AUSTRALIA

7

Resource Report

Handbook of Australian black coals:

Geology, resources, seam properties, and product specifications

M.B. Huleatt

[MIN]ERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DEPARTMENT OF PRIMARY INDUSTRIES & ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

RESOURCE REPORT 7

Handbook of Australian black coals: geology, resources, seam properties, and product specifications

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ABSTRACT

With a current annual export value of approximately $A6 billion, black coal is Australia's single most important foreign exchange earner. Part 1 of this handbook outlines the geological setting of Australia's black-coal basins, sequences, and seams (supported by location maps and stratigraphic diagrams), gives a brief history of mining, and cites major literature references. Part 2 lists the main parameters of the more important seams at the various mines and prospects. Part 3 lists the indicative properties of the main coal products marketed. The five Appendixes list the State mining authorities, Australian coal mines and mining companies, the Australian code for reporting coal resources and reserves, and BMR's resource classification scheme.

INTRODUCTION

Australia is the world's leading exporter of coal, and shipped overseas approximately 99 Mt of black coal in 1989. It consumed over 49 Mt of black coal in domestic industry in 1989, when production of raw black coal totalled about 182 Mt. These results are based on economic demonstrated resources of over 71 000 Mt in situ, covering a wide range of coal qualities. Although most of these resources are in Queensland and New South Wales (Fig. 1), significant black coal deposits are also present in Tasmania, South Australia, and Western Australia. The most important Australian black coals range in age from Permian to Jurassic, i.e. from about 280 to 180 million years. Australia also has major deposits of Tertiary age brown coal (lignite) but these are outside the scope of this handbook (in Victoria, brown coal deposits have been developed on a large scale for power generation).

This handbook is intended as an introduction to Australian black coals, their occurrence and properties. Although data are presented on geology, coal, and mining, the handbook does not contain detailed information on each coal-bearing sequence. Analyses shown for seams (Part 2) are a guide only, and are not definitive statements on coal quality. The product specifications (Part 3) have been provided by the companies concerned or have been published elsewhere. Readers interested in a company's coals should contact the company directly to obtain current definitive specifications. Company addresses are listed in Appendix 3 (p. 105). Entries in the various sections of the handbook are arranged on a 'north to south' and 'east to west' basis.

The resource terminology used in the handbook is explained in Appendix 5 (p. 109).

To keep the entries to a workable size and because of the indicative nature of the handbook, the number of items in each analysis of coal properties has been kept to a maximum of 35. Should further details be required, the relevant State mining authority or the appropriate company may be able to supply them.

Exploration

Both government organisations and private enterprise groups explore for coal in Australia. Legislative and administrative responsibility for exploration, e.g. the granting of exploration rights to an area and the oversight of those rights, rests with the individual States and is exercised by a Department of Mines or equivalent in each State.

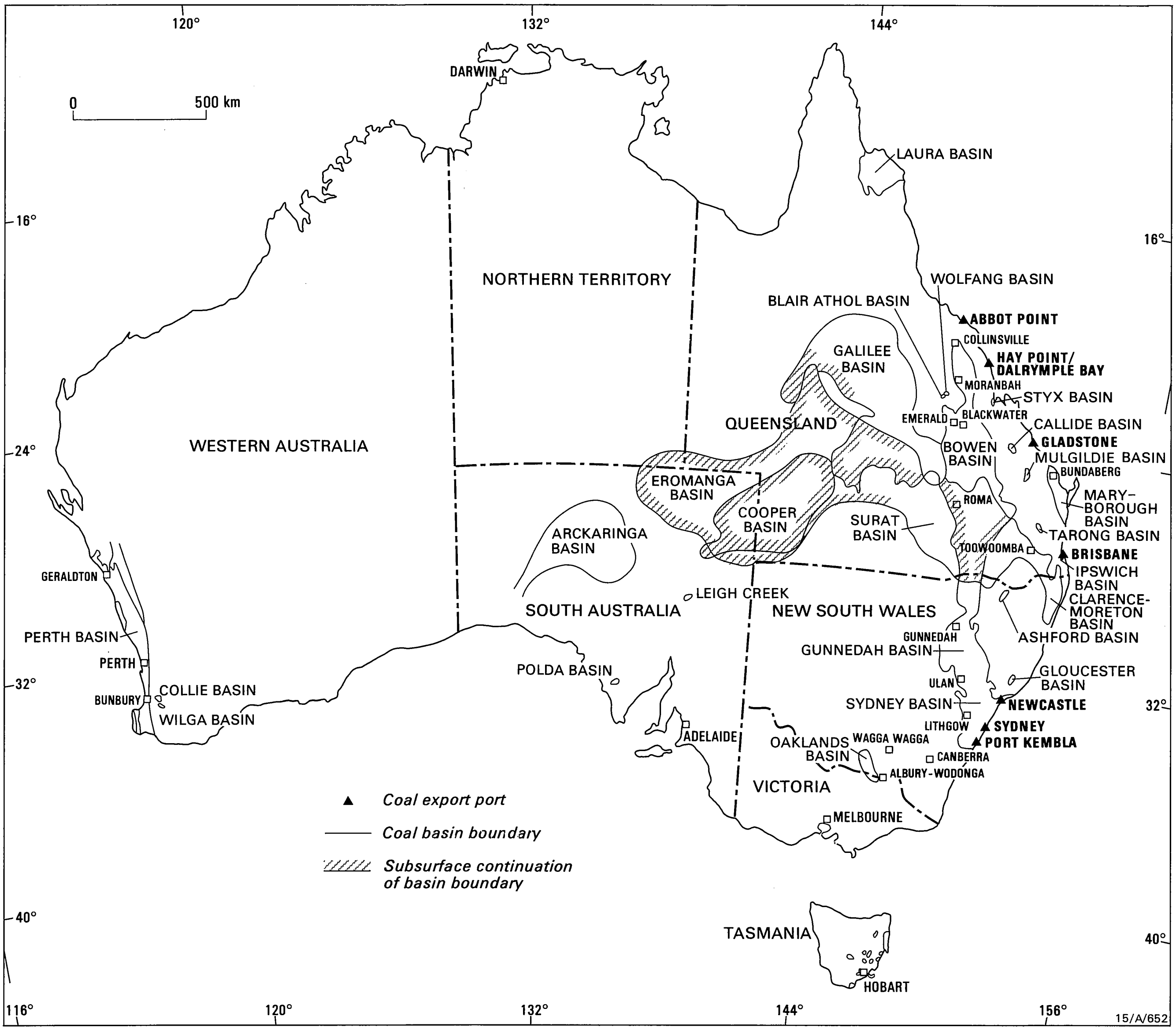

Fig. 1. Principal black coal basins of Australia.

Table 1. Private expenditure ($'000) on coal exploration in Australia, 1979–80 to 1988–89 (a)(b)

Year	*Total*	*In production leases*
1979–80	46 711	6 155
1980–81	74 936	8 857
1981–82	108 733	10 088
1982–83	61 418	7 572
1983–84	43 660	4 591
1984–85	34 752	4 103
1985–86	32 200	6 900
1986–87	36 600	9 500
1987–88	24 500	n.a.
1988–89	25 800	n.a.

(a) Years are from 1 July to 30 June.
(b) Includes some relatively minor expenditure on brown coal exploration.
Source: Australian Bureau of Statistics.
n.a.: not available.

In New South Wales and Queensland the State governments generally do basic exploration to determine the existence of coal in an area and the approximate size and quality of any deposit. More detailed exploration is usually done by private enterprise. A major exception to this is the Electricity Commission of New South Wales, a State government body, which undertakes detailed exploration and operates its own mines to supply its own power stations. Its exploration programs may involve cooperation with the NSW Department of Minerals & Energy.

Information on exploration in each State is available from the relevant mining authorities (see Appendix 1).

Private expenditure on exploration peaked in 1981–82 and then declined sharply (Table 1), following the economic stagnation of the mid-1980s and the recognition by then that Australia has abundant coal resources that are already well defined.

Companies and other organisations exploring for coal are encouraged to report their resource estimates under the terms of the 'Australian Code for Reporting Identified Coal Resources & Reserves' (Appendix 4). The Code standardises the assessment and reporting of coal resources in individual deposits and regions, and also provides the Bureau of Mineral Resources, Geology & Geophysics (BMR — a federal, as opposed to State, agency) with a consistent base from which to prepare national resource estimates. Appendix 5 sets out the system used by BMR to classify mineral resources and prepare national resource estimates.

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Comments on appropriate sections were provided by the Tasmanian Department of Resources & Energy, the South Australia Department of Minerals & Energy, the South Australian Office of Energy Planning, the Queensland Department of Resource Industries, the Western Australian Department of Mines, and the New South Wales Department of Minerals & Energy.

Many coal mining companies provided data on the properties of their products, and are cited individually in the appropriate sections of Part 3.

Part 1

Geology, resources, and mining

Contents, Part 1

FIGURES

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OVERVIEW OF RESOURCES

Australia's economic demonstrated in-situ resources of black coal are estimated to amount to 71 130 Mt. Of this, over 69 000 Mt is in Queensland and New South Wales (Table 2), mainly in the Bowen Basin in Queensland and the Sydney Basin in New South Wales. Important resources also occur in Tasmania, South Australia, and Western Australia.

The various coal-bearing basins are discussed here in clockwise order, starting in Queensland, then New South Wales, Tasmania, South Australia, and Western Australia. Black coal resources are insignificant in Victoria and the Northern Territory.

QUEENSLAND

Queensland's coal resources occur in the Bowen, Galilee, Blair Athol, and Wolfang Basins (Permian) and in the Laura, Styx, Callide, Mulgildie, Maryborough, Tarong, Ipswich, Surat, and Clarence–Moreton Basins (Mesozoic) (Fig. 1; Table 3).

Coal is mined in the Bowen, Blair Athol, Callide, Maryborough, Tarong, Ipswich, and Clarence–Moreton Basins; output from the Bowen Basin exceeds that from all others.

Some 155 Mt of demonstrated in-situ resources of Jurassic coking coal occur in the **Laura Basin**, west of Cooktown, in the north of the State. The coal is amenable only to underground mining. There has been no production, and the basin is not considered further in this handbook.

The Permian coal-bearing succession in the **Bowen Basin**, a major coal basin in world terms, is exposed, either outcropping or subcropping beneath thin Cainozoic deposits, over a length (north-northwesterly) of 600 km and width of up to 200 km. The Bowen Basin contains almost three-quarters of Queensland's demonstrated resources of coal. In 1989, the Queensland Department of Mines estimated that, of the basin's demonstrated in-situ resources of 26 602 Mt, some 14 029 Mt is of coking quality. Exploration is increasing these demonstrated resources faster than they are being mined.

Both coking and non-coking coal occurs in numerous sequences, all of Permian age, throughout the basin. The most widespread sequence is the Rangal Coal Measures which extend from around Blackwater in the south to Newlands in the north. Along the western margin of the basin, major resources occur in the Moranbah Coal Measures in the north and German Creek Formation in the south and equivalent sequences in the Dysart district. At the northern extremity of the basin the Collinsville Coal Measures have long been a source of both steaming and coking coal. In the southeastern extension of the basin important resources occur in the Baralaba Coal Measures.

In-situ demonstrated resources of 285 Mt of steaming coal occur in the **Blair Athol Basin** (Queensland Department of Mines, 1989, p. 22). The coal is mined by open-cut methods, principally from one thick seam. The Blair Athol Basin is immediately north of the central Queensland town of Clermont.

The **Wolfang Basin** lies immediately east of the Blair Athol Basin. Coal is not currently mined but there is an in-situ demonstrated resource of 250 Mt of steaming coal amenable to open-cut mining (Queensland Department of Mines, 1989, p. 24).

There has been no production of coal from the **Galilee Basin**. Demonstrated in-situ resources of non-coking coal amounting to 2701 Mt (Table 4) are present in three deposits (Permian).

About 4 Mt of demonstrated in-situ resources of Cretaceous non-coking coal occur in the **Styx Basin** on the central Queensland coast, midway between Rockhampton and Mackay. It is mineable by underground methods only. No coal is currently produced, but small underground mines supplying coal to the railways operated until the 1960s.

Demonstrated resources of coal in the Triassic **Callide Basin,** 100 km southwest of Rockhampton, total 578 Mt in situ. Of this, 173 Mt is mineable by open-cut methods. Open-cut mines are currently working this coal, which is used by domestic industry. The resources are all non-coking coal.

Resources in the **Mulgildie Basin**, 120 km west of Bundaberg, are of Jurassic age. Demonstrated in-situ resources total some 110 Mt of non-coking coal suitable for open-cut mining.

Centred on the town of Bundaberg, the **Maryborough Basin** produces small tonnages of Cretaceous coal for local markets. The Queensland Department of Mines did not report a resource estimate for the basin in 1989.

A total of 490 Mt of demonstrated in-situ resources of Triassic non-coking coal is present in three areas in the **Tarong Basin**, 150 km northwest of Brisbane. All can be mined by open-cut methods, and the Meandu open-cut mine is currently supplying coal to the Tarong power station.

The **Ipswich Basin** adjoins the city of Brisbane on the east, south, and southwest. It is Triassic in age and contains 583 Mt of

Table 2. Australia's economic demonstrated coal resources (Mt)

	In-situ	*Recoverable*
Queensland	36 000	25 944
New South Wales	33 450(a)	23 702
Tasmania	530	250
South Australia	150	150
Western Australia	1 000	730
	71 130	50 776

(a) Rounded to the nearest 50 Mt.

Table 3. Demonstrated in-situ coal resources of Queensland (Mt) (a)

Basin	*Underground*	*Open-cut*	*Total*
Laura	150	0	150
Bowen	20 300	5 150	25 450
Blair Athol	0	300	300
Wolfang	0	250	250
Galilee	0	2 700	2 700
Styx	—	0	—
Callide	400	150	550
Mulgildie	0	100	100
Maryborough	—	0	—
Tarong	0	500	500
Ipswich	—	550	550
Surat–Moreton	250	5 200	5 450
Total	21 100	14 900	36 000

(a) Rounded to the nearest 50 Mt.
Source: *Queensland Government Mining Journal*, January 1989.
—: less than 25 Mt.

Table 4. Demonstrated in-situ coal resources of the Galilee Basin (Mt)

Deposit	*Underground*	*Open-cut*	*Total*
Alpha	0	1 250	1 250
Kevins Corner	0	900	900
Pentland	0	550	550
Total	0	2 700	2 700

Source: *Queensland Government Mining Journal*, January 1989.

demonstrated, in-situ, non-coking coal resources. Of the total resource, only 15 Mt is amenable to open-cut mining. Both underground and open-cut mines currently operate.

The resources in the **Clarence–Moreton and Surat Basins** lie to the west of Ipswich and from south to northwest of Toowoomba. The coal is Jurassic and non-coking and some has potential for conversion to liquid fuel. Total demonstrated in-situ resources are 5447 Mt, of which all but 256 Mt is amenable to open-cut mining. There is some production in the Clarence–Moreton Basin from mines near Ipswich. Production in the recent past had also come from the Acland mine near Toowoomba, but this has now ceased.

NEW SOUTH WALES

In New South Wales (Fig. 1; Table 5) the principal coal-bearing area is the Sydney Basin (Fig. 2), which has four designated coalfields: Hunter, Newcastle, Western, and Southern. Of the other NSW basins, the Gunnedah and Oaklands Basins contain the largest resources.

Coal is currently produced from each coalfield in the Sydney Basin and from the Gunnedah Basin. Future production from the Oaklands and Gloucester Basins is feasible. Production from the small Ashford Basin is sporadic. Identified resources in the Clarence–Moreton Basin in New South Wales are minimal.

The State's demonstrated in-situ resources (Table 5) are dominated by the Sydney Basin. Resources at Ashford are very small but are included here because of their past use for local electricity generation.

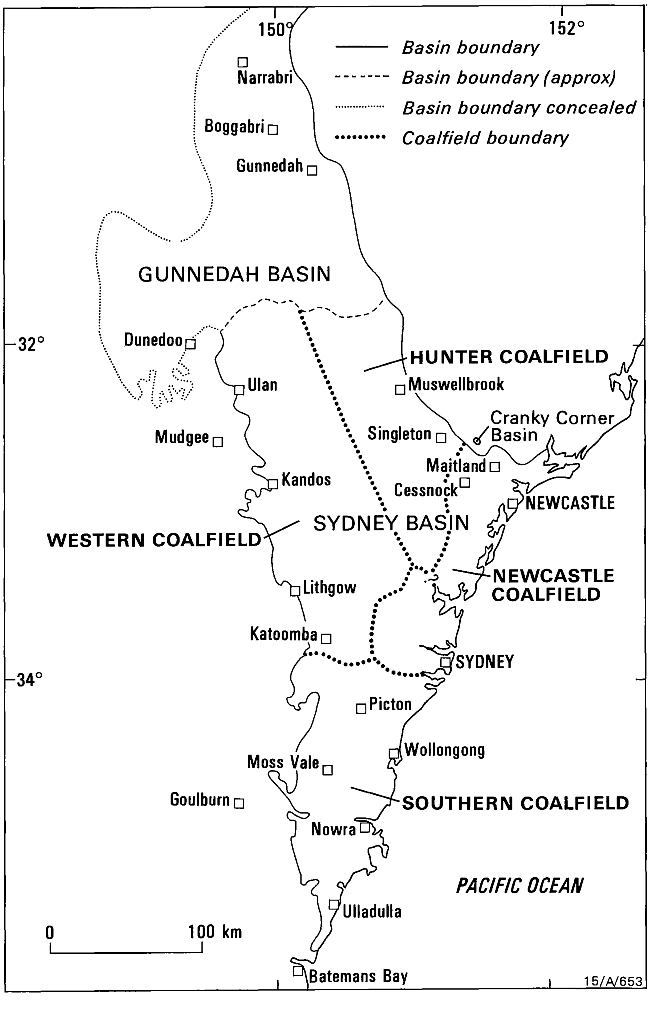

Fig. 2. Sydney and Gunnedah Basins, NSW, showing coalfields.

Table 5. Demonstrated in-situ coal resources of New South Wales (Mt) (a)

Basin	*Underground*	*Open-cut*	*Total*
Ashford	0	—	—
Gloucester	50	100	150
Gunnedah	1 600	550	2 150
Sydney	17 850	11 900	29 750
Oaklands	0	1 400	1 400
	19 500	13 950	33 450

Source: Sniffin & others (1986).
(a) Rounded to nearest 50 Mt.
—: less than 25 Mt.

Triassic and Jurassic coals in the **Clarence–Moreton Basin** in New South Wales are not mined. Production in the past has come from the Nymboida Coal Measures (Triassic); the coal was used for electricity generation at Grafton (McElroy, 1975). Resources in the Clarence–Moreton Basin in New South Wales are minimal and are not considered further here.

Coal in the **Ashford Basin**, 500 km north of Sydney, was mined until recently for use in local electricity generation. Remaining resources are very small and amenable to underground mining only.

The **Gloucester Basin** is about 80 km north of Newcastle. Demonstrated coal resources occur in the Avon Subgroup of the Gloucester Coal Measures and in the Dewrang Group; in-situ resources total 143 Mt (39 Mt underground, 104 Mt open-cut). Coal also occurs in the Craven Subgroup of the Gloucester Coal Measures, although none has been proved to the demonstrated resource category. No coal has been produced from the basin but it could yield medium to high ash, medium volatile products for use in thermal applications.

The **Gunnedah Basin** is a northern extension of the Sydney Basin and its demonstrated resources are contained in the Maules Creek Formation and the Black Jack Formation (Fig. 3). In addition to the demonstrated resources (Table 5) there are inferred resources of almost 30 000 Mt (Sniffin & others, 1986). By far the largest demonstrated resource is in the Maules Creek Formation which contains 497 Mt of open-cut coal and 1560 Mt of 'underground' coal. Both thermal and soft coking coal can be produced from each of the two coal bearing formations. The Maules Creek Formation coals tend to contain more volatile matter and less ash than those of the Black Jack Formation.

The **Sydney Basin**, which, like its geological contemporary the Bowen Basin, is also a major coal basin in world terms, is exposed over a length (north-northwesterly) of 450 km and width of up to 180 km, and over an area of about 35 000 km^2.

In the Sydney Basin the preserved Triassic cover is much thicker and more continuously preserved than in the Bowen Basin. Consequently the coal measures are economically accessible at present only around the basin margins, as compared with the Bowen, where tectonism and erosion have brought the coal measures to shallow depths over parts of the centre of the basin. The Sydney Basin passes to the north into the Gunnedah Basin, the boundary being placed somewhat arbitrarily at the Mount Coricudgy Anticline. It is geologically probable that the Gunnedah Basin is in turn connected at depth, beneath the overlying Jurassic–Cretaceous Surat Basin, with the Bowen Basin 600 km to the north.

The Sydney Basin contains about 90% of the State's in-situ demonstrated coal resources, and almost two-thirds of these resources are in the Hunter Coalfield (Table 6).

Hunter Coalfield. The Hunter Coalfield is centred on the Muswellbrook–Singleton District, in the north of the basin. Resources occur in the Wittingham Coal Measures and Wollombi Coal Measures of the Singleton Supergroup and in the Greta Coal

Measures (Table 7 and Fig. 3). The Wollombi Coal Measures contain significant resources but estimates of their magnitude are not yet available.

Coals from the Wittingham Coal Measures and Greta Coal Measures yield both thermal and coking products, many of which are the result of blending coal from several seams. Coking coals are generally medium to high volatile, soft coking, with low ash. Thermal coals, for export, are usually medium to high volatile with low to medium ash contents. Thermal coals for use in domestic industry, principally for electricity generation, tend to have slightly higher ash levels than the export products.

Table 6. Demonstrated in-situ coal resources of the Sydney Basin (Mt)(a)

Coalfield	*Underground*	*Open-cut*	*Total*
Hunter	8 050	10 950	19 000
Newcastle	4 450	200	4 650
Western	1 900	750	2 650
Southern	3 450	0	3 450
	17 850	11 900	29 750

Source: Sniffin & others (1986).
(a) Rounded to nearest 50 Mt.

Table 7. Demonstrated in-situ coal resources of the Hunter Coalfield (Mt) (a)

	Underground	*Open-cut*	*Total*
Wittingham Coal Measures	7 600	10 650	18 250
Greta Coal Measures	450	300	750
	8 050	10 950	19 000

Source: Sniffin & others (1986).
(a) Rounded to nearest 50 Mt.

Newcastle Coalfield. The Newcastle Coalfield underlies the Newcastle, Maitland, Cessnock, and Wyong districts. The sedimentary sequence contains the Greta, Newcastle and Tomago Coal Measures, of which the Newcastle Coal Measures are the most important (Table 8). Underground-mineable resources predominate, with less than 5% of the total in-situ resource being amenable to open-cut mining (Tables 6 and 8).

Thermal coals produced from the Newcastle Coalfield are medium to high volatile. Coals for use in domestic electricity generation have a medium to high ash content but those for the export market are produced with a low to medium ash content.

Table 8. Demonstrated in-situ coal resources of the Newcastle Coalfield (Mt) (a)

	Underground	*Open-cut*	*Total*
Newcastle Coal Measures	4 250	100	4 350
Tomago Coal Measures	100	100	200
Greta Coal Measures	100	(b)	100
	4 450	200	4 650

Source: Sniffin & others (1986).
(a) Rounded to nearest 50 Mt.
(b) About 2 Mt.

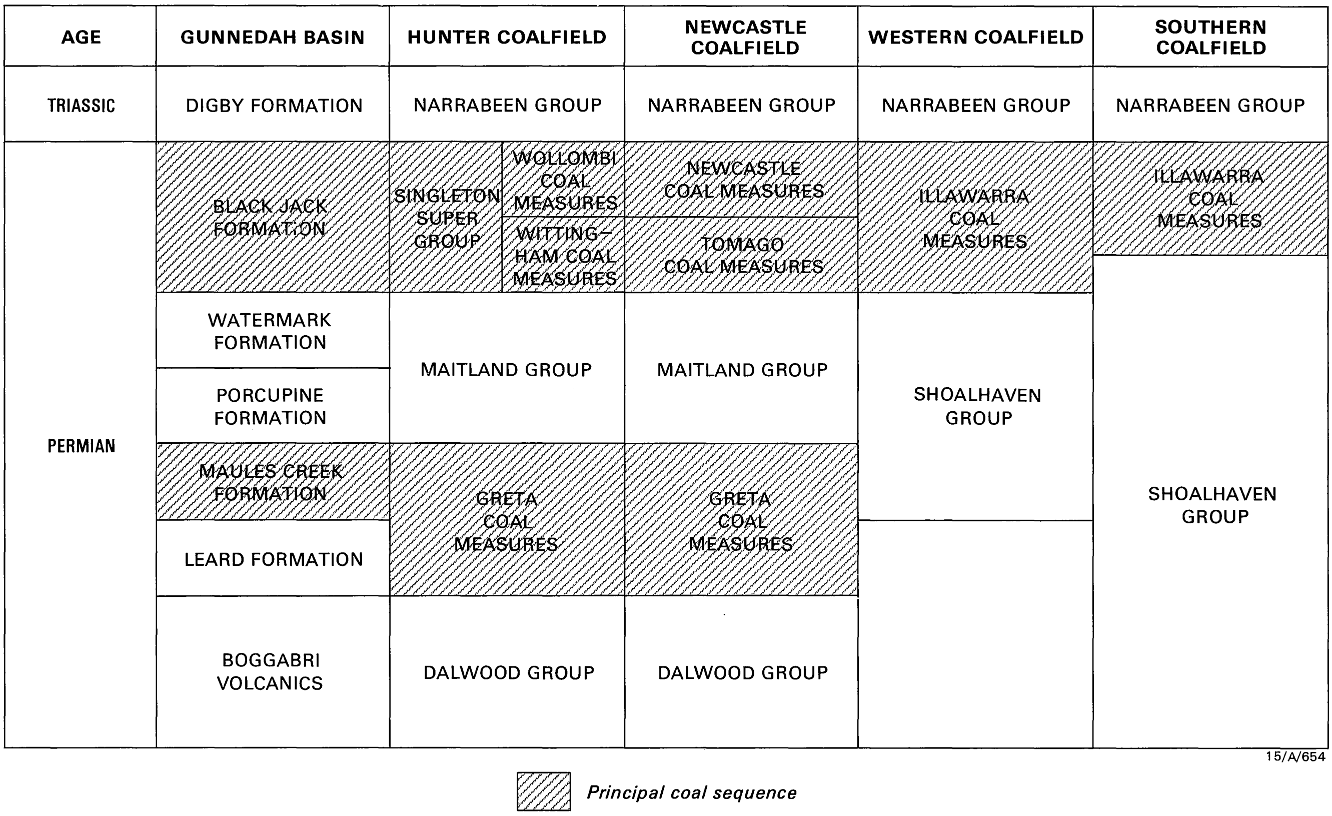

Fig. 3. Stratigraphic units in the Sydney and Gunnedah Basins (after Sniffin & others, 1986).

Table 9. Demonstrated in-situ coal resources of the Western Coalfield (Illawarra Coal Measures) (Mt) (a)

	Underground	*Open-cut*	*Total*
South	1 500	(b)	1 500
North	400	750	1 150
	1 900	750	2 650

Source: Sniffin & others (1986).
(a) Rounded to nearest 50 Mt.
(b) About 10 Mt.

Soft coking coal produced from the coalfield is used at the Newcastle steelworks and is exported. It generally has a low to medium ash content and is medium to high in volatile matter.

Western Coalfield. The Western Coalfield underlies the Lithgow–Kandos–Ulan area at the western margin of the basin. The main demonstrated resources are in the Cullen Bullen Subgroup and Wallerawang Subgroup of the Illawarra Coal Measures (Table 9). The principal coal seams in the south are the Katoomba, Lidsdale, and Lithgow seams; in the north of the field the Ulan seam is predominant.

The Western Coalfield yields a medium to high volatile steaming coal, with a medium to high ash content, from all seams. These coals are principally exported for use in electricity generation or cement production. Some are used for domestic power generation and by general industry.

Most coal is won by underground methods, although there are large open-cut resources in the Ulan seam in the north of the field. This seam is worked at the Ulan open-cut/underground mine complex. The Ulan open cut is the largest producer of raw coal in the State.

Southern Coalfield. The Southern Coalfield underlies the Wollongong–Picton–Moss Vale district. The economic resources are in the Sydney Subgroup of the Illawarra Coal Measures where the four principal seams are Bulli, Balgownie, Wongawilli, and Tongarra, of which the Bulli and Wongawilli have the largest resources.

There are no resources amenable to open-cut mining in the Southern Coalfield. Resources in the Bulli and Wongawilli seams total 2945 Mt demonstrated in situ, which is about 85% of the field's total demonstrated in-situ resources (Table 6).

The Bulli seam in the eastern half of the coalfield yields hard, low to medium volatile coking coal. The same seam in the Burragorang Valley generally yields a medium to high ash thermal coal for domestic industry and a medium ash coking coal for blending.

The Balgownie and Tongarra seams yield medium to high ash thermal coals for domestic electricity generation and general industry use. They also yield coals suitable for use in coke oven blends.

The **Oaklands Basin** is in southern New South Wales, in the Jerilderie–Urana district. Substantial resources of open-cut coal are contained in the Coorabin Coal Measures (Table 5).

The Lanes Shaft seam, in the Narrow Plain Formation, is the only seam of economic significance. The coal is sub-bituminous with medium to high ash and medium to high volatile matter. Inferred resources of 3255 Mt are present at depths in excess of 350 m.

Coal in the basin is being investigated for possible on-site power generation.

TASMANIA

Tasmania's coal resources are Triassic in age and occur in the **Tasmania Basin** in the upper sequences of the Late Carboniferous to Late Triassic Parmeener Supergroup. The coal is mined in the Fingal district, in the northeast. Morrison & Bacon (1986) record several locations of coals with a seam thickness of 1.5 m or greater in eastern and southeastern Tasmania. Bacon (1986) gives a general review of coal in Tasmania. Demonstrated in-situ resources in the State total 530 Mt, of which all but 25 Mt is amenable only to underground mining. The coals are generally sub-bituminous, with high ash and low sulphur.

SOUTH AUSTRALIA

Black coal occurs at Leigh Creek and in the Arckaringa and Polda Basins in South Australia. At present, only the Leigh Creek coal is considered to be commercially viable.

Permian coals in the **Arckaringa Basin** occur in the Arckaringa Coalfield and the Lake Phillipson deposit. Demonstrated in-situ resources in the Arckaringa Coalfield total 2965 Mt (South Australia Department of Mines & Energy (SADME), 1984). Exploration of the Lake Phillipson coals has not yet progressed far enough to allow demonstrated resources to be determined but SADME has reported inferred resources of 4700 Mt in situ for the deposit. These coals are generally sub-bituminous, with high moisture, low ash, and low energy content. They would be suitable for electricity generation.

The Triassic sub-bituminous coal at **Leigh Creek** is used for electricity generation. Demonstrated in-situ resources total 500 Mt and are mineable by open cut. These coals have a high moisture content and low content of volatile matter.

Jurassic sub-bituminous coal occurs in the Polda Basin at Lock, north of Port Lincoln. Demonstrated in-situ resources total 260 Mt of high moisture, high ash coal. These resources are not considered economic.

WESTERN AUSTRALIA

The principal coal resource in Western Australia is the Permian black coal of the **Collie Basin,** southeast of Perth, which is used mainly for power generation. Economic demonstrated in-situ resources in the basin total 740 Mt. Generally the coal is low in ash, of medium volatile matter content, and sub-bituminous. There are both open-cut and underground mines.

Black coal resources also occur in the **Perth Basin.** Deposits occur at Irwin River and Hill River, north of Perth, and at Vasse River south of Perth. Exploration and evaluation of these resources are continuing.

COAL BASINS

This section of the handbook summarises the coal measure geology, including the occurrence, thickness and nature of the coals themselves, and contains notes on mining history ands present mining methods. Further data on the geology of the coals can be found in the references quoted.

QUEENSLAND

Coal is mined in Queensland in seven basins (Fig. 1): the Bowen, Blair Athol, Callide, Maryborough, Tarong, Ipswich, and Clarence–Moreton Basins. Substantial resources are present also in the Galilee, Wolfang, Surat, and Mulgildie Basins. The Bowen Basin (Permian) is by far the most important and, together with the Wollongong area (Southern Coalfield) of New South Wales, is the source of Australian hard coking coal exports.

Both thermal and coking coal are produced in the **Bowen Basin**. Thermal coals are high, medium and low volatile bituminous coals and semi-anthracite. The high volatile thermal coals are won from the Moura, South Blackwater, Blackwater, Cook, and Newlands mines. Medium volatile thermal coals are produced at the Moura, Curragh, and Collinsville mines. Low volatile thermal coal is mined at Jellinbah East. Anthracite is mined at the Yarrabee open cut and some trial mining has been done at Baralaba.

High, medium, and low volatile coking coals are mined. High volatile product comes from the Moura, South Blackwater, Cook, Blackwater, Gregory, and Oaky Creek mines. Medium volatile coking coal is drawn from the Curragh, German Creek, Peak Downs, Goonyella, Riverside and Collinsville mines. Low volatile coking coal is produced at the Norwich Park and Saraji mines.

A very thick seam of Early Permian, high-quality steaming coal is mined in the **Blair Athol Basin** for export. The Blair Athol open cut is the only mine operating in the basin. The Blair Athol Basin can be regarded as an outlier of the Bowen Basin.

Although there is no current production from the **Wolfang Basin**, it has the potential to produce a high quality steaming coal. The seam stratigraphy is similar to that in the adjacent Blair Athol Basin. The Wolfang Basin similarly can be regarded as an outlier of the Bowen Basin.

The Permian coals of the **Galilee Basin** are not mined. They are generally high volatile steaming coals.

Some 4 Mt (measured and indicated) of high-volatile thermal coal of Cretaceous age occurs in the small **Styx Basin** between Rockhampton and Mackay. The Styx Basin coals were last mined in 1963.

The Triassic coals of the **Callide Basin** are sub-bituminous, and are used as thermal coal for electricity generation and for general industry use.

Coals of the **Mulgildie Basin** are Jurassic in age and are not currently mined. The coal is a high volatile bituminous steaming coal amenable to open-cut production.

