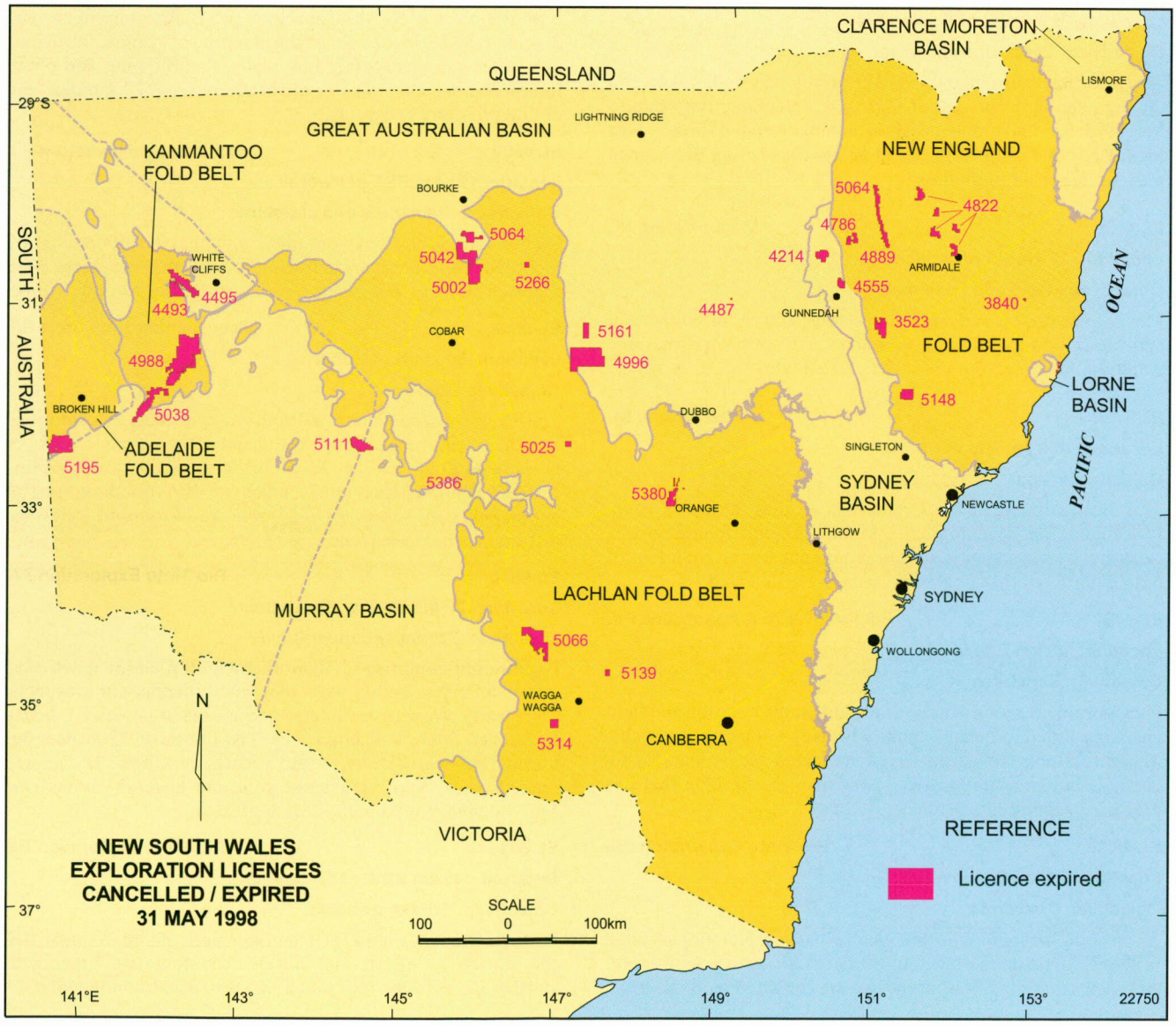
Mapping and sampling focussed exploration on an area of brecciation, quartz–pyrite veining, silicification, K–feldspar alteration and peripheral kaolin alteration. Initial drilling on the outcropping portion of the prospect indicated subeconomic gold mineralisation (eg 1 m at 0.57 g/t Au). Further drill testing of the non-outcropping central portion recovered no significant mineralisation.

EL 4271 **Rio Tinto Exploration P/L**

Location: 50 km N of Orange

Objective: Porphyry copper–gold

This is one of a group of licences acquired between Wellington and Molong to explore Ordovician volcanics for porphyry



copper–gold deposits. The only work completed was compilation of previous data and bulk leach extractable gold (BLEG) stream sediment sampling (48 samples).

EL 4227 **Pioneer Building Products P/L**

Location: 7 km S of Bungendore

Objective: Clay shale

Drilling in the vicinity of an existing quarry site identified a resource of white-firing weathered shale estimated at 300 000 m^3. The material would be suitable for brick manufacture but would require blending with more plastic components. Adjacent material has similar properties except it is red- to pink-firing. A thin layer of red-firing clay at the top of the deposit has suitable plasticity.

EL 4476 **Rio Tinto Exploration P/L**

Location: 30 km SW of Wellington

Objectives: Copper and gold

The licence was taken to explore for porphyry copper–gold systems. Regional stream sediment sampling was followed up by rock and soil sampling. Results were generally disappointing and the area was concluded to have little potential for economic deposits.

EL 4621 **Aberfoyle Resources Ltd**

Location: 35 km SW of Broken Hill

Objectives: Lead, zinc and silver

An airborne electromagnetic (EM) survey was undertaken and the area shown to be one of high surface conductivity due to overburden. Only one possible anomaly (rated 'low') was identified. A strong magnetic anomaly transecting the licence may be due to amphibolites.

EL 4636 **Mogul Mining NL**

Location: 25 km NE of Manilla

Objectives: Gold and base metals

The licence area was thought to be prospective for epithermal and mesothermal gold deposits and for Cyprus type massive sulphide, but no exploration was carried out.

EL 4722 **Desertstone NL**

Location: 150 km NW of Bourke

Objectives: Opal

This licence covered the Cretaceous Rolling Downs Group. Lineament, photogeological and topographic mapping was followed by a systematic stream sediment survey. No traces of potch, nor any other opal indicators, were detected.

EL 4757 **PJ McSharry & Associates P/L**

Location: 25 km E of Inverell

Objective: Sapphires

Palaeodrainage reconstruction, airphoto interpretation and field checking failed to locate sapphire bearing volcanogenic rocks. Mapping along Newstead Creek indicated the volcaniclastic deposits are stratigraphically lower than the horizon that has produced sapphires at Braemar.

EL 4822 **Rio Tinto Exploration P/L**

Location: 50 km S of Inverell

Objective: Diamonds

An airborne magnetic and photogeological interpretation resulted in about 270 features,of which 180 were followed up with gravel and rock sampling. Four of these were considered prospective, one of which returned chromites indicative of a deep seated source. One hundred and seventeen units of the original area (more than 2900 units) remain in force as 5 separate 'follow-on' licences held by Diamond Ventures Exploration Pty Ltd.

EL 4823 **Gundagai Gold P/L**

Location: Gundagai

Objective: Gold

The area was geochemically sampled using a Russian developed technique analogous to mobile metal ion geochemistry. The results suggested enrichment of some metals and depletion of others relative to an undefined "caldera".

EL 4941 **Newcrest Mining Ltd**

Location: 20 km N of Nyngan

Objectives: Gold and copper

The area has deep cover of 75 m to over 140 m of Cainozoic sedimentary rock. Basement, with pronounced aeromagnetic signature, is assumed to be Ordovician volcanics and intrusions at the western edge of the Parkes Structural Zone. A 31 hole program of air core drilling confirmed mafic to dioritic intrusions but did not encounter any alteration or geochemical anomalism.

ELs 4956 & 4957 **Mount Conqueror Minerals NL**

Location: 35 km SE of Ulan

Objectives: Diamonds and feldspar

Exploration was for the source of the Cudgegong deep lead diamonds and also to evaluate the potential of syenitic intrusions as a source of feldspathic raw material. Mapping and photo interpretation, and indicator mineral sampling (22 samples) did not identify any prospects.

EL 4999 **Accord Capital Investors P/L**

Location: 21 km ESE of Inverell

Objectives: Diamonds and sapphires

Preliminary literature work indicated that no diamonds are recorded from the licence area although some sapphires were reported along part of Kings Creek. No further work was done.

EL 5002 **Silver Standard Australia P/L**

Location: 60 km N of Cobar

Objective: Gold

The licence area contains small gold mines in a complex deformed sequence featuring pillow basalts and other volcanic rocks of possible Ordovician age. Contouring of earlier soil sampling results revealed a previously unknown NW trending zone of anomalous gold values up to 23 ppm Au. Proposed follow-up drilling did not take place.

EL 5020 **Rio Tinto Exploration P/L**

Location: 30 km SSW of Condobolin

Objective: Porphyry copper–gold

Exploration comprised bulk soil, rock chip and magnetic lag geochemistry, together with geological mapping at prospects. The Gnarly prospect was interpreted as a metal-depleted lithocap in leached felsic volcanic rock. The Laurieston prospect has tourmaline-bearing quartz and breccia in silica–clay altered igneous rock, with coincident gold and bismuth anomalism. Molybdenum (to 20 ppm) is also present.

EL 5025 **Rio Tinto Exploration P/L**

Location: 45 km SSW of Tottenham

Objectives: Copper and gold

Drilling of a circular +75nT aeromagnetic anomaly identified the source as basalt and basaltic hyaloclastic breccia of shoshonitic affinity. No mineralisation was encountered.

EL 5042 **Silver Standard Australia P/L**

Location: 70 km N of Cobar

Objectives: Gold and base metals

The licence covered interpreted structures flanking the south-western corner of the non-outcropping Galambo granitic complex. The area has many small prospector pits for which the history is unknown. Soil sampling along traverse lines (17.5 km) gave no significant results.

EL 5111 **Rio Tinto Exploration P/L**

Location: 53 km NE of Ivanhoe

Objectives: Diamonds, or possible massive sulphides

The licence was obtained to investigate an aeromagnetic feature. Modelling indicated the target at about 200–500 m depth. A drill test intersected a magnetic olivine basalt at about 449 m down hole. No anomalous geochemistry was returned and the basalt was also considered to have no diamond potential.

EL 5139 **Savage Australian Exploration P/L**

Location: 10 km NNE of Junee

Objectives: Copper and gold

A 200–600 m wide linear magnetic feature to the west of the Gilmore fault zone and along strike of Junee Reefs was tested by two traverses of rotary air blast (RAB) drilling. Most holes intersected weathered granite and no anomalous geochemistry was encountered. Based on a single intersection of magnetic source rock, the magnetic feature may be a sheared mafic dyke.

EL 5140 **Savage Australian Exploration P/L**

Location: 15 km SW of Narrandera

Objectives: Gold and base metals

This licence was acquired to test linear aeromagnetic features interpreted as possible mineralised shears close to granite. Five RAB holes were drilled but failed to penetrate heaving clays and silcrete to reach basement. A review of previous exploration indicated that cover sediments are likely to exceed 100 m.

EL 5240 **North Mining Ltd**

Location: 3 km SE of Cooma

Objectives: Copper and gold

Airborne magnetic and radiometric surveys and stream sediment sampling identified numerous prospects. Follow-up reconaissance mapping and rock chip sampling focused on those within the Ordovician Kenyu Formation and Walli Volcanics. Although gold anomalism was confirmed at some prospects, funding for the project was terminated.

EL 5258 **Jervois Mining NL & Newcrest Operations Ltd**

Location: 9 km SW of Orange

Objective: Gold

Prospective palaeozoic rocks, principally the Forest Reefs Volcanics are almost totally covered by Tertiary basalt. Available geophysical data proved unhelpful and the licence was relinquished for lack of cost-effective means of exploring through this cover.

EL 5281 **W. Davies**

Location: 20 km SE of Wellington

Objective: Gold

Loaming and panning along creeks located one quartz reef with fine visible gold (2 g/t Au maximum grade), plus a large source area of high level cemented wash. As the grade of the latter was unencouraging the licence was relinquished.

EL 5371 **North Mining Ltd**

Location: Oberon

Objectives: Copper and gold

Interpretation of Landsat and airborne geophysical survey data was followed by stream sediment and rock chip sampling. Several areas of stream sediment copper anomalism were identified within Ordovician Rockley Volcanics. The anomalies were tested by aircore drilling but this failed to return any significant intercepts.

OTHER EXPLORATION LICENCES CANCELLED OR EXPIRED

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

ELs 2652, 2662, 3785, 4184, 4223, 4224, 4454, 4487, 4900, 5009, 5195, 5201 5298.

EARLIER TERMINATED EXPLORATION LICENCES NOT PREVIOUSLY REPORTED

ELs 2672 & 3598 **Helix Resources NL**

Location: 5 km SW of Tottenham

Objectives: Platinum group metals and vermiculite

Exploration for platinum group metal in Alaskan type intrusions returned up to 4 m at 0.29 ppm Pt in rocks of the outer ultramafic annulus of the Bulbodney Creek Intrusive Complex. Overlying quartz-rich gravels also contain trace platinum, up to 4 m at 0.09 ppm Pt. Good development of vermiculite occurs over the smaller, satellite, Hillview intrusion, and this has been retained under an assessment lease application.

EL 3066 **RZM P/L**

Location: NW of Tuncurry

Objective: Heavy mineral sands

Results of drilling indicated that no economically viable mineralisation or placer strand line was developed in the licence area. Mineralisation occurs in isolated patches of uneconomic grade and volume.

EL 3321 **Southpac Ltd**

Location: 50 km W of Wauchope

Objective: Gold

Geochemical and ground induced polarisation (IP) and magnetometer surveys indicated only one prospect worthy of follow-up. Six reverse circulation (RC) holes were drilled into chargeability anomalies. Only a maximum of 0.07 ppm Au was returned within silica–sericite altered andesitic rocks.

EL 3909 **R.A. & R.J. Frazier**

Location: 44 km E of Inverell

Objective: Sapphire

Prospecting along the valley and lower tributaries of Kings Creek confirmed sapphire as ubiquitous but the grades present (maximum 5 g/m^2) are not encouraging.

EL 3910 **F. Franke and B. Nielsen**

Location: 13 km W of Sofala

Objective: Gold

The Quartz Ridge reef workings were prospected by percussion drilling and grab sampling. One result of 1530 ppm Au was reported from a grab sample.

ELs 4249 & 4419 — **J. Giannarelli**

Location: 25 km S of Forbes

Objective: Dimension stone

The Eugowra Granite was explored for a new source of granite close to an existing quarry site. Testing gave sufficient encouragement to lodge a mining lease application.

EL 4522 — **Rio Tinto Exploration P/L**

Location: Temora

Objective: Porphyry copper–gold

Photogeomorphological studies and geological mapping was supplemented by maghemite lag geochemistry. This generated several targets with values of up to 189 ppb Au, 259 ppm Cu, 18 ppm Mo. Follow-up comprised soil and rock chip geochemistry and aircore and RC drilling. Drilling results were not considered significant, the best intersections being 1 m at 4.25 g/t Au and 4 m at 0.96 g/t Au.

EL 4526 — **Rio Tinto Exploration P/L**

Location: 15 km N of Temora

Objective: Porphyry copper–gold

Exploration was for porphyry systems associated with Ordovician and younger volcanics and granitoids. Photogeomorphological and geological studies, an aeromagnetic survey, soil sampling and maghemite lag sampling were conducted. The area contains earlier identified prospects, such as 1 m at 0.2 g/t Au. New results were of low tenor (a maximum of 7 ppb Au).

EL 4793 — **Rocktam P/L**

Location: 40 km SSW of Coffs Harbour

Objective: Heavy mineral sands

No exploration for heavy mineral sands was conducted although minor shallow test drilling for gravel was done.

EL 4839 — **Renison Ltd**

Location: 150 km S of Cobar, Mount Hope

Objectives: Gold and copper

This area was taken up subsequent to detailed regional airborne magnetic and radiometric surveys by Renison. Work did not proceed beyond target identification based on the geophysical data and a literature review.

EL 4893 — **B. Marheine (Holdings) P/L**

Location: Willow Tree

Objective: Bentonite

Drilling failed to locate bentonite. A narrow interval of smectite bearing altered basalt was identified but with only a moderate cation exchange capacity. The drilling did however identify (adjacent to the Council quarry) an aggregate resource (basalt) and a road base resource (conglomerate/sandsone).

EL 5171 — **Rio Tinto Exploration P/L**

Location: 50 km NE of Brewarrina

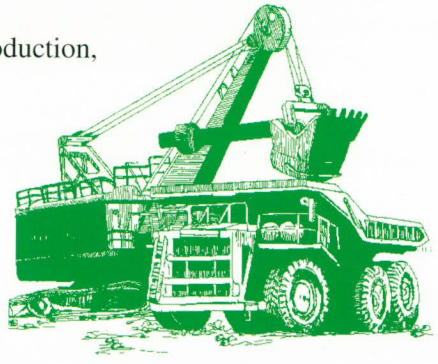
Objective: Base metals

This licence was acquired to investigate a cluster of 29 discrete aeromagnetic anomalies identified by Discovery 2000 surveys. The anomalies are sourced in basement beneath the Surat Basin and were evaluated in conjunction with an overlaping licence (EL 5023) for diamonds. Two drill holes intersected alkali basalt breccia and xenolithic ankaramite, and yielded no anomalous assay results. The cluster of bodies was interpreted as Cretaceous plugs unlikely to have associated mineralisation.

New

1998 NSW Minerals Industry Annual

A comprehensive reference publication on the minerals industry in New South Wales, covering exploration, mining and minerals processing. The Annual is crammed with a wealth of information, including:



- ✔ Overview of mining in NSW, including industry trends, production, exports, exploration, safety, environmental management, processing, and new mines and projects.
- ✔ Summaries of over 30 significant mineral commodities, including metallic, energy and industrial minerals, and covering production, developments and outlook for each.
- ✔ Profiles of significant mines/mining operations.
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The Annual is invaluable for mining and exploration companies, financial and investment organisations, manufacturers, libraries, local councils, product and service suppliers, research and educational organisations, mining consultants, and government and industry organisations.

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COAL INDUSTRY UPDATE

DONALDSON COMMISSION OF INQUIRY

Commissioner Cleland has been appointed to conduct an inquiry into the Donaldson coal project. The proponent, Donaldson Projects Pty Ltd, requested a Commission of Inquiry in view of residents' concerns about the possible impact of the mine.