Only the small Burgowan colliery operates in the **Maryborough Basin.** It produces high volatile bituminous coal from Cretaceous coal measures. The product can be marketed as either thermal or coking coal.

High volatile, bituminous thermal coal from the **Tarong Basin** (Triassic) is used for local electricity generation at the Tarong Power Station.

The **Ipswich Basin** (Triassic), immediately to the east, south, and southwest of Brisbane, yields high volatile thermal coal for the domestic and export markets, and small tonnages of coking coal for export.

Jurassic coals from the **Clarence–Moreton Basin** are mined in the Rosewood–Walloon coalfield west of Ipswich. They yield a high volatile, bituminous thermal coal.

The **Surat Basin** contains numerous coal deposits of Jurassic age but none are currently mined. They are generally high volatile bituminous coals suitable for steam raising. Some coals in the basin are also suitable for use in the production of liquid fuels.

Bowen Basin

The Bowen Basin covers some 70 000 km^2 in central eastern Queensland. It contains a 6000 m thickness of sedimentary and volcanic rocks (Wells, 1981) ranging in age from Permian to Triassic. Numerous coal-bearing units occur in the Permian sequence throughout the basin and coal measures are confined to Permian strata. Coal was first reported from the area by the explorer Ludwig Leichhardt in 1845 (Goscombe, 1985). The basin has since become an important source of coal for world markets.

Both Flood (1983) and Murray (1985) have reviewed the Bowen Basin's origins and consider it to be a typical foreland basin. It is bounded to the east by the Eungella–Cracow Mobile Zone and to the west by the Clermont Stable Block. The southern extension of the Basin is covered by Jurassic–Cretaceous sediments of the Surat Basin; however, it extends further south in the subsurface and is presumed to be coextensive with the Gunnedah and Sydney Basins.

Coals in the basin range from Early to Late Permian and occur in numerous stratigraphic units. Those mined include medium and high volatile thermal coal, low, medium, and high volatile coking coal, and anthracitic coal.

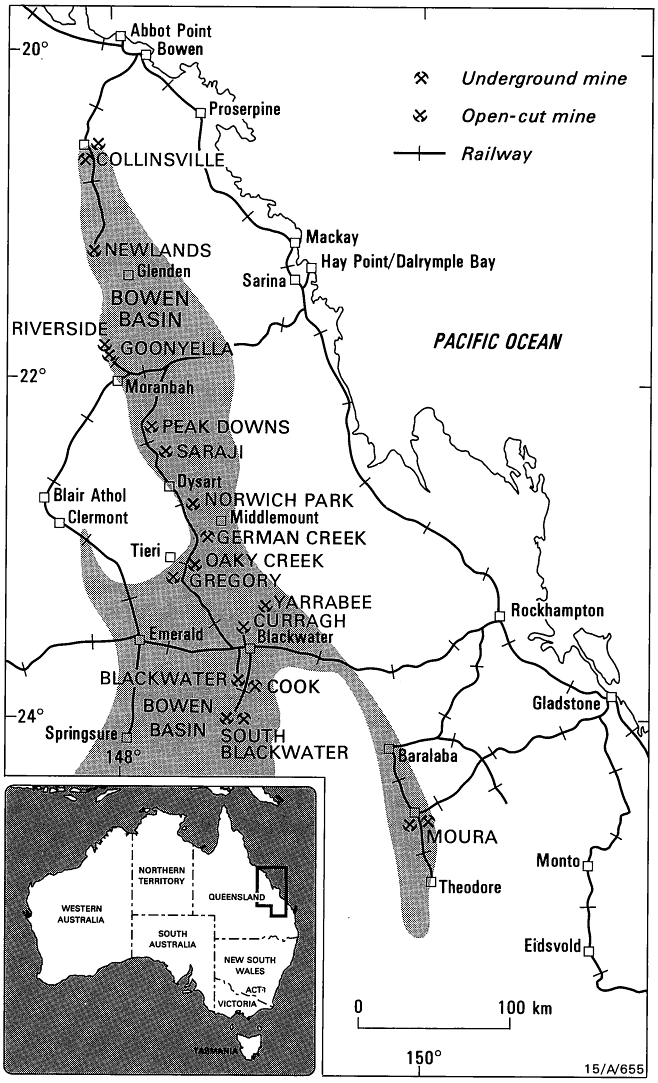

Fig. 4. Location map for the Bowen Basin, Qld, and mines operational at the end of 1989.

Mining began in 1913 at Collinsville and in 1917 at Baralaba (Svenson & others, 1975). The locations of existing mines are given in Figure 4.

An outstanding feature of mining in the Bowen Basin is the predominance of large open cuts. Underground mining has not proved easy, being complicated by gas and outburst problems (this caused the premature closure of the Leichhardt Colliery, south of Blackwater in 1982). However, successful underground bord and pillar operations have been established for many years and Queensland's first longwall mine is the German Creek Colliery. Four longwalls are now in operation and several others are under consideration or have been committed.

Reids Dome beds (D'Arcy, 1990; Edenborough, 1985)

The Reids Dome beds (Early Permian) are developed in the Denison Trough, on the western side of the Bowen Basin. Seismic work in 1964 suggested the presence of potentially significant coal in the Cullin-la-ringo area south of the Fairbairn Reservoir near Emerald (D'Arcy, 1990). The Department of Mines drilled the coals between 1976 and 1989 and the results are summarised by D'Arcy (1990). Coal also occurs in the Reids Dome beds southwest of Capella (Edenborough, 1985), which is 50 km north-northwest of Emerald; exploration of these coals began in 1968. No coal has been mined in these areas.

In the Cullin-la-ringo area the Reids Dome beds overlie pre-Permian sedimentary rocks. They are mostly overlain by Cainozoic sediments and volcanics, but in parts they are unconformably overlain by silty mudstone of the Cattle Creek Formation. D'Arcy records three sedimentary phases in the Reids Dome beds at Cullin-la-ringo: a basal alluvial fan sequence ranging from clay to conglomeratic horizons with some highly banded coal and tuffaceous units; the second phase has mudstone, siltstone, fine sandstone, some tuffs and most of the more important coal seams; the third phase consists of increasing amounts of sandstone, some mudstone and thinner coal seams which are also more subject to splitting.

At the Capella occurrence Edenborough (1985) has equated coal measures overlying pre-Permian metamorphic and igneous rocks with the Reids Dome beds. Edenborough divides the unit into three: lower coal measures; a barren unit (mainly siltstone, mudstone and some sandstone); and upper coal measures (sandstone, siltstone, conglomerate and coal). The Reids Dome beds are conformably overlain by the Aldebaran Sandstone.

Coal seam nomenclature at Cullin-la-ringo has not been formalised and D'Arcy (1990) notes that up to 49 different seams can be grouped into 17 seam horizons. These coals are generally low in ash and sulphur and are high volatile bituminous thermal coals. Tests have shown that the ash level can be substantially reduced by beneficiation (D'Arcy, 1990) from an average of nearly 16% to 7.3% ash, with 90% recovery.

At Capella, Edenborough (1985) reports nine seams in the Reids Dome beds and two in the overlying Aldebaran Sandstone. From the base the Reids Dome seams are: Anakie, Gardner, Llandillo, Capella, Slateford, Selma, Kettle, Burn, and La Poule. The seams in the Aldebaran Sandstone are the Carbine and Theresa. The coals are generally high volatile bituminous and the Anakie, Gardner, and Llandillo seams have some coking properties.

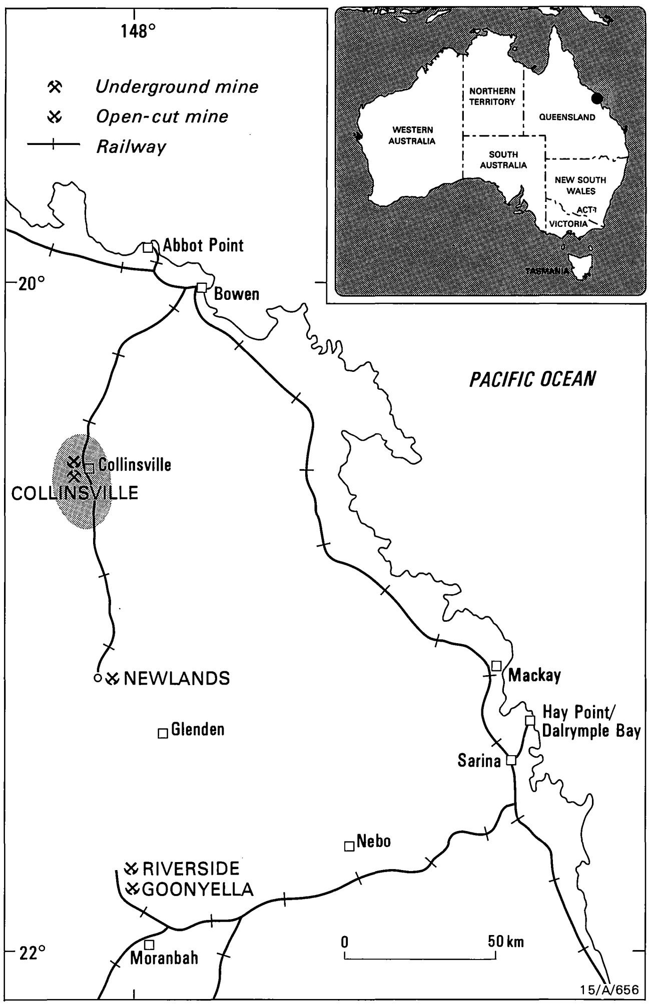

Fig. 5. Distribution (diagrammatic) of the Collinsville Coal Measures, Bowen Basin, Qld.

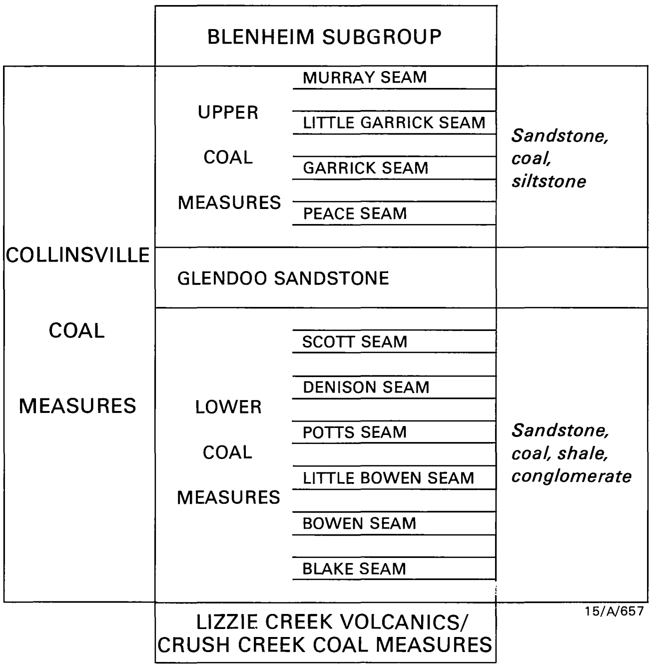

Fig. 6. Stratigraphy and lithology, Collinsville Coal Measures, Bowen Basin.

Collinsville Coal Measures (Mengel, 1975a; Clare, 1985)

The Collinsville Coal Measures occur at the extreme northern end of the Bowen Basin (Fig. 5). Although the date of discovery of the coal is not known, Mengel (1975a), in reviewing the exploration history of the unit, notes that the first substantial geoscientific investigation took place in 1879. Coal production began in 1913 but between then and the arrival of the railway in 1922 output was small.

The Collinsville Coal Measures are Early Permian. They overlie the Crush Creek Coal Measures and the Lizzie Creek Volcanics and are conformably overlain by the Blenheim Subgroup (Fig. 6) (Clare, 1985). The top of the coal measures is at the top of the Murray seam.

There are three distinct units in the Collinsville Coal Measures: the Lower Coal Measures, the Glendoo Sandstone Member and the Upper Coal Measures. The Lower Coal Measures consist of sandstone and shale and the Scott, Denison, Potts, Little Bowen, Bowen, and Blake coal seams; the basal horizons are conglomeratic. Fine to medium-grained sandstone and siltstone of the Glendoo Sandstone Member contain thin bands of marine fossils. The Upper Coal Measures consist of sandstone, siltstone and the Murray, Little Garrick, Garrick, and Peace seams.

There are ten principal seams in the sequence, although the Scott and Denison seams coalesce in places to form the Scott–Denison seam. Of the ten seams only the Garrick, Scott, Denison, Scott–Denison, Bowen, and Blake are of commercial interest. The Garrick, Scott, and Denison seams yield export coking coals, the Bowen seam yields both coking and steaming coal, but only steaming coal is won from the Blake seam (Clare, 1985).

Generally, the Bowen and Blake seams contain less volatile matter than the others, and the Blake seam has a higher proportion of dull coal.

Igneous intrusions are widespread. They have destroyed much of the coal and have formed natural coke in places (Mengel, 1975).

There has been a long history of mining. In 1988–89 coal was won from the Bocum and Bowen No. 2 underground mines and the Bowen Central No. 3 open cut. Underground production in 1988–89 was 0.99 Mt saleable and open-cut production was 2.2 Mt (1.61 t saleable). Exports from these mines in 1988–1989 totalled 0.85 Mt of coking coal and 0.17 Mt of steaming coal. The mines are owned and operated by Collinsville Coal Co. Pty Ltd, which is owned by MIM Holdings Ltd (75%) and Agipcoal Australia Pty Ltd (25%). Coal exported from Collinsville is shipped from Abbot Point, north of Bowen. Collinsville coal is also used for electricity generation at the Mount Isa power station, in metal treatment plants at Mount Isa (lead) and Yabulu (nickel), and as coke oven feed at the coke works at Bowen, which is also owned by MIM.

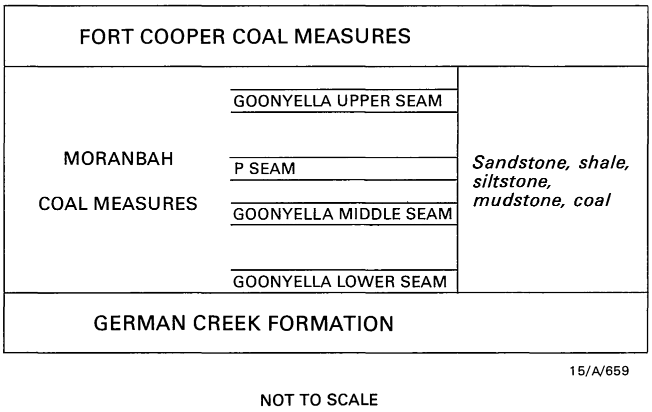

Fig. 8. Generalised stratigraphy of the Moranbah Coal Measures in the Goonyella area, Bowen Basin.

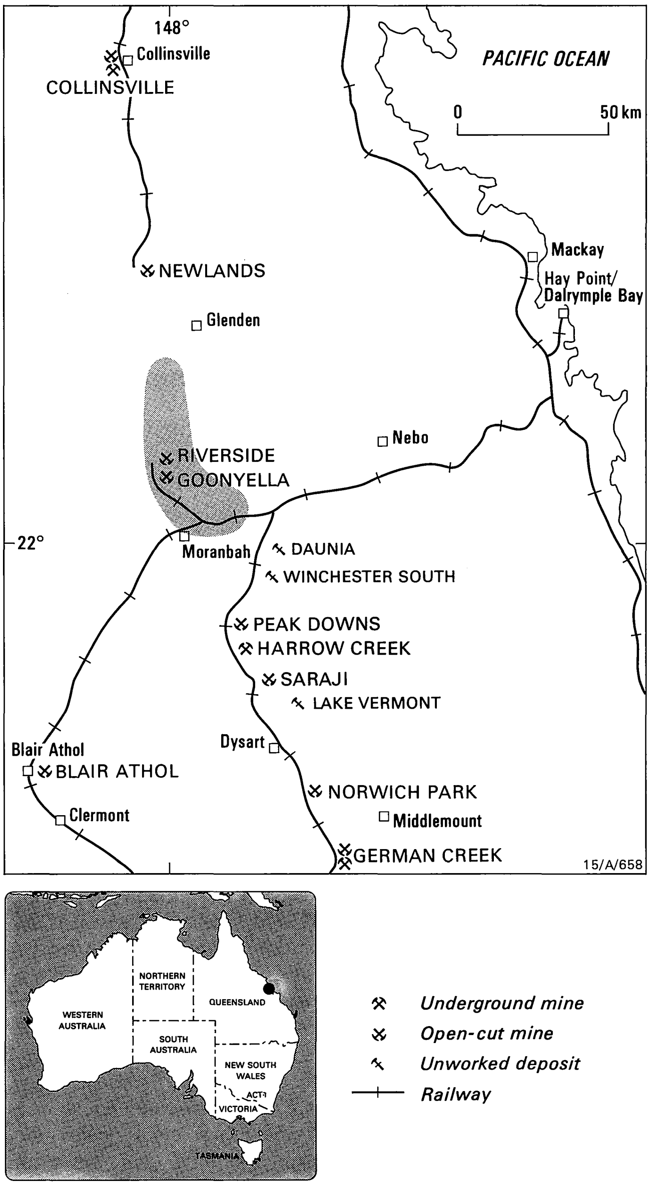

Fig. 7. Northern area (diagrammatic) of the Moranbah Coal Measures, Bowen Basin.

Moranbah Coal Measures (northern area) (Godfrey, 1985)

The northern area of Moranbah Coal Measures is in the northwest Bowen Basin, extending from Moranbah to north of the Goonyella and Riverside mines (Fig. 7). Coal is won from this sequence at both mines.

The Moranbah Coal Measures are of early Late Permian age. They are underlain by the lower part of the German Creek Formation (Fig. 8), a marine horizon, and are overlain by the Fort Cooper Coal Measures and Tertiary sediments or basalt. They grade southwards into the German Creek Formation near the Norwich Park open-cut mine; the difficulty of correlating the two units and their contained seams has been discussed by Milligan (1975) and Godfrey (1985).

Labile sandstone, shale, siltstone, and mudstone are the main clastic rock types (Utah Development Company Ltd Staff, 1985c). Rare tuffaceous beds are also present.

There are three principal seams: Goonyella Upper, Goonyella Middle, and Goonyella Lower (Fig. 8). In addition, Utah Development Company Ltd Staff (1985c) have noted the presence of the 'P' seam between the Goonyella Middle and Upper seams. The 'P' seam has been referred to as the 'Goonyella Middle seam rider'. Use of the term 'P' seam for this coal implies correlation with the 'P' seam in the Peak Downs area. In addition to these coals, Quinn (1985a) has reported another seam, which he refers to as the 'Basal' seam, some 30 m below the Goonyella Lower seam in the Riverside Mine area. Splitting occurs in seams of the Moranbah Coal Measures but is not complex. Both Goonyella Upper and Goonyella Lower seams may each split into two seams.

Mines in this sequence win high-quality, hard coking coal for the export market.

Currently two open-cut mines produce coal from the Moranbah Coal Measures in this northern area. The Goonyella open-cut mine started production in 1971, mining the Goonyella Middle seam, and in 1983 production from the Goonyella Lower seam began. The Riverside open cut started mining the Goonyella Lower seam in 1983. Both mines use draglines for overburden removal. In addition the Goonyella mine uses a bucketwheel excavator in some areas for pre-stripping overburden prior to dragline operations. The Moranbah Coal Measures are also the coal-bearing sequence at the Wards Well prospect north of the Riverside mine.

Moranbah Coal Measures (southern area) (Godfrey, 1985; Dash, 1987)

The southern area extends from north of the Peak Downs mine, south to the Dysart–Norwich Park district (Fig. 9).

In this area the Moranbah Coal Measures rest conformably (Fig. 10) on the lower part of the German Creek Formation in the north and grade laterally into the upper sequence of that unit and

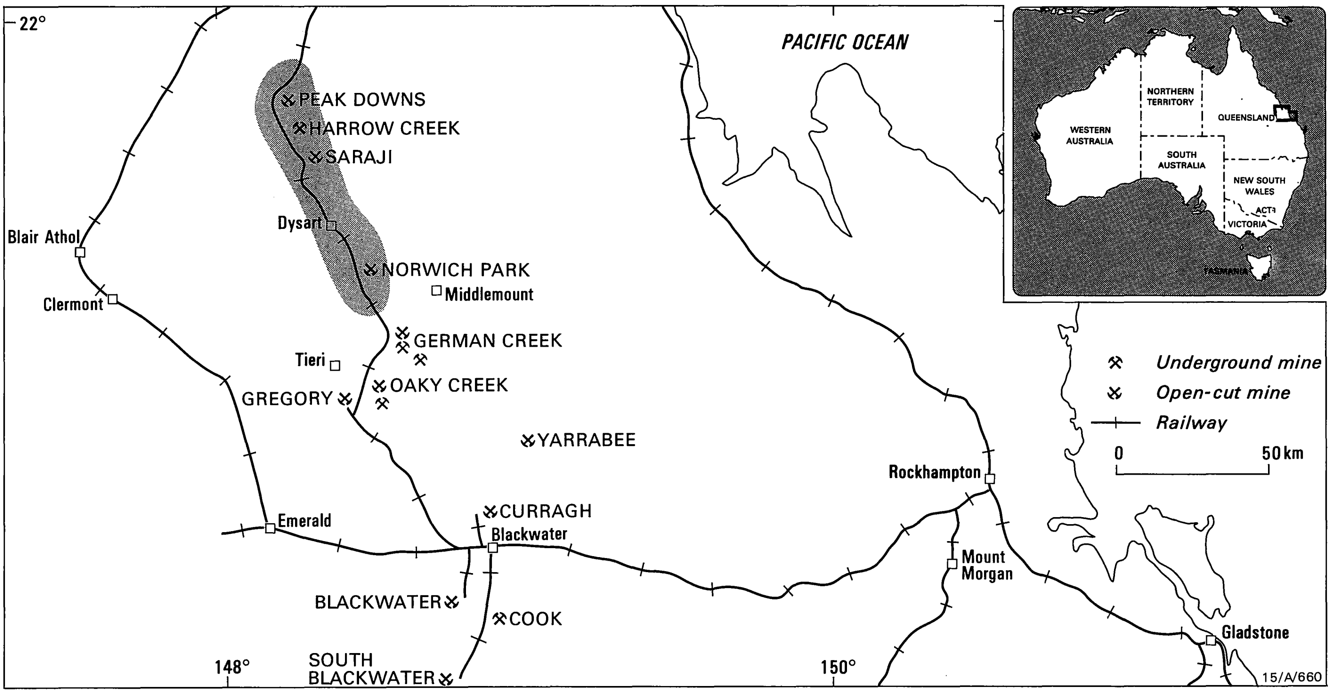

Fig. 9. Southern area (diagrammatic) of the Moranbah Coal Measures, Bowen Basin.

the Macmillan Formation in the south, as figured by Dash (1987, fig. 5). They are overlain conformably by the Fort Cooper Coal Measures (Fig. 10).

Coal occurs throughout the Moranbah Coal Measures; interseam material is sandstone, shale, and siltstone with minor claystone. A prominent tuff marker horizon, the P Tuff, occurs midway up the sequence and is recognised throughout the unit. Aspects of the geology of this sequence have been discussed by numerous authors including Archibald (1983) and Devey (1983). Devey noted that the faulting present is more complex and intense than was previously thought, although less severe in the Moranbah Coal Measures than in the younger Rangal Coal Measures.

The coal is in seven principal seams — S, R, Q, P, Harrow Creek, Harrow Creek Lower, and Dysart. Of prime economic interest is the Dysart seam but the Harrow Creek seam is also of interest. Complex splitting and coalescing of the lower seams in particular causes some uncertainty in correlations both across the area and with seams in sequences to the north and south. Because of the large number of splits in the sequence and in the Dysart seam in particular, analytical data are presented only for the main seam. Information on various splits may be obtained by consulting references quoted.

The Dysart seams yield good-quality coking coals, which are exported.

Three open-cut mines — Peak Downs, Saraji, and Norwich Park — and one underground mine, Harrow Creek, have worked the Moranbah Coal Measures in this area. The open cuts all produce from the Dysart seam and splits from it. At Harrow Creek the Harrow Creek Upper seam has been mined. It was blended with Peak Downs coal prior to washing and sale. The Peak Downs operation commenced in 1972, Saraji in 1974, and Norwich Park in 1979. Production from the Harrow Creek trial colliery started in 1978 and ended in 1987.

All mines produce coking coal for export. The Norwich Park open cut also produces steaming coal for export.

German Creek Formation (Phillips & others, 1985)

The coal-bearing German Creek Formation occurs in the central western Bowen Basin in the vicinity of the German Creek, Oaky Creek, and Gregory open-cut mines (Fig. 11). German Creek coal is won at each of these mines and at the German Creek Central underground mine.

The German Creek Formation conformably overlies the Maria Formation and is conformably overlain by the Macmillan Formation (Fig. 12). There are many coal seams in the sequence. The non-coal strata in the unit are sandstone with less common siltstone and mudstone (Phillips & others, 1985). The sandstones are lithic, having less than 50% quartz and a high mica content.

The German Creek Formation is considered to be, in part, a southern extension of the Moranbah Coal Measures, but correlation of seams between the two is difficult (Milligan, 1975; Godfrey, 1985).

There are dykes and sills in the German Creek Formation in the area of the German Creek mine, and the coal in the Aquila, Tieri,

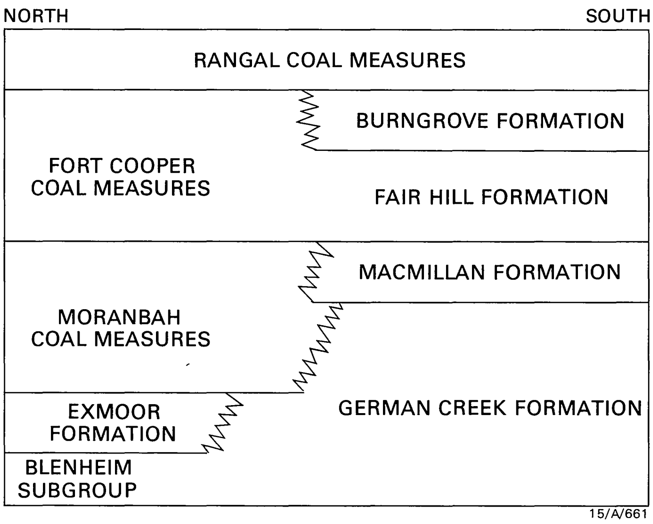

Fig. 10. Generalised stratigraphy of the southern area of the Moranbah Coal Measures (based on Dash, 1987, fig. 5).

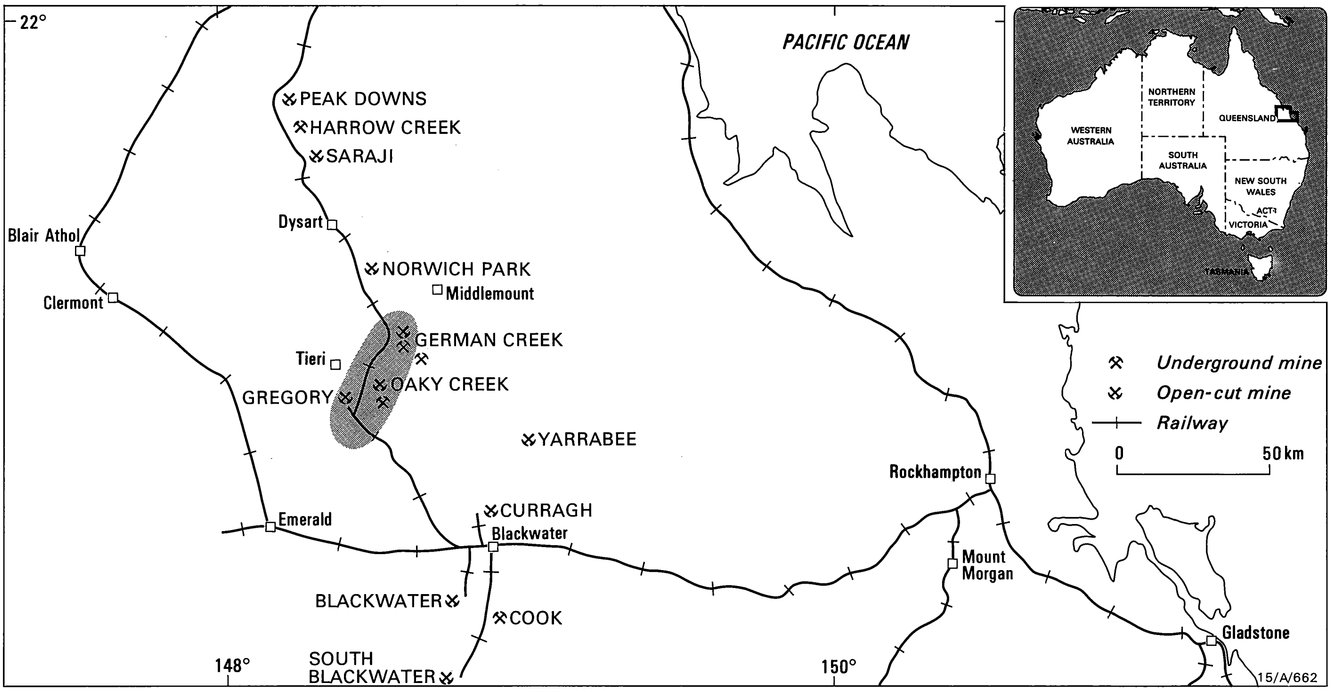

Fig. 11. Distribution (diagrammatic) of the German Creek Formation, Bowen Basin.

and German Creek seams has been adversely affected by them. Intrusions are not common elsewhere but there is local overlying Tertiary basalt.

The principal seams present are the German Creek seam and, at the Gregory open cut, the Lilyvale seam. These are the basal seams in the sequence. Other seams present, in ascending stratigraphic order, are Corvus, Tieri, Aquila, and Pleiades. There can be up to three splits in the Pleiades, Tieri, and Corvus seams. The German Creek seam has, in places, upper and lower splits.

At the Gregory mine only the Pleiades and Lilyvale seams exceed 1 m in thickness (Utah Development Company Ltd Staff, 1985b).

Medium volatile high-quality coking coal is produced at Oaky Creek and medium to high volatile coking coal at Gregory. The first longwall mining unit to be used in Queensland came into operation at the German Creek Central underground mine and there are now two longwalls at German Creek. Mining started at Gregory in 1979, at German Creek in 1981, at Oaky Creek in 1982, and at German Creek Central in 1987.

At German Creek, the principal seams mined are the German Creek, Aquila, and Tieri. The German Creek lower split is mined in part of the open cut and it is expected that the Corvus I and II seams will also be mined. Only the Lilyvale seam is mined at the Gregory open cut. Both the Aquila and German Creek seams are mined at Oaky Creek.

		GERMAN CREEK OPEN CUT	OAKY CREEK OPEN CUT	GREGORY OPEN CUT	
MACMILLAN FORMATION					
GERMAN CREEK FORMATION	UPPER SEQUENCE	PLEIADES SEAM	PLEIADES I SEAM PLEIADES II SEAM PLEIADES III SEAM	PLEIADES SEAM	*Sandstone, siltstone, mudstone, coal*
		AQUILA SEAM	AQUILA SEAM	AQUILA SEAM	
		TIERI I SEAM TIERI II SEAM	TIERI I SEAM TIERI II SEAM	TIERI I SEAM TIERI II SEAM	
		CORVUS I SEAM CORVUS II SEAM	CORVUS I SEAM CORVUS MIDDLE SEAM CORVUS II SEAM	CORVUS SEAM	
		GERMAN CREEK SEAM	GERMAN CREEK SEAM GERMAN CREEK SPLIT	LILYVALE SEAM	
	LOWER SEQUENCE				*Sandstone, siltstone, mudstone, conglomerate*
MARIA FORMATION					

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Fig. 12. Lithology and coal seams, German Creek Formation, Bowen Basin.

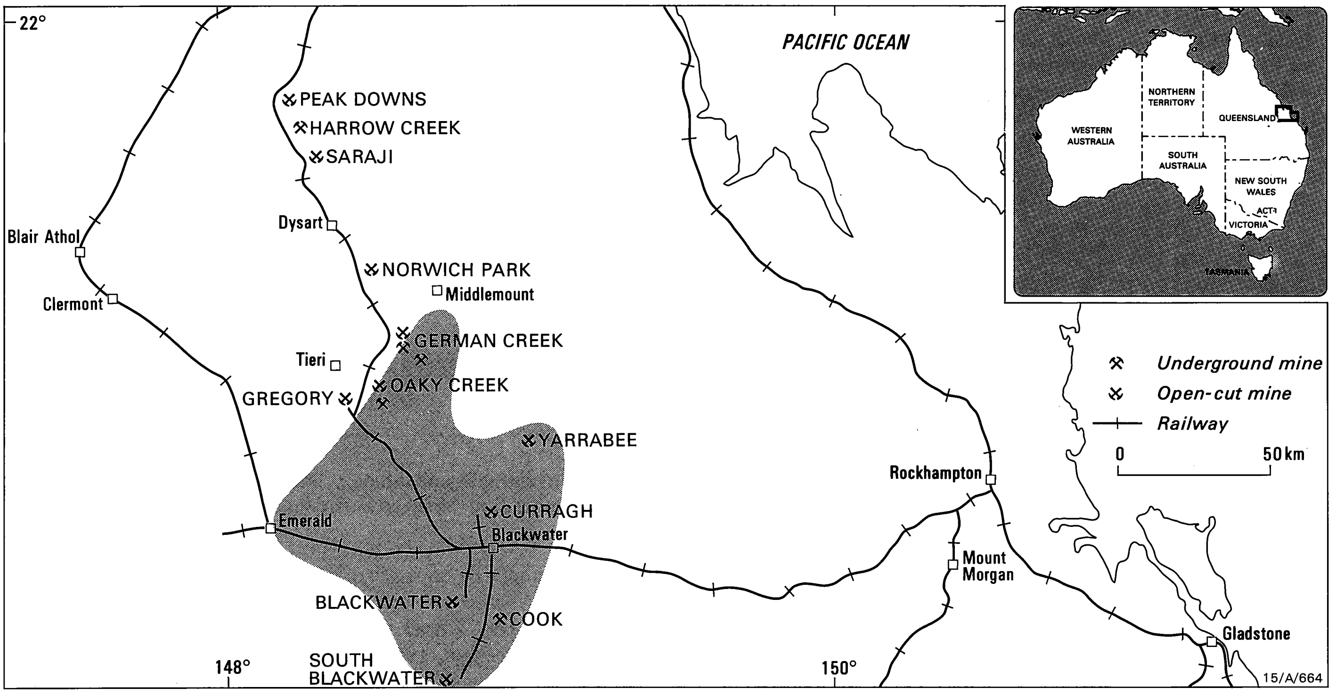

Fig. 13. Distribution (diagrammatic) of the Rangal Coal Measures in the Blackwater District, Bowen Basin.