Underground Longwall operations at Ellalong Colliery

COORANBONG COMMISSION OF INQUIRY

Hearings by Commissioner Carleton were completed in mid May. Many submissions were received from local residents who were concerned about the impact of subsidence from the planned mine on flood-prone land in the Mandalong Valley. To address residents' concerns, Powercoal presented sophisticated computer models of predicted flow regimes after mining.

ELLALONG COLLIERY TO RE-OPEN

The recently closed Ellalong Colliery near Cessnock will reopen shortly under the ownership of Gympie Gold Ltd. The mine will in future be known as the Southland Colliery, which will include the Ellalong Colliery and the adjacent Bellbird Lease. Underground development and production are planned to begin later this year. The mine will employ about 90 people and will produce 1.5 Mt of coking coal per year by 2000.

CLARENCE TO RESUME OPERATIONS

Clarence Colliery, near Lithgow, is due to recommence mining operations in the near future, providing about 90 jobs. Australian company Centennial Coal Company Pty Ltd is the new major partner in joint venture with Korean and Japanese interests. The colliery has reserves sufficient for about 20 years of mining.

PRESTON COLLIERY CLOSES

The Preston Colliery near Gunnedah, which has been operating since the 1880s, closed in May as a result of depletion in reserves. A total of 18 miners lost their jobs with the closure.

WEST WALLSEND REDUNDANCIES

Almost a quarter of the workforce at West Wallsend Colliery near Lake Macquarie, has been offered redundancies. The principal mine owner, Oceanic Coal Aust Ltd, blamed falling coal prices and reduced demand for the retrenchments.

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

1998 AAPG CONVENTION, UTAH

The American Association of Petroleum Geologists (AAPG) annual conference is one of the biggest international petroleum conferences in the world. About 7000 delegates attended the 1998 conference in Salt Lake City, Utah, USA. At the accompanying exhibition, 240 companies promoted various services or investment opportunities and 41 countries presented displays to encourage oil company investment.

A New South Wales exhibition, part of the Australian stand, highlighted the underexplored areas of the State, with particular emphasis on the Murray and the Eromanga Basins, as internationally attractive exploration regions.

The increasing number of overseas countries attending the conference gave a clear indication of the competition between countries to attract petroleum exploration capital. Data obtained under the Discovery 2000 program have helped to raise the profile of New South Wales. Great interest was shown in coal seam methane potential, in the western areas of the State and the Sydney–Gunnedah Basins.

For further information contact Dave Alder, Principal Geologist — Petroleum, on (02) 9901 8512, fax (02) 9901 8520, or e-mail alderd@minerals.nsw.gov.au

APPEA CONFERENCE, CANBERRA, 1998

The annual Australian Petroleum Production and Exploration Association (APPEA) conference is one of the focal points for petroleum exploration in Australia. The 1998 conference was held in Canberra on 8–11 March 1998. The conference took as its theme the national prosperity delivered to the nation by the petroleum industry.

The Department used the opportunity to display the latest information from the Discovery 2000 program. The New South Wales stand drew a great deal of interest from the exploration industry with a large number of companies requesting additional information on Discovery 2000 products and opportunities.

David Alder and Brad Mullard from the Department presented technical papers based on data from Discovery 2000 projects on the Darling and Sydney Basins. These basins continue to be of particular interest to industry and Departmental officers were kept very busy answering numerous enquiries about exploration opportunities.

Brad Mullard also gave a presentation at the Onshore Exploration Opportunities Workshop which drew considerable interest from industry.

For further information contact Dave Alder, Principal Geologist—Petroleum, on (02) 9901 8512, fax (02) 9901 8520, or e-mail alderd@minerals.nsw.gov.au

(photograph by Dave Alder)

The New South Wales stand at the APPEA Conference

NEWCASTLE PORT COAL LOADERS

In *Minfo* **59**, it was reported that the Port Waratah operator of the Newcastle Port coal loaders, Port Waratah Coal Services, had applied to the Australian Competition and Consumer Commission for authorisation of a capacity allocation system for shipping. The system was to have applied if shipping demand exceeded capacity of the port, as it had done during the second half of 1997 and the early part of 1998.

The Commission initially rejected the application for an interim authorisation, but agreed in March to approve a capacity allocation system until the end of September 1998, subject to some conditions. These included:

1. The system expires on 30 September 1998;
2. The system may only be implemented if the vessel queue has been equal to or exceeded 25 vessels for 7 consecutive days;
3. PWCS must notify the Commission of any planned implementation of the system and provide evidence that Condition 2 has been met;
4. The allocation system can only be implemented on a two month cycle;
5. No changes may be made without approval of the Commission.

A combination of improved efficiency at the port and along the coal chain, and some drop in demand, has led to a reduction in the shipping queue to single figures for the first time for almost a year. On 2 June, for the first time in four years, there were no coal ships waiting off the Port of Newcastle.

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

COAL AUTHORISATIONS/EXPLORATION LICENCES JUNE 1998*

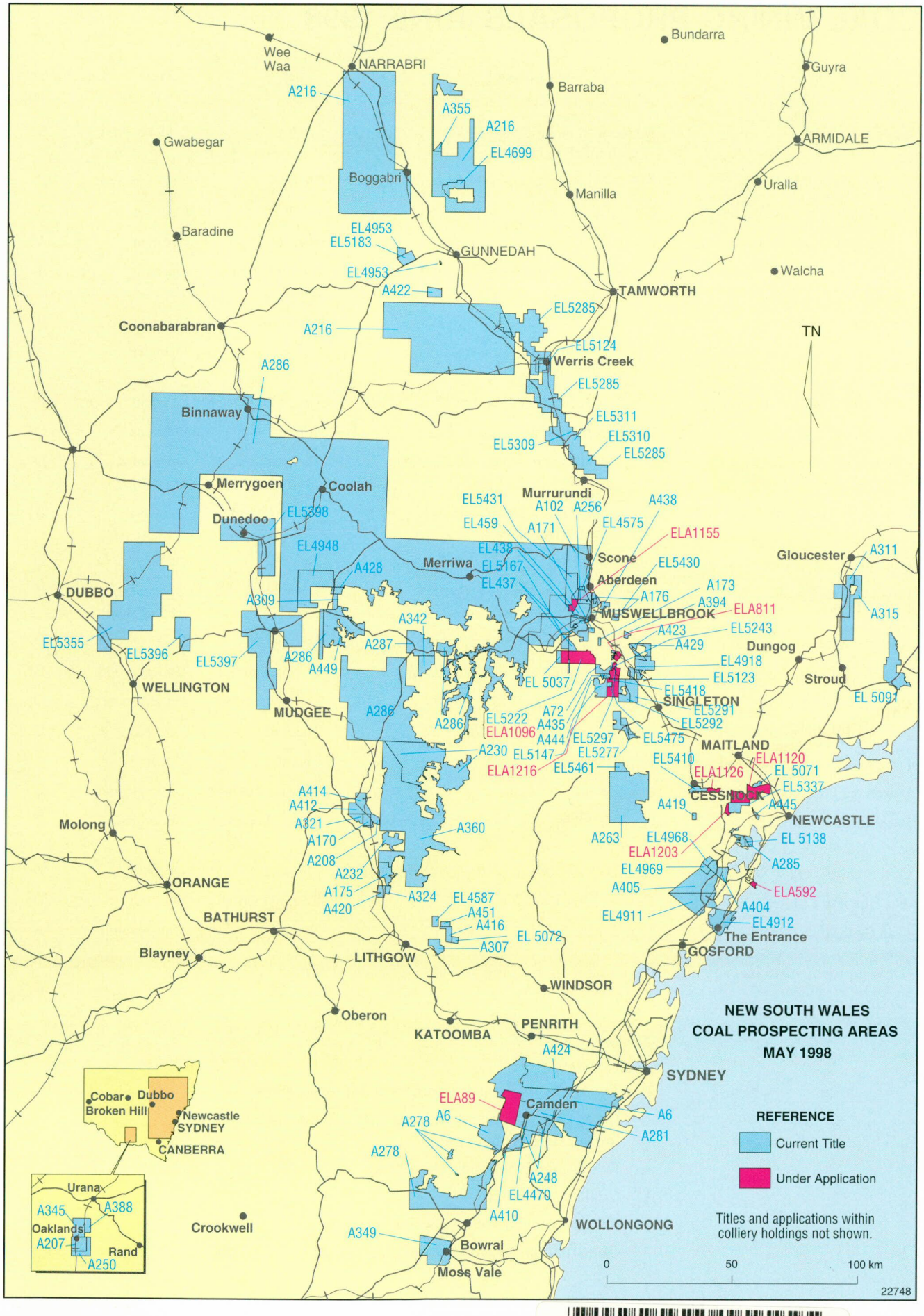
No	Holder	Nearest town
A6	Dept Mineral Resources	Campbelltown
A72	Novacoal Australia P/L Mitsubishi Development P/L	Jerrys Plains
A81	Navidale P/L Toyota Tsusho Mining (Aust) P/L DIA Coal Mining P/L	Camberwell
A102	Dept Mineral Resources	Muswellbrook
A168	Dept Mineral Resources	Muswellbrook
A170	Genders Mining P/L	Capertee
A171	Bayswater Colliery Co P/L	Muswellbrook
A173	Drayton Coal P/L	Muswellbrook
A175	Coalex P/L	Ben Bullen
A176	Muswellbrook Coal Co Ltd	Muswellbrook
A208	Genders Mining P/L	Capertee
A216	Dept Mineral Resources	Gunnedah
A230	Dept Mineral Resources	Rylstone
A232	Novacoal Australia P/L	Capertee
A248	BHP Steel (AIS) P/L	Menangle
A250	Mitsubishi Development P/L Queensland Coal P/L	Oaklands
A256	The Bellambi Coal Co P/L Marubeni Thermal Coal P/L Showa Coal (NSW) P/L	Aberdeen
A263	Dept Mineral Resources	Wollombi
A278	Dept Mineral Resources	Mittagong
A281	Dept Mineral Resources	Camden
A285	Dept Mineral Resources	Toronto
A286	Dept Mineral Resources	Gulgong
A287	Austen & Butta Ltd	Bylong
A307	Hartley Valley Coal Co P/L	Lithgow
A309	Ulan Coal Mines Ltd	Ulan
A311	CIM Resources Ltd CIM Strathford P/L	Gloucester
A315	CIM Resources Ltd CIM Strathford P/L	Gloucester
A321	Genders Mining P/L	Capertee
A324	Lithgow Coal Co Ltd	Ben Bullen
A342	Austen & Butta Ltd	Bylong
A349	Austen & Butta Ltd	Sutton Forest
A355	Idemitsu Boggabri Coal P/L	Boggabri
A360	Dept Mineral Resources	Rylstone
A388	Queensland Coal P/L Mitsubishi Development P/L	Oaklands
A394	Liddell Tenements P/L	Muswellbrook
A404	Powercoal P/L	Morisset
A405	Coal Operations Australia Ltd	Coorangong
A410	Tahmoor Coal P/L	Picton
A412	Genders Mining P/L	Ilford
A414	Charbon Coal P/L Yukong Aust P/L	Kandos
A419	Newcastle Wallsend Coal Co P/L	Cessnock
A420	Lithgow Coal Co Ltd	Ben Bullen
A422	Preston Coal Co P/L	Gunnedah
A423	Hunter Valley Coal Corporation	Ravensworth
A424	Dept Mineral Resources	Campbelltown
A428	Ulan Coal Mines Ltd	Gulgong
A429	Hunter Valley Coal Corp P/L	Singleton
A435	Coal & Allied Operations P/L	Singleton
A437	Bayswater Colliery Co P/L	Muswellbrook
A438	Bengalla Mining Co P/L	Muswellbrook
A444	The Construction Forestry Mining & Energy Union	Singleton
A445	Newcastle Wallsend Coal Co	Boolaroo
A449	Dept Mineral Resources	Ulan
A450	Saxonvale Coal P/L	Bulga
A451	Coalex P/L	Lithgow
A459	Coal & Allied Operations P/L	Aberdeen

EL No	Holder	Nearest town
4470	BHP Steel (AIS) P/L	Camden
4574	The Bellambi Coal Co Ltd Marubeni Thermal Coal P/L Showa Coal (NSW) P/L	Muswellbrook
4575	The Bellambi Coal Co P/L Marubeni Thermal Coal P/L Showa Coal (NSW) P/L	Muswellbrook
4587	Clutha Springvale Ltd Samsung Development (Aust) P/L	Lithgow
4699	Namoi Valley Coal P/L	Boggabri
4911	Coal Operations Australia Ltd	Wyee
4912	Coal Operations AUstralia Ltd	Wyee
4918	Dept Mineral Resources	Ravensworth
4948	Dept Mineral Resources	Ulan
4953	Namoi Mining P/L	Gunnedah
4968	Powercoal P/L	Wyee
4969	Powercoal P/L	Wyee
5037	Dept Mineral Resources	Denman
5071	Donaldson Projects P/L	Thornton
5072	Coalex Pty Ltd	Lithgow
5091	Hunter Valley Mining Corp P/L	Buladelah
5124	Alphadale P/L	Quirindi
5138	Powercoal P/L	Awaba
5167	Bayswater Colliery P/L	Muswellbrook
5183	Namoi Mining P/L	Gunnedah
5222	Dept Mineral Resources	Jerrys Plains
5243	Novacoal Aust Pty Ltd Mitsubishi Development P/L	Ravensworth
5277	Saxonvale Coal P/L	Warkworth
5285	Rio Tinto Exploration P/L	Quirindi
5291	Esso Australia Resources Ltd	Warkworth
5292	Esso Australia Resources Ltd	Warkworth
5297	Peabody Resources Ltd	Ravensworth
5309	Alphadale P/L	Willow Tree
5310	Alphadale P/L	Quirindi
5311	Alphadale P/L	Quirindi
5337	Newcastle Coal Co P/L	Seahampton
5347	Coal Operations Australia Ltd Catherine Hill Resources P/L	Wyee
5355	Rio Tinto Exploration P/L	Dubbo
5370	Namoi Mining P/L	Gunnedah
5396	Rio Tinto Exploration P/L	Wellington
5397	Rio Tinto Exploration P/L	Gulgong
5398	Rio Tinto Exploration P/L	Gulgong
5410	Oceanic Coal Australia Ltd	Cessnock
5417	Coal & Allied Operations P/L	Warkworth
5418	Coal & Allied Operations P/L	Warkworth
5430	Bayswater Colliery Co P/L	Muswellbrook
5431	Muswellbrook Coal Co P/L	Bunnan
5461	Saxonvale Coal P/L Nippon Steel Australia P/L	Broke
5475	Coal & Allied Operations P/L	Jerrys Plains

EXPLORATION LICENCE APPLICATIONS

No	Mining Division	Applicant
89	Sydney	Clutha Coal P/L (Camden)
811	Singleton	Cumnock No 1 Colliery P/L
1081	Singleton	Ulan Coal Mines Ltd (Ulan)
1096	Singleton	The Shell Co of Aust Ltd & others (Denman)
1120	Singleton	Excel Mining P/L (West Wallsend)
1126	Singleton	Oceanic Coal Australia Ltd (Kurri Kurri) Excel Mining P/L
1155	Singleton	The Bellambi Coal Co P/L Marubeni Thermal Coal P/L Showa Coal (NSW) P/L Ssanyong Resources P/L (Muswellbrook)
1203	Singleton	Seaham Holdings P/L
1216	Singleton	Coal & Allied Operations P/L

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


Wee Waa
NARRABRI
Bundarra
Guyra
Barraba
ARMIDALE
Gwabegar
Boggabri
Manilla
Uralla
Baradine
GUNNEDAH
Walcha
TAMWORTH
Coonabarabran
Werris Creek
TN
Binnaway
Merrygoen
Coolah
Dunedoo
Murrurundi
Scone
Gloucester
Merriwa
Aberdeen
DUBBO
MUSWELLBROOK
Dungog
Stroud
WELLINGTON
MUDGEE
SINGLETON
MAITLAND
CESSNOCK
NEWCASTLE
Molong
ORANGE
BATHURST
LITHGOW
Blayney
Oberon
WINDSOR
KATOOMBA
PENRITH
SYDNEY
The Entrance
GOSFORD
WOLLONGONG
Bowral
Moss Vale
Crookwell
Cobar
Dubbo
Broken Hill
Newcastle
SYDNEY
CANBERRA
Urana
Oaklands
Rand
Camden
NEW SOUTH WALES
COAL PROSPECTING AREAS
MAY 1998
REFERENCE
Current Title
Under Application
Titles and applications within colliery holdings not shown.
0
50
100 km
22748

COAL MINING PROPOSALS JUNE 1998

Company	Location	Coal type	Mine type	Development stage
Austral Coal Ltd	Tahmoor Mine infill areas ('prohibited' in LEP)	Coking	Underground	B*
Centennial Coal Co Ltd	Airly Mountain, 42 km north-west of Lithgow	Thermal	Underground	F*
Coal & Allied Operations Pty Ltd	Carrington, 18 km west of Singleton	Thermal	Opencut	A
Coal & Allied Operations Pty Ltd	Cheshunt, 15 km west of Singleton	Thermal	Opencut	A*
Coal & Allied Operations Pty Ltd	Mount Pleasant, 6 km north-west of Muswellbrook	CWM/thermal coking	Opencut	B
Dartbrook Joint Venture	Kayuga, south of Dartbrook Mine	Thermal	Opencut	B
Coal Operations Australia Ltd	Mount Arthur North, 5 km south-west of Muswellbrook	Thermal	Opencut	A
Donaldson Projects Pty Ltd	Donaldson, 5 km south-east of Maitland	Thermal/coking	Opencut	B
Duralie Coal Pty Ltd	Duralie, 20 km south of Gloucester	Coking	Opencut	D*
Idemitsu Boggabri Coal Pty Ltd	Boggabri, 17 km north-east of Boggabri	Thermal	Opencut & underground	D
Lemington Coal Mines Ltd	Lemington Mine southern extension, 10 km west of Singleton	Coking/thermal	Opencut	B
Liddell Coal Operations Pty Ltd	Glendell, 18 km north-west of Singleton	Thermal	Opencut	D
Lithgow Coal Co Ltd	Feldmast, 20 km north of Lithgow	Thermal	Opencut & underground	C
Maitland Main Collieries	Glennies Creek, 12 km north-west of Singleton	Coking	Underground	D
Nardell Coal Corp Pty Ltd	Nardell, 18 km north-west of Singleton	Coking/thermal	Underground	E*
Oceanic Coal Aust Ltd	Lachlan, near Wakefield	Thermal/coking	Underground	D
Peabody Resources Ltd	Ravensworth West extension	Thermal	Opencut	B
Peabody Resources Ltd	Ravensworth East	Thermal	Opencut	A
Powercoal Pty Ltd	Cooranbong extension	Thermal/coking	Underground	B
Powercoal Pty Ltd	Newstan Mine extension, 30 km south-west of Newcastle	Thermal/coking	Underground	A
Queensland Coal Pty Ltd	Maules Creek, 20 km north-east of Boggabri	Thermal	Opencut	D
Rio Tinto Pty Ltd	Howick Mine extension	Coking/thermal	Opencut	D*
Ulan Coal Mines Ltd	Ulan expansion	Thermal	Underground	A

*Development stage has advanced since publication of the previous schedule (February 1998)

NOTES:

Stages defined:

A Environmental and preliminary feasibility studies.