Rangal Coal Measures (Quinn, 1985b)

The Late Permian Rangal Coal Measures and equivalents are the youngest coal-bearing units in the Bowen Basin. They extend throughout the basin and contain some seams which are mined and others that have potential for mining.

The Rangal Coal Measures conformably overlie the Fort Cooper Coal Measures or the Burngrove Formation (a correlative of part of the Fort Cooper Coal Measures) and are overlain by the sedimentary Permo–Triassic Rewan Group, which does not contain coal. The Rangal Coal Measures correlate with the upper section of the Baralaba Coal Measures in the southeast of the Basin. They are also correlated with the upper part of the Bandanna Formation in the southwest of the basin. A summary of the geology of the Rangal Coal Measures and their equivalents, together with proposed stratigraphic changes, is given by Quinn (1985b).

Labile sandstone, mudstone, and coal dominate the Rangal Coal Measures. Volcanic clasts derived from older volcanic strata are dominant in the sandstones but quartz and feldspar are minor. An important distinguishing feature of these coal measures is the absence of the tuffs or tuffaceous sediments common in older units.

Coal seams occur in the unit throughout the basin, but the number of seams present at any one place varies greatly. Also, the seams present may split rather abruptly, making correlation difficult. Both steaming and coking coal is produced.

Both open-cut and underground mines are working in the Rangal Coal Measures, producing mainly for export.

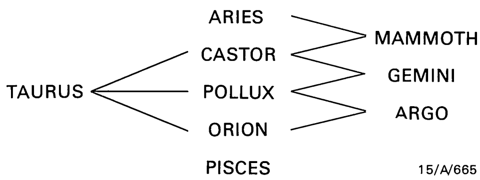

Fig. 14. Seam stratigraphy, Rangal Coal Measures, Blackwater District.

Blackwater (Wallin & Dawson, 1985). The region covered by the Rangal Coal Measures in the Blackwater area occupies much of the central and south-central Bowen Basin (Fig. 13).

The Rangal Coal Measures conformably overlie sandstone, siltstone, tuff, and minor coal intervals of the Burngrove Formation and are conformably overlain by sedimentary rocks of the Permo–Triassic Rewan Group. The dominant non-coal rock types are mudstone, shale, siltstone, and sandstone.

Coal seams are numerous throughout the Blackwater area. The general seam stratigraphy is shown in Figure 14 but there are

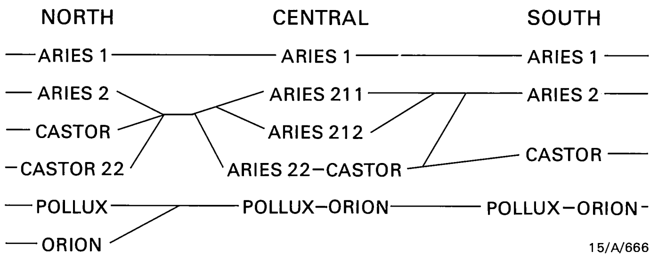

Fig. 15. Seam stratigraphy of the Rangal Coal Measures in the Ensham deposit showing complex splitting and coalescing (based on Wallin & Dawson, 1985).

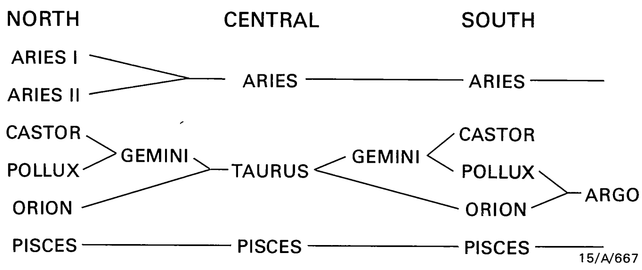

Fig. 16. Seam stratigraphy of the Rangal Coal Measures at the Blackwater mine, showing complex splitting (after Utah Development Co. Ltd Staff, 1985a).

major variations. There is extensive splitting and coalescing, sometimes over relatively short distances, causing complex coal distributions such as that described by Coffey & others (1983) for the Ensham area east-northeast of Emerald. The complex splitting at Ensham has also been described by Wallin & Dawson (1985) (Fig. 15) and for the Blackwater mine by Utah Development Company Ltd Staff (1985a) (Fig. 16). The complexity of splitting and coalescing makes correlation of individual seams across the area difficult.

In Part 2 of this handbook, the principal seams in the sequence are listed first and are followed by the seams and splits in the Ensham project area, to illustrate the nature of variations in the sequence.

The coals are of both thermal and coking quality and are both exported and used domestically. Generally they are high volatile bituminous coal, although low to medium volatile coals do occur and anthracite occurs at Yarrabee.

Coal is mined at the Blackwater, Yarrabee, Curragh and Jellinbah East open cuts, the Cook underground mine, and the South Blackwater underground and open-cut mine complex. The Yarrabee mine is on one of the few anthracitic deposits in Australia.

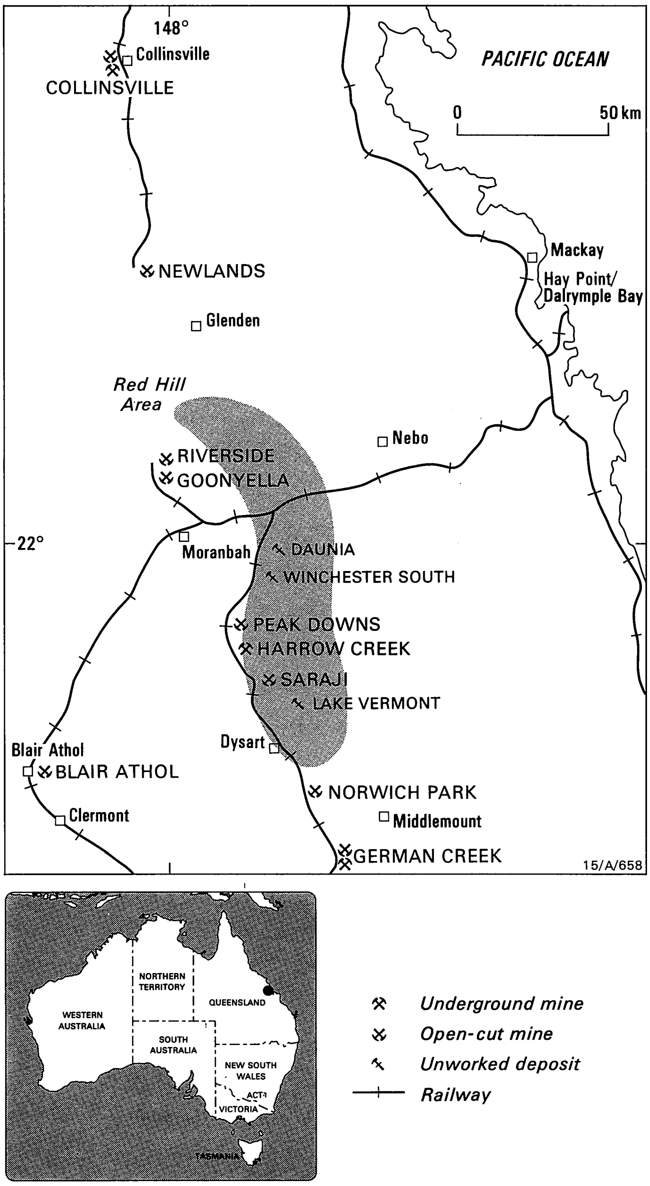

Fig. 17. Distribution (diagrammatic) of the Rangal Coal Measures in the Red Hill–Lake Vermont area, Bowen Basin.

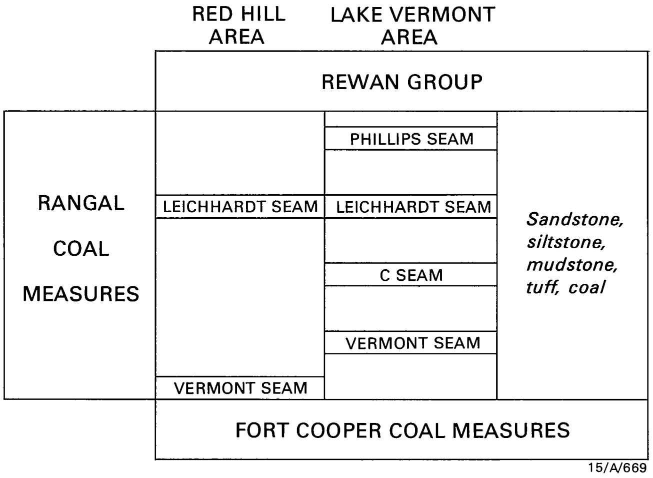

Fig. 18. Stratigraphy and lithology, Rangal Coal Measures, Red Hill–Lake Vermont area (based on Sorby & others, 1983, and Matheson, 1985).

Lake Lindsay–Roper Creek (Anderson & Jameson, 1982; Anderson & Beeston, 1980). This area extends from just north of the Curragh open cut in the south to Roper Creek and takes in the Middlemount district.

The Rangal Coal Measures in this area are conformably overlain by the Rewan Group and are underlain by the Burngrove Formation (which includes the high ash Girrah seam). As in other areas the principal non-coal rock types in the Rangal Coal Measures are labile sandstone, siltstone and mudstone with some calcareous horizons.

Coal occurs in three main seams, Middlemount, Tralee and Pisces, of which the topmost seam, Middlemount, is economically the most important. Seams in the area exhibit complex splitting and coalescing. This feature when combined with structural disturbance from faulting makes seam correlation within the area difficult. Similarly correlation with Rangal Coal Measures in other areas is also difficult for the Middlemount and Tralee seams.

Both thermal and coking products can be derived from the area. Coking coals have low fluidity and are suitable for blending with other Bowen Basin coking coal. Currently coal is won from the Roper Creek area at the German Creek East open cut, which is part of the German Creek project. Mining is from the Middlemount seam and product is blended with coking coals from the other German Creek mines in the region. This coal is exported.

Red Hill–Lake Vermont (Matheson, 1985; Sorby & others, 1983). This area extends from south of the township of Glenden in the north to about Lake Vermont, east of the Saraji open-cut mine (Fig. 17), and includes the Daunia, Winchester South, and Lake Vermont deposits.

Here the Rangal Coal Measures conformably overlie the Fort Cooper Coal Measures and are conformably overlain by the Rewan Group (Fig. 18). Labile sandstone, siltstone, and mudstone are the dominant rock types but some calcareous horizons may be present.

There is a distinctive tuff marker horizon (originally recognised in the Blackwater–Bluff area; Kempton, 1971). Matheson (1985) records its presence within the Vermont seam while Sorby & others (1983) put it at over 10 m below the base of the seam in places. Quinn (1985b) also records the presence of another such bed, the Yarrabee Tuff Bed, within the Vermont seam (or its equivalent, the Hynds seam) in the Poitrel and Bee Creek prospects south-southeast and east of the Goonyella mine.

There are only two seams, the Leichhardt and Vermont, in the north at Red Hill. In the south, four may be present: Phillips, Leichhardt, 'C', and Vermont.

The Leichhardt seam consists of dull and bright interbanded coal. In the north, at Red Hill, the Leichhardt Lower seam splits from the main seam. It is possible to derive both thermal and coking coal products from the seam in the Lake Vermont area. Sorby & others (1983) provide analyses for simulated thermal and coking coal products.

In the Daunia deposit both the Leichhardt and Vermont seams are present and the Vermont locally splits (Utah Development Co. Ltd Staff, 1985d). At the Winchester South deposit (thermal coal) near Peak Downs both the Leichhardt and Vermont seams are also present.

In the Lake Vermont area the Vermont seam splits into two, the lower of which also splits into two: Vermont Lower 1 and Vermont Lower 2. To the north, at Red Hill, Matheson (1985) records two plies separated by carbonaceous bands and a tuffaceous band. He regards the tuffaceous band as representing the base of the Rangal Coal Measures in the area, so this would place the bottom ply of the Vermont seam in the Fort Cooper Coal Measures. Both thermal and coking coal products could be derived from the Vermont seam (Sorby & others, 1983).

The Phillips seam and 'C' seam in the Lake Vermont area have no economic potential.

No mining has been carried out in these seams although there is potential for development.

Newlands. This area is north-northwest of the township of Glenden, in the northern Bowen Basin (Fig. 19).

The Rangal Coal Measures here overlie carbonaceous shale and coal of the Fort Cooper Coal Measures (Fig. 20) and are overlain by sandstone of the Rewan Group. Both contacts are conformable. Two coal seams, Upper Newlands and Lower Newlands, occur towards the middle of the unit and are separated by mudstone and siltstone. Upper sections of the Rangal Coal Measures in the area are mainly siltstone but contain some mudstone and sandstone.

Only the Upper Newlands seam is economically important. It is a hard, dull coal of consistent thickness and has no major splits. It may be correlated with the Elphinstone seam to the east and southeast of Newlands.

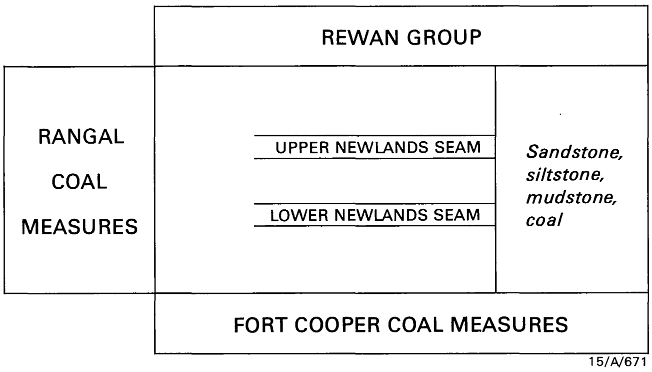

Fig. 20. Stratigraphy and lithology, Rangal Coal Measures, Newlands area.

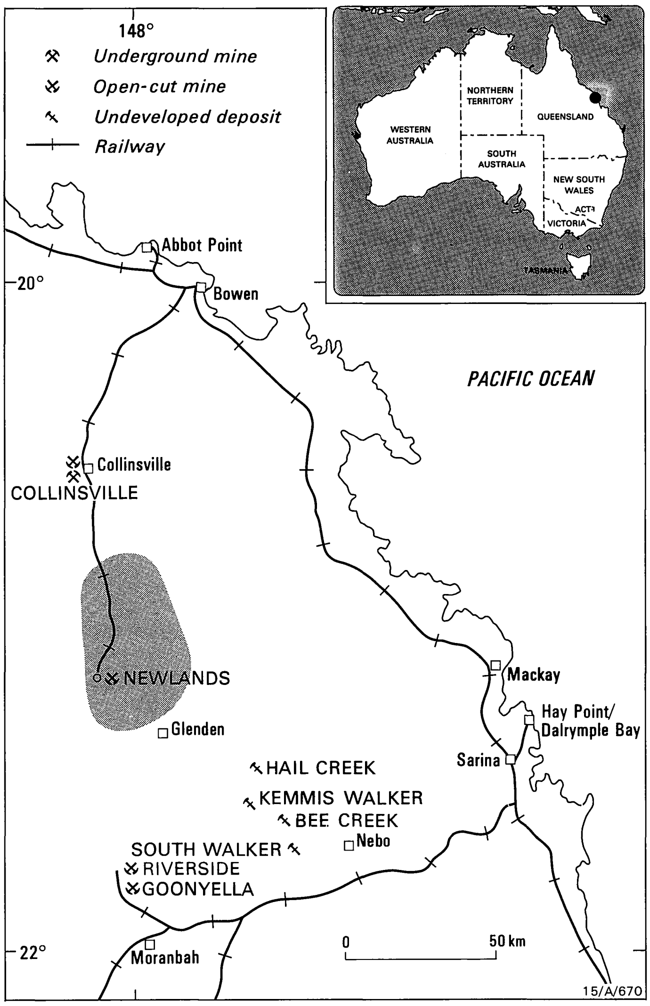

Fig. 19. Distribution (diagrammatic) of the Rangal Coal Measures in the Newlands area, Bowen Basin.

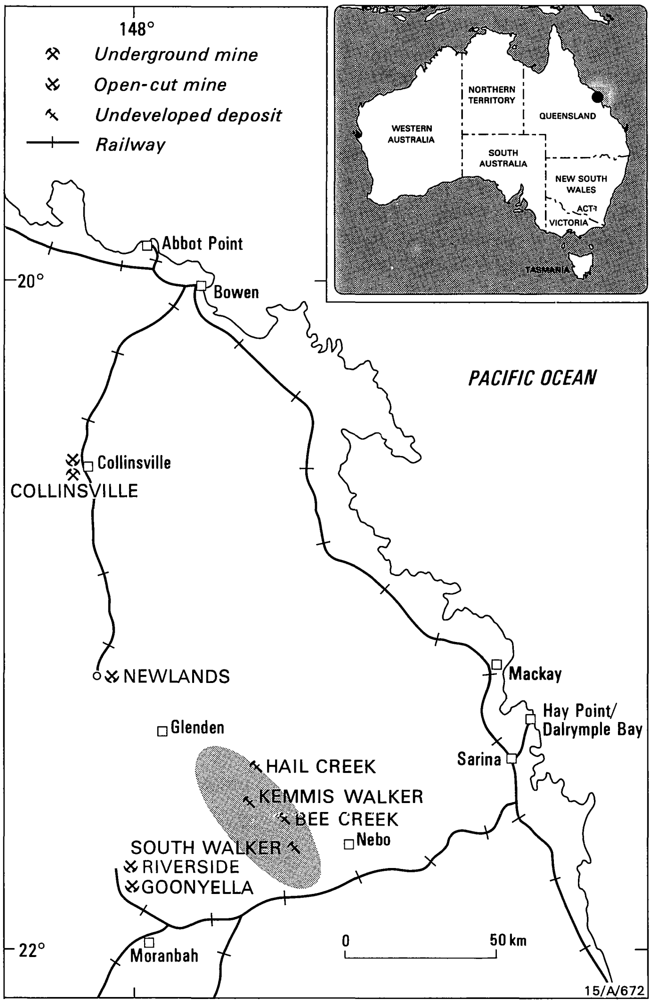

Fig. 21. Distribution (diagrammatic) of the Rangal Coal Measures in the Nebo resource area, Bowen Basin.

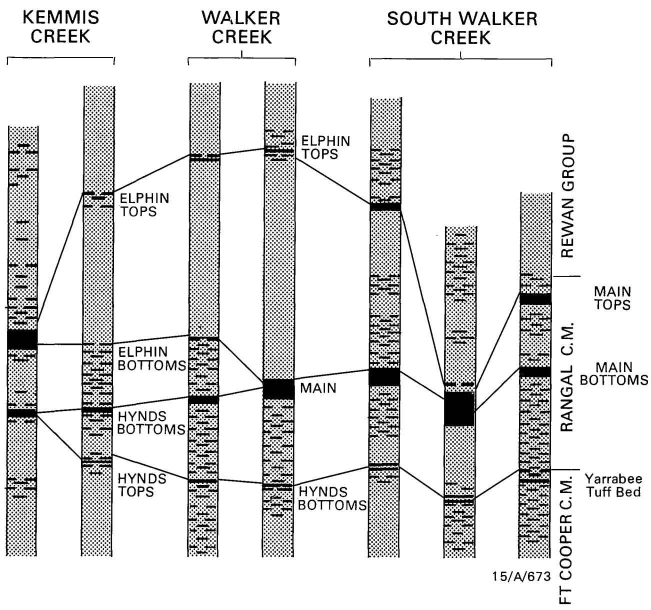

Fig. 22. Stratigraphy of the Rangal Coal Measures in the Nebo resource area (after Quinn, 1985c).

The Lower Newlands seam lies between 1.5 m and 20 m below the Upper Newlands seam and may correlate with the Hynds seam in the east and southeast. It is not regarded as economic.

The Upper Newlands seam is currently mined in the Newlands open cut. This is operated by Newlands Coal Pty Ltd, which is owned by MIM Holdings Ltd (75%) and Agipcoal Australia Pty Ltd (25%). Mining commenced in 1983. Product coal is a high energy, medium volatile thermal coal suitable for use in power stations and cement production. The mine is a conventional open-cut operation using draglines for overburden removal and hydraulic excavators and trucks for coal handling and transport. All of the output is currently exported, from Abbot Point, near Bowen.

Nebo (Quinn, 1985c). This area is on the eastern edge of the Bowen Basin between the towns of Glenden and Nebo (Fig. 21). It includes the Hail Creek, Kemmis Walker, Bee Creek, and South Walker deposits.

The Rangal Coal Measures in this area have sometimes been referred to as the Elphinstone Coal Measures (e.g. Goscombe, 1975). However, the terminology used by Quinn (1985c) is adopted here. The coal measures conformably overlie the Fort Cooper Coal Measures and are conformably overlain by the Permo–Triassic Rewan Group. Coal seams extend throughout the area. The dominant non-coal rock types are sandstone and siltstone, with some mudstone.

The principal seams in the sequence are the Elphinstone and Hynds, both of which are subject to splitting, particularly in the Kemmis Creek–South Walker area (Fig. 22). In this area, the Elphinstone seam splits into the Elphinstone Tops and Bottoms and the Hynds seam into the Hynds Tops and Bottoms. In the Walker Creek–South Walker Creek area, the Elphinstone Bottoms and Hynds Tops coalesce to form the Main Seam, which itself subsequently splits into the Main Tops and Main Bottoms (Quinn, 1985c).

At the Hail Creek project site Goscombe (1975) records the presence of a seam, Schammer, between the Elphinstone and Hynds seams. He notes that although the Schammer seam has a maximum thickness of 6.4 m and a strike length of 4 km its average thickness is less than 2 m and it is regarded as of little commercial importance because of its high ash content.

The Elphinstone and Hynds seams may correlate with the Upper and Lower Newlands seams, respectively, to the northwest.

Both thermal and high-quality coking coal could be derived from the Rangal Coal Measures in this area.

Seams in this area are not mined. Several potential coking and thermal coal projects, e.g. Hail Creek, could be developed if market conditions become favourable.

Baralaba Coal Measures (Quinn, 1985d)

The Baralaba Coal Measures occur in the southeastern extension of the exposed Bowen Basin, between Theodore and Baralaba, a distance of over 110 km (Fig. 23). Svenson & others (1975) briefly reviewed the history of coal mining in the Baralaba Coal

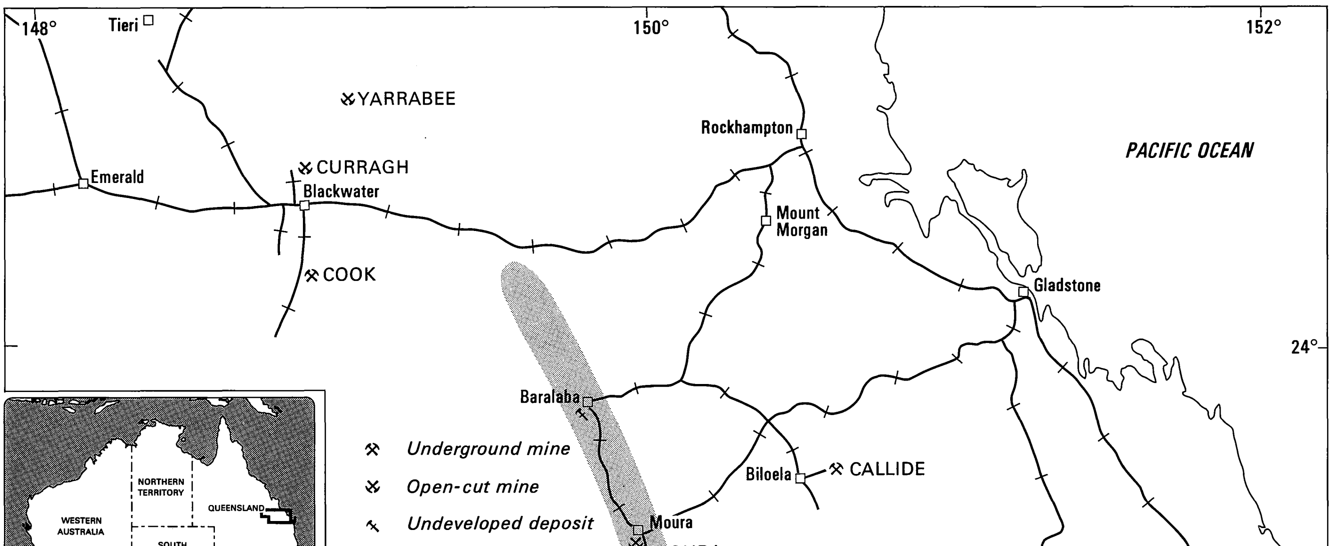

Fig. 23. Distribution (diagrammatic) of the Baralaba Coal Measures, Bowen Basin.

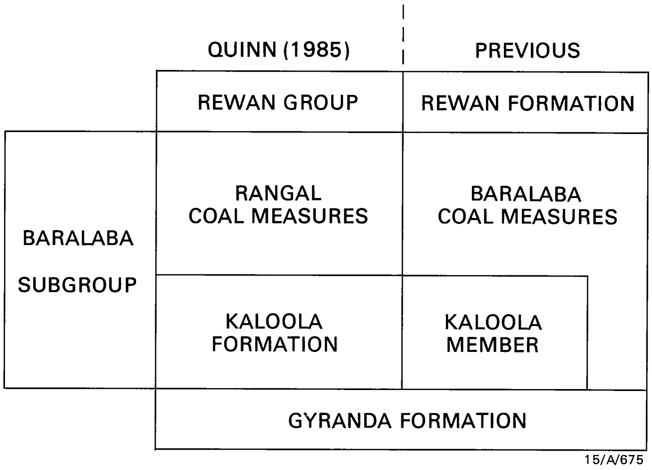

Fig. 24. Current and former Baralaba Subgroup nomenclature, Baralaba–Theodore area, Bowen Basin (based on Quinn, 1985b).

Measures, which have been known from the late nineteenth century. Mining is currently carried out at Moura and there has been trial mining at Baralaba, 35 km to the north.

These Late Permian coal measures are the uppermost formation of the Blackwater Group in the Theodore–Baralaba region. They overlie the Gyranda Formation, which is composed essentially of shale, sandstone, conglomerate, mudstone and tuff. The Gyranda Formation is the basal unit of the Blackwater Group in the area (Draper, 1985). Overlying the coal measures is the Permo–Triassic Rewan Group

Historically, the Baralaba Coal Measures (Fig. 24) have been divided into an upper sequence, which contains the coal seams, and a lower tuffaceous sequence, the Kaloola Member. The coal-bearing sequence is correlated with the Rangal Coal Measures of the central and northern Bowen Basin and the Kaloola Member with the Burngrove Formation of the central Bowen Basin and part of the Fort Cooper Coal Measures of the northern Bowen Basin. The underlying Gyranda Formation is equated with the central Bowen Basin's Fair Hill Formation and part of the Fort Cooper Coal Measures. The similarity of the Baralaba Coal Measures to those units prompted Quinn (1985d) to suggest a revision of the nomenclature (Fig. 24).

The number of seams varies along strike, and splitting and coalescing are common. At Baralaba there are 12 seams; in the Moura–Kianga–Nipan area the number may vary from four to ten depending on splits (Quinn, 1985b). Boyd (1982) reported 12 seams in the Theodore North area, at the southern limit of the Baralaba Coal Measures; however, CSR Ltd (undated pamphlet) note the presence of 18 seams at Theodore (presumably including all splits of principal seams).

Rank generally increases to the north, from high volatile bituminous at Theodore through low and medium volatile bituminous at Moura to semi-anthracite at Baralaba. Moura coal is used for coking, thermal, PCI (pulverised coal injection) and briquetting purposes.

The only mines in the Baralaba Coal Measures are at Moura where both coking and steaming coal are produced. Exports from these operations in 1988–89 totalled 2.1 Mt coking coal and 0.8 Mt steaming coal. At the end of June 1989, the Moura No. 2 underground mine and the Moura open cut were operating. A trial mining operation has produced large-tonnage samples from the Baralaba deposit for testing.

Blair Athol Basin

(Preston, 1985)

The small Blair Athol Basin covers only 36 km^2 and is centred 20 km northwest of Clermont, west of the Bowen Basin (Fig. 25). Coal was discovered in 1864 during the sinking of a water well

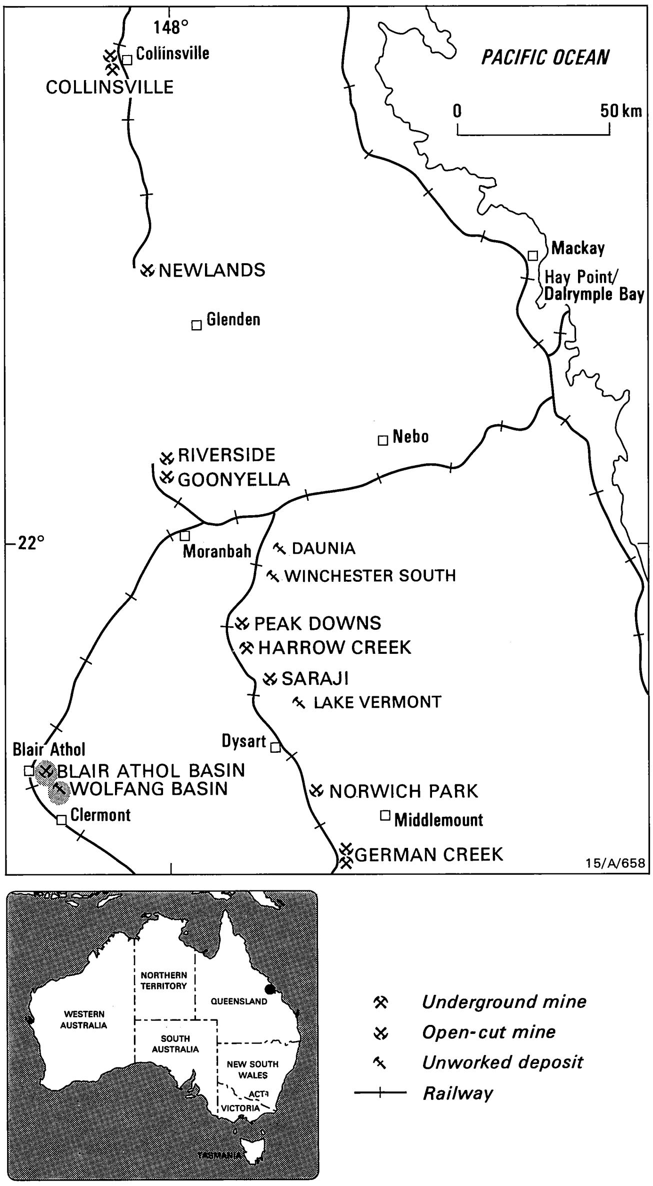

Fig. 25. Location of the Blair Athol and Wolfang Basins.

(Osman & Wilson, 1975). Preston (1985) and Osman & Wilson (1975) have briefly reviewed the exploration history of the basin.

The Early Permian Blair Athol Coal Measures were deposited in a topographic depression in terrain developed on the early

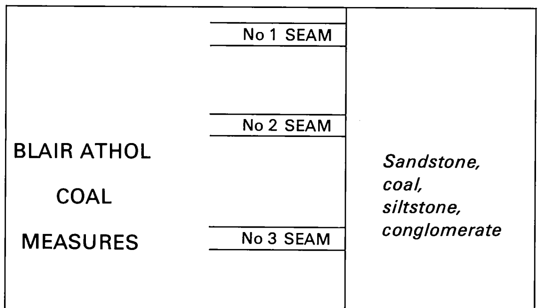

Fig. 26. Stratigraphy and lithology, Blair Athol Coal Measures.

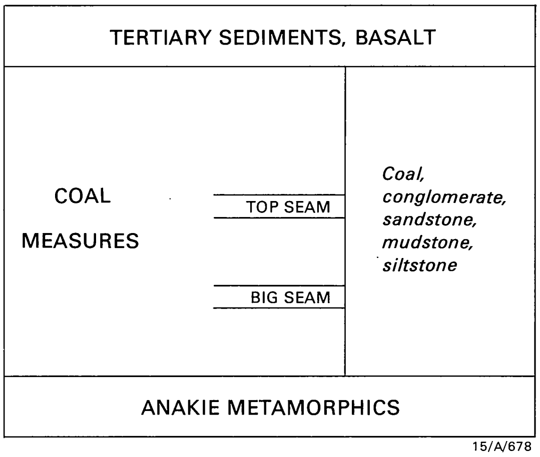

Fig. 27. Stratigraphy and lithology, Wolfang Basin (based on Carr, 1980).

Palaeozoic Anakie Metamorphics. They have a maximum thickness of 216 m, made up of 116 m in a lower coal measures sequence and 100 m in an upper sequence (Preston, 1985).

Preston's lower sequence consists of coarse sandstone, conglomerate, and minor dirty coal. The upper sequence is dominated by coals; non-coal sediments are mainly sandstone, including a kaolinised sandstone at the top of the unit; minor siltstone, and claystone are also present.

The Blair Athol Coal Measures contain four principal seams, numbered 1 to 4 (Fig. 26). In some publications the No. 3 seam has also been referred to as the 'Big Seam'.

The No. 1 seam is present as two separate lenses but it is not intended that either of these be mined in the existing operation. Similarly the No. 2 seam, though more widespread, will not be mined. It splits into upper and lower horizons.

The No. 3 seam is one of the most spectacular black coal occurrences in Australia. It has a maximum thickness of 33 m and is essentially entirely dull coal, with only thin stone bands towards the base. This seam has persistent thickness but some thinning occurs at the present basin edge. Preston (1985) considers this thinning to be depositional rather than erosional.