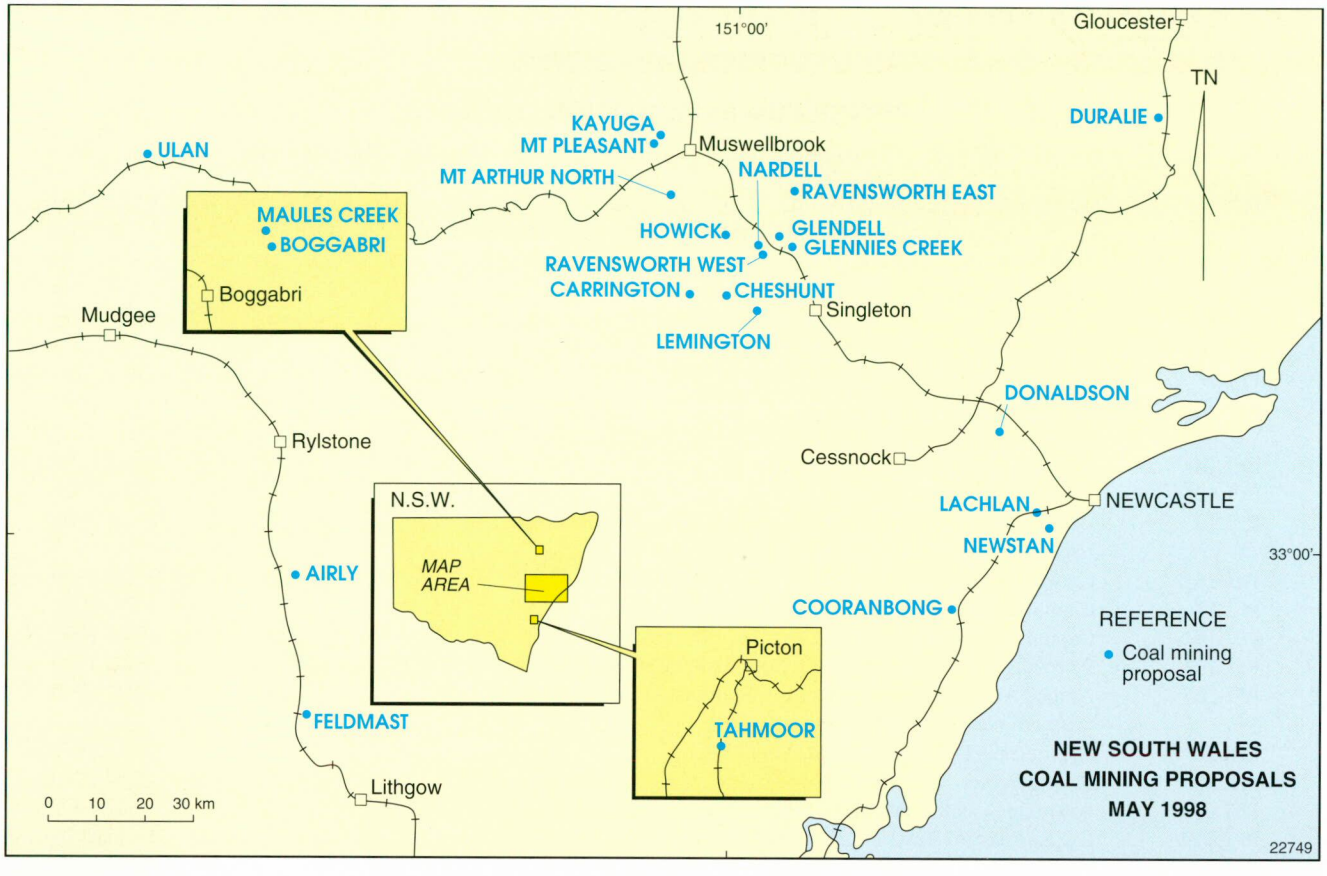
B Development application lodged, environmental impact statement complete.

C Development consent determined.

D Coal lease granted.

E All government approvals obtained.

F Construction/development in progress.



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

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

.....

PETROLEUM TITLES — JUNE 1998

PETROLEUM EXPLORATION LICENCES

No	Holder	Area (No of blocks)*	Expiry date#
PEL 1	Australian Coalbed Methane P/L	127	10.02.1999
PEL 2	Amoco Australia Development Co, AGL Gas Company (NSW) Ltd Pacific Power	120	28.03.1999
PEL 4	Amoco Australia Development Co, Pacific Power	113	10.11.1999
PEL 5	Pacific Power	40	10.11.1999
PEL 6	Eastern Energy Australia P/L	82	08.12.1996
PEL 8	Maple Oil & Exploration NL	135	13.12.1999
PEL 9	Oil Co Australia Ltd, Claremont Petroleum NL, St Barbara Mines Ltd, Pacific Power	19	19.12.1999
PEL10	Australian Coalbed Methane P/L	6	10.02.1999
PEL12	Australian Coalbed Methane P/L	39	26.09.2001
PEL13	Oil Co Australia Ltd, Pacific Power, Claremont Petroleum NL, St Barbara Mines Ltd	41	26.11.2001
PEL16	Carlita Holdings P/L	11	12.11.1999
PEL17	Capital Energy NL	91	30.01.2003
PEL18	Capital Energy NL	93	30.01.2003
PEL238	Petroleum Securities P/L, Great Southland Petroleum P/L	132	31.08.1999
PEL267	Amoco Australia Development Co, Sydney Oil Co (NSW) P/L, Government Insurance Office of NSW	107	19.01.1999
PEL283	Capital Energy NL, Tyers Investment P/L	70	09.04.1999
PEL285	Pacific Power	24	15.04.1999
PEL286	Australian Coalbed Methane P/L	24	10.02.1999
PEL419	GO Resources (Aust) P/L	140	19.12.2003
PEL420	GO Resources (Aust) P/L	122	19.12.2003
PEL421	First Sourcenergy Group Inc	136	01.02.2004
PEL422	First Sourcenergy Group Inc	108	01.02.2004
PEL423	First Sourcenergy Group Inc	86	01.02.2004
PEL424	First Sourcenergy Group Inc	123	01.02.2004
PEL425	Otto Oil P/L	140	26.02.2004
PEL426	Oil Co Australia Ltd, Claremont Petroleum NL, Pacific Power, St Barbara Mines Ltd	83	20.04.2004
PEL427	Strike Oil NL	122	20.05.2004
PSPA5	First Sourcenergy Group Inc	140	11.06.1999

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

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

PETROLEUM EXPLORATION LICENCE APPLICATIONS

No	Applicant	Area (No of blocks)	Application date
PELA43	Strike Oil NL	140	19.03.1998