An upper and lower split may occur in the No. 4 seam, which has similar properties to the No. 3 seam. It has a maximum thickness of about 6 m, and has proportionally more stone bands than the No. 3 seam.

Mining in the Blair Athol Coal Measures commenced in the No. 2 seam soon after its discovery in 1864. Production from the No. 3 or 'Big Seam' started in 1890 and has continued since (Osman & Wilson, 1975). A major expansion of mining at the Blair Athol open cut came in 1984 when production from the new mine commenced. It is likely that most of the resources in the No. 3 seam will be readily recoverable, although some difficulties may be encountered when old underground workings are intersected in the open cut.

The high volatile bituminous thermal coal produced is exported, principally to Japan, without having to be washed.

Wolfang Basin

(Carr, 1980)

The Wolfang Basin, a small structure similar to the Blair Athol Basin, is centred 10 km north of Clermont, adjacent to the Peak Downs Highway (Fig. 25). A brief history of exploration in the area is given by Carr (1980).

As at Blair Athol, the Early Permian rocks of the Wolfang Basin unconformably overlie the Anakie Metamorphics (Fig. 27). The coal-bearing sediments include a basal conglomerate, coal, siltstone, and sandstone.

Similarly, the major coal seam is the thick 'Big' (or Wolfang) seam, which Carr (1980) records as averaging 29.86 m, with a maximum of 38.4 m (the lease-holder refers to this as the Wolfang seam). This seam correlates with the No. 3 seam in the Blair Athol deposit. Generally the coal is dull, with occasional bright bands, and is suitable for steam-raising but has no coking or conversion potential.

The 'Top' seam may be up to 52 m above the 'Big' seam and has an average thickness of 2.75 m and maximum thickness of 3.46 m (Carr, 1980). This seam also consists of dull coal but has more numerous bright bands; again, it is suitable for steam-raising. Neither coal would require washing before use.

Mining would be by open cut methods despite an average overburden thickness of about 140 m. An added disadvantage is that the overburden contains, on average, a thickness of 53 m of basalt and may contain substantial volumes of water. Despite the thickness of overburden, Carr reports a stripping ratio (based on both seams) of 4.3 to 1. Carr advocates open-cut mining despite the overburden thickness because of the large proportion of coal that would be lost if underground methods were to be used.

Resources for the basin are estimated by the Department of Mines, Queensland (1989) as 250 Mt of open-cut coal in situ.

Galilee Basin

The Galilee Basin is broadly the same age as the Bowen Basin; its outcropping eastern edge trends parallel to the Bowen Basin but 150 km to the west of it and separated from it by older strata. Of interest in terms of coal resources is the eastern margin of the basin, extending for about 400 km from approximately Alpha in the south to northwest of Pentland in the north. To the west, the Galilee Basin is overlain unconformably by the Jurassic–Cretaceous Eromanga Basin, which thickens to the west.

A considerable amount of information is available on the general geology of the Galilee Basin. Hawkins (1982) gives a list of references to pre-1982 work. Since then, Matheson (1987a, 1987b) has reported on drilling done in the northern and central areas of the basin in the mid 1970s by the Queensland Department of Mines. Although these reports provide little data on the coal geology of the basin as a whole, they both contain analyses of coals encountered in the drilling.

Coal of Late Permian age occurs along the eastern margin of the basin in a sequence dominated by sandstone and siltstone, conformably overlying a similar clastic sequence of probable Early Permian age. The coal measures are generally overlain conformably by sediments of Early Triassic age, possibly equivalent to the Rewan Group of the Bowen Basin.

Coal is present along the whole of the eastern margin of the basin. It is consistently a high-ash, sub-bituminous thermal coal. The Queensland Department of Mines (1989) report demonstrated in-situ resources of 2701 Mt of non-coking coal in the basin in three principal deposits. From south to north these are: Alpha (1235 Mt), Kevins Corner (910 Mt), and Pentland (556 Mt) (Queensland Department of Mines, 1989).

No coal has been mined commercially in the Galilee Basin.

Central (Carr, 1977b; Matheson, 1987b)

This area is approximately midway between Pentland and Alpha (Fig. 28).

Late Permian coal measures in this part of the Galilee Basin conformably overlie Early Permian clastic sediments comprising predominantly sandstone but with some siltstone and mudstone. Carr (1977b) reports the coal measures are mainly sandstone (with minor mudstone and siltstone) although coal seams may comprise over 30% of the sequence.

Carr also considers the basal section of the overlying Triassic sequence (interbedded sandstone and mudstone) to be very like the Rewan Formation and the upper part to be correlative with the Dunda beds (Fig. 29).

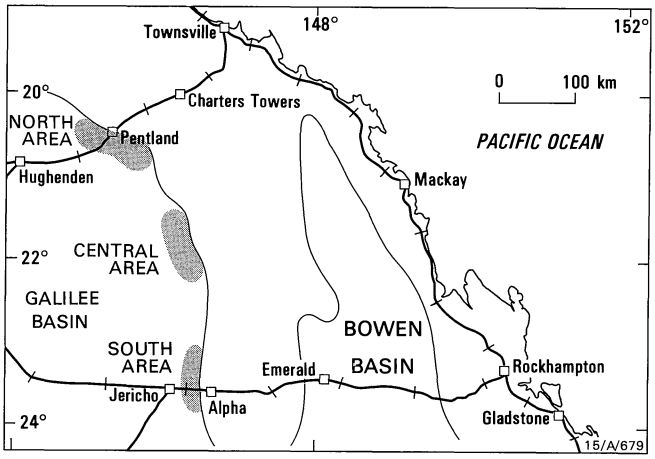

Fig. 28. Main coal-bearing areas (diagrammatic) along the eastern margin of the Galilee Basin, Qld.

Matheson (1987b) records five major coal horizons, of which two are of economic interest. These are the A–B and D seams, which have average workable thicknesses of 7 m and 12 m respectively.

Although the thick seams occur over a wide area, Matheson (1987b) notes that the open-cut potential is limited by the depth of weathering and thickness of cover.

North (Matheson, 1987a)

The principal area of interest is the region around Pentland (Fig. 28).

Gray (1977) summarised the stratigraphy. The lowermost unit, the Late Carboniferous to Early Permian Boonderoo beds, is presumed to rest unconformably at depth on sediments of the Drummond Basin (Fig. 30). Overlying the Boonderoo beds with a regional unconformity are the Late Permian Betts Creek beds, the main coal-bearing sequence in the area. The Triassic Warang Sandstone overlies the Betts Creek beds with local unconformity and is in turn unconformably overlain by the Jurassic–Cretaceous Eromanga Basin sequence.

Each of the three units in the Galilee Basin sequence in the area is dominated by sandstone and siltstone or mudstone and each contains conglomerate. The Boonderoo beds (Vine & Paine, 1974)

EARLY TRIASSIC	DUNDA BEDS		
LATE PERMIAN	COAL MEASURES	A SEAM	*Coal, sandstone, siltstone, claystone, conglomerate*
		B SPLIT SEAM	
		C SEAM	
		D SEAM	
		E SEAM	
		F SEAM	
EARLY PERMIAN	*Undifferentiated*		

15/A/680

Fig. 29. Stratigraphy and lithology, central area, Galilee Basin (based on Matheson, 1987b).

TRIASSIC	WARANG SANDSTONE	
LATE PERMIAN	BETTS CREEK BEDS	*Sandstone, siltstone, conglomerate, tuffaceous, mudstone, up to 6 coal seams (unnamed)*
LATE CARBONIFEROUS–EARLY PERMIAN	BOONDEROO BEDS	

15/A/681

Fig. 30. Stratigraphy and lithology, northern area, Galilee Basin (based on Matheson, 1987a).

are a glacial sequence of mixed lithology; the Betts Creek beds are also heterogeneous. The coal is mainly in the Betts Creek beds but some is present also in the Boonderoo beds.

Gray noted three apparent coal zones in the Betts Creek beds, the thickest of which was 5 m. Matheson (1987a), reporting on earlier drilling, recorded four and six seams respectively in two drillholes. The topmost seam in each hole was thickest, reaching a maximum of nearly 20 m.

In general the coals are of thermal quality. They are generally of sub-bituminous rank and relatively high in ash, and are suitable for electricity generation (Matheson, 1987a).

There has been no commercial mining in the area. At Pentland demonstrated thermal coal resources total 555 Mt in situ (Queensland Department of Mines, 1989). All is amenable to open-cut mining.

Styx Basin

(Svenson & Taylor, 1975)

The Styx Basin is on the Queensland coast 130 km north of Rockhampton (Fig. 1), and underlies about 320 km^2. Coal was discovered there in 1887; mining started in 1919 and continued until 1963, for a total production of 1.76 Mt.

The coal is in the Early Cretaceous Styx Coal Measures, which are unconformable on the Permian Back Creek Group. The coal measures comprise sandstone, conglomerate, siltstone, carbonaceous shale, and coal and are overlain by Quaternary sediments.

The Styx coals vary in thickness and lateral extent and are difficult to correlate. There are nine seams in the Tooloombah Creek area but only two at Waverley Creek. At Tooloombah Creek Svenson & Taylor (1975) report four seams with a potential economic thickness of 1.22 to 2.74 m. The coals are high volatile thermal although some have weak coking properties.

It is currently estimated that the Styx Basin contains some 4 Mt of measured and indicated resources (Queensland Department of Mines, 1989).

Callide Basin

The small Callide Basin occupies some 180 km^2 in central Queensland, 90 km southwest of Gladstone (Fig. 31). Coal was discovered in 1890 but was not developed until 1945, when open-cut mining began. In 1949 Thiess Bros Pty Ltd became operators of the mine. Two open-cut mines are currently operated by Callide Coalfields which is owned by The Shell Company of Australia Ltd (66⅔%) and the AMP Society (33⅓%). A general review of mining at Callide was given by Leveritt (1978).

Callide Coal Measures (Leveritt, 1978)

The Late Triassic Callide Coal Measures unconformably overlie the Early–Middle Triassic Muncon Volcanics (Fig. 32) in the northwest and southeast, and in the southwest they unconformably overlie the Late Permian Rainbow Creek Beds (Svenson & Hayes, 1975). Elsewhere the coal measures probably unconformably

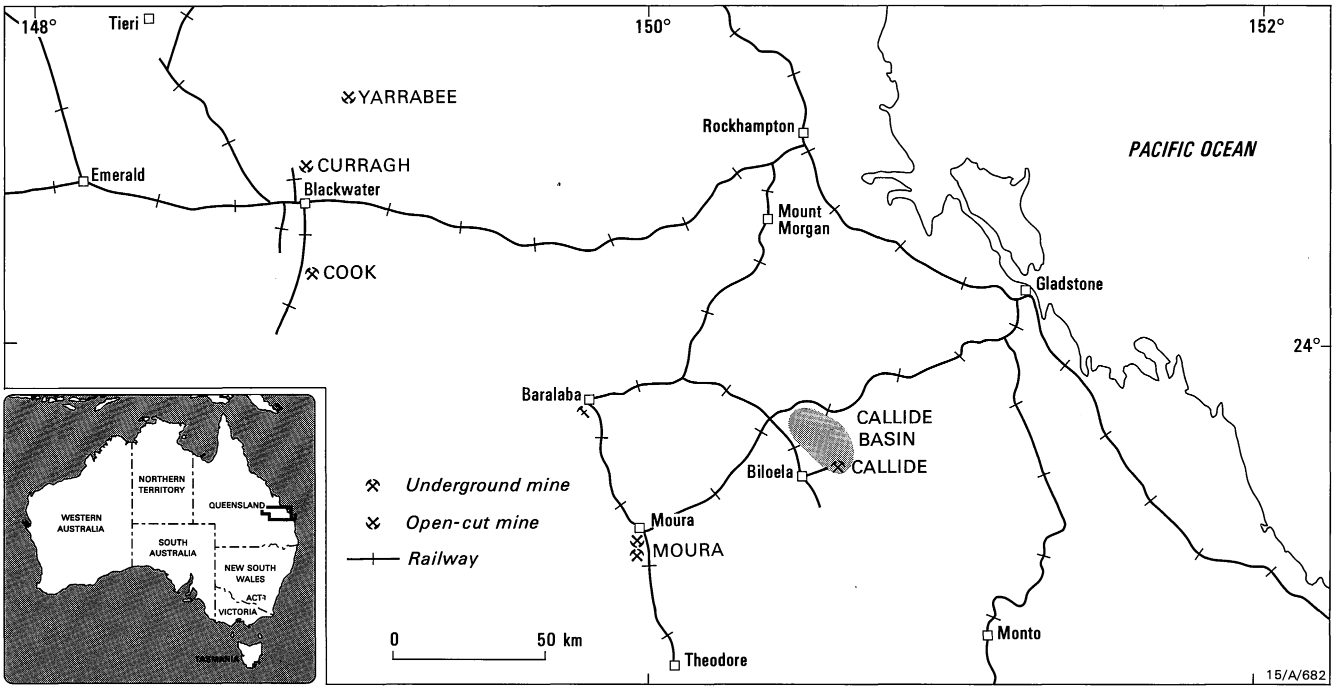

Fig. 31. Distribution (diagrammatic) of the Callide Coal Measures, Callide Basin, Qld.

overlie the Permian Youlambie Conglomerate. Conformably overlying the coal measures is the Precipice Sandstone (Jurassic). Various aspects of the geology and coal resources of the basin have been discussed by numerous authors including Grimestone & Roach (1978), Gould & Shibaoka (1980), Smythe (1980), and Flood (1983).

The Callide seam is the only seam of commercial interest and it may divide into at least two main splits.

Callide coal is high volatile bituminous and is essentially a medium-ash thermal coal with low sulphur. Leveritt (1978) has briefly reviewed some of the sales of this coal, whose principal use has been for electricity generation in power stations both on site and at the alumina refinery of Queensland Alumina Ltd and the cement works of Queensland Lime & Cement Ltd, both at Gladstone. It is also used in ships' bunkers on the Weipa–Gladstone bauxite route.

Since an open-cut mine produced 408 t in 1945, there has been continuous production from the Callide open-cut mines. Two open cuts, Boundary Hill and Callide, operated in 1988–89 for a raw coal output of 3.4 Mt, of which 1.38 Mt was from Boundary Hill.

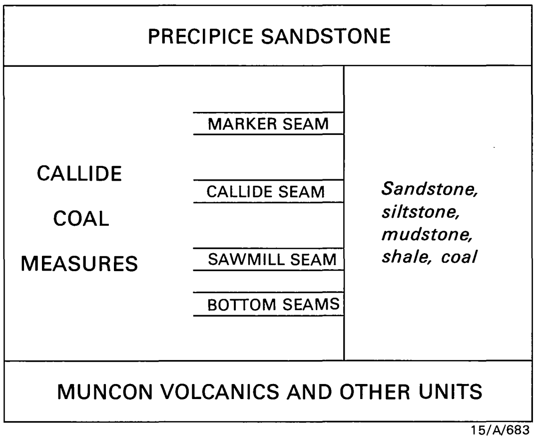

Fig. 32. Stratigraphy and lithology, Callide Coal Measures.

Virtually no material is rejected from these mines: all of the coal mined is saleable.

Mulgildie Basin

The small Mulgildie Basin extends for 20 km southeast from the town of Monto, 370 km northwest of Brisbane (Fig. 33).

Svenson & Rayment (1975) state that the Mulgildie Basin is fault-controlled and the best coal is developed east and southeast of the township of Mulgildie, 12 km south of Monto.

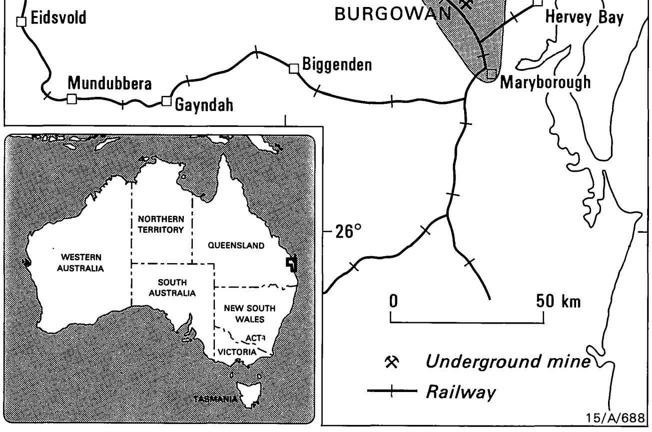

Fig. 33. Location (semi-diagrammatic) of the Maryborough and Mulgildie Basins, Qld.

Mulgildie Coal Measures (Svenson & Rayment, 1975)

The Mulgildie Coal Measures (Jurassic) conformably overlie the Hutton Sandstone (also Jurassic). Shale, claystone, and sandstone are the principal non-coal strata in the coal measures.

There are five seams of high volatile thermal coal in the Mulgildie Coal Measures referred to by Svenson & Rayment as, from the top down, A, B, C, D, and E. B seam is the best developed. The seams are subject to splitting and some consist of poor-quality coal. The Queensland Department of Mines (1989) has estimated demonstrated resources in the Mulgildie Basin to amount to 110 Mt of non-coking coal, all of which is amenable to open-cut production.

Coal was discovered in the basin in 1922. The Selene Colliery, southeast of Mulgildie, produced 510 000 t of coal between 1949 and 1966. There is no operating mine in the basin.

Maryborough Basin

The Jurassic–Cretaceous Maryborough Basin is on the Queensland coast and underlies the cities of Bundaberg and Maryborough (Fig. 33); it extends offshore.

The preserved onshore part of the basin is a northwest-trending structure dominated by northwest-trending large-scale folds (Koppe, 1975). The most important coal occurrences are associated with the Burrum Syncline.

The basin strata unconformably overlie the Triassic Brooweena Formation and are unconformably overlain by the Tertiary Elliott Formation. Cranfield (1982) has recognised five formations, of which two, the Burrum Coal Measures (Cretaceous) and Tiaro Coal Measures (Jurassic), are coal-bearing (Fig. 34). Non-coal rock types are mainly sandstone, siltstone, mudstone, shale, and, in the Late Jurassic–Early Cretaceous Grahams Creek Formation, Cranfield also records andesite, trachyte, and pyroclastics. A distinctive ferruginous oolite zone occurs in the Tiaro Coal Measures.

Seams in the Tiaro Coal Measures are too thin to be workable. Those in the Burrum Coal Measures have been mined for many years; there are five or six major and several minor seams. The seams are a source of high-energy thermal coal.

Mining began in the basin in 1866 (Koppe, 1975), peaked in 1951 (160 000 t mined), and is still carried on. Production has always been by underground methods and has usually been less than 100 000 t/year.

Burrum Coal Measures (Chiu Chong, 1965; Koppe, 1975)

The Burrum Coal Measures extend throughout the Maryborough Basin. They comprise mainly fresh-water sediments and are more than 1650 m thick (Koppe, 1975). They occur at the top of the sequence, conformably overlying the marine Maryborough Formation, and being overlain unconformably by sandstone and claystone of the Elliott Formation (Tertiary).

Coal occurs throughout the Burrum Coal Measures (Fig. 35). Non-coal sediments are mainly sandstone, siltstone, and shale, with some conglomerate.

The coals are best developed in the Burrum Syncline, Goodwood Anticline, and Pig Creek Syncline (Koppe, 1975, fig. 1). All of these structures have either been mined or explored for coal.

Generally the seams in the Burrum Syncline are lenticular: Chiu Chong (1965, p.11) notes that, on the western limb, 'although some holes penetrated workable coal thicknesses, in most cases equivalent sections in adjacent holes proved unworkable'.

Coal is best developed in the upper part of the coal measures, where five or six major seams are present and up to another six minor seams. The Ellangowan seam is the most important.

Generally the Burrum coals are bright, with a medium to high content of volatile matter. They are high-swelling coals that will make coke, although the coke is weak and the coal's main use is as a high-energy thermal product.

Koppe notes that there are three seams of workable coal over a section of 50 m on the west side of the Goodwood Anticline. They vary laterally in quality and thickness. In the Pig Creek Syncline only one seam of interest is present. Neither the Goodwood nor the Pig Creek coals are mined. Total economic demonstrated resources in the Burrum Coal Measures amount to less than 6 Mt.

The Burrum Coal Measures are mined at the Burgowan Colliery, which works the Ellangowan Seam. Production in 1986 from the Burgowan Colliery was 23 563 t of raw coal.

Tarong Basin

(Wilson, 1975)

The small Tarong Basin is centred about 10 km west of Nanango, 130 km northwest of Brisbane (Fig. 36). Coal has been known in this area since about 1939 when it was accidentally discovered during road works. Discoveries were also made in water wells but lack of markets hindered development. In 1978 the Queensland

TERTIARY	ELLIOTT FORMATION	
	unconformity	
CRETACEOUS	BURRUM COAL MEASURES	*Sandstone, siltstone, coal*
CRETACEOUS	MARYBOROUGH FORMATION	*Mudstone, sandstone, siltstone, conglomerate*
JURASSIC–CRETACEOUS	GRAHAMS CREEK FORMATION	*Andesite, trachyte, pyroclastics*
JURASSIC	TIARO COAL MEASURES	*Sandstone, carbonaceous shale, coal, ferruginous oolite*
TRIASSIC–JURASSIC	MYRTLE CREEK SANDSTONE	*Sandstone, siltstone*
	unconformity	
TRIASSIC	BROOWEENA FORMATION	

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34. Stratigraphy and lithology, Maryborough Basin (based on 'field, 1982).

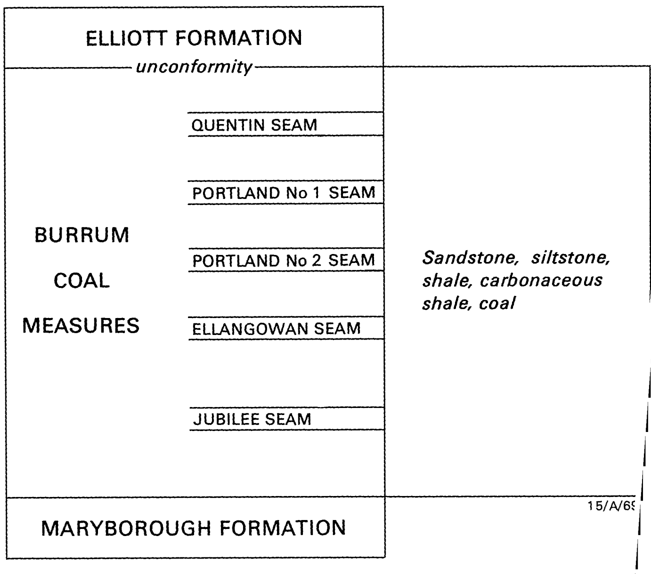

Fig. 35. Stratigraphy and lithology, Burrum Coal Measures, Maryborough Basin.

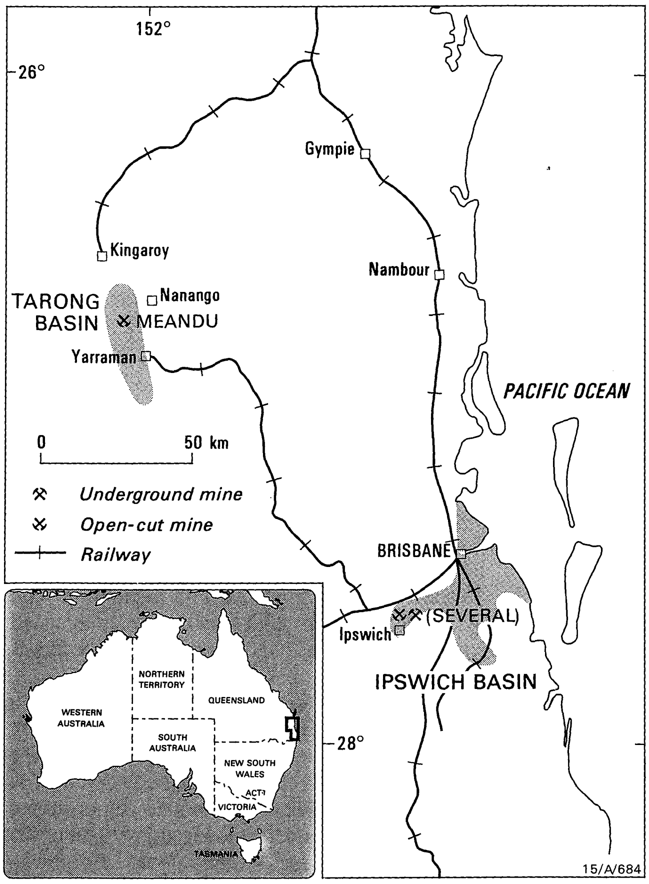

Fig. 36. Location (diagrammatic) of the Tarong and Ipswich Basins, Qld.

Government decided to build a 1400 MW power station in the area and the dedicated Meandu open cut was developed.

Coal seams in the basin occur mainly in the upper parts of the Late Triassic Tarong beds. The Tarong beds unconformably overlie Palaeozoic metasediments and granite. They are unconformably overlain by Jurassic conglomerate and Cainozoic volcanics and sediments. Non-coal sediments in the Tarong beds are predominantly sandy conglomerate, although siltstone and mudstone horizons are associated with the coal seams.

There are seven named seams in the Tarong Basin at the Meandu mine, from the bottom: Duke, Baron, Prince, Joker, Queen, King, and Ace. Of these, the Duke seam is considered to be too deep for normal open-cut mining and the Baron seam is of poor quality. Seams split and coalesce throughout the basin. The seams, mainly the King and Queen, yield a high volatile, high-ash thermal coal.

Mining at the Meandu open cut is by conventional strip mining. Operations commenced in 1983–84 and the initial coal mined was used without washing. This coal was won from the King seam. Mining is now concentrated on the King and Queen seams and the coal is washed.

Ipswich Basin

Ipswich Coal Measures (Mengel & Carr, 1976)

The Ipswich Coal Measures (Late Triassic) are developed at Ipswich, some 40 km west of Brisbane, in the western (exposed) part of the small Ipswich Basin, which adjoins the city of Brisbane on the east, south, and southwest (Fig. 36). Coal was discovered in the area in 1825 and mining began in 1846. The history of activity in the basin and summaries of the geology are given in Mengel (1975b) and Mengel & Carr (1976).

The two principal structures in the area mined (which is part of the West Moreton coal-mining district) are the north-trending Bundamba Anticline, and the Booval Syncline 3 km to the west. There are numerous mainly northwest-trending faults. Mengel (1975b) notes that there are rapid lateral changes in displacement on these faults.

Late Triassic sediments and volcanics of the Ipswich Coal Measures rest unconformably on the Carboniferous Neranleigh–Fernvale beds (metasediments). Within the coal measures Mengel and Mengel & Carr distinguish the basal Kholo Subgroup and overlying Brassall Subgroup. The coal measures are unconformably overlain by the Late Triassic–Early Jurassic Bundamba Group.

The coal is in the Brassall Subgroup. The Kholo Subgroup contains sedimentary breccia, sandstone, shale, conglomerate, tuff, and basalt.

Two formations, the Tivoli and the overlying Blackstone, make up the Brassall Subgroup, and coal is present in both. Non-coal rock types in the Tivoli Formation are siltstone, mudstone, sandstone, and conglomerate. Mengel reports beds of impure limestone in shale and mudstone. Mengel & Carr distinguish the Cooneana Sandstone Member, a coarse-grained sandstone, some 40 m thick, at the top of the formation.

The Blackstone Formation consists of coal, mudstone, siltstone, sandstone, and shale.

There are many coal seams and more than 20 have been mined. Generally the coals are stony because of shale and/or mudstone horizons. The seams coalesce and split over short distances (Mengel, 1975b; Carr, 1977a). Mostly the coals require substantial preparation before sale in order to obtain acceptable ash levels (not more than about 24%). The coal is mainly bright, although Mengel notes that interbedded dull and bright coal may be present in some seams. Many seams have been intruded by dykes and sills.

In general the coal is a high volatile, weak to soft coking coal. It is used mainly as thermal coal, both domestically and in export markets. *Note: the indicative analyses in Part 2 are general summaries of the coals of the Ipswich coalfield, and do not represent any particular seam.*

Commercial mining began in 1846 on the south bank of the Brisbane River at Redbank (Mengel, 1975b). Mining in recent years has been by both open-cut and underground methods. The coal was used mainly for local electricity generation but an export market has also developed for West Moreton coal. In 1986 just under half the saleable coal produced was exported.

Mining contracted in 1987, particularly as a result of the phasing out of the Swanbank power station.

Clarence–Moreton Basin

(Cranfield & others, 1975; Fielding, 1988)

The Clarence–Moreton Basin (Late Triassic to Early Cretaceous) extends from southeastern Queensland across the border into northeastern New South Wales (Figs 37, 39).

Middle to Late Jurassic coal-bearing sediments (the Walloon Coal Measures) are present throughout, and continue to the northwest across the Kumbarilla Ridge into the Surat Basin.

The Clarence–Moreton strata rest unconformably on the Late Triassic Nymboida and Ipswich Coal Measures. The Late Triassic–Early Jurassic Bundamba Group, consisting mainly of sandstone with lesser conglomerate and siltstone and occasional coal, is conformably overlain by the Walloon Coal Measures (coal, shale, and sandstone). Above the Walloons in Queensland are various fine-grained strata with some coal.

Several authors including Cranfield & others (1975) and Fielding (1988) have discussed the geology of the basin.

There are substantial coal deposits in the basin. They include the Rosewood–Walloon Coalfield and deposits at Millmerran and Felton. Coals generally are high volatile bituminous thermal coals; some are also suitable for conversion to liquid fuels.

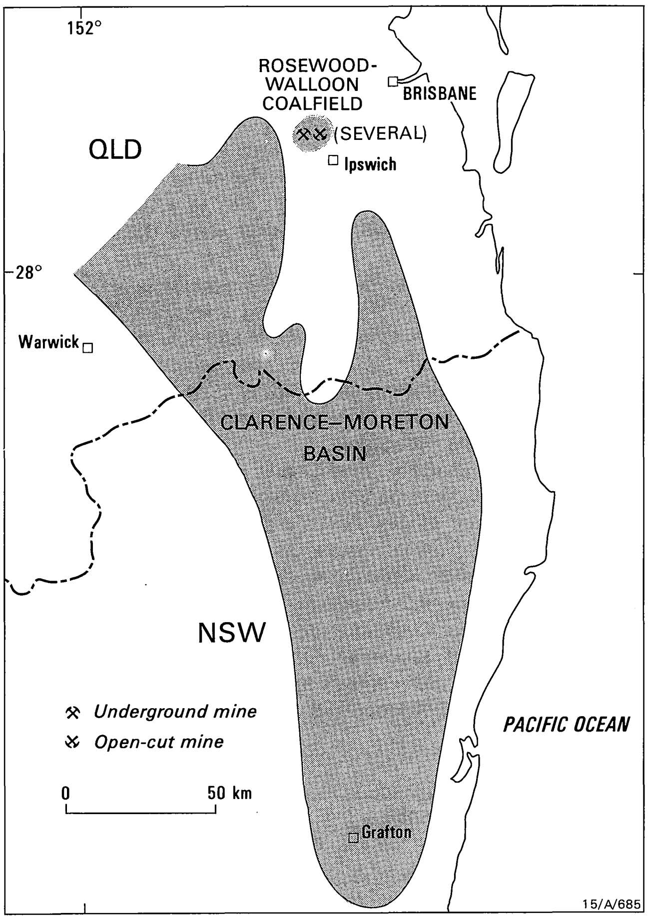

Fig. 37. Location (semi-diagrammatic) of the Clarence–Moreton Basin, and Rosewood–Walloon Coalfield, Qld, and NSW.

The only current mining area is the Rosewood–Walloon Coalfield, west of Ipswich. Production from the Acland mine near Toowoomba ceased in 1985.

Walloon Coal Measures (Cameron, 1970; Nutter & others, 1982)

Rosewood–Walloon Coalfield. The Rosewood–Walloon Coalfield is immediately west of Ipswich.

The geology of the coalfield has been reviewed comprehensively by Cameron (1970), and Fielding (1988) has reviewed the sedimentary history. Cameron notes that the regional dip of the strata is usually 3° or less and there has been some normal faulting, but poor outcrop tends to conceal the faults.

The principal coal-bearing unit is the Walloon Coal Measures (Middle to Late Jurassic). The coal measures rest conformably on the Marburg Formation (Early–Middle Jurassic). Besides coal, the Walloon Coal Measures consist of fine sandstone, siltstone, mudstone and shale. Cainozoic basalts and sediments unconformably overlie the coal measures.

In this coalfield Cameron (1970) has recognised upper and lower, predominantly sandstone, intervals sandwiching the coal-bearing sequence. The coal zone is about 150 m thick and has 18 main seams.

Cameron (1970) proposed a coalfield-wide seam nomenclature to replace the multitude of local names that had arisen.

Coals from this sequence are generally high volatile and bituminous and are mainly used as thermal coal. The Queensland Coal Board (1986) notes that they can also be used for gas generation.

Mining on the coalfield began in 1881 (Cameron, 1970). There are now four mines operating: Oakleigh No. 3 underground, and the Oakleigh, Jeebropilly, and Ebenezer open cuts. A summary of past production in Cameron (1970) shows output peaked at about 435 000 t/year, but by 1988–89 saleable coal production exceeded 1.75 Mt/year.

Millmerran–Felton. The Middle–Late Jurassic Walloon Coal Measures are the coal-bearing unit in this area of the Clarence–Moreton Basin. They rest conformably on sediments of the Marburg Formation (Early–Middle Jurassic) and are conformably overlain by the Kumbarilla beds (Jurassic–Cretaceous) (Fig. 38). Nutter & others (1982) have divided the coal measures into five sub-units from the base: a Lower Transition Unit, Lower Coal Bearing Unit, Barren Unit, Upper Coal Bearing Unit, and an Upper Transition Unit.

Generally, dips are less than 3°.

Coals from these deposits are typical Walloon coals with a high content of volatile matter and a low sulphur content. All coal of economic interest is in the Lower Coal Bearing Unit. In the Commodore 1 deposit at Millmerran, Nutter & others (1982) describe three seams: the Bottom Rider, Commodore, and Top Rider, of which Commodore is the most important. The Bottom Rider has an average thickness of 0.5 m and has siltstone, mudstone, and sandstone bands. The coal is predominantly dull. The Top Rider seam may be eroded but where present it has a maximum thickness of 3 m and common stone bands.

Nutter & others refer to five seams at Felton: BB, B, M, T, and H. The M Seam, with an average thickness of 7 m, and the T Seam, 3 m, are the most important. In general the coal is similar to that from the Commodore Seam. There is also a sixth seam, the G seam, present in parts of the area but it is not of economic interest.

There is no mining at present, although in the past there have been several small-scale operations.

Toowoomba–Dalby (Mengel 1963a, b; McLean-Hodgson & Kempton, 1982). The general geological sequence is similar to that described above for the Millmerran–Felton area. The coal measures conformably overlie the Marburg Formation and are in

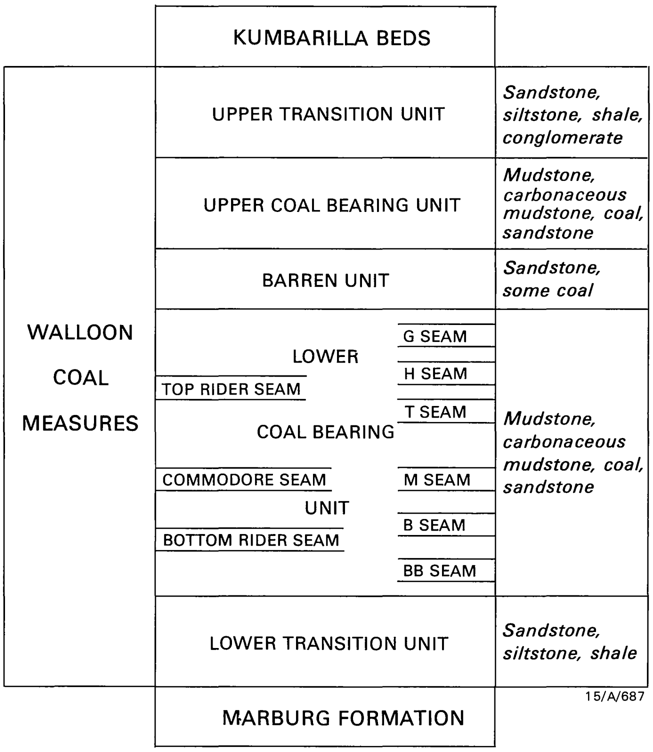

Fig. 38. Stratigraphy and lithology, Walloon Coal Measures, Millmerran–Felton Area (based on Nutter & others, 1982).

turn conformably overlain by the Kumbarilla beds. Extensive reviews of the geology of the region are given by McLean-Hodgson & Kempton (1982) and Mengel (1963a, b), who have delineated seven rock units within the sequence, the lowest of which is the Marburg Formation. Three coal units have been identified, of which the oldest is the Balgowan coal interval. The main coal-bearing horizon is the middle unit, the Acland–Sabine coal interval. The Waipanna coal interval (the second-highest unit of the seven) is the youngest coal-bearing unit.

As in other areas, the Walloon Coal Measures in this locality dip only gently.

Up to seven thin seams make up the Balgowan coal interval. The seams are generally subject to splitting. The Waipanna coal interval contains four coal-bearing zones; each of these may be up to 10 m thick but their coal content ranges from only 10% to 60% (McLean-Hodgson & Kempton, 1982).

The main economic interest lies in the Acland–Sabine coal interval. The Acland sequence contains four seams: A1 (top) to A4 (bottom). The A1 seam is from 3 to 15 m thick (McLean-Hodgson & Kempton, 1982) but has numerous thin stone bands. A2 is about 1.5 m thick and is also banded. The A3 and A4 seams were mined in the Acland underground mine.

McLean-Hodgson & Kempton record 11 seams in the Sabine sequence. Generally they are less than 1 m thick and occur in a 30 m thick zone.

Coals from this region are generally high volatile bituminous thermal coals. Ash tends to be high but sulphur is low. The coals have potential for conversion to liquid fuel.

There are no operating mines in the region. The last colliery, Acland, closed in 1985. Deposits in the area can be mined by open cut.

Surat Basin

(Jones & Patrick, 1981)

The Surat Basin contains coal measures (Walloon) in a north-westerly-trending zone from immediately west of Dalby to west of Injune (120 km west of Taroom; Fig. 39), in a continuation of strata from the Clarence–Moreton Basin across the Kumbarilla Ridge.

Exon (1976; 1981) has described the general geology of the basin. Jones & Patrick (1981) proposed a revision of the coal-bearing sequence involving raising the Walloon Coal Measures to subgroup status (Walloon Subgroup). They named the upper coal-bearing unit of the subgroup the Juandah Coal Measures and the lower coal unit the Taroom Coal Measures. The two are separated by the Tangalooma Sandstone.

The Walloon sequence conformably overlies the Eurombah Formation and is conformably overlain by the Springbok Sandstone; all three are of Middle–Late Jurassic age.

In the Taroom Coal Measures the predominant rock type is sandstone with lesser siltstone, mudstone, shale, and coal. The intervening Tangalooma Sandstone, as described by Jones & Patrick, fines upward to siltstone and mudstone. The Juandah Coal Measures consist of sandstone, siltstone, mudstone, and coal.

There are several coal deposits in the area but none are mined. The lack of lateral persistence of the individual seams precludes a

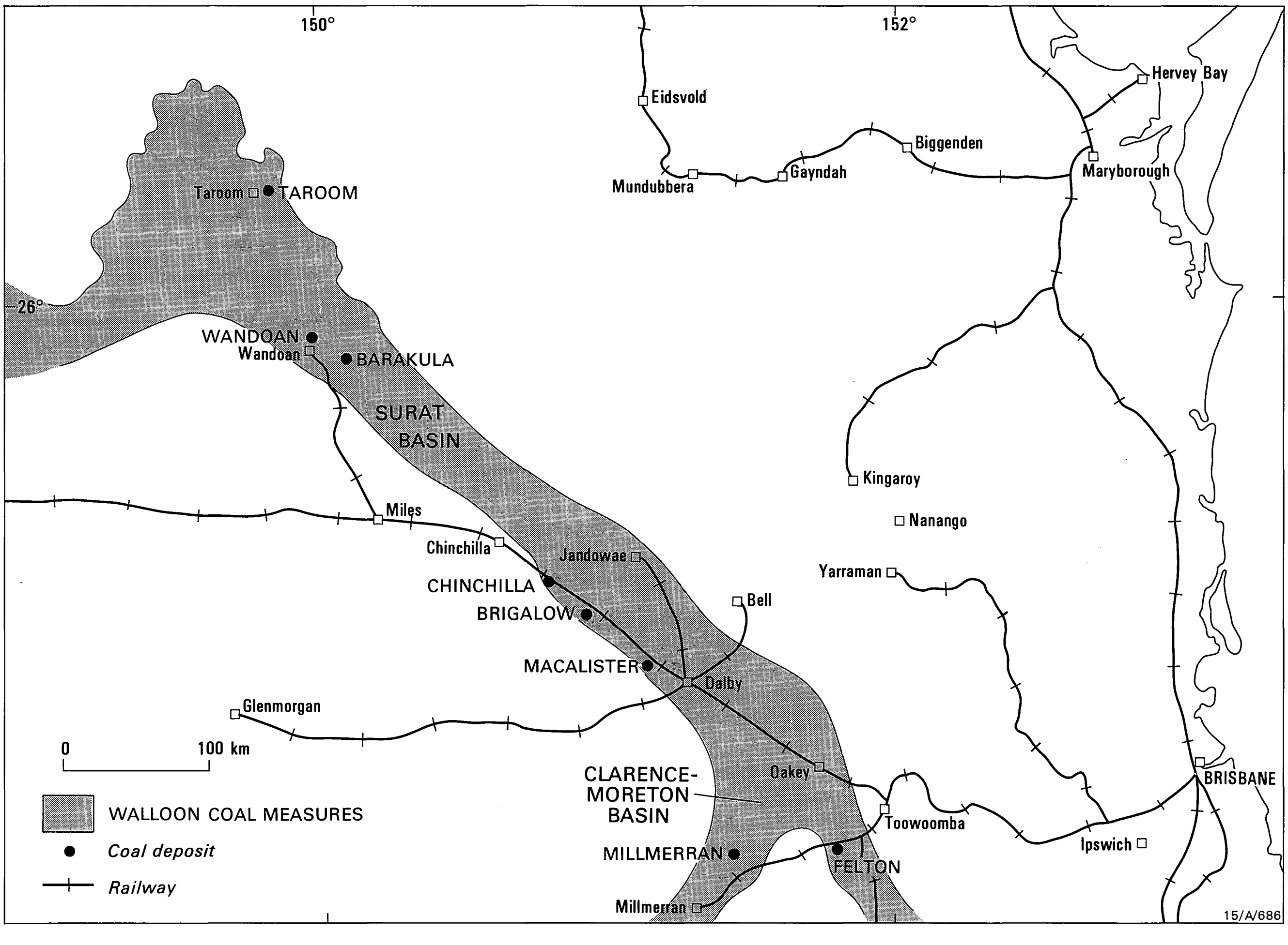

Fig. 39. Distribution (diagrammatic) of the Walloon Coal Measures in the Clarence–Moreton & Surat Basins, Toowoomba–Taroom region, Qld, and locations of some deposits.

uniform seam nomenclature. They are generally high volatile bituminous thermal coals, many of which are suitable for conversion to liquid fuels. The principal deposits in the basin are, from northwest to southeast, Taroom, Wandoan, Barakula, Chinchilla, Brigalow, and Macalister (Fig. 39).

Coal is not mined, although there is potential for open-cut production.

NEW SOUTH WALES

In New South Wales, coal occurs in the Clarence–Moreton, Ashford, Gloucester, Gunnedah, Sydney, and Oaklands Basins. Coal is currently mined in the Gunnedah and Sydney Basins, and the Gloucester and Oaklands Basins have the potential to support mining.

Resources of black coal (Triassic and Jurassic) in the **Clarence–Moreton Basin** in New South Wales are minimal and are not considered further here.

Coal from the **Ashford Basin** (Permian) was used until recently for local electricity generation. Sniffin & others (1986) note that the Ashford seam is highly variable, ranging from a high ash thermal coal to a medium volatile coking coal. Because of the isolation of Ashford from potential markets it is unlikely that Ashford coal would be used in coke oven blends.

The **Gloucester Basin** is Permian in age and has no coal mining operations. Coal resources occur in the Gloucester Coal Measures and Dewrang Group. Sniffin & others record considerable seam variability in the basin but note that medium to high ash coking and thermal coals could be won.

In the **Gunnedah Basin**, substantial resources of Permian coal occur in the Maules Creek and Black Jack Formations. Both formations are currently mined and major new mines are planned for the Maules Creek Formation. High volatile, soft coking coal is the principal product. Medium to high volatile thermal coal can also be produced. High volatile, soft coking and thermal coals can be produced from the Maules Creek Formation.

The **Sydney Basin** is the principal coal basin in the State. It contains four designated coalfields: Hunter (Singleton–Muswellbrook), Newcastle (Newcastle), Western (centred on Lithgow), and Southern (Wollongong) (Fig. 2). A wide range of products is won from these coalfields, e.g.

Hunter	Medium volatile soft coking coal; medium volatile thermal coal.
Newcastle	Medium to high volatile soft coking coal; medium volatile thermal coal
Western	Medium to high volatile thermal coal and minor soft coking coal for blending.
Southern	Low to medium volatile, hard coking coal; medium to hard, medium volatile coking coal; low to medium volatile thermal coal.

Further product differentiation is possible on the basis of other properties.

All Sydney Basin coals are of Permian age.

The Cranky Corner Basin, a small (15 km^2) outlier of the Sydney Basin 50 km northwest of Newcastle, is treated here under the Sydney Basin ('Greta Coal Measures' heading).

The **Oaklands Basin** (Permian), in the south of the State, is being investigated as a possible site for a coal mine with associated power station. Medium to high ash, medium to high volatile thermal coals occur in two seams.

Ashford Basin

(Britten, 1975c)

Coal was discovered in the small, narrow Ashford Basin, north of Ashford in the New England area in northeastern New South Wales, in 1884.

The Ashford Coal Measures were discussed briefly by Britten (1975c). They occur discontinuously in a narrow north-northeast trending zone that extends over some 50 km and they unconformably overlie the Beacon Mudstone (Early Carboniferous). The coal measures are up to 300 m thick and comprise mainly shale, sandstone, and conglomerate, with some coal. They are of Permian (probably Early Permian) age and are broadly correlated with the Greta Coal Measures.

The coal seams dip at 20° to 40°.

Two named seams, Bonshaw and Ashford, are present. The Bonshaw seam is inconsistent in thickness and of poor quality. It is not considered to be of economic importance. The Ashford seam was mined sporadically until recently and yielded coal that would be suitable for use in coking blends but because of the distance from markets it was used for local electricity generation only.

Remaining demonstrated in-situ resources total some 0.5 Mt (Sniffin & others, 1986).

A small colliery on the field closed in 1925 after producing less than 2000 t. Recent mining was from a small open cut just over 20 km north of Ashford. This was a joint venture between White Industries Ltd and Mareeba Mining Ltd and supplied thermal coal to the Ashford power station.

Gloucester Basin

(Sniffin & others, 1986)

The Gloucester Basin is some 80 km north of Newcastle. The geology of the basin has been described by George (1975), and a revised general stratigraphy has been published by Sniffin & others (1986).

The basin is a narrow north-trending syncline with several marginal strike faults against older Permian and pre-Permian rocks (George, 1975). There are east–west transverse faults on both flanks. The coal-bearing sequence is Late Permian.

The stratigraphy proposed for the basin (see Sniffin & others) is shown in Figure 40. The Dewrang Group conformably overlies the

GLOUCESTER COAL MEASURES	CRAVEN SUBGROUP	CROWTHERS ROAD CONGLOMERATE	
		WOODS ROAD FORMATION	LINDEN SEAM BINDABOO SEAM DEARDS SEAM
		BUCKETTS WAY FORMATION	CLOVERDALE SEAM ROSEVILLE SEAM
		WARDS RIVER CONGLOMERATE	
		WENHAMS FORMATION	BOWENS ROAD SEAM
	SPELDON FORMATION		
	AVON SUBGROUP	DOG TRAP CREEK FORMATION	GLENVIEW SEAM MARKER II SEAM
		WAUKIVORY CREEK FORMATION	AVON SEAM TRIPLE SEAM ROMBO SEAM GLEN ROAD SEAM VALLEY VIEW SEAM PARKERS RD SEAM
DEWRANG GROUP		MAMMY JOHNSONS FORMATION	
		WEISMANTEL FORMATION	WEISMANTEL SEAM
		DURALLIE ROAD FORMATION	

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Fig. 40. Stratigraphy, Late Permian coal-bearing sequence, Gloucester Basin (based on Sniffin & others, 1986).

Early Permian Stroud Volcanics and is conformably overlain by the Gloucester Coal Measures.

The Dewrang Group is mainly sandstone but also contains conglomerate and siltstone. There is one coal horizon, the Weismantel seam.

In the Gloucester Coal Measures the Avon Subgroup has eight named seams and the Craven Subgroup six named seams. Sandstone, conglomerate, and siltstone are the principal other rock types.

Sniffin & others (1986) note that there are more than 50 coal seams in the basin, but only 15 are named, and of these only six can be correlated across the basin. These six are the Weismantel seam of the Dewrang Group; the Glenview, Avon, and Triple seams of the Avon Subgroup; and the Cloverdale and Bowens Road seams of the Craven Subgroup.

The Weismantel seam contains up to 3% sulphur, which, after the coal is washed, may be reduced to the range of 1.4–1.8% (Sniffin & others). Generally the coals in the basin are medium to high volatile and high swelling.

The Gloucester Basin coals would be suitable for use as either coking or thermal coal, although the ash content may be high.

George (1975) reports that several attempts to establish small-scale mines had been made since coal was first discovered in the basin in 1855. No mines are working now although two potential mining areas have been identified (Sniffin & others, 1986), in the Stratford and Wards River areas in the central and southern parts of the basin where seams are flat and shallow. Sniffin & others (1986) regard the Triple and Avon seams as having the greatest economic potential at Stratford and the Weismantel seam as having the greatest potential at Wards River. They record demonstrated in-situ resources of 71 Mt of open-cut coal in the Avon and Triple seams and 32 Mt in the Weismantel seam.

Gunnedah Basin

(Gunnedah Coalfield) (Tadros & others, 1987)

The Gunnedah Basin (Fig. 2) is contiguous with the Sydney Basin. The regional geological setting of the basin is briefly described by Tadros & others (1987) as an elongate north-northwesterly trending structure bounded to the east by the Mooki Thrust and eroded in the southwest from off the underlying Lachlan Fold Belt.

The basin is Permian to Triassic in age. Much of it is overlain by Tertiary and Jurassic volcanics, and regionally to the west and north it passes beneath the Jurassic–Cretaceous Surat Basin. The boundary between the Gunnedah Basin and the Sydney Basin to the south is placed somewhat arbitrarily at the Mount Corricudgy Anticline (Mayne & others, 1974, p. 4). It is geologically probable that the Gunnedah Basin extends north at depth to link up with the Bowen Basin in Queensland.

Sniffin & others (1986) record the stratigraphy of the basin and show an Early Permian sequence of volcanics, claystone, sandstone, and coal. Overlying this is a later Permian sequence of mainly sandstone, siltstone, and coal.

Coal is present in the Early Permian Maules Creek Formation and the Late Permian Black Jack Formation (Fig. 41). Only the Black Jack Formation has been mined so far; it yields both thermal and coking coal. Generally the Maules Creek Formation coals have a lower ash content and are slightly higher in volatile matter than those of the Black Jack Formation; similarly, the Maules Creek Formation has the potential to yield both coking and thermal coal.

Mining in the Gunnedah Basin started in 1890, with two collieries working south of Gunnedah (Doyle & others, 1986). Coal was used mainly by the railways. Production is now directed to exports. Production from underground mines slightly exceeds that from open cuts.

Maules Creek Formation (Doyle & others, 1986)

The Maules Creek Formation extends throughout the Gunnedah Basin, and is the uppermost sequence of the Early Permian section in the basin. It conformably overlies the Early Permian Leard Formation and is conformably overlain by the Late Permian Porcupine Formation; it is generally correlated with the Greta Coal Measures in the Newcastle and Hunter Coalfields.

The number of coal seams varies. In the Vickery area some 20 km north of Gunnedah seven seams are reported by Sniffin & others (1986). The same authors reported 15 seams north of Maules Creek, and their approximate correlation between the two areas is shown in Figure 41.

In general the Maules Creek coals are likely to yield products with lower ash and higher volatile matter than the younger Black Jack Formation coals.

At Vickery, underground mining has commenced in the Gundawarra seam following earlier bulk sampling. The principal seams of interest for open cut mining here are the Cranleigh, Stratford, Shannon Harbour, and Gundawarra.

Black Jack Formation (Tadros & others, 1987)

The Late Permian Black Jack Formation extends throughout the Gunnedah Basin. It conformably overlies the Watermark Formation (Fig. 42) and is unconformably overlain by the Triassic Digby Formation. Various authors including Tadros & others (1987) and Beckett & others (1983) have discussed the geology of the Black Jack Formation in some detail.

Non-coal rock types in the unit are sandstone and siltstone with subordinate claystone and conglomerate. The topmost unit in the formation is tuffaceous. Three coal seams are recognised: Melvilles, Hoskissons, and Wondoba.

The Black Jack Formation is usually correlated with the Singleton Supergroup of the Newcastle and Hunter Coalfields. The Hoskissons and Melvilles seams are currently mined. Either thermal or coking coal can be produced. The coal is exported through Newcastle.

Thermal coal products are medium to high ash and have a high volatile matter content. Soft coking coal has low ash and is high volatile. Sniffin & others (1986) report that a low volatile coal is produced from the formation.

Coal is produced at the Gunnedah No. 2 colliery and the Preston Extended colliery. Gunnedah No. 2 colliery produces high volatile coking coal and thermal coal for export.

Sydney Basin

Along the New South Wales coast the Sydney Basin (Permian–Triassic) extends from near Batemans Bay in the south to north of

PORCUPINE FORMATION			
	VICKERY AREA	MAULES CREEK AREA	
MAULES CREEK FORMATION		HERNDALE SEAM	*Coal, sandstone, claystone*
		ONAVALE SEAM	
		TESTON SEAM	
		THORNFIELD SEAM	
	GUNDAWARRA SEAM	BRAYMONT SEAM	
		BOLLOL CREEK SEAM	
	WELKEREE SEAM	JERALONG SEAM	
	KURRUMBEE SEAM	MERRIOWN SEAM	
		VELYAMA SEAM	
	SHANNON Hbr SEAM	NAGERO SEAM	
	STRATFORD SEAM	NORTHAM SEAM	
	BLUE VALE SEAM	THERRIBRI SEAM	
	CRANLEIGH SEAM	FLIXTON SEAM	
		TARRAWONGA SEAM	
		TEMPLEMORE SEAM	
LEARD FORMATION			*Pelletoid claystone, some sandstone*

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Fig. 41. Stratigraphy and lithology, Early Permian coal-bearing sequence, Gunnedah Basin, NSW (seam nomenclature and approximate correlation follow Sniffin & others, 1986).

BLACK JACK FORMATION	WONDOBA SEAM	*Coal, sandstone, siltstone, claystone, conglomerate*
	HOSKISSONS SEAM	
	MELVILLES SEAM	
WATERMARK FORMATION		*Sandstone, siltstone*
PORCUPINE FORMATION		*Sandstone, siltstone*

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Fig. 42. Stratigraphy and lithology, Late Permian coal-bearing sequence, Gunnedah Basin.

Newcastle (Fig. 2). It stretches in a north-northwesterly direction to beneath the Tertiary basalts of the Liverpool Range, where its boundary with the mainly coeval Gunnedah Basin is arbitrarily placed. In the same area it is also overlain unconformably by the Jurassic–Cretaceous strata of the Surat Basin.

Herbert & Helby (1980) have reviewed the geology of the basin.

The basin is bounded in the northeast by the Hunter–Mooki Thrust zone. In the west its boundary is erosional, where the basin strata lie unconformably on older Palaeozoic rocks.

The Sydney Basin strata range from Carboniferous to Middle Triassic in age, the thickest sequences being Permian and Triassic. All coals in the basin are Permian. Sniffin & others (1986) have presented a generalised stratigraphy for New South Wales coalfields from which Figure 3 has been derived.

Coals produced from the Sydney Basin cover a wide range of compositions and are both exported and sold on domestic markets.

Coal was first discovered in Australia near Newcastle and was first mined there in the last years of the eighteenth century. Mining is currently in the shallower, marginal areas of the basin. A wide variety of product coal is won.

Historically, underground mining has predominated, but open-cut mining has increased in importance in recent years. Production in the Southern Coalfield is entirely from underground mines. In the Western and Newcastle fields open-cut mines operate but underground mines still predominate. In the Hunter Coalfield, the largest producing region in the State, production from open-cut mines predominates.

Greta Coal Measures

The Greta Coal Measures are the oldest of the economically important coal-bearing units in the Sydney Basin. They reach shallow depths in two separate areas near Maitland and Muswellbrook in the Hunter Valley, along the northeastern edge of the basin. Several seams are present at both localities but detailed correlation between the areas is uncertain.

Many revisions have been made to the stratigraphy of the Greta Coal Measures, and to the underlying and overlying sequences, since Edgeworth David first named them in 1888. The Greta Coal Measures conformably overlie Early Permian marine strata of the Dalwood Group and are conformably overlain by Late Permian Marine strata of the Maitland Group (Britten, 1975a).

MAITLAND GROUP	
GRETA COAL MEASURES	*Volcanolithic clastic facies*
	Pelletoid clayrock facies
DALWOOD GROUP AND SKELETAR FORMATION	

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Fig. 43. Generalised stratigraphy of the Greta Coal Measures, Sydney Basin, NSW (after Hamilton, 1986).

The stratigraphy proposed by Hamilton (1986) is adopted here for the Muswellbrook area in the Hunter Coalfield. Hamilton has proposed the replacement of defined units of formation status within the Greta Coal Measures with two sedimentary sequences — an older 'pelletoidal clayrock facies' and a younger 'volcanolithic clastic facies' (Fig. 43). Rocks of the pelletoidal clayrock facies consist of unstratified colluvium with angular pellets, and alluvial deposits containing rounded and flattened pellets. The Lewis, Loder, and Balmoral seams interfinger with the claystone and are considered to be part of this facies (Hamilton, 1986, p. 5). The overlying volcanolithic clastic facies makes up most of the Greta Coal Measures. Predominant rock types are sandstone, conglomerate in places, siltstone with interbedded sandstone, siltstone, and carbonaceous claystone. Several coal seams occur throughout this facies in the Muswellbrook area.

Outside the Muswellbrook area, the Greta Coal Measures occur in the Greta–Maitland–Cessnock area in the Newcastle Coalfield and in the Cranky Corner Basin east of Glendon Brook. In these areas sandstone and siltstone are again dominant, with minor conglomerate. There are fewer coal seams here than in the Muswellbrook area.

In the Newcastle Coalfield and the Cranky Corner Basin there are three principal coal seams; elsewhere up to six may be present.

The coals are generally high to very high in volatile matter. Parts of some seams commonly have a higher sulphur content than other Australian coals although the Greta coals near Muswellbrook are somewhat lower in sulphur than elsewhere.

Demonstrated in-situ resources in the Greta Coal Measures total 885 Mt (581 Mt underground; 304 Mt open-cut) (Tables 7 & 8).

The Greta Coal Measures were first mined at Anvil Creek near Greta, west of Maitland, in 1868 (Britten, 1975a). Much of the Greta coal in the Newcastle Coalfield has been worked out but mining is continuing at Pelton/Ellalong and there are proposals for deeper mining beyond earlier workings. South of Muswellbrook, in the Hunter Coalfield, the coal measures are worked at the Bayswater No. 2 open cut (1.3 Mt saleable coal 1988–89) and the Drayton open cut (3.2 Mt). Immediately east of Muswellbrook the Muswellbrook No. 2 underground mine (0.24 Mt) and the Muswellbrook No. 2 open cut (0.90 Mt) also work the unit. Near

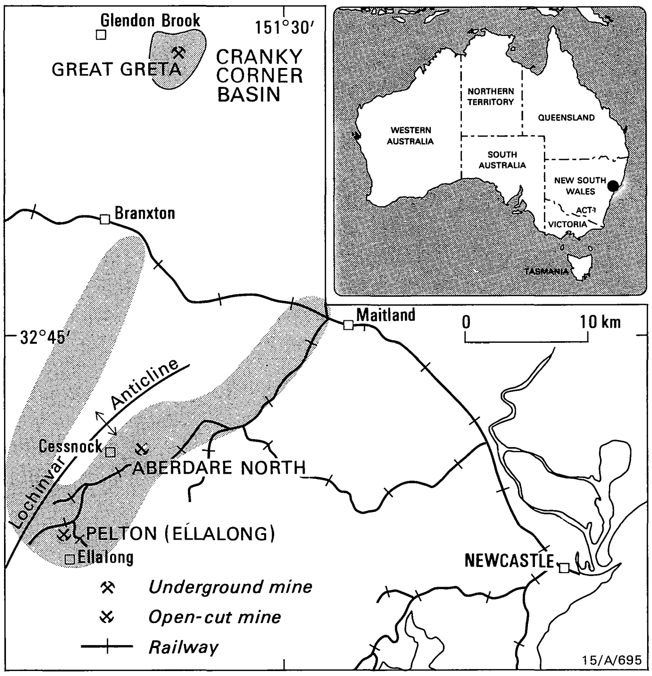

Fig. 44. Distribution (diagrammatic) of the Greta Coal Measures in the Newcastle Coalfield and Cranky Corner Basin.

Glendon Brook (Cranky Corner Basin) the Great Greta underground mine and open cut work the Tangorin seam.

Newcastle Coalfield (Britten, 1975a). The Greta Coal Measures crop out around the flanks of the Lochinvar Anticline (Fig. 44). Doyle & others (1986) note that access to coal in the western part of the area is limited by faulting and major faults also occur in the north. The principal rock types, apart from coal, are sandstone and conglomerate, with lesser siltstone and claystone. In the type section the Greta Coal Measures are '... of the order of 100 m thick...' (Doyle & others, 1986, p. 32).

The three principal seams in the sequence are, in ascending order, the Homeville, Greta, and Pelton seams. The Homeville and Greta coals have prominent upper and lower splits in parts of the area and are the only seams of economic interest. Splitting is prominent and complex throughout the area.

The coals generally have a relatively low ash content although they are relatively high in sulphur compared to other Australian coals. Doyle & others (1986) have noted that high sulphur in the top of the Greta seam has limited the workings to a section about 6 m thick. An additional problem is that the sulphur is mostly organic and cannot be removed by the usual beneficiation processes. The Greta seam in the Newcastle Coalfield is mainly used as a blend in coking coals but has also been used by the chemical industry and for gas making.

There is no current production from the Homeville seam, although it has similar properties to those of the Greta seam.

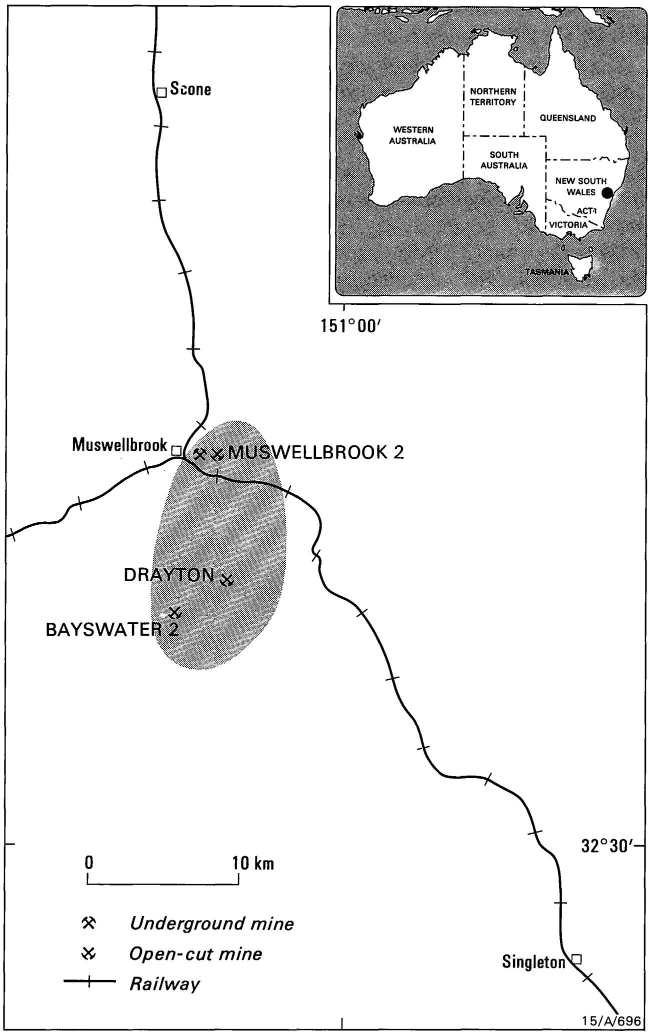

Fig. 45. Distribution (diagrammatic) of the Greta Coal Measures in the Hunter Coalfield.

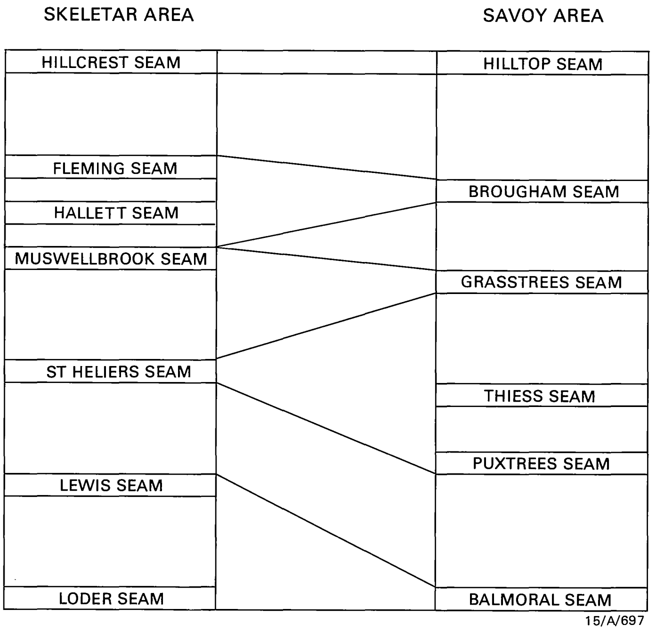

Fig. 46. Gross seam correlations for the Greta Coal Measures in the Muswellbrook District, Hunter Coalfield (published with the permission of the Greta Working Party of the Standing Committee on Coalfield Geology of NSW).

There has been continuous production since 1868, although currently only one mine, Pelton/Ellalong, works the unit (production of 1.6 Mt in 1988–89).

Hunter Coalfield: Skeletar area (Hamilton, 1986). The Greta Coal Measures in this region are present immediately east and northeast of Muswellbrook (Fig. 45).

The stratigraphy has been revised by numerous authors; Hamilton's (1986) revisions are adopted here.

Correlation of seams between the Skeletar area and the Savoy area south of Muswellbrook is uncertain. However, the Greta Working Party of the Standing Committee on Coalfield Geology of New South Wales has proposed a broad correlation of sedimentary sequences between the areas (Fig. 46).

Coals in this area are typically low in ash and high in volatiles. Sulphur content is relatively high compared to other Australian coals but is lower than in Greta coals elsewhere. Saleable coal produced is used for metallurgical and thermal applications.

Of the seams in the Skeletar area the Lewis, St Heliers, and Muswellbrook are the most important and are worked in the Muswellbrook mines. There has been minor production from the Hallett seam.

Britten (1975b) notes that mining began in the area in the mid nineteenth century and by the early 1970s about 9 Mt of open-cut coal and 7 Mt of underground coal had been won. The Muswellbrook No. 2 mines worked the sequence in 1988–89.