OFFSHORE PETROLEUM EXPLORATION PERMIT APPLICATION

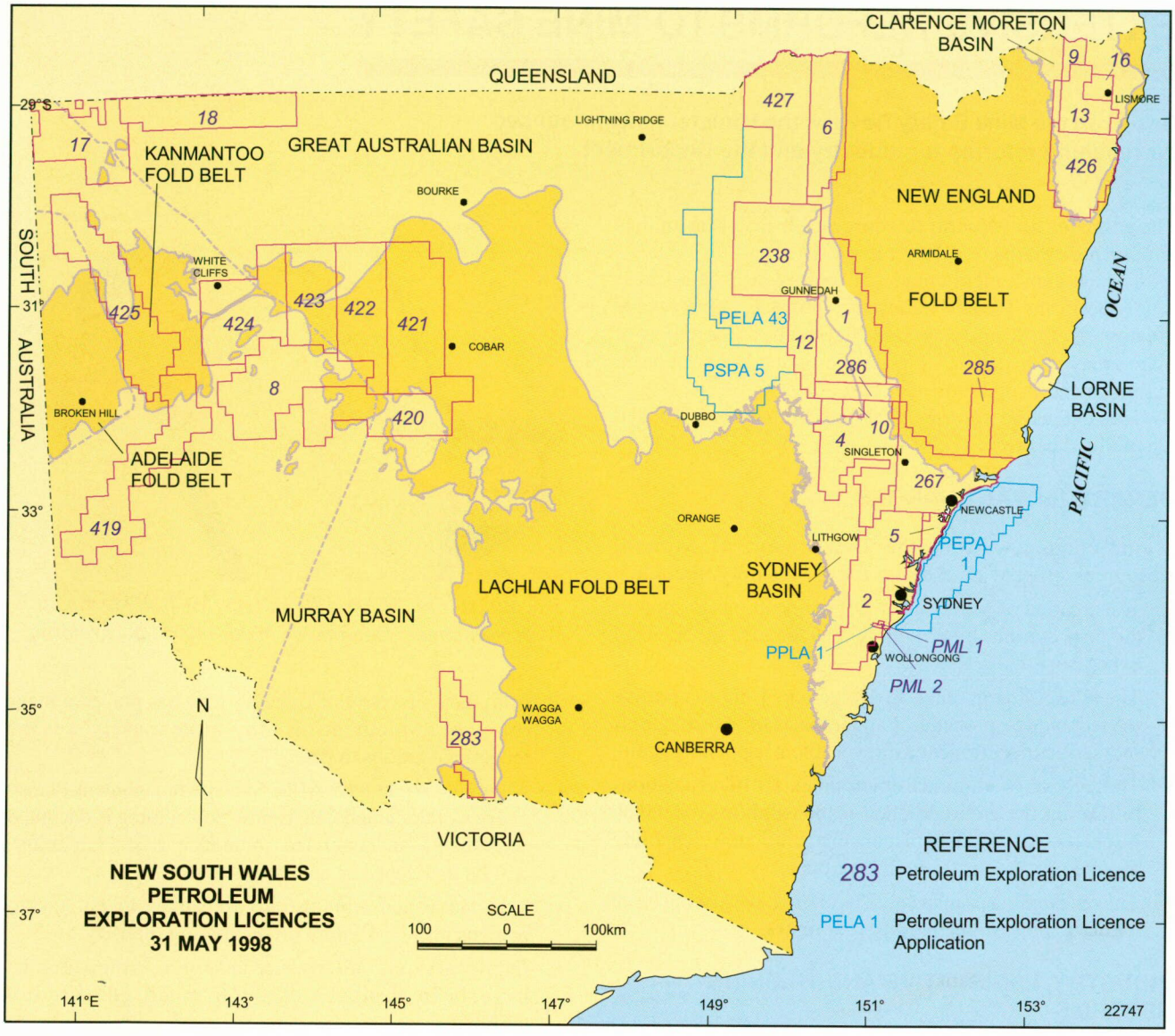
No	Applicant	Area (No of blocks)	Application date
1	Flare Petroleum NL	129	27.11.1997

PETROLEUM MINING LEASES

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

PETROLEUM PRODUCTION LEASE APPLICATIONS

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



CHANGES TO COAL MINE OWNERSHIP

Table 2 lists major changes to coal mine ownership between 1 October 1997 and 30 June 1998.

TABLE 2

MAJOR CHANGES TO COAL MINE OWNERSHIP IN NEW SOUTH WALES

Colliery	Previous interest		New interest	
Bayswater 2 and 3	Coal Operations (Aust) Pty Ltd Nippon Oil Pty Ltd Kepco Resources Australia Pty Ltd	85.5% 9.5% 5.0%	Coal Operations (Aust) Pty Ltd Nippon Oil Pty Ltd Kepco Resources Australia Pty Ltd Nippon Steel Pty Ltd	78.3% 8.7 % 5.0%
Airly Proposal	Novacoal Australia Pty Ltd	100%	Centennial Coal Company Ltd	100%
Metropolitan	Denehurst Kanematsu	90% 10%	Under administration	100%
Mount Owen	BHP Coal Pty Ltd	100%	Glencore Australia Pty Ltd	100%
Swamp Creek	Pacific Power	100%	Peabody Resources Ltd	100%

EXTENSIVE REFORMS TO MINE SAFETY

Based on the Mine Safety Review, the Minister has announced far reaching reforms for industry and the Department.

The Minister for Mineral Resources, Mr Bob Martin, has announced extensive safety reforms.

The announcement, made at Warkworth Mine near Singleton in the Hunter Valley in April, has come twelve months after the Minister released the results of the review of mine safety. Since then, significant progress has been made to implement its recommendations.

The extensive reforms that the Minister announced are outlined below.

DEPARTMENTAL CHANGES

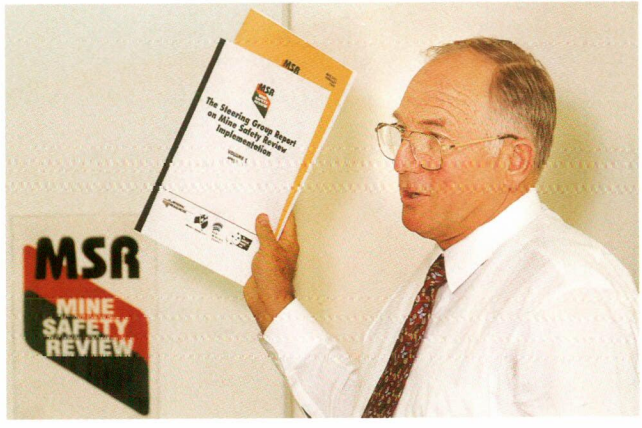
Major changes within the Department of Mineral Resources, to provide a better focus on safety, include:

- The creation of Mine Safety Officer positions to support the inspectorates by providing a wide range of technical expertise;
- The establishment of an 'Investigations Unit' to improve the techniques, procedures and impacts of investigations into serious occurrences to prevent them happening again;
- The creation of additional environmental officer positions to take up the environmental responsibilities for which inspectors have been responsible until now, enabling inspectors to focus fully on core business; and,
- The redesigning of inspectors' work to have a much more focused and systematic impact at mines.

INDUSTRY, LEGISLATIVE AND TRAINING REFORMS

Other reforms are:

- The establishment of an industry safety committee to oversee the continued implementation of the reforms. This committee will be chaired by Professor Dennis Else from the University of Ballarat, who has played a major role in implementing the mine safety review recommendations to date.
- All mine sites to have Mine Safety Management Plans – a series of documents that show how a mine is designed, constructed and operated to reduce risks. Guidelines will be developed as an interim step.
- Legislative and administrative changes to put greater responsibility for safety on the mining industry.
- Improved safety performance measures — measures that have been designed through much consultation with industry.
- Improved core hazard management and risk management.
- Production of more targeted safety handbooks and guidelines.
- Better training - the New South Wales Mining Industry Training Advisory Body has already produced a guide to help mine managers introduce structured safety and communications training programs.



The Minister for Mineral Resources, Mr Bob Martin, at Warkworth mine, announcing major mine safety reforms

Bob Humphris (right), Managing Director, Peabody Resources Ltd, at Warkworth with Professor Dennis Else, chair of the newly established industry safety committee

The Minister praised the efforts of all involved in the implementation of the *Mine Safety Review's* recommendations and urged industry and unions to continue the momentum for improved safety in the New South Wales mining industry.

He believes that Government can set the legislative and regulatory framework, but the responsibility for carrying through the reforms rests very much with industry and unions.

Each of the Task Groups responsible for the Mine Safety Review recommendations has produced detailed plans to ensure the reforms are implemented within a 3 to 5 year timetable.

For further information contact Nicole Webb, Mine Safety Review Secretariat, (02) 9901 8689, fax (02) 9901 8468, or e-mail webbn@minerals.nsw.gov.au

SEALING REQUIREMENTS FOR COAL EXPLORATION BOREHOLES

The Department has recently released two sets of guidelines which set out for licenceholders the environmental and safety requirements for sealing coal exploration boreholes.

The Department uses the guidelines to assess coal borehole sealing and site rehabilitation when application is made for the return of an exploration licence security deposit.

The guidelines cover five main areas:

- Filling requirements
- Cement mixtures
- Sealing procedures
- Rehabilitation requirements
- Survey requirements.

FILLING AND SEALING

Boreholes drilled on the bed of a waterbody must not be left open. Those drilled on land may pass through artesian groundwater and may be left in an open state if the landowner has requested it, and the hole has been licensed by the Department of Land and Water Conservation. The Department of Mineral Resources prefers all coal exploration boreholes to be cemented for the full depth of the hole and totally sealed at the surface.

Figure 23 provides an example of how boreholes should be sealed — collar, identification plate and capping.

SEALING RECORDS

Exploration project managers need to keep records of the method(s) they have used to seal boreholes, the volumes and types of materials used, and borehole information such as depth, diameter and casing string(s) left inhole. These records are used by the Department for audit and inspection purposes.

RETURN OF SECURITY DEPOSITS

Included in the guidelines is a pro-forma statutory declaration which has been developed to help expedite the return of security deposits. The Department may need to carry out an on site inspection to ensure compliance with the guidelines and conditions of an exploration licence before returning the security deposit.

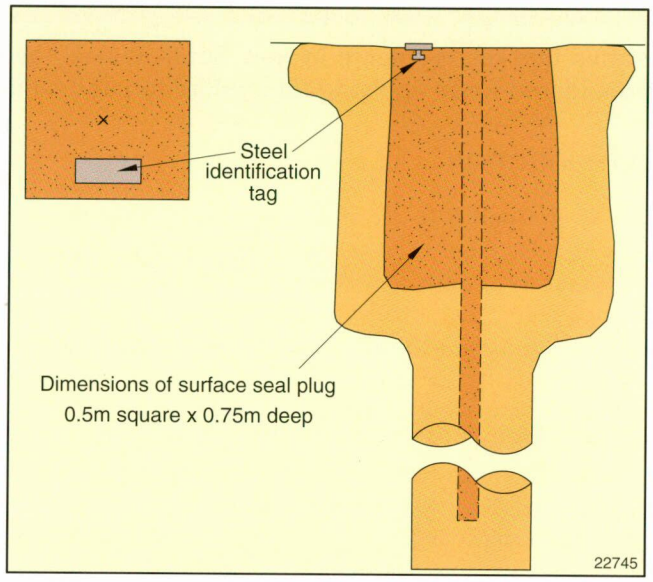


Figure 23. Drillhole plug details

Licenceholders should send applications to relinquish exploration licences, with statutory declarations, to their regional Titles Branch of the Department.