Hunter Coalfield: Savoy area (Hamilton, 1986). The Savoy area is south of Muswellbrook (Fig. 45).

The Greta Coal Measures in this area are exposed along the axis of the Muswellbrook Anticline. The geology is complicated by faults and igneous intrusions. Hamilton (1986) has described three sandstone marker horizons: the Ayrdale Sandstone Member, the 'Brougham Sandstone', and the 'Hilltop Sandstone'. The Ayrdale Sandstone Member is a 30 m unit containing minor siltstone and conglomerate, between the Balmoral and Puxtrees seams. The 'Brougham Sandstone' separates the Grasstrees and Brougham seams and contains minor siltstone and some carbonaceous bands. The third horizon is the 'Hilltop Sandstone' which overlies the Brougham seam; where present it consists partly of sandstone and sandstone–siltstone laminite. Neither the Brougham nor the

Hilltop sandstone has been formally defined. These horizons are absent in the Skeletar area, making correlation of seams uncertain.

The seams in the Savoy area (Fig. 46) generally have a low to medium ash content and are high in sulphur and volatile matter. They are used in metallurgical blends and as thermal coals.

Intrusions are abundant, and, with small-scale faulting, cause problems in geological interpretation. Seams in the area are more subject to splitting than are the seams in the Skeletar area.

A split from the Balmoral seam yields a semi-anthracite product.

The coal is extracted at the Bayswater and Drayton open-cut mines (Balmoral and Thiess seams at Bayswater; Balmoral, Puxtrees, Thiess, and Brougham seams at Drayton). The Bayswater mine produces high volatile metallurgical coal for export and a thermal coal for export and domestic markets. Drayton produces thermal coal for export and domestic consumption.

Cranky Corner Basin (Britten, 1975a). A small (15 km^2) outlier of Greta Coal Measures, known as the Cranky Corner Basin, is present east of Glendon Brook (Fig. 44), 20–25 km east of Singleton.

The Cranky Corner Basin contains the Dalwood Group, Greta Coal Measures, and Maitland Group overlying Carboniferous volcanics; the Greta Coal Measures are mainly sandstone with minor conglomerate.

Only three seams are present, in ascending order: Stanhope, Tangorin, and Eui. Of these only the Tangorin seam is of economic interest. The Eui seam is only 1 m thick (Britten, 1975a); the Stanhope seam is high in sulphur and very banded. The Tangorin seam also is high in sulphur but its other properties, e.g. low ash, compensate for this.

The Tangorin seam is mined in the Great Greta underground mine (0.36 Mt of saleable coal in 1988–89). In 1984–85 there was also a small open cut operating. The seam yields high volatile metallurgical coal for export as well as steaming coal for both export and domestic markets.

Tomago Coal Measures (Newcastle Coalfield) (Britten, 1987)

The Tomago Coal Measures (Late Permian) occur north and northwest of Newcastle, in the Newcastle Coalfield (Fig. 47).

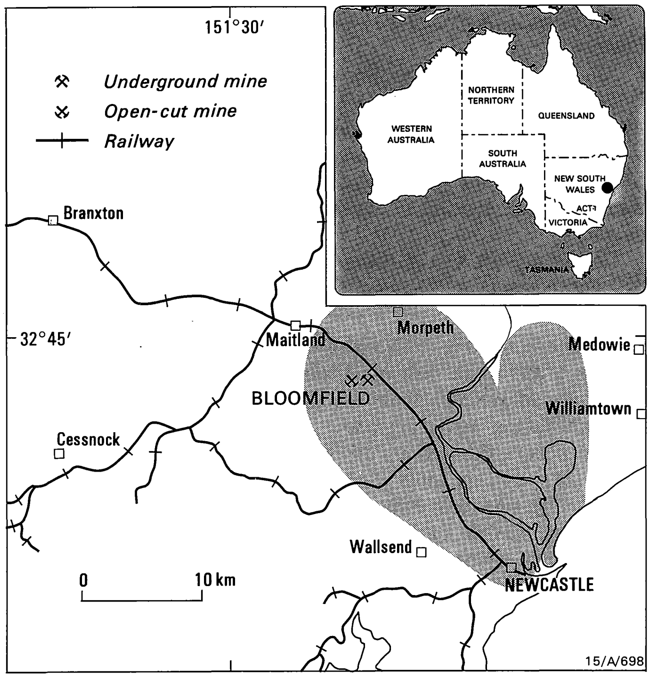

Fig. 47. Distribution (diagrammatic) of the Tomago Coal Measures, Newcastle Coalfield.

The stratigraphy and depositional history of the Tomago Coal Measures have been discussed by numerous authors including Crapp (1975), Whitehouse (1984) and Britten (1987). There are two distinct areas: (1) a western area around Wallsend, Morpeth, and Maitland (Thornton Syncline area); and (2) an eastern area around Medowie and Williamtown (Port Stephens Syncline area). Coal seams occur in both, although correlation between them has not been successful (Whitehouse, 1984) and to date only the Thornton Syncline area has been of economic interest. Whitehouse considers that the part of the Port Stephens Syncline studied by him has economic potential, although more exploration is required to prove the resource.

The stratigraphy adopted here for the Western area is that used by Brown & Preston (1985) (Fig. 48) and Britten (1987). The stratigraphy in Sniffin & others (1986, table 6.1) differs from that of Brown & Preston, indicating some continuing uncertainty regarding the overall stratigraphy of the Tomago Coal Measures.

Under Brown & Preston's stratigraphy the Tomago Coal Measures are divided into three subgroups, in ascending stratigraphic order: Wallis Creek, Four Mile Creek, and Hexham. Sandstone and siltstone are the dominant rock types and coal is present throughout the sequence. In marked contrast to the overlying Newcastle Coal Measures there is little conglomerate.

Marine sediments of the Maitland Group underlie the Tomago Coal Measures, separating them from the Greta Coal Measures. The Newcastle Coal Measures conformably overlie the Tomago Coal Measures.

Only the coals in the Wallis Creek and Four Mile Creek Subgroups are of economic interest. In general they are high volatile coals with a medium sulphur content. They are used for blending in coke oven feeds and as thermal coal.

The Tomago Coal Measures have been mined for many years. At present only the open-cut (0.83 Mt saleable coal, 1988–89) and underground (0.13 Mt) mines of Bloomfield Collieries Pty Ltd are exploiting them. The coking coal is exported and the thermal coal is either exported or consumed domestically.

	NEWCASTLE COAL MEASURES	
TOMAGO COAL MEASURES	HEXHAM SUBGROUP	SHORTLAND FORMATION
		SANDGATE FORMATION
		DEMPSEY FORMATION
	FOUR MILE CREEK SUBGROUP	IRONBARK FORMATION
		THORNTON CLAYSTONE
		ALNWICK FORMATION
	WALLIS CREEK SUBGROUP	STONY PINCH FORMATION
		SCOTCH DERRY FORMATION
		SURVEYOR CREEK FORMATION
		RATHLUBA FORMATION
		METFORD FORMATION
		MORPETH FORMATION
		RAWORTH CLAYSTONE
		TENAMBIT SANDSTONE
	MAITLAND GROUP	

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Fig. 48. Stratigraphy, Tomago Coal Measures, Newcastle Coalfield (based on Brown & Preston, 1985).

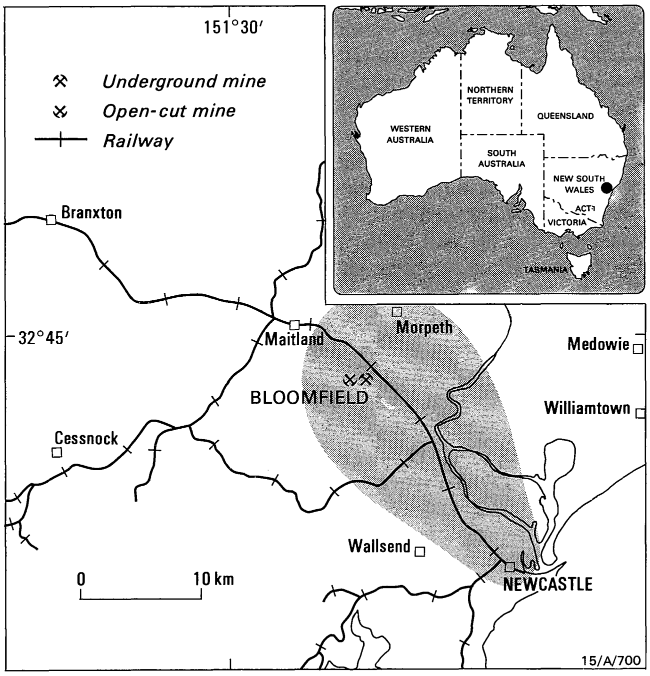

Fig. 49. Distribution (diagrammatic) of the Tomago Coal Measures in the area of the Thornton Syncline, Newcastle Coalfield.

Thornton Syncline: Fullerton–Maitland area. This area is bounded approximately by Fullerton Cove, Morpeth, Maitland, and Wallsend in the Thornton Syncline (Fig. 49).

The **Wallis Creek Subgroup** (Britten, 1987) conformably overlies the Mulbring Siltstone of the Maitland Group and is itself conformably overlain by the Four Mile Creek Subgroup (Fig. 50).

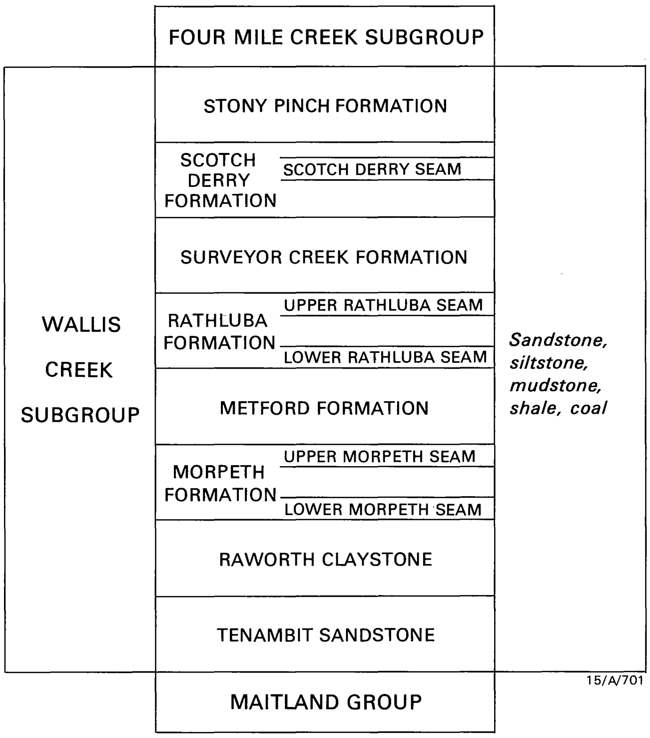

Fig. 50. Stratigraphy and lithology, Wallis Creek Subgroup, Tomago Coal Measures, Maitland–Morpeth area of the Newcastle Coalfield (based on Brown & Preston, 1985).

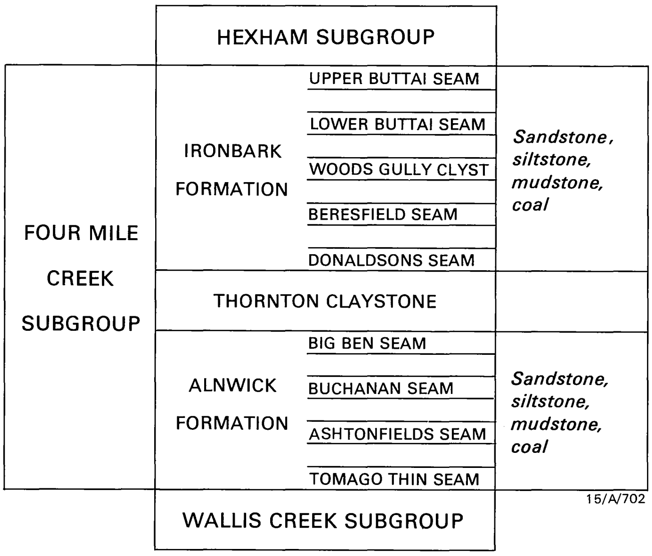

Fig. 51. Stratigraphy and lithology, Four Mile Creek Subgroup, Tomago Coal Measures, Maitland–Morpeth area of the Newcastle Coalfield.

Sandstone and sandy siltstone or shale are the main rock types. Minor mudstone (Raworth Claystone) occurs near the base of the sequence.

Coal occurs in three formations (Morpeth, Rathluba, and Scotch Derry), in five seams. Of these, only the seams in the Rathluba Formation are of economic interest. Whitehouse (1982) describes the coals in general as being high volatile, high fluidity, low sulphur, soft coking coals. He notes that most seams are less than 2 m thick and have a raw ash content of over 25%. The Morpeth seams are relatively stony and have little economic potential.

Britten (1987) discusses and illustrates splitting of the Rathluba seam in some detail. Two prominent splits are referred to as the Upper Rathluba and Lower Rathluba seams. Plies of coal split from these principal seams but are of no economic interest. The inter-split sediments are sandstone with minor mudstone.

The Scotch Derry seam is highly banded and not of economic interest.

All seams in the subgroup have been mined in the past by isolated small pits (Crapp, 1975, p. 178). The Rathluba seam is the lowest seam in the Bloomfield workings (Britten, 1987), where most production is from the overlying Four Mile Creek Subgroup. Of the three coal horizons in the Wallis Creek Subgroup, the Rathluba sequence is the most important economically.

The **Four Mile Creek Subgroup** (Britten, 1987) extends over the entire area of Tomago Coal Measures in the Thornton Syncline.

The subgroup (Fig. 51) conformably overlies the Wallis Creek Subgroup and is in turn conformably overlain by the Hexham Subgroup. Major rock types are sandstone, shale and coal, with some mudstone and claystone.

Coal occurs throughout the Subgroup, in eight seams.

The seam nomenclature used by Britten (1987) differs from that proposed by Brown & Preston (1985), but Britten has proposed a correlation between the two. He considers the Elwells Creek and Whites Creek seams of the western part of the area to be equivalent to part of the Big Ben and Donaldsons seam sequences respectively.

All seams split, sometimes complexly. Britten describes some of the splitting in the Bloomfield Colliery workings.

The coals are generally high volatile with medium to high sulphur levels. They are used in coking coal blends and as thermal coal.

Coal is won at the Bloomfield Collieries Pty Ltd's open-cut and underground mines south of Maitland. Mining has extended for over 100 years, and many collieries have been worked out. R.W. Miller & Co. Pty Ltd has made a proposal to develop the open-cut and underground Ironbark colliery southeast of Bloomfield. The Ashtonfields, Buchanan, Big Ben, Donaldsons, and Beresfield seams would all be mined in the open cut and the Upper Donaldsons seam would be mined underground.

The **Hexham Subgroup** extends over the entire area of the Tomago Coal Measures in the Thornton Syncline.

The subgroup is overlain by the basal horizons of the Newcastle Coal Measures.

The Hexham Subgroup consists of the Dempsey, Sandgate, and Shortland Formations, of which only the Sandgate contains coal. The top of the Upper Sandgate seam is the top of the Sandgate Formation. The base of the Lower Sandgate seam forms the base of the Formation. Shale and mudstone predominate over sandstone and coal.

Neither of the Sandgate seams is of economic interest. Seams in the Hexham Subgroup are not mined.

Port Stephens Syncline (Whitehouse, 1984). The coal measures in the Port Stephens Syncline underlie the area west of Williamtown and Medowie in the Newcastle Coalfield (Fig. 52). The coal measures here have not been worked. Whitehouse (1982; 1984) has discussed the geology and coal resources of the area. He notes that there is potential for development but more detailed exploration is required.

The revised stratigraphy for the Tomago Coal Measures in the Thornton Syncline area (Brown & Preston, 1985) has not been correlated with the Port Stephens Syncline sequence. Whitehouse (1982) retained a stratigraphy comprising three formations, in ascending order: Wallis Creek, Four Mile Creek, and Dempsey.

While sandstone, shale, and mudstone dominate the Wallis Creek Formation, there are some thin seams of coal. The Four Mile Creek Formation contains coal (in ten principal seams) as a major component, along with sandstone, shale, and mudstone. The Dempsey Formation is composed mainly of shale and mudstone with thin coal. Only one substantial seam, the Fullerton Cove seam, is present.

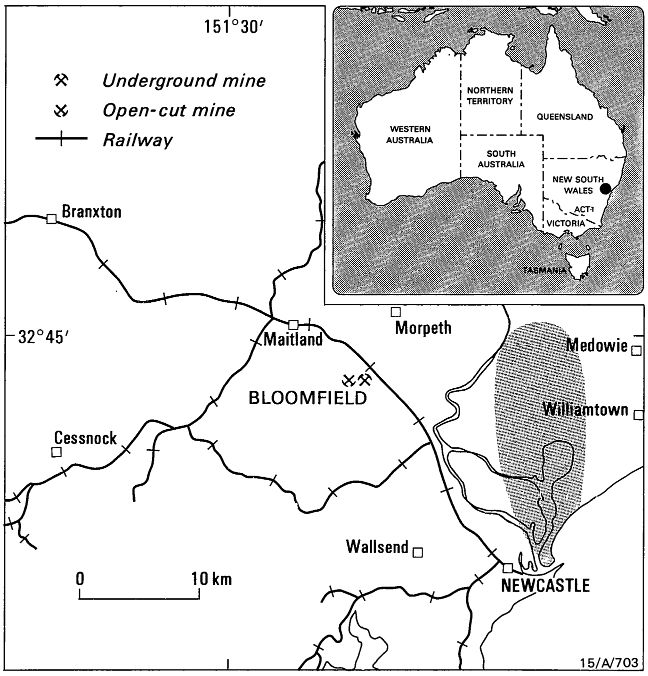

Fig. 52. Distribution (diagrammatic) of the Tomago Coal Measures in the area of the Port Stephens Syncline, Newcastle Coalfield.

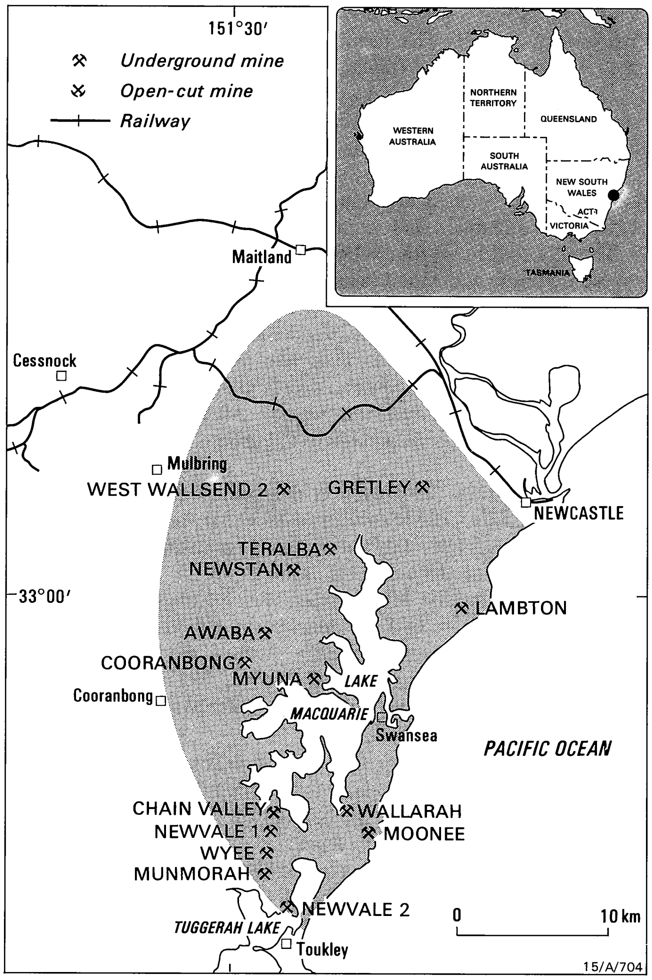

Fig. 53. Distribution (diagrammatic) of the Newcastle Coal Measures, Newcastle Coalfield.

Seams in the Four Mile Creek Formation have the best potential. In ascending order the seams are: Borda, Camp Vale, Medowie, Moffats Creek, Galloping Swamp, Telegraph Swamp, Duckhole, Saltash, Tilligerry Creek, and Williamtown.

In studying this sequence in the area of Authorisation 203, Whitehouse (1984) concluded that a number of the seams examined could have working sections of up to 4.8 m. He reports that the Medowie, Moffats Creek, and Galloping Swamp seams appear to have the most potential. They could yield a medium to high volatile, low ash coking coal. Within Authorisation 203 these seams contain indicated and inferred resources of 200 Mt (Whitehouse, 1984, table 4).

Whitehouse also reports that the Camp Vale, Tilligerry Creek, Saltash, and Duckhole seams could yield similar coking coal, although areas with working sections thicker than 1.5 m may be limited. Indicated and inferred resources total 235 Mt (Whitehouse, 1984; table 4). Limited resources of coking coal are also present in the Telegraph Swamp and Williamtown seams.

No mines operate in this sequence and any future mining will be by underground methods.

Newcastle Coal Measures (Newcastle Coalfield)

The Newcastle Coal Measures (Late Permian) underlie an area to the west and south of Newcastle, as far as Tuggerah Lake in the south, and Mulbring and Cooranbong in the west (Fig. 53).

The Newcastle Coal Measures conformably overlie the Tomago Coal Measures and are conformably overlain by the Narrabeen Group (Triassic). Numerous authors have discussed aspects of the geology and stratigraphy of the Newcastle Coal Measures, e.g. Crapp & Nolan (1975), Bowman & Whitehouse (1984), and Warbrooke (1987). The terminology adopted here follows that used by Bowman & Whitehouse (1984, table 1).

Four separate subgroups have been identified, each of which has several coal seams. In ascending order the subgroups are: Lambton, Adamstown, Boolaroo, and Moon Island Beach.

Of the non-coal rocks in the Newcastle Coal Measures, conglomerate is most abundant. Other rock types include tuff, sandstone, siltstone, and sandy siltstone.

There is coal in all four subgroups but mining has concentrated on the Lambton and Moon Island Beach Subgroups. The Lambton Subgroup provides coking coal for the Newcastle Steelworks and for export, whereas the Moon Island Beach Subgroup supplies the basic thermal coal needs of the region, particularly for the power stations around Lake Macquarie. The Boolaroo Subgroup coals are not mined and are unattractive targets. Although there has been some mining in the Adamstown Subgroup, it is not currently worked.

Sniffin & others (1986) report demonstrated in-situ resources for the Newcastle Coal Measures of 4337 Mt, with a further 2590 Mt inferred. All but 100 Mt of the demonstrated resources is amenable only to underground mining.

Production from the Moon Island Beach Subgroup is from the central western shore of Lake Macquarie and south of the Lake. The Lambton Subgroup is mainly worked west of Newcastle.

Lambton Subgroup (Crapp & Nolan, 1975). The Lambton Subgroup occurs to the east and west of Lake Macquarie and as far as Newcastle in the north.

The Lambton Subgroup (Fig. 54) overlies the Tomago Coal Measures (Late Permian) and is overlain by the Adamstown Subgroup. It extends from the base of the Borehole seam to the roof of the Victoria Tunnel seam.

The five principal coals are the Borehole, Yard, Dudley, Nobbys, and Victoria Tunnel seams. Non-coal strata are mainly siltstone and sandstone, with minor conglomerate and some tuff.

The Lambton Subgroup coals are mainly used as coking coals, both for export and domestic use. Some is also used as thermal coal.

The Nobbys, Dudley, Yard, and Borehole seams may coalesce to form other recognisable seams (Fig. 55). Coalescence of Nobbys and Dudley seams forms the Young Wallsend seam. Where the Young Wallsend, Yard and Borehole seams coalesce in the west the resultant seam is the West Borehole seam.

All seams including the Young Wallsend and West Borehole have been mined, although production from the Victoria Tunnel seam declined sharply in the mid 1980s. Nobbys seam was mined only in 1985–86 and production was very small. Production is overwhelmingly from underground mines.

Adamstown Subgroup (Crapp & Nolan, 1975). The coals of the Adamstown Subgroup are of most interest in the area to the east, west and northwest of Lake Macquarie.

As with other units in the Newcastle Coal Measures, the Adamstown Subgroup (Fig. 56) has a high proportion of conglomerate. It conformably overlies the economically important Lambton Subgroup and is conformably overlain by the Boolaroo Subgroup.

There are four seams: Fern Valley, Wave Hill, Montrose, and Australasian. Conglomerate is the main non-coal rock type and tuff is also common; sandstone and siltstone are subordinate.

The Australasian is the most important seam. However, although it may exceed 10 m in thickness, only about the lower

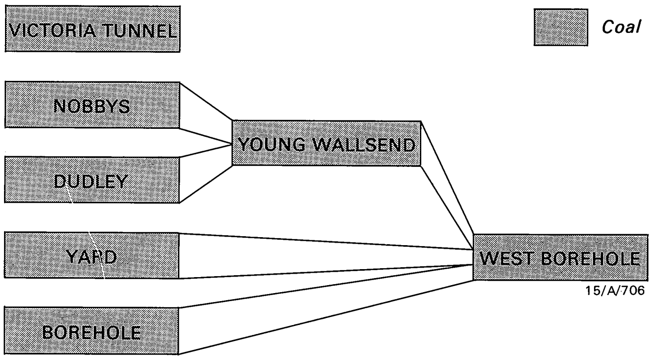

Fig. 55. Seam coalescence and nomenclature, Lambton Subgroup, Newcastle Coalfield.

	ADAMSTOWN SUBGROUP	
LAMBTON SUBGROUP	VICTORIA TUNNEL SEAM	*Coal*
	SHEPHERDS HILL FORMATION	*Tuff, sandstone, siltstone*
	NOBBYS SEAM	*Coal*
	BAR BEACH FORMATION	*Siltstone, sandstone, conglomerate*
	DUDLEY SEAM	*Coal*
	BOGEY HOLE FORMATION	*Siltstone, conglomerate, sandstone, coal*
	YARD SEAM	*Coal*
	TIGHES HILL FORMATION	*Siltstone, conglomerate, sandstone*
	BOREHOLE SEAM	*Coal*
	WARATAH SANDSTONE	*Sandstone*
	TOMAGO COAL MEASURES	

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Fig. 54. Stratigraphy and lithology, Lambton Subgroup, Newcastle Coal Measures, Newcastle Coalfield.

	BOOLAROO SUBGROUP	
ADAMSTOWN SUBGROUP	AUSTRALASIAN SEAM	*Coal*
	TICKHOLE FORMATION	*Conglomerate, sandstone, siltstone, tuff*
	MONTROSE SEAM	*Coal*
	KAHIBA FORMATION	*Sandstone, conglomerate, siltstone, tuff*
	WAVE HLL SEAM	*Coal*
	GLEBE FORMATION	*Tuff, conglomerate, siltstone, sandstone*
	FERN VALLEY SEAM	*Conglomerate, sandstone, coal, siltstone*
	KOTARA FORMATION	*Sandstone, conglomerate, siltstone, tuff*
	LAMBTON SUBGROUP	

15/A/707

Fig. 56. Stratigraphy and lithology, Adamstown Subgroup, Newcastle Coal Measures, Newcastle Coalfield.

	MOON ISLAND BEACH SUBGROUP	
BOOLAROO SUBGROUP	CROUDACE BAY FORMATION	*Conglomerate, sandstone, shale*
	UPPER PILOT SEAM	*Coal, sandstone, shale, tuff*
	REIDS MISTAKE FORMATION	*Sandstone, tuff*
	LOWER PILOT SEAM	*Coal, tuff, shale*
	WARNERS BAY FORMATION	*Sandstone, shale, tuff*
	HARTLEY HILL SEAM	*Coal*
	MOUNT HUTTON FORMATION	*Sandstone, shale, tuff*
	ADAMSTOWN SUBGROUP	

15/A/708

Fig. 57. Stratigraphy and lithology, Boolaroo Subgroup, Newcastle Coal Measures, Newcastle Coalfield.

one-third is of economic interest. The rest contains numerous stone bands (up to 2 m thick). Towards the west, the Australasian seam coalesces with the underlying Montrose and Wave Hill seams.

A relatively low ash, high volatile coking coal can be produced from the Australasian seam. The other seams in the sequence are of little economic interest.

Only the Australasian seam has been mined but there are no mines working it at present. Previous workings were in the Cardiff–Swansea area.

Boolaroo Subgroup (Bowman & Whitehouse, 1983). The Boolaroo Subgroup extends throughout the general area of the Newcastle Coal Measures.

It conformably overlies the Adamstown Subgroup and is conformably overlain by the Moon Island Beach Subgroup (Fig. 57). It consists mainly of sandstone with some shale and tuff. The top sequence, the Croudace Bay Formation, has a well developed conglomerate. Coal occurs at three levels.

In ascending stratigraphic order the three coal seams are the Hartley Hill, Lower Pilot, and Upper Pilot. However, in comparison with other seams in the Newcastle Coal Measures, the Boolaroo seams are generally too thin or banded to be of immediate economic interest. They have not been mined.

	NARRABEEN GROUP	
MOON ISLAND BEACH SUBGROUP	WALLARAH SEAM	*Coal*
	CATHERINE HILL BAY FORMATION	*Conglomerate, siltstone, shale, tuff, coal*
	GREAT NORTHERN SEAM	*Coal*
	ELEEBANA FORMATION	*Conglomerate, siltstone, tuff, coal*
	FASSIFERN SEAM	*Coal*
	BOOLAROO SUBGROUP	

15/A/709

Fig. 58. Stratigraphy and lithology, Moon Island Beach Subgroup, Newcastle Coal Measures, Newcastle Coalfield.

Moon Island Beach Subgroup (Crapp & Nolan, 1975; Bowman & Whitehouse 1983). The main area of interest for this unit is in the south of the area occupied by the Newcastle Coal Measures.

The Moon Island Beach Subgroup is the top unit of the Newcastle Coal Measures. It conformably overlies the Boolaroo Subgroup and is conformably overlain by the Triassic Narrabeen Group.

There are three principal coal seams, in ascending order: Fassifern, Great Northern, and Wallarah. Other, minor, coals are present. The dominant non-coal rock type is conglomerate which occurs in several horizons. Tuffs are also common throughout and there is minor shale and siltstone. The stratigraphy of the unit is summarised in Figure 58.

The Fassifern Seam may split into an upper and lower seam of which the lower is usually of greater interest. Occasionally a third split will be present. The Fassifern seam has a higher proportion of stone bands and gives a higher-ash raw coal than the other two seams. Generally the coal is high volatile, low sulphur thermal coal.

The Great Northern seam is a high volatile, low sulphur thermal coal that has been mined for many years for fuel for power stations in the district. The coal is mainly dull but has minor bright bands. Crapp & Nolan (1975) note the presence of two coal horizons, the Toukley Member and Buff Point Member, between the Wallarah and Great Northern seams in some areas, and suggest that these horizons 'may, in most cases, be attributed to splitting of either the Great Northern or Wallarah seams' (p. 167).

The Wallarah seam has been mined for many years and yields a high quality thermal coal. Some splitting is recorded by Crapp & Nolan (1975) in the Swansea area. The coal is essentially dull but has minor bright bands. It has a high volatile and low sulphur content.

The Moon Island Beach coals have for many years fuelled the large power stations around the south and west of Lake Macquarie. Some of the coal is exported.

All mining is by underground methods. In places, extraction of the Great Northern seam is made difficult or dangerous by the presence of a weak claystone roof instead of the more common conglomerate. The problems caused by this and ways of overcoming them have been investigated by Olsen (1984).

The mines are operated by the Electricity Commission of New South Wales subsidiaries Newcom Collieries Pty Ltd and Elcom Collieries Pty Ltd and by Coal & Allied Industries Ltd. With the exception of the Newstan Colliery which has a longwall system all operations are conventional bord and pillar mines.

Wittingham Coal Measures (Hunter Coalfield)

The principal area of interest for the Wittingham Coal Measures is bounded approximately by the towns of Singleton, Scone, Denman, and Broke in the Hunter Coalfield (Fig. 59).

The Wittingham Coal Measures are the basal unit of the Late Permian Singleton Supergroup (Fig. 3) and conformably overlie sediments of the Maitland Group. There are three non-coal-bearing units, the Saltwater Creek Formation, the Archerfield Sandstone and the Denman Formation, separated from each other by two coal-bearing units, the Vane Subgroup and Jerrys Plains Subgroup (Fig. 60).

The Saltwater Creek Formation (sandstone) rests conformably on marine sediments of the Maitland Group. The Vane Subgroup has six principal coal horizons and two sub-units, the Bulga Formation and Foybrook Formation. The Standing Committee on Coalfield Geology of NSW (1986a) has subdivided the Jerrys Plains Subgroup into eight units containing 15 coal seams. The Denman Formation is predominantly interbedded shale and siltstone, with minor sandstone. Britten (1975b) and Sniffin & others (1986) have correlated the Wittingham Coal Measures with the Tomago Coal Measures.

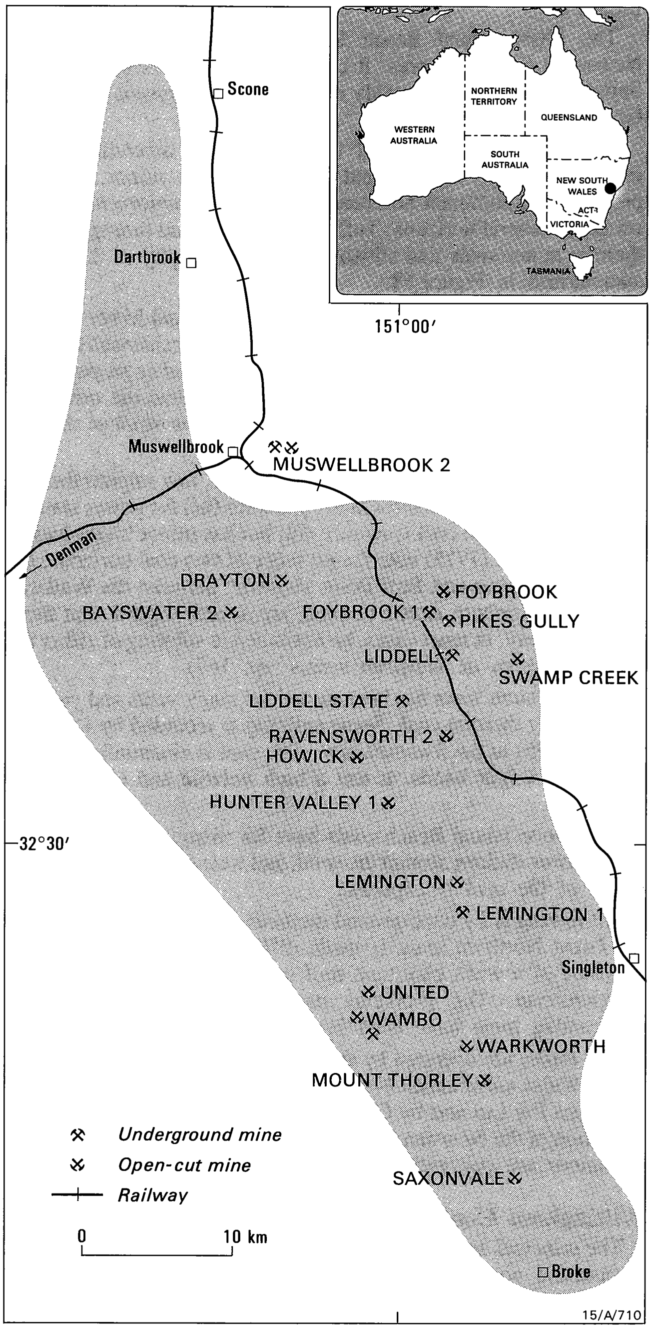

Fig. 59. Distribution (diagrammatic) of the Wittingham Coal Measures, Hunter Coalfield.

Coals from both the Jerrys Plains Subgroup and Vane Subgroup are mined. Both high volatile coking coal and thermal coal are produced.

Mining in the Wittingham Coal Measures occurs in an area bounded approximately by Muswellbrook, Broke, and Singleton. Both open-cut and underground methods are used. Production has come from the Jerrys Plains Subgroup, particularly from seams in the lower half of the sequence. Some of the coal is exported through Newcastle and some used by local industry, especially for electricity generation.

WOLLOMBI COAL MEASURES	
WITTINGHAM COAL MEASURES	DENMAN FORMATION
	JERRYS PLAINS SUBGROUP
	ARCHERFIELD SANDSTONE
	VANE SUBGROUP
	SALTWATER CREEK FORMATION
MAITLAND GROUP	

15/A/711

Fig. 60. Stratigraphy, Wittingham Coal Measures, Hunter Coalfield.

Vane Subgroup (Sniffin & others, 1986). The Vane Subgroup extends throughout the area of Wittingham Coal Measures shown in Figure 59. It conformably overlies the sandstone of the Saltwater Creek Formation (Fig. 61), which is in turn conformable on the marine sediments of the Maitland Group. It is conformably overlain by the Archerfield Sandstone. The subgroup is divided into the Foybrook Formation, which contains coal, and the overlying sandstones and siltstones of the Bulga Formation.

The Foybrook Formation contains nine coal seams in the area around Foybrook (Fig. 61), six seams in the Muswellbrook area (Fig. 62), and ten seams at Howick (Fig. 63).

The coal seams are generally high in volatile matter and relatively low in ash and sulphur. They yield both thermal and soft coking coal.

The Foybrook Formation coals have been mined for many years, expecially the Liddell seam which has been mined mainly for export as coking coal. Substantial production has also come from the Arties and Pikes Gully seams, coals from which are used either in coking coal blends or for thermal use. Since the early 1980s, output from the Barrett seam, which yields a high volatile, low ash coking coal, has grown rapidly.

The Pikes Gully seam was mined in the Pikes Gully underground mine and the Arties Seam is worked at the Howick open

	ARCHERFIELD SANDSTONE		
VANE SUBGROUP	BULGA FORMATION		*Sandstone, siltstone*
	FOYBROOK FORMATION	LEMINGTON SEAM	*Coal, sandstone, siltstone, conglomerate*
		PIKES GULLY SEAM	
		ARTIES SEAM	
		UPPER LIDDELL SEAM	
		MIDDLE LIDDELL SEAM	
		LOWER LIDDELL SEAM	
		UPPER BARRETT SEAM	
		LOWER BARRETT SEAM	
		HEBDEN SEAM	
	SALTWATER CREEK FORMATION		

15/A/712

Fig. 61. Stratigraphy and lithology, Vane Subgroup, Wittingham Coal Measures, in the Foybrook area of the Hunter Coalfield.

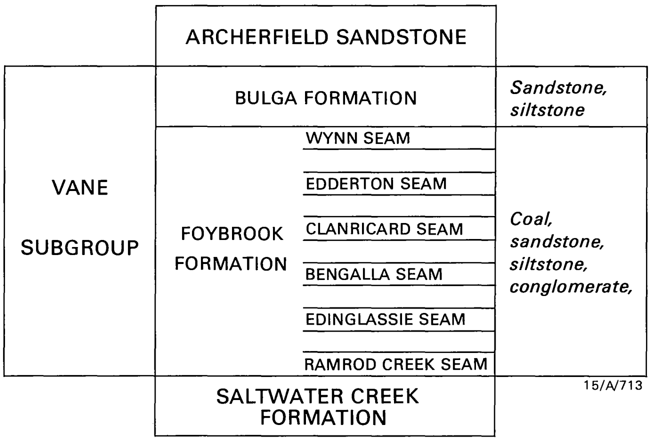

Fig. 62. Stratigraphy and lithology, Vane Subgroup, Wittingham Coal Measures in the Muswellbrook area of the Hunter Coalfield.

cut. Mines winning coal from the Liddell seam are the Howick open cut (2 Mt saleable coal, 1988–89 in total), and Liddell (0.32 Mt) and Liddell State (0.56 Mt). Coal from the Barrett seam is won at the Howick open cut. New mines at Camberwell and Rixs Creek will work the Vane Subgroup coals, as will the planned Glennies Creek mine.

Jerrys Plains Subgroup (Standing Committee on Coalfield Geology of NSW, 1986). The Jerrys Plains Subgroup underlies the area of the Wittingham Coal Measures outlined in Figure 59.

The stratigraphy of the Singleton Supergroup (Fig. 3) and the Jerrys Plains Subgroup has been discussed by numerous authors including Britten (1975b) who lists some of the more important contributions. The Standing Committee on Coalfield Geology of NSW (1986a) revised the stratigraphy of the Jerrys Plains Subgroup and this revision is followed here. In all, the Committee has defined eight units of formational status which include 15 coal seams.

Subdivision of the Jerrys Plains Subgroup (Fig. 64) is based on the recognition of the prominent and generally tuffaceous claystone units — the Fairford Formation, Milbrodale Formation,

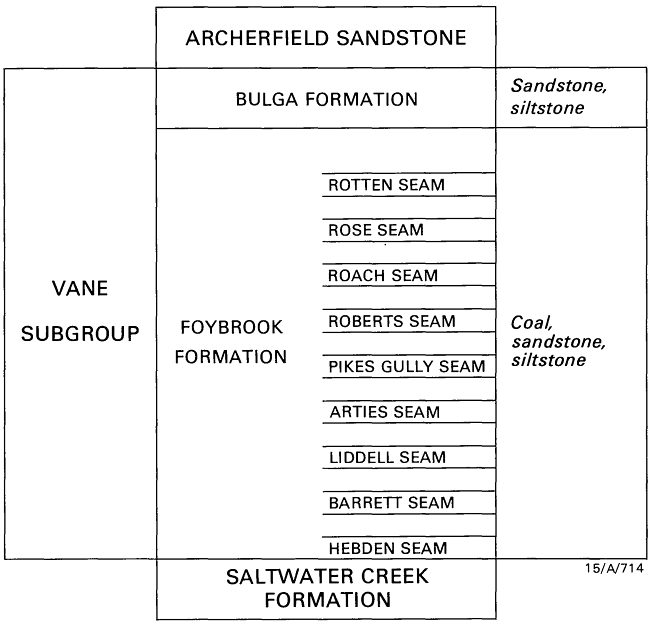

Fig. 63. Stratigraphy and lithology, Vane Subgroup, Wittingham Coal Measures, in the Howick area of the Hunter Coalfield.

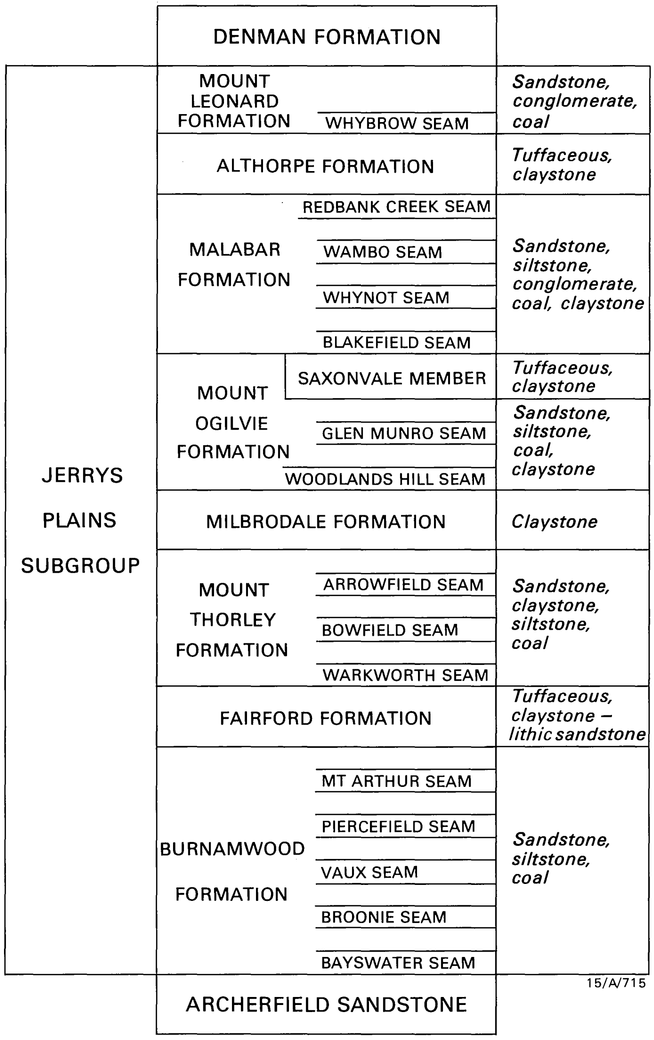

Fig. 64. Stratigraphy and lithology, Jerrys Plains Subgroup, Wittingham Coal Measures, Hunter Coalfield.

Saxonvale Member, and Althorpe Formation. These all consist of white claystone, cherty in places, and locally silty. In the Saxonvale Member a silty sandstone may also be present, and lithic sandstone may occur in the Fairford Formation.

The other formations of the Jerrys Plains Subgroup mainly consist of sandstone, shale, siltstone, and coal, with minor conglomerate and mudstone.

The Bayswater seam of the Jerrys Plains Subgroup conformably overlies the Archerfield Sandstone. At the top, the Denman Formation conformably overlies the Mount Leonard Formation.

All non-claystone units of the Subgroup contain coal. Probably the best known coal is the lowest seam in the sequence — the Bayswater Seam. However, although the Burnamwood Formation coals have been of most economic interest in the past (and still are very important), in recent years more interest has been shown in coals from the Mount Ogilvie, Malabar, and Mount Leonard Formations.

The Bayswater seam is a massive, dull coal, although in places banded bright coal may be present at the top of the seam (Standing Committee on Coalfield Geology of NSW, 1986a). Hunt & others (1986) have discussed the Bayswater and similar seams from elsewhere in the Sydney and Gunnedah Basins. The Broonie, Vaux, Piercefield, and Mount Arthur seams are mostly banded bright coal. Sniffin & others (1986) note the presence of an additional seam, the Kayuga, in the Burnamwood Formation in the Dartbrook area. It occurs between the Vaux and Piercefield seams.

In the Mount Thorley Formation the Warkworth seam is banded dull coal while the Bowfield and Arrowfield seams are dull to banded bright and dull.

The Woodlands Hill and Glen Munro seams of the Mount Ogilvie Formation are both dull and bright coal, with low to medium ash.

The four seams — Blakefield, Whynot, Wambo, and Redbank Creek — in the Malabar Formation are all subject to splitting. The Wambo seam is essentially bright coal and the Redbank Creek seam has a banded bright basal section. The other seams in the sequence contain varying proportions of dull coal.

The Mount Leonard Formation contains only one significant seam, the Whybrow seam, which is a low ash, bright and banded bright coal.

Coals in the Burnamwood and Mount Leonard Formations have been the main targets for mining for many years. From the late 1970s interest has also been focused on seams in the Mount Ogilvie and Malabar Formations. There has also been interest in the Mount Thorley Formation.

Production from the Burnamwood Formation is dominated by the large open-cut mines of the Hunter Valley, namely Ravensworth, Swamp Creek, Saxonvale, Warkworth, Hunter Valley No. 1, and Lemington. The Mount Arthur seam of the Burnamwood Formation is also worked in the Lemington No. 1 underground mine. The Mount Thorley Formation is worked at the Warkworth open cut and the Mount Ogilivie Formation at both the Mount Thorley and Saxonvale open cuts. Coal is won from the Malabar Formation at the United, Wambo, Mount Thorley and Saxonvale open cuts. The Whybrow seam of the Mount Leonard Formation is worked at the Wambo underground mine. Total production of raw coal from these mines reported by the Joint Coal Board (1989) for 1988–89 was: Hunter Valley No.1, 5.3 Mt; Lemington open cut, 1.35 Mt; Lemington No.1, 0.77 Mt; Mount Thorley, 4.0 Mt; Ravensworth, 3.5 Mt; Saxonvale, 1.2 Mt; Swamp Creek, 1.4 Mt; United, 100 t; Wambo open cut, 0.4 Mt; Wambo underground, 0.99 Mt; and Warkworth, 3.0 Mt.

Wollombi Coal Measures (Hunter Coalfield) (Doyle & others, 1986; Britten, 1975b)

The Wollombi Coal Measures (Late Permian) underlie the Singleton–Muswellbrook area, in the Hunter Coalfield. They conformably overlie the Wittingham Coal Measures, at the top of the Singleton Supergroup. Sniffin & others (1986) show the basal unit as the Watts Sandstone, which is overlain by four subgroups, in ascending order, Apple Tree Flat, Horseshoe Creek, Doyles Creek, and Glen Gallic (Fig. 65).

WOLLOMBI COAL MEASURES	GLEN GALLIC SUBGROUP	GREIGS CREEK SEAM
		HILLSDALE SEAM
		HOBDEN GULLY SEAM
	DOYLES CREEK SUBGROUP	WYLIES FLAT SEAM
	HORSESHOE CREEK SUBGROUP	EYRIE BOWER SEAM
		ROMBO SEAM
		CARRAMERE SEAM
		ALCHERINGA SEAM
	APPLE TREE FLAT SUBGROUP	STAFFORD SEAM
		ABBEYGREEN SEAM
	WATTS SANDSTONE	
	WITTINGHAM COAL MEASURES	

15/A/716

Fig. 65. Stratigraphy, Wollombi Coal Measures, Hunter Coalfield.

Significant coal is known to occur within the Apple Tree Flat, Horseshoe Creek, and Glen Gallic Subgroups, and some in the Doyles Creek Subgroup. Non-coal strata consist of sandstone, siltstone, and mudstone.

Although coal occurs in all subgroups, Britten (1975b) considered only the Greigs Creek and Hillsdale seams (Glen Gallic Subgroup) possibly economic, and Doyle & others (1986) agreed.

Britten suggested the Greigs Creek seam is at a similar stratigraphic position to the Wallarah (Newcastle Coal Measures), Bulli (Illawarra Coal Measures), and Katoomba (Illawarra Coal Measures) seams elsewhere in the Sydney Basin, and that the Hillsdale seam is equivalent to the Great Northern seam of the Newcastle Coal Measures.

Not enough exploration has been undertaken to allow even partly reliable resource estimates to be made (Sniffin & others, 1986).

The Wollombi Coal Measures are not being mined at present. Some coal has been mined in the past from a colliery near Greigs Creek (Britten, 1975b).

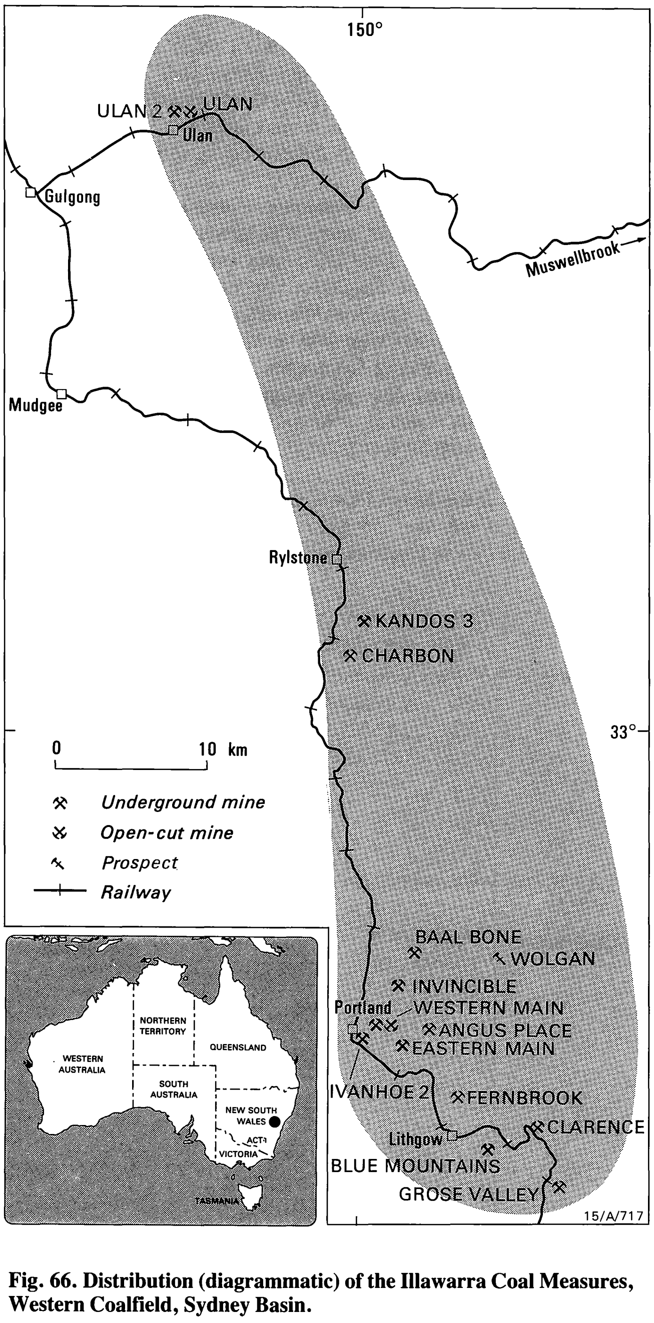

Fig. 66. Distribution (diagrammatic) of the Illawarra Coal Measures, Western Coalfield, Sydney Basin.

Illawarra Coal Measures (Bembrick, 1983)

Western Coalfield. The Illawarra Coal Measures in the Western Coalfield occupy a north-northwesterly trending zone extending from near Katoomba in the south to east of Dunedoo in the north (Figs. 2 and 66).

Bembrick (1983) revised the stratigraphy of the Illawarra Coal Measures in the Western Coalfield. Later, the Standing Committee on Coalfield Geology of NSW (1986b) supported this new stratigraphy.

Four subgroups — Nile, Cullen Bullen, Charbon, and Wallerawang — were recognised (Fig. 67). The Nile Subgroup is made up of claystone, sandstone, shale, siltstone, and coal. In the overlying Cullen Bullen Subgroup sandstone, conglomerate, mudstone, claystone, coal, and some oil shale are present. The Charbon Subgroup is the thickest of the four and is made up of mudstone, siltstone, claystone, sandstone, coal, oil shale, and siliceous claystone. At the top of the sequence the Wallerawang Subgroup consists of claystone, siltstone, coal, sandstone, mudstone, and oil shale.

The coal in the Nile subgroup is thin and not of economic interest. In the Cullen Bullen Subgroup the Lithgow and Lidsdale seams are the main economic coals, and to the north, at Ulan, part of the Ulan seam is considered to be equivalent to the Lithgow seam. In the Charbon Subgroup the Irondale and Moolarben seams are the principal coals. In some areas the Irondale seam has been referred to previously as the Wolgan seam. The main seams in the Wallerawang Subgroup are the Middle River and Katoomba.

Mining started in the Western Coalfield in 1868 and has continued to the present (Bembrick, 1983). Production is mainly from underground mines (Fig. 66), in both bord-and-pillar and longwall operations. The mines usually produce medium to high volatile thermal coal, but also some coals suitable for use in coke blends.

The **Cullen Bullen Subgroup** (Bembrick, 1983) extends throughout the Western Coalfield. It overlies the Nile Subgroup, or, in places, the Shoalhaven Group, and is overlain conformably by the Charbon Subgroup. The constituent units of the Cullen Bullen Subgroup are shown in Figure 68.

In the northeast and near Ulan and Kandos, Bembrick (1983) reports a merging of the Lithgow and Lidsdale seams to form a single thick seam (the Standing Committee on Coalfield Geology (1986b) considers the Lithgow seam is equivalent to part of the Ulan seam). Pebbly sandstone, conglomerate, and coal are the principal rock types present, with lesser carbonaceous claystone, mudstone, and oil shale.

The Lithgow and Lidsdale seams are important economically. In the north, the merged Lithgow and Lidsdale seams retain the name 'Lithgow Coal' (Bembrick, 1983, fig. 4). The Lidsdale seam is essentially dull coal with carbonaceous mudstone and claystone. The Standing Committee on Coal Field Geology records the possible presence of oil shale in the seam.

NARRABEEN GROUP	
ILLAWARRA COAL MEASURES	WALLERAWANG SUBGROUP
	CHARBON SUBGROUP
	CULLEN BULLEN SUBGROUP
	NILE SUBGROUP
SHOALHAVEN GROUP	

15/A/718

Fig. 67. Stratigraphy, Illawarra Coal Measures, Western Coalfield.

	CHARBON SUBGROUP	
CULLEN BULLEN SUBGROUP	LIDSDALE COAL	*Coal, mudstone, claystone*
	BLACKMANS FLAT CONGLOMERATE	*Sandstone, conglomerate*
	LITHGOW COAL	*Coal, claystone, sandstone, mudstone, oil shale*
	MARRANGAROO CONGLOMERATE	*Sandstone, conglomerate, mudstone*
	NILE SUBGROUP/ SHOALHAVEN GROUP	

15/A/719

Fig. 68. Generalised stratigraphy of the Cullen Bullen Subgroup, Illawarra Coal Measures, Western Coalfield. The Lithgow seam is equivalent to part of the Ulan seam.

The Lithgow seam is the main seam mined. Morris (1975) records a thickness variation of 0.8–7.1 m in the Lithgow area. Moloney & others (1983) note a thickness range of 0.86–16.87 m in the Rylstone area but they caution that where the seam is thickest it is either very banded or split into a maximum of three coaly sequences of which only the lowest is of economic interest.

The Ulan seam in the north is at a similar stratigraphic level to the Lithgow seam. It is a high volatile thermal coal with low to medium ash content.

Both the Lithgow and Lidsdale seams have been mined in the past. Raw coal production from the Lithgow seam in 1986–87 was 4.88 Mt and from the Lidsdale seam 30 700 t. Production of raw coal from the Ulan seam in the Ulan open-cut and Ulan No. 2 underground mine in 1988–89 was 7.4 Mt.

Moloney & others (1983) have discussed extensive igneous intrusions in the Rylstone area that affect coals above the Lithgow seam. They consider that the intrusions will have had only a

	WALLERAWANG SUBGROUP	
CHARBON SUBGROUP	STATE MINE CREEK FORMATION MOOLARBEN COAL	*Claystone, mudstone, siltstone, sandstone*
	ANGUS PLACE SANDSTONE	*Sandstone*
	BAAL BONE FORMATION	*Mudstone, claystone, siltstone, sandstone, coal, oil shale*
	GLEN DAVIS FORMATION	*Claystone, siltstone, sandstone, coal, oil shale*
	NEWNES FORMATION	*Sandstone, mudstone, siltstone*
	IRONDALE COAL	*Coal, claystone*
	LONG SWAMP FORMATION	*Claystone, siltstone, mudstone, sandstone*
	CULLEN BULLEN SUBGROUP	

15/A/720

Fig. 69. Stratigraphy and lithology, Charbon Subgroup, Illawarra Coal Measures, Western Coalfield.

minimal sterilisation impact on coal resources, but the presence of intrusions could preclude the use of longwall mining. They also draw attention to possible difficult roof conditions caused by the combined effect of stress from the intrusions and the Coricudgy Anticline.

The **Charbon Subgroup** (Bembrick, 1983) (Fig. 69) extends throughout the Western Coalfield. It conformably overlies the Cullen Bullen Subgroup and is conformably overlain by the Wallerawang Subgroup.

The Charbon Subgroup consists of mudstone, siltstone, claystone, and sandstone, with minor coal and oil shale. Coal is thin and local (Bembrick, 1983). Oil shale seams in the Glen Davis Formation have been mined in the past.

The Irondale seam is the main coal. The Wolgan seam in the Wolgan Valley (Cox & others, 1980) is referred to the Irondale seam under the revised stratigraphy. The Standing Committee on Coalfield Geology of NSW (1986b, p.154) comments that the seam is 'a commonly thin (1.3–1.4 m) but persistent coal horizon characterised by two or three stone bands giving it a distinctive seam section...' The Wolgan seam (Fraser, 1975) is a high volatile coking coal capable of yielding a product with 9 to 11% ash.

The Moolarben Coal Member near the top of the Charbon Subgroup is persistent and may be up to 3.5 m thick locally, e.g. at Ulan (Bembrick, 1983), but generally it is just thin coal or carbonaceous claystone.

The Charbon Subgroup has not yet been mined. The proposed Wolgan colliery has been planned to work the Irondale seam by underground methods, but remains undeveloped.

The **Wallerawang Subgroup** (Standing Committee on Coalfield Geology of NSW, 1986a) extends throughout the Western Coalfield (Fig. 70). It is the topmost major subdivision of the Illawarra Coal Measures in the Western Coalfield; it conformably overlies the Charbon Subgroup and is unconformably overlain by sediments of the Triassic Narrabeen Group.

The number of coal horizons present in the Middle River Coal Member varies. Although high in ash, a coking coal product may be produced from the seam near Newnes Junction (Fraser, 1975).

Coal is won from the Katoomba seam, which extends throughout the area. Fraser (1975) records that three splits can occur. A medium volatile, medium ash steaming coal is produced.

The Grose Valley and Clarence collieries have produced coal from the Katoomba seam. Both are underground operations. Raw coal production from the Katoomba seam in 1986–87 totalled 2.4 Mt.

Southern Coalfield (Doyle & others, 1986). The Illawarra Coal Measures in the Southern Coalfield (Fig. 71) underlie an area south of Sydney bounded approximately by Berrima, the Burragorang Valley, Campbelltown, and Wollongong.

The Southern Coalfield is dominated by a major syncline with a north–south axial trend; folds on the limbs of the main structure trend northwesterly. Doyle & others (1986) note that faulting is not intense, major faults having only up to 90 m displacement and a northwest trend. They also note the presence of northeasterly trending en-echelon faults with displacements of up to 15 m.

	NARRABEEN GROUP		
WALLERAWANG SUBGROUP	FARMERS CREEK FORMATION	KATOOMBA SEAM	*Claystone, coal, mudstone, sandstone, siltstone, oil shale*
		BURRAGORANG CLAYSTONE	
		MIDDLE RIVER SEAM	
	THE GAP SANDSTONE		*Medium to fine sandstone, mudstone*
	CHARBON SUBGROUP		

15/A/721

Fig. 70. Stratigraphy and lithology, Wallerawang Subgroup, Illawarra Coal Measures, Western Coalfield.

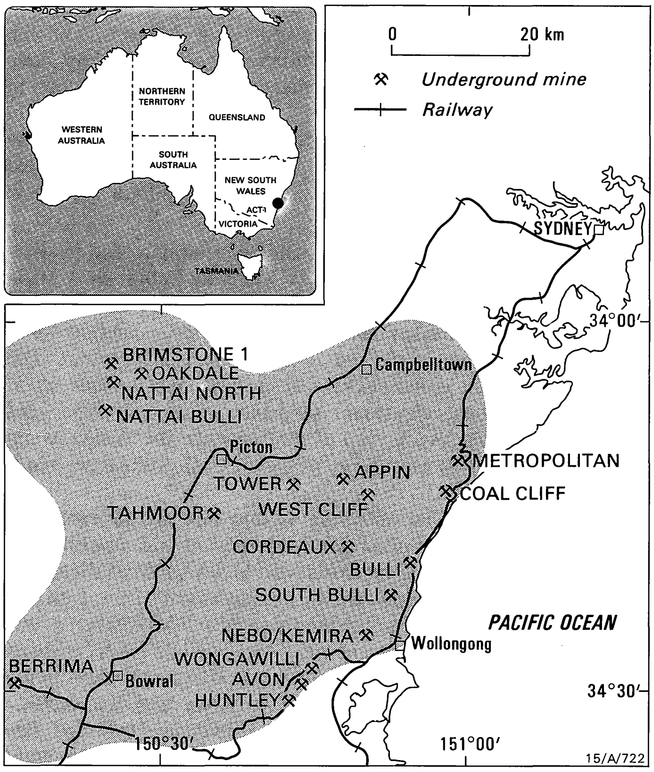

Fig. 71. Distribution (diagrammatic) of the Illawarra Coal Measures, Southern Coalfield, Sydney Basin.

The Illawarra Coal Measures are the topmost Permian unit in the southern Sydney Basin. They conformably overlie sediments and volcanics of the Shoalhaven Group and are overlain by Triassic sediments of the Narrabeen Group.

The younger of the two subgroups making up the Illawarra Coal Measures, the Sydney Subgroup (Fig. 72), has the most important coal resources. The Cumberland Subgroup contains coal but is not of economic importance.

Intrusions occur in the coal measures and adversely affect mining in some areas.

There are five principal coal seams in the Illawarra Coal Measures in the Southern Coalfield, in ascending order: Woonona, Tongarra, Wongawilli, Balgownie, and Bulli. The Bulli, Wongawilli, and Tongarra seams are mined currently and the Balgownie seam has been mined in the past.

The Bulli seam is the most important. Its properties vary between the Burragorang Valley (Brimstone 1, Oakdale, Nattai North, Nattai Bulli mines) in the western part of the Coalfield and the eastern and southern areas. In the Burragorang Valley the Bulli Seam is essentially a medium volatile, medium ash coal which, when washed, yields a low ash coking coal for the export market. Elsewhere, it is a low to medium volatile, low ash coal yielding a hard coking coal for use in the local steel industry and for export.

The Wongawilli seam yields both coking and thermal coal. The coking coal requires washing, but the thermal coal is a medium to high ash unwashed product. The Balgownie seam yields a medium ash thermal coal, and the Tongarra seam a high to medium ash thermal coal.

The Southern Coalfield is one of the oldest and most important coal mining regions in Australia. It is the only source of hard coking coal in New South Wales. All production is from underground mines and principally from the Bulli seam. An increasing number of the mines are using longwall mining methods.

The coking coal is used at the Port Kembla steelworks and in coke ovens operated by Kembla Coal & Coke Pty Ltd. It is also

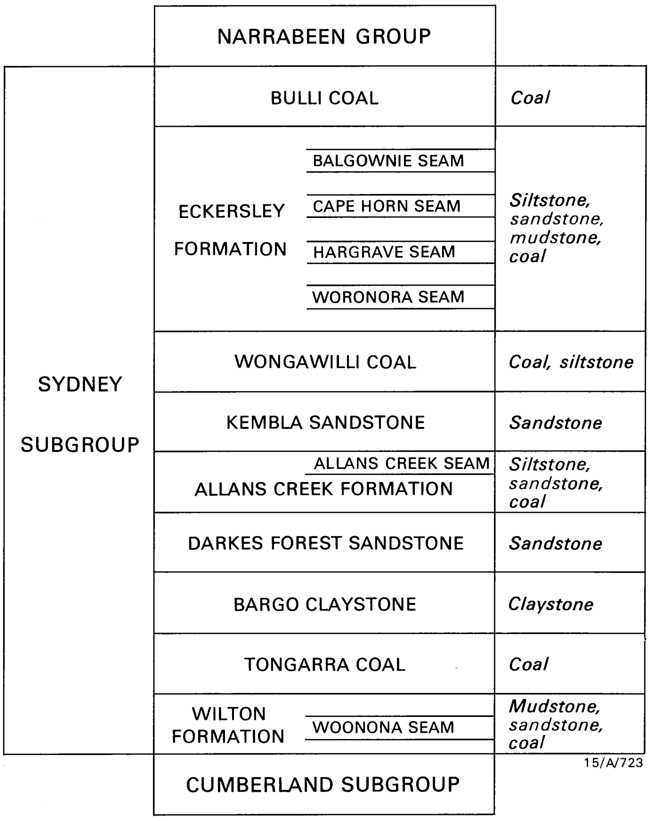

Fig. 72. Stratigraphy and lithology, Sydney Subgroup, Illawarra Coal Measures, Southern Coalfield.

exported. The thermal coal is used domestically for electricity generation, cement production, and minor local use; it is also exported.

Oaklands Basin

(Yoo, 1982)

The Oaklands Basin is in southern New South Wales, some 50 km west of Albury (Fig. 1).

Several authors, including Driver (1975) and Yoo (1982), have discussed the geology of the Oaklands Basin. Late Palaeozoic and younger sediments overlie early Palaeozoic basement. The elongated basin trends north-northwest and is probably an extension of the Ovens Valley Graben in Victoria.

Unnamed Early Permian sediments unconformably overlie the basement. They are overlain by the Late Permian Coorabin Coal Measures. Within the coal measures a lower unit, the Narrow Plain Formation, and an upper unit, the Loughmore Formation, have been delineated. Coal occurs in both formations. The coal measures are overlain by the Tertiary Jerilderie Formation and associated younger sediments.