Guidelines for borehole sealing requirements on land, Coal Exploration Environment Design Guidelines (EDG) No 1, and Guidelines for borehole sealing requirements on the beds of waterbodies, Coal Exploration EDG No 2, are available from regional offices of the Department or from the Information Counter of the Head Office at St Leonards on (02) 9901 8269, fax (02) 9901 8247.

For further information contact Greg Summerhayes , Principal Environmental Officer, Singleton Office, on (02) 6572 1899, fax (02) 6572 1201, or Matt Barnes, Regional Mining Officer, on (02) 4954 7899, fax (02) 4954 8019. ■

THE WIK DECISION: HOW WILL IT AFFECT TITLES IN NEW SOUTH WALES?

Native title requirements in New South Wales need to be carefully considered when applying for exploration and mining titles.

INTRODUCTION

The High Court Wik decision in December 1996 means that it now cannot be assumed that pastoral leases necessarily completely extinguish native title. Consequently, the area of land potentially affected by native title in New South Wales is substantially larger than previously thought. In particular, native title may still exist on extensive areas covered by Western Lands leases in the State.

This has the greatest impact on the grant and renewal of exploration titles where the Department's recent practice, of granting and renewing exploration titles using the 'exclusion condition' to postpone the 'right to negotiate' process, may be of questionable benefit in some circumstances. As a result, changes have been made to the procedures relating to exploration titles, particularly in the use of the 'expedited procedure'.

The main impact on the grant and renewal of mining titles is that the number of these transactions which may have to be subject to the right to negotiate process has potentially increased. However, no changes have been made to the procedures relating to mining titles.

'NORMAL' TITLES AND EXCLUSIVE CONDITION TITLES: HOW DO THEY COMPARE?

The fundamental difference between an exploration title without the exclusion condition (a normal title) and one with the condition (an exclusion condition title) is that for a normal title, the right to negotiate process is pursued before the grant or renewal of the title. For an exclusion condition title, the right to negotiate process is invoked after grant or renewal, and then only if and when the licence holder wishes to prospect on native title land.

The main advantage of a normal title is that once it has been granted or renewed, the holder has the right to prospect on any native title land in it for the whole current term of the title, regardless of any subsequent native title claims (but subject to any arrangements which might have been made in agreements negotiated with the Government and previously registered native title parties). It should be noted however, that before renewal of a normal title, the right to negotiate process must again be followed, or the exclusion condition must be imposed on the renewed title.

The main disadvantage of a normal title is that the grant or renewal may be subject to the potentially costly and time-consuming delays of the right to negotiate process even though the holder may never wish to prospect on native title land.

The main advantage of an exclusion condition title is that these potential costs and delays can be avoided if prospecting is never undertaken on native title land.

The main disadvantage of an exclusion condition title is that, if prospecting is to be undertaken on native title land, seeking the Minister's consent and following the right to negotiate process are carried out during the term of the title, and any delays resulting from the process will affect the time available for exploration. If the Minister's consent is given, it applies only to the current term of the title. It must be sought and obtained again if needed in a subsequent term.

More land than was previously thought may be affected by native title

SOME TERMS EXPLAINED

DEFINITION OF AN 'ACT'

The term 'act', in this article, means acts of Government which create or extend a right to mine, and are thereby subject to the right to negotiate process. A right to mine includes a right to explore. In New South Wales, the 'acts' comprise the grant and renewal of all forms of exploration and mining titles under mining and petroleum legislation.

THE RIGHT TO NEGOTIATE PROCESS

The right to negotiate process mainly applies when the Department proposes to grant or renew an exploration or mining title over native title land or where the Minister's consent has been sought with the 'exclusion condition' on an exploration title.

The process is designed to ensure that indigenous people who claim an interest in the land have the opportunity to express this interest formally by lodging a native title claim, and to negotiate with the Government and the applicant about the proposed exploration or mining title, or to consent to access to the native title land.

In summary the process provides for:

- notification and advertisement, to alert existing and potential native title parties to the Government's intention to consider the grant or renewal of a title;
- negotiation between any native title claimants, the Government and the applicant to seek agreement about the exploration or mining title;
- mediation, where appropriate, by the Native Title Tribunal to assist in agreement being reached;
- where agreement cannot be reached, decision by the Native Title Tribunal as to whether or not the grant or renewal of title may proceed and under what conditions; and
- overruling by the relevant Minister of the Native Title Tribunal's decision if it is not considered to be in the national interest.

The arbitral body for New South Wales matters is currently the National Native Title Tribunal, and the relevant Minister is the Commonwealth Minister with responsibility for the Commonwealth Native Title Act.

EXPEDITED PROCEDURE

The 'right to negotiate' provisions of the Commonwealth Native Title Act include a procedure known as the 'expedited procedure' which is designed to fast track, amongst other things, grants and renewals of exploration and mining titles where impacts on native title areas are minimal.

Expedited procedure may be used if:

- it does not interfere with the community life of native title holders,
- it does not interfere with areas or sites of particular significance to native title holders, and
- it does not involve or result in major disturbance of any land or waters concerned.

In essence, the expedited procedure is as follows:

- the Government party may include in its right to negotiate notices a statement that it considers the act to be one which attracts the expedited procedure.
- if native title parties do not object within the two month notification period, the Government may grant an exploration or mining title.
- if native title parties object, then the Native Title Tribunal determines the matter, and if it determines that the expedited procedure does not apply, then negotiations must proceed as would normally be the case.

The process is unlikely to be applicable to mining; its main potential is for exploration.

WHAT IS THE EXCLUSION CONDITION?

Some exploration titles in New South Wales may be excluded from the requirement to follow the right to negotiate process, provided that the titles include a condition informally called the exclusion condition.

An exclusion condition has the effect of postponing the right to negotiate process from the grant or renewal stage of a title to such time as the titleholder wishes to prospect on native title land within the title. The titleholder must then seek the New South Wales Minister for Mineral Resources' consent to prospect on native title land. The Commonwealth Minister has approved such consent as triggering the right to negotiate process.

The Commonwealth Minister's approval does not prevent the New South Wales Minister for Mineral Resources from granting or renewing an exploration title free of the condition if native title is not affected or if the right to negotiate process is followed first.

Since November 1996, the Minister has granted exclusion condition titles to all exploration title applications unless specifically requested otherwise by the applicants.

WHICH IS THE BEST FORM OF EXPLORATION TITLE FOR ME?

The Department believes that an exclusion condition exploration title is of most benefit to explorers if the potential for native title land to exist in the exploration area is limited to relatively small, discrete parcels of land. In this circumstance, holders of such titles can limit the costly and time-consuming effects of the right to negotiate process by planning exploration to avoid potential native title land.

Some applicants will know, before grant or renewal of title, where in their title area they wish to explore (this is often the case for coal exploration, for example). These applicants are in a good position to decide which form of title is best for them. If none of the land on which they plan to prospect is potential native title land, then an exclusion condition licence is most appropriate, because they know they will never have to invoke the condition.

If applicants wish to conduct activities which do not constitute prospecting under the Mining Act 1992, then there may be benefits in obtaining an exclusion condition title, which will allow them to proceed with the non-prospecting activities while awaiting the Minister's consent. Activities such as airborne surveys and, arguably, geological mapping, do not constitute prospecting under the Mining Act, although they do under the Petroleum (Onshore) Act 1991. Exclusion condition licences over substantial areas of potential native title land may therefore not be practical for petroleum exploration titles.

If there are significant areas of potential native title land earmarked for exploration, it may be better to go through the right to negotiate process before title grant to avoid the delays and the potentially piecemeal approach which would result from an exclusion condition title.

WHEN IS THE MINISTER'S CONSENT NEEDED?

It is the responsibility of holders of exclusion condition exploration titles to determine if the land on which they wish to prospect is native title land and, consequently, if they need to seek the Minister's consent. In this regard, the Department expects titleholders to seriously consider the potential for native title to exist on any parcel of land on which they wish to prospect, and whether their proposed activities constitute prospecting under the Mining Act 1992.

Clearly, titleholders must seek the Minister's consent if native title has been determined to exist on land on which they wish to prospect. The Department takes the view that titleholders should also, at the very least, seek the Minister's consent to prospect on any land which is subject to a current native title claim.

Guidance as to what land the Department considers to be potential native title land is available on request and is provided with all exploration title application forms and all granted or renewed exclusion condition exploration titles.

WHEN WILL THE DEPARTMENT APPLY THE PROCEDURES?

- The Department will apply the following procedures when it proposes to grant or renew an onshore exploration or mining title which affects potential native title land. (The procedures do not apply to the grant or renewal of offshore titles, where the right to negotiate provisions of the Commonwealth Native Title Act do not apply.)
- In this context, potential native title land is land where native title has not been extinguished by an incompatible land tenure, either current or historic.
- In general, the Department will not take into consideration whether or not there are any Aboriginal or Torres Strait Islander people who are likely to be able to establish native title rights over the area.
- The procedures do not apply to the renewal of mining titles granted in the period 31 October 1975 to 31 December 1993, because it is not necessary to pursue the right to negotiate process for these transactions.
- The procedures do not apply to the grant or renewal of mineral claims or opal prospecting licences in the Lightning Ridge and White Cliffs Mineral Claims districts.

WHAT ARE THE PROCEDURES?

Grant or Renewal of Exploration Titles

- The Department will generally assume that the grant or renewal of any exploration title will affect some potential native title land and therefore that the requirements of the Commonwealth Native Title Act will have to be satisfied in every case. (Because of the generally large area of exploration titles, it is impractical in most cases for the Department to attempt to identify the status of any of the affected land.)
- Applications for grant or renewal of exploration titles will be dealt with in one of two ways, depending on the wishes of the applicant:
  1. a title including the exclusion condition will be granted or renewed, without the right to negotiate process first having been pursued; or
  2. a title free of the exclusion condition will be granted after the right to negotiate process has been pursued. If this process results in there being any native title claims over the proposed title area, the applicant will have the choice of either:
     a) excluding the area of the native title claims from the exploration title (in which case negotiations with the native title parties will not be necessary), or
     b) negotiating agreements with the native title parties and the Government to allow the inclusion of the claimed areas in the title.

- The application of the expedited procedure will be sought when the right to negotiate process is followed as part of the grant and renewal of normal exploration titles or the Minister's consent under exclusion condition exploration titles.
- Applicants will be required to pay the advertising costs associated with notification under the right to negotiate process, whether undertaken before the grant or renewal of title, or arising from a request for Ministerial approval on exclusion condition exploration licences. As far as possible, the Department will combine the advertisements required under the Commonwealth Native Title Act with other advertisements it places about exploration title applications, thus avoiding duplication of costs.
- Any negotiations arising from the process will be conducted in accordance with guidelines developed by the Department.

Grant or Renewal of Mining Titles

- Applicants will be requested to carry out a search of the tenure history of the land. If neither the current tenure nor any earlier tenure is considered to have extinguished native title, the right to negotiate process will be followed.
- Alternatively applicants may ask the Department to follow the right to negotiate process from the outset.
- Applicants will be required to pay the advertising costs associated with notification under the right to negotiate process. As far as is possible, the Department will combine the advertisements required under the Commonwealth Native Title Act with other advertisements it is statutorily required to place about mining title applications, thus avoiding duplication of costs.
- Any negotiations arising from the process will be conducted in accordance with guidelines developed by the Department.

Information is available in: 'How to' Brochure Number 13 *The effects of native title on titles administration in NSW*, which is available from the Information Counter at the Department's Head Office, St Leonards, on (02) 9901 8269, fax (02) 9901 8247.

For further information contact Alec Ramsland, Titles Manager, on (02) 9901 8483, or Rolf Goodacre on (02) 9901 8476, fax (02) 9901 8493.

TAS 2

The redevelopment of one of the Department's core business systems has been under way for some time(*Minfo* **57**, p 71). The new Titles Administration System (TAS 2) is due to become operational in July 1998. The redevelopment has involved the re-organisation and streamlining of existing titles administration work practices and systems, and included the transfer of titles records from the existing VAX 6240 central computer to a new DEC 8200 server.

TAS 2 now includes detailed graphic records of titles and applications for titles. A computerised mapping system will replace the existing hard copy mapping system.

The major benefits of the redeveloped TAS are:

- Improved delivery of service to clients, such as reduced time for title processing, and reduced turnaround time for use of land by other mining companies.
- Hard copy maps replaced by computer generated maps.
- Easier, faster production of title conditions.
- Ease and flexibility of title maintenance.
- Electronic identification, plan and diagram production.
- Integrated and improved workflow tracking and work procedures system.
- Graphic selection of units for exploration licences.
- Enhanced enquiry, analysis and reporting capabilities.
- Improved data integrity and elimination of duplicate databases.
- Integrated name and address system.
- Improved Geographical Information System (GIS) interface with the DIGS system for counter enquiries by clients.
- Electronic creation of newspaper advertisements.

For further information contact David Campbell, TAS 2 Project Manager, on (02) 9901 8482, fax (02) 9901 8493, or e-mail campbeld@minerals.nsw.gov.au

NEW DRILL CORE AVAILABLE FOR INSPECTION

The drill core listed below was received by the Department of Mineral Resources Core Library at Londonderry during the period January to June 1998.

Prospect (Area)	Tenement	Company	Details	
*West Wallsend	A0253	FAI Insurance Pty Ltd	Diamond core	1 hole
*John Darling	A0265	Oceanic Coal Australia Ltd	Diamond core	1 hole
*Lake Macquarie	A0301	Oceanic Coal Australia Ltd	Diamond core	1 hole
*Macquarie Colliery	A0368	Oceanic Coal Australia Ltd	Diamond core	1 hole
Collerina	EL4950	Rio Tinto Exploration P/L	Diamond core	1 hole
Yeoval	EL4235	Rio Tinto Exploration P/L	Diamond core	1 hole
Blue Mountain	EL3527	RGC Exploration Pty Ltd	Diamond core	2 holes

*Confidential

For further information and to arrange inspection contact Steve Hall, A/Core Library Manager, on (02) 4724 4997. Where core is marked as confidential, permission of the company must be obtained before inspection can be arranged.

PUBLICATIONS RELEASED APRIL — JUNE 1998

MAPS

Euriowie 1:25 000 Geological Map (including part of Campbells Creek), compiled by B.P.J. Stevens, I.L. Willis and R.E. Brown — $30.00

Inverell 1:250 000 Metallogenic Map, compiled by W.J. Stroud, data by R.E. Brown, W.J. Stroud, J.W Brownlow — $30.00

Coal Mining Operations and Proposals in New South Wales, 1998 — $5.00

MINFO No 59 (subscription gratis) — per single purchase $5.00

GENERAL

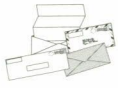
Mining Royalities and Statistics in New South Wales 1998 (update) — gratis

Investmin Newsletter Issue No 3 June 1998 — gratis

Fossickers Guide ... discovering the Earth's riches (1st Edition), produced by Information and Customer Services Branch, Department of Mineral Resources — $20.00

MDG (Mechanical Design Guidelines)

No 5003 Guidelines for Contractor Occupational Health and Safety Management for NSW Mines — $25.00



Mail to Information Counter,
Dept of Mineral Resources,
PO Box 536 St Leonards NSW 1590

Fax order through, marked
Attention: Information Counter
Dept of Mineral Resources
e-mail: www.slnsw.gov.au/mineral_resources

Only credit card orders will be accepted by phone. Please have this flyer and your credit card ready

DEPARTMENT OF MINERAL RESOURCES

ADDRESSES

HEAD OFFICE	29-57 Christie Street ST LEONARDS 2065 www.slnsw.gov.au/mineral_resources	(02) 9901 8888 PO BOX 536 ST LEONARDS 1590 Fax: (02) 9901 8777 DX: 3324 ST LEONARDS Telex: DEPMIN 74875
ARMIDALE	Level 2, ABS House 97-101 Faulkner Street ARMIDALE 2350	(02) 6770 2100 PO Box 65 Fax: (02) 6770 2121
BROKEN HILL	32 Sulphide Street BROKEN HILL 2880	(08) 8080 0620 PO Box 459 Fax: (08) 8087 8005
CARDIFF	35 Aruma Place CARDIFF 2285	(02) 4954 7899 PO BOX 410 FAX: (02) 4954 8019 DX: 12618 CHARLESTOWN
COBAR	62-64 Marshall Street COBAR 2835	(02) 6836 4392 PO Box 157 Fax: (02) 6836 4395
LIDCOMBE LABORATORIES	State Hospital Grounds Cnr Joseph Street & Weeroona Road LIDCOMBE 2141	Mine Safety & Technical Services (02) 9646 1644 Fax (02) 9646 3224 Environmental Geochemistry (02) 9646 1344 Fax: (02) 9749 1405 PO Box 76
LIGHTNING RIDGE	Lot 60 Morilla Street LIGHTNING RIDGE 2834	(02) 6829 0678 PO Box 314 Fax: (02) 6829 0825
LITHGOW	Suite 1, Level 1 184 Mort Street LITHGOW 2790	(02) 6351 3052 PO Box 69 Fax: (02) 6352 3876
LONDONDERRY	Core Library 947-953 Londonderry Road LONDONDERRY 2753	(02) 4724 4997 (02) 4777 4316 Fax: (02) 4777 4397
ORANGE	185 Anson Street ORANGE 2800	(02) 6360 8305 PO Box 53 Fax: (02) 6360 8344
SINGLETON	Level 1 1 Civic Avenue SINGLETON 2330	(02) 6572 1899 (Inspectors) (02) 6572 4200 (Geology) PO Box 51 Fax: (02) 6572 1201 DX: 7071 SINGLETON
SPECIALIST SERVICES AND APPLIED RESEARCH SECTION	State Hospital Grounds Cnr Joseph Street & Weeroona Road LIDCOMBE 2141	(02) 9649 5266 PO Box 76 Fax: (02) 9646 3224
WOLLONGONG	State Government Offices Level 3, Block F 84 Crown Street WOLLONGONG 2500	(02) 4227 1699 PO Box 674 WOLLONGONG EAST 2520 Fax: (02) 4226 3851

RESPONSIBLITY FOR INFORMATION

While all care has been taken in producing *Minfo*, the Department accepts no responsibility where information is incorrect. Also, inclusion of any product, service or company in *Minfo*, either in editorial or advertisement, does not imply Governmental or Departmental endorsement.

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