The Narrow Plain Formation is composed primarily of poorly cemented sandstone and some conglomerate. The top of the Formation is defined as the top of the Lanes Shaft seam. The Loughmore Formation consists of relatively unconsolidated sandstone, with some claystone and siltstone, and contains the Coreen Creek seam.

Much of the sedimentary sequence in the Oaklands Basin is water-charged, which would be a major factor in mine planning.

Sniffin & others (1986) report that only the Lanes Shaft seam has economic potential. The Coreen Creek seam is thin and discontinuous and may be highly oxidised. They record a thickness of 11.3 m for the Lanes Shaft seam in the southern part of the basin.

Raw coal from the Lanes Shaft seam has medium to high ash, medium to high volatile matter and is generally sub-bituminous. Sniffin & others (1986, table 10.3), record a specific energy range of 4851–5317 kcal/kg.

Coal was produced sporadically from the time of its discovery in 1915 until about 1960, for a total output of about 125 000 t (Driver, 1975). At present CRA and Mitsubishi Development are studying the feasibility of producing coal to fuel an on-site power station.

Estimates of resources in the basin are: 1388 Mt of demonstrated in-situ coal amenable to open-cut mining and inferred resources of 3255 Mt amenable to underground mining (Sniffin & others, table 10.4).

TASMANIA

Tasmania Basin

(Bacon, 1986)

Black coal deposits in Tasmania occur in the Tasmania Basin, which occupies the eastern half of the State except for a small area in the northeastern corner. Coal was discovered by French explorers in 1793 (Bacon 1986); it is mined in the Fingal district (Fig. 73).

Sediments of the Parmeener Supergroup (Late Carboniferous–Triassic) occupy the basin. Williams (1989) notes that the Lower Parmeener Supergroup (Late Carboniferous–Permian) consists of glacigene and glaciomarine deposits and a freshwater coal measure sequence. The Upper Parmeener Supergroup is Late Permian to Triassic and consists of fluvial sediments and a thick coal measure sequence.

In a review of the Lower Parmeener Supergroup Clarke (1989) discusses several minor coal measure sequences and notes that only the Mersey Coal Measures have been worked on any appreciable scale (p. 302). Coal is better developed in the Upper Parmeener Supergroup and the stratigraphy of these sequences is reviewed by Forsyth (1989), who reports (p. 309) that the older coal measures (Cygnet and Adventure Bay) are generally too thin

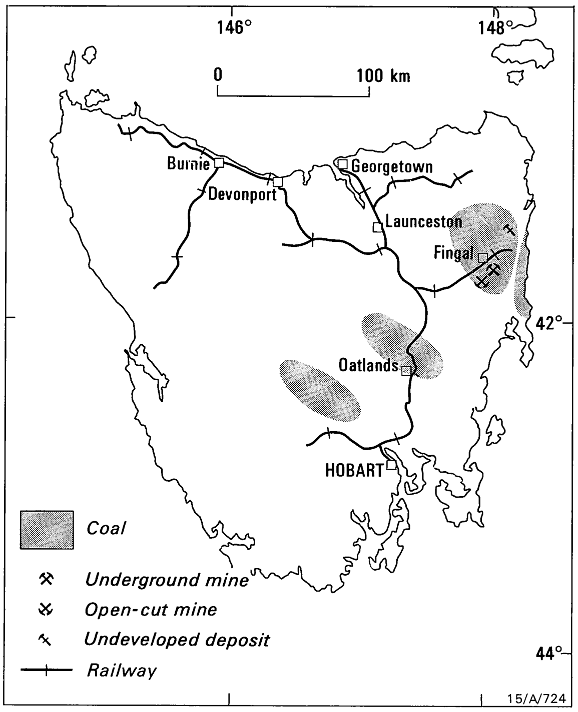

Fig. 73. Extent (diagrammatic) of principal black coal deposits in Tasmania.

to be of economic value and production has been very small.

The principal coal-bearing sequences in Tasmania are Triassic and occur toward the top of the Upper Parmeener Supergroup. They have been reviewed by Forsyth (1989). Coal is won from these coal measures in the Fingal and Mount Nicholas areas.

Coals in Tasmania have been reviewed by Bacon (1986) and Banks & others (1989). Banks & others note that, of the older coal-bearing sequences, the Mersey Coal Measures are high in sulphur (3–5%), low in ash (up to 12%), and have specific energies of about 29–30 MJ/kg. In contrast, the Cygnet Coal Measures have lower sulphur (less that 0.57%) and lower specific energy (about 26 MJ/kg), but higher ash (17–23%).

For the Triassic sequence, Banks & others (1989) note that seams may be up to 5 m thick (although generally less than 1 m), and the coals are mostly dull; sulphur is low (around 0.5%), ash is high (25–30%), and the specific energy of the coal before beneficiation is 20–24 MJ/kg. They further note that faulting and dolerite intrusions have disrupted seams and restricted the life of most mines to a maximum of two years.

At the Duncan Colliery, at Fingal, coal is won from the 2.0–5.0 m thick Duncan seam by bord and pillar methods. Bacon (1986) notes that it is a low vitrinite coal reaching a maximum of 30% at the base. Inertinite is dominant throughout. The Blue seam is mined at the Blackwood Colliery, Mount Nicholas. This seam is about 5.0 m thick, of which Bacon (1986) reports that 3.6 m is mined by bord and pillar methods. Bacon also notes that vitrinite is up to 40% at the base but only 10% at the top and inertinite is dominant. At the intermittently mined Merrywood open cut the Merrywood seam is dominantly semifusinite.

Tasmania's economic demonstrated black coal resources total 530 Mt in situ, of which just under 5% is amenable to open-cut mining.

Black coal mining began in Tasmania in 1834 on the Tasman Penisula (Bacon, 1986) and there has been continuous production since 1866. The principal area has been the Mount Nicholas–Fingal region where there are two mines, the Duncan and Blackwood Collieries, together producing more than 0.5 Mt of raw coal annually. The mines are operated by Goliath Cement Holdings Ltd and the output is used by the company in the production of cement and sold for use in other local industry. In addition, a small open cut, the Merrywood mine, is operated by the Merrywood Coal Company NL near Royal George, southwest of Fingal (C.A. Bacon, pers. comm., 1990). There is a proposal to mine coal on the north side of Mount Nicholas (Dalmayne Coalfield) currently under consideration (C.A. Bacon, pers. comm. 1990).

SOUTH AUSTRALIA

South Australia has substantial near-surface resources of sub-bituminous coal in three widely separated and relatively remote areas (Fig. 74). These include the Permian Arckaringa Basin, Triassic coal basins at Leigh Creek, and the Jurassic Polda Basin.

There are extensive resources of Permian sub-bituminous coal in the Arckaringa Basin in the State's central north (Arckaringa Coalfield and Lake Phillipson Coalfield). The Leigh Creek coalfield is 550 km north of Adelaide and has the State's only operating coal mine. Coal is won from the small (25 km^2) Telford Basin and is railed to a power station at Port Augusta. The coal is of Late Triassic age and has been mined since 1943. At Lock, on the Eyre Peninsula, Jurassic sub-bituminous coal occurs in the Polda Basin. Development of the deposits other than Leigh Creek and particularly those in the Arckaringa Basin has been hindered by numerous factors including remoteness, low grade, depth of overburden and proximity to groundwater (G.Kwitko, SADME, pers. comm., 1990).

Petroleum drilling has delineated hundreds of billions of tonnes of high rank coal in the Permian Cooper Basin, the shallowest of which is more than 1000 m deep. This huge resource of coal is of

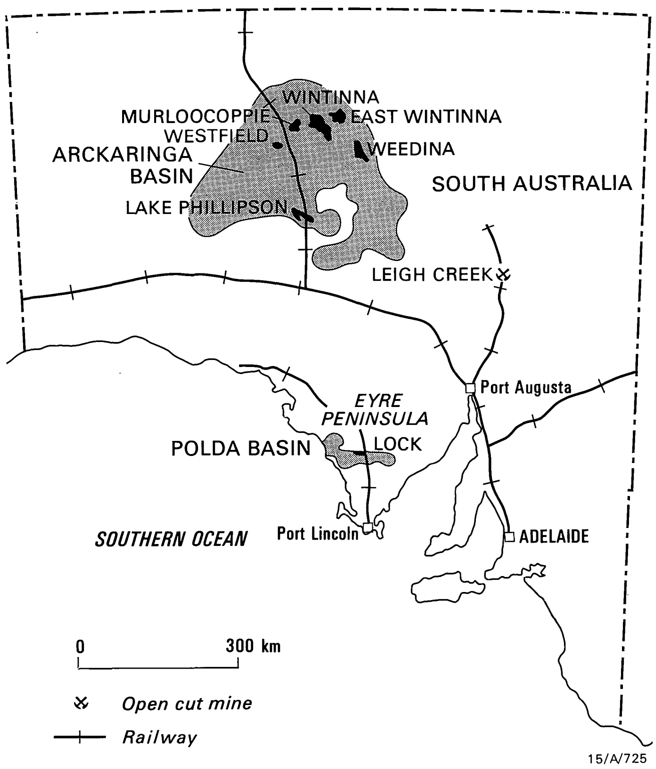

Fig. 74. Location of black coal deposits in South Australia (based on SADME, 1984).

bituminous to anthracite rank and seams up to 25 m thick have been intersected. Conventional mining is not feasible with current technology, but in-situ gasification may be possible in the future (G. Kwitko, SADME, pers. comm., 1990).

Arckaringa Basin

The Arckaringa Basin (Permian) is in central northern South Australia and covers over 80 000 km^2.

Hibburt (1983 and 1984) briefly reviewed the geology of the basin, which he considers to have been formed by downfaulting along marginal depressions. These are filled with coal-bearing sediments of Early Permian age that overlie Proterozoic and early Palaeozoic sediments and crystalline basement.

Three formations are delineated in the basin, in ascending order: Boorthanna, Stuart Range, and Mount Toondina. The coal is in the upper part of the Early Permian Mount Toondina Formation and is interbedded with siltstone, carbonaceous mudstone and minor sandstone.

Coal occurs in six deposits, of which four are in the Arckaringa Coalfield. The other two are the Weedina and Lake Phillipson deposits in the Lake Phillipson Coalfield. These deposits are generally flat-lying and underlie poorly consolidated and frequently water-saturated Jurassic and Cretaceous sandstone and mudstone of the Eromanga Basin (G. Kwitko, SADME, pers. comm., 1990).

No coal has been mined yet in the basin.

Arckaringa Coalfield (Hibburt, 1983; G. Kwitko, SADME, pers. comm., 1990)

The Arckaringa Coalfield was discovered in 1980 by Meekatharra Minerals Ltd. The four coal deposits are associated with the Boorthanna, Mount Furner, and Kankaro Troughs. The deposits have a total resource of over 10 000 Mt of low-grade, sub-bituminous coal.

The basal diamictite of the Boorthanna Formation is overlain by sandstone and conglomeratic sandstone. The Stuart Range Formation is mainly shale. The overlying Mount Toondina Formation contains a lower siltstone sequence separated from an upper siltstone by thin sandstones. Coals occur in the upper siltstones.

Jurassic and Cretaceous sandstones and Cretaceous mudstone unconformably overlie the Mount Toondina Formation, averaging 170 m thick in the west and up to 300 m in the east (SADME, 1984). The sandstones are locally unconsolidated and water-saturated.

Of the four distinct coal deposits, the easternmost, **East Wintinna**, is the deepest; it has six or seven persistent seams. The topmost potentially mineable coal has a cumulative coal thickness of up to 20 m in a stratigraphic interval of 60 m and is 220–300 m below the surface.

The **Wintinna** deposit, 30 km southwest of East Wintinna, has eight persistent seams in the north and ten in the south. G. Kwitko (pers. comm., 1990) reports a cumulative coal thickness of up to 25 m in a stratigraphic interval of 75 m in the north and 15 m in a 120–125 m interval in the south. Overburden ranges from 140–240 m.

Further west is the **Murloocoppie** deposit with eight persistent seams and a cumulative coal thickness of 20 m within a 70 m stratigraphic interval. Overburden is 140–230 m deep.

The **Westfield** deposit lies to the southwest of the Murloocoppie deposit and immediately west of the Stuart Highway and Tarcoola–Alice Springs Railway. It has two persistent seams about 30 m apart, the upper 6–9 m thick and the lower 1–2 m thick. Overburden thickness on the top seam is 145–215 m.

The coals in all deposits are generally similar: only minor components are variable. Hibburt (1983) records an approximate in-situ moisture content of 35%, ash 6%, and energy content 18 MJ/kg.

Evaluation of these deposits has been centred on Wintinna and studies suggest that the coal there can be mined by open cut methods and that the quality is suitable for conventional pulverised-fuel power stations, although in-situ moisture is relatively high (35–42%) compared with other black coals.

Weedina deposit (G. Kwitko, SADME, pers. comm., 1990)

The deposit was discovered by Getty Oil Development Co. Ltd in 1984 and tenure has since been acquired by Cyprus Australia Coal Company, a subsidiary of the US parent Cyprus Minerals Company.

The deposit lies in the Boorthanna Trough on the eastern side of the Arckaringa Basin and is 10 to 20 km wide and 40 km long. The 150 m thick coal-bearing zone includes six major and several minor coal seams; the seams are up to 8 m thick, with a cumulative thickness of 35 m. The coals are generally flat-lying and are covered by 130 to 150 m of overburden, of which 60 to 70 m is water-saturated Mesozoic sand (Cadna-owie Formation and Algebuckina Sandstone), the remainder being impermeable Cretaceous Bulldog Shale.

Drilling has delineated a very large coal resource containing 1200 Mt in the measured and indicated categories, with an additional 6000 Mt in the inferred Class 1 category.

Coal quality is similar to that of the Arckaringa Coalfield deposits and a preliminary assessment has been made of the deposit's potential to fuel a power station.

Lake Phillipson deposit (Hibburt, 1983, 1984; G. Kwitko, SADME, pers. comm., 1990)

The Lake Phillipson deposit is near the southern edge of the Arckaringa Basin; the Tarcoola–Alice Springs Railway crosses it.

The deposit occupies two northwest-trending troughs — the Main Basin (420 km^2) and the West Basin (300 km^2) — within the Phillipson Trough, along the southern margin of the basin.

As in the north of the Arckaringa Basin, the coal is in the Mount Toondina Formation. Coal is interbedded with mainly siltstone and carbonaceous mudstone, with minor sandstone. The formation is unconformably overlain by the Algebuckina Sandstone (Jurassic) and the Bulldog Shale and Cadna-owie Formation (Cretaceous), all of which are commonly only poorly consolidated.

The State Government first discovered coal in the Lake Phillipson stratigraphic bore drilled between 1902 and 1905, which intersected six seams ranging from 0.3 to 8.7 m thick (SADME, 1984). Utah Development Co. subsequently located six major seams and numerous minor seams in exploration between 1971 and 1982. Individual seam thickness ranges up to 7 m and a cumulative coal thickness of up to 25 m is present.

The total resource is approximately 5000 Mt. Coal quality is comparable to the other deposits in the Arckaringa Basin although high sodium and chlorine levels (about 2%) may lead to severe problems of slagging, fouling and high temperature corrosion if the coal is used in conventional pulverised-fuel power station boilers. This has been one of the main obstacles to development despite the large inferred resource.

Leigh Creek Coalfield

(Johns & Townsend, 1975; G. Kwitko, SADME, pers. comm., 1990)

Leigh Creek, in the Leigh Creek Coalfield, in the Flinders Ranges 550 km north of Adelaide, is the only operating coal mine in South Australia. It is owned and operated by the Electricity Trust of South Australia (ETSA). The coal (Late Triassic) is mined by open-cut methods using shovel and trucks, then railed 225 km south to power stations at Port Augusta.

It is expected that coal mining will continue at Leigh Creek to the year 2025, supplying coal to both the present 240 MW Thomas Playford B Power Station and the adjoining new 2 x 250 MW Northern Power Station, as well as a possible third 250 MW unit.

Approximately 2.7 Mt/year of Leigh Creek coal is used to generate 40% of the State's electricity.

A comprehensive review of the geology of the Leigh Creek Coalfield is given in Johns & Townsend (1975) and a summary in Johns (1975). A review of the current and future mining methods at Leigh Creek is given by O'Brien & Swift (1988).

Low grade sub-bituminous coal occurs in four small basins, from north to south: North Field Lobe D, North Field Lobe C, the Telford Basin (Lobe B), and the Copley Basin (Lobe A). These basins occur over a distance of 20 km; they are probably remnants of an originally more extensive Triassic sedimentary cover.

The Leigh Creek Coal Measures are markedly unconformable on folded Adelaidean strata. Horizontal Late Jurassic sandstone unconformably overlies a small part of the Copley Basin; elsewhere there is a surficial covering of Quaternary sediments. The coal measures consist essentially of coal, carbonaceous siltstone, and mudstone.

Coals occur in all four basins, although the **North Field Lobe D** (formerly with 22 Mt of resources) has been completely worked out and about half of the 21 Mt in **Lobe C** has been mined. Lobe D had two seams, the lower of which was 6 to 8 m thick and separated from the 9 m thick upper seam by 10 m of shale. In Lobe C the single seam is from 1.6 to 16 m thick.

In the **Copley Basin** there are a number of coal horizons up to 3 m thick; 11 Mt of demonstrated resources is present. No mining is envisaged in this basin because of the thin seams and small resources.

The **Telford Basin** contains the main resource — some 500 Mt in a coal measure series 1000 m thick. There are three principal coal horizons — the Lower series coals, the Main series, and the Upper series (Fig. 75).

The Upper and Lower series contain numerous seams, up to 8 m thick, interbedded with mudstone and siltstone. The Main series (essentially a single seam) varies in thickness from 6 to 18 m. All seams are characterised by steep dips (10° to 30°), variable seam thickness, seam splitting and faulting in the Main and Lower series seams, although the Upper series seams are not affected by

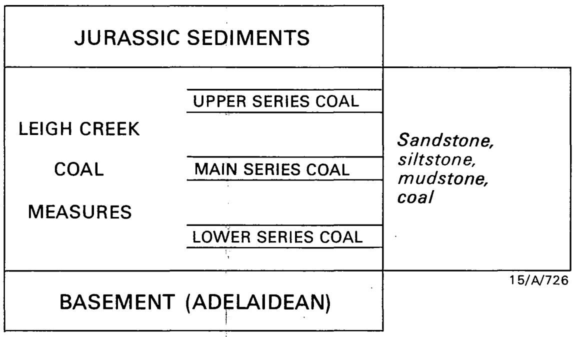

Fig. 75. Generalised stratigraphy of the Leigh Creek Coal Measures in the Telford Basin, SA.

faulting. Only the Main and Upper series coals are currently mined.

A history of mining at Leigh Creek is given in Gray & Fee (1975). Coal was discovered in 1888 and mining commenced in the Telford Basin in 1943. In 1956, operations moved to the North Field and continued there until the coal was worked out in 1976. Operations then returned to the Telford Basin. Because of the steeply dipping seams, economic recovery of the coal by existing methods will probably be limited to between 70 and 100 Mt, or depths between 150 and 200 m. ETSA is investigating ways to reduce mining costs and extend the economic life of the mine (O'Brien & Swift, 1988).

Polda Basin

(G. Kwitko, SADME, pers. comm., 1990)

A small deposit of low-grade black coal, the Lock deposit, occurs in the Polda Basin on Eyre Peninsula (SADME, 1987). This Jurassic coal is in the Polda Formation which is composed predominantly of mudstone and sandstone and lies directly on Permian or Proterozoic basement rocks and is overlain by poorly consolidated Tertiary and Quaternary sand and clay.

The **Lock** deposit was delineated in 1977 by drilling undertaken by ETSA and SADME. It is confined to a narrow east-west-trending sub-basin, and is 2 to 4 km wide and 15 km long. The deposit consists of numerous flat to gently dipping (2° to 5°) seams of high-ash coal, 0.5 to 6 m thick. Cumulative coal thickness reaches a maximum of 17 m, but is usually between 5 and 15 m. Overburden depths range from 35 to 230 m.

A coal resource of 260 Mt has been delineated.

Ash content is high, commonly 20–25% in situ, and the coal seams are often difficult to distinguish from the enclosing carbonaceous sediments. If mining were to proceed, the coal could be extracted by open cut methods but it may need beneficiation for use in conventional pulverised-fuel power stations.

Aquifers are present above and below the coal zone, and the dewatering requirements for mining could affect the use of groundwater in the region.

To date, the poor coal quality, seam variability and presence of freshwater aquifers have made development of this deposit unattractive.

WESTERN AUSTRALIA

Black coal in Western Australia occurs in the Bonaparte, Boyup, Canning, Carnarvon, Collie, Perth, and Wilga Basins. Only the Permian coals of the Collie Basin are currently mined; some of the other coals are suitable for use and may be mined in the future.

Collie Basin

(Wilson, 1990; Lord, 1975)

The small Collie Basin (Permian), covering about 230 km^2, is some 160 km south-southeast of Perth, in the Darling Range

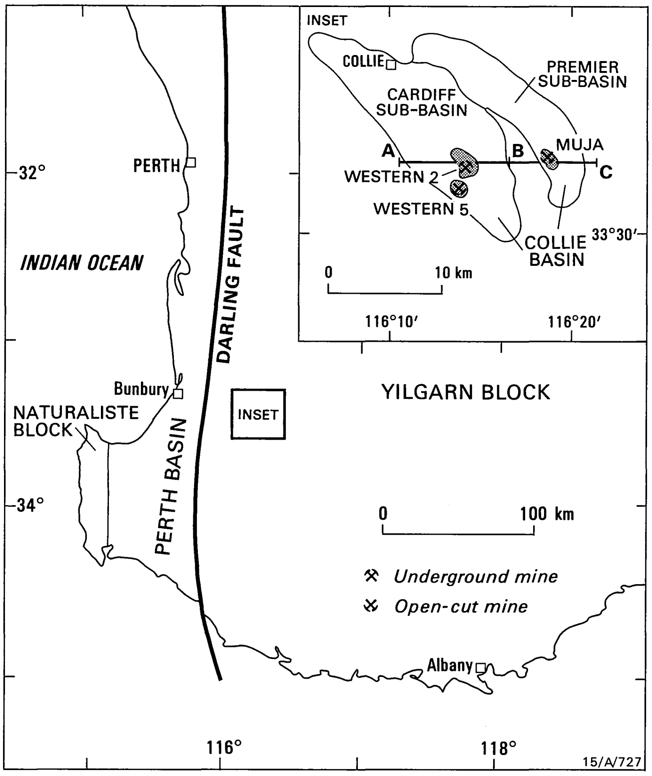

Fig. 76. Location of the Collie Basin and sub-basins, WA (after Lord, 1975).

(Fig. 76). At present it is the only coal-producing basin in Western Australia. It was discovered in 1883 and coal production started in 1898 (Wilson, 1990).

The Collie Basin consists of two parallel northwest-trending troughs, the Cardiff and Premier Sub-basins (Fig. 76). Wilson (1990) summarises the various hypotheses on the evolution of the basin.

The Stockton Formation is the oldest unit and unconformably overlies basement. It occurs in both sub-basins and is conformably overlain by the Collie Coal Measures, but the internal stratigraphy of the coal measures differs in each sub-basin (Figs. 77 to 81).

The Stockton Formation, as described by Wilson (1990), consists of a basal tillite, blue-grey claystone and minor fine sandstone, and siltstone.

Coal occurs throughout the overlying Collie Coal Measures in each sub-basin.

Conglomerate, sandstone, and claystone are the dominant rock types of the Miocene Nakina Formation, the uppermost unit in the Basin.

The coals in the Collie Basin are sub-bituminous, with low ash. They have a medium content of volatile matter and a high moisture content, and are used mainly for electricity generation (small tonnages are consumed by other industries). Economic demonstrated resources in the Collie Basin total 740 Mt in situ, of which 482 Mt is considered recoverable.

Mining began on the Collie Coalfield in 1898. Output has risen from 3564 t in 1898 (Kalix & others, 1966) to 3.8 Mt in 1986 (3.9 Mt in 1983).

The Griffin Coal Mining Company Ltd and Western Collieries Ltd mine coal in the Collie Basin. Griffin operates the Muja and Chicken Creek open cuts in the Premier Sub-basin and Western operates both open-cut and underground mines in the Cardiff Sub-basin. Coal won by both companies is used mainly for the generation of electricity by the State Energy Commission of Western Australia, but some is used by general industry.

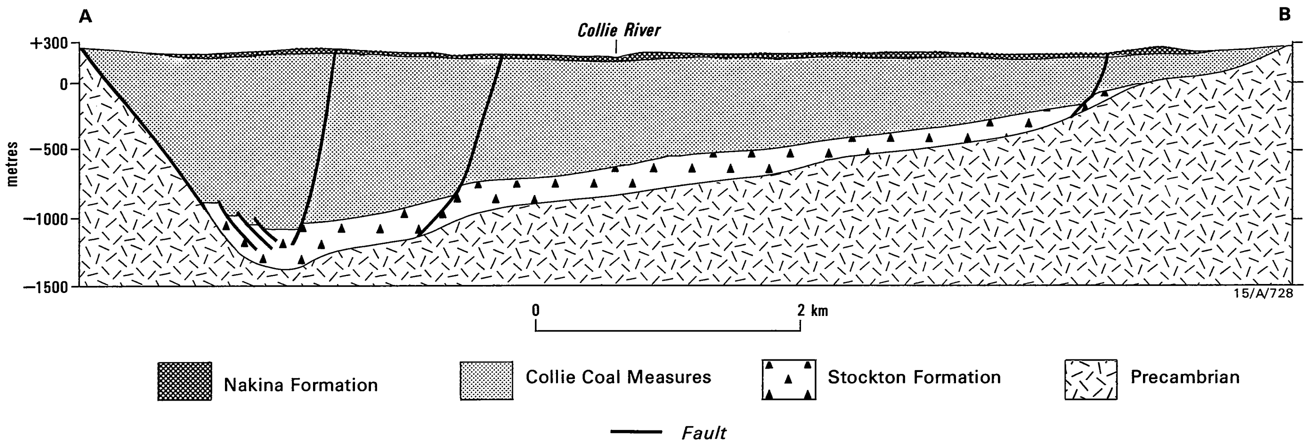

Fig. 77. Structure of the Cardiff Sub-basin. The location of this section is shown in Figure 76 (after Lord, 1975).

Cardiff Sub-basin

The Cardiff is the larger of the two sub-basins. The deepest part of the trough is near its western boundary (Fig. 77). Faulting is not common but there are some normal faults parallel to the axis. Wilson (1990, p. 530) notes that 'strong circumstantial evidence suggests that the western margin of the Cardiff [sub-basin...is] faulted'.

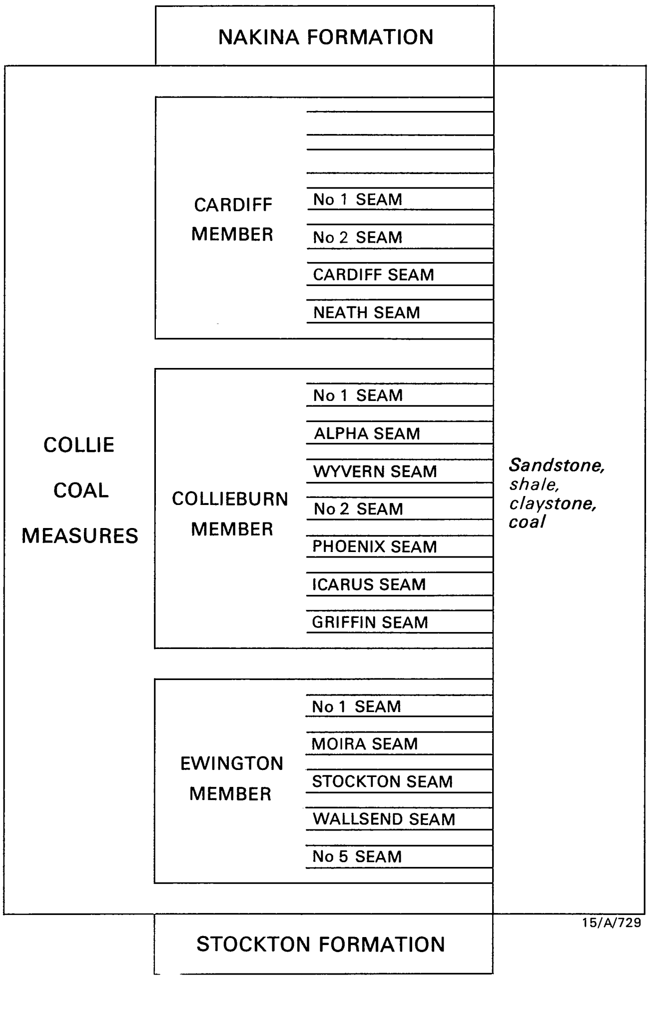

Fig. 78. Stratigraphy and lithology, Collie Coal Measures, Cardiff Sub-basin (based on Wilson, 1990).

Figure 78 illustrates the coal stratigraphy. The Ewington Member occurs in both sub-basins. The coal seams cannot be directly correlated across the sub-basins. The principal non-coal rock types are sandstone, siltstone, and shale. There are rare coarser sediments.

Premier Sub-basin

As in the Cardiff Sub-basin, the main trough in the Premier Sub-basin is on its western side (Fig. 79) which may also be faulted (Wilson, 1990). Small-scale normal faults parallel to the basin margin are widespread. Lord (1975) records a maximum throw of 150 m.

Figure 80 shows the coal stratigraphy in the southeastern part of the sub-basin and Figure 81 the stratigraphy in the centre and northwest. Apart from coal, the main rock types are sandstone and siltstone, with some coarser-grained sediments.

Coal is won from seams in the Muja Member in the Muja open cut and from the Centaur seam of the Chicken Creek Member in the Chicken Creek open cut.

The Griffin Coal Mining Company Ltd has mined coal for over 50 years in the area. At the Muja open cut it mines all nine seams in the Muja Member for consumption at the Muja Power Station.

Coal mined from the Centaur seam in the Chicken Creek open cut is sold for use by general industry.

Coal was mined underground in the Premier Sub-basin for many years but mining was difficult because of water in the coal measures (a mine working the Hebe seam had to be abandoned in 1965 after a borehole passed through an aquifer into the mine workings below, causing rapid flooding).

Both existing open cuts are worked using a truck and excavator system. In the Muja open cut, intersection of the old underground workings in the Hebe seam has made it unsafe for heavy equipment to work directly on the seam; production is by use of a backhoe attachment on an excavator which can then work the coal from a shale section left on top of the seam for that purpose.

Coal is drilled and blasted and then loaded into dump trucks.

Perth Basin

(Le Blanc Smith, 1990a)

The Perth Basin is an elongate feature extending for 700 km from north of Geraldton south to beyond Cape Leeuwin. Coals of both Permian and Jurassic age occur in the basin but none is currently mined. The coal geology is reviewed in some detail by Le Blanc Smith (1990a).

There are three main deposits: Vasse River and Irwin River (Permian), and the Hill River coalfield (Jurassic).

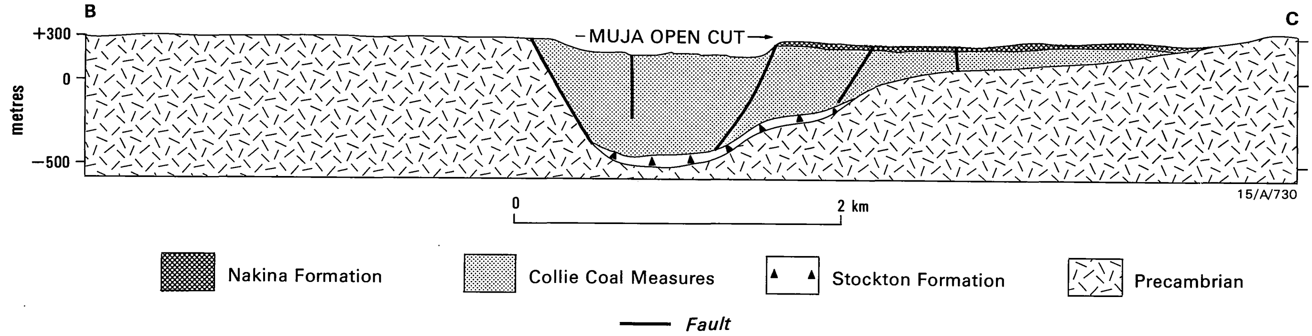

Fig. 79. Structure of the southeastern part of the Premier Sub-basin. Location of section is shown in Figure 76 (after Lord, 1975).

Vasse River

The Vasse River deposit is south of Busselton, at the southern end of the Perth Basin. The coal was discovered by the Geological Survey of Western Australia while drilling for water in 1966–67.

The Sue Coal Measures (Early to Late Permian) unconformably overlie Precambrian basement and are overlain by the Early Cretaceous Warnbro Group. The shallowest seam is 80 m below the surface.

Le Blanc Smith (1990a) notes that coal rank varies with age. The Early Permian coal is bituminous, whereas the Late Permian coal is hydrous sub-bituminous to lignitic. He records ash as varying from 7% to 20%, volatile matter as 23%, sulphur 0.5–1.4%, specific energy 17–31 MJ/kg, and ash fusion temperature 1200°C. Coal occurs in up to 17 seams or carbonaceous shales but the more interesting targets are towards the base of the unit. There are eight groups of seams, of which Le Blanc Smith (1990a) considers that four seams, between 180 and 450 deep, have potential to be economically worked.

Indicated resources in seams over 1.3 m are reported by Le Blanc Smith (1990a) as totalling 600 Mt.

Irwin River

The Irwin River deposit is in the Irwin Sub-basin, west of Geraldton. Coal occurs in the Early Permian Irwin River Coal Measures and was discovered in 1846. Le Blanc Smith (1990a) reports the presence of nine seams with a total thickness of 10 m and individual seams ranging from 0.5 m to 3.0 m thick. He records the following properties: ash 21%, volatile matter 25%, specific energy 16 MJ/kg, and sulphur 0.5%. In-situ inferred resources are 1180 Mt.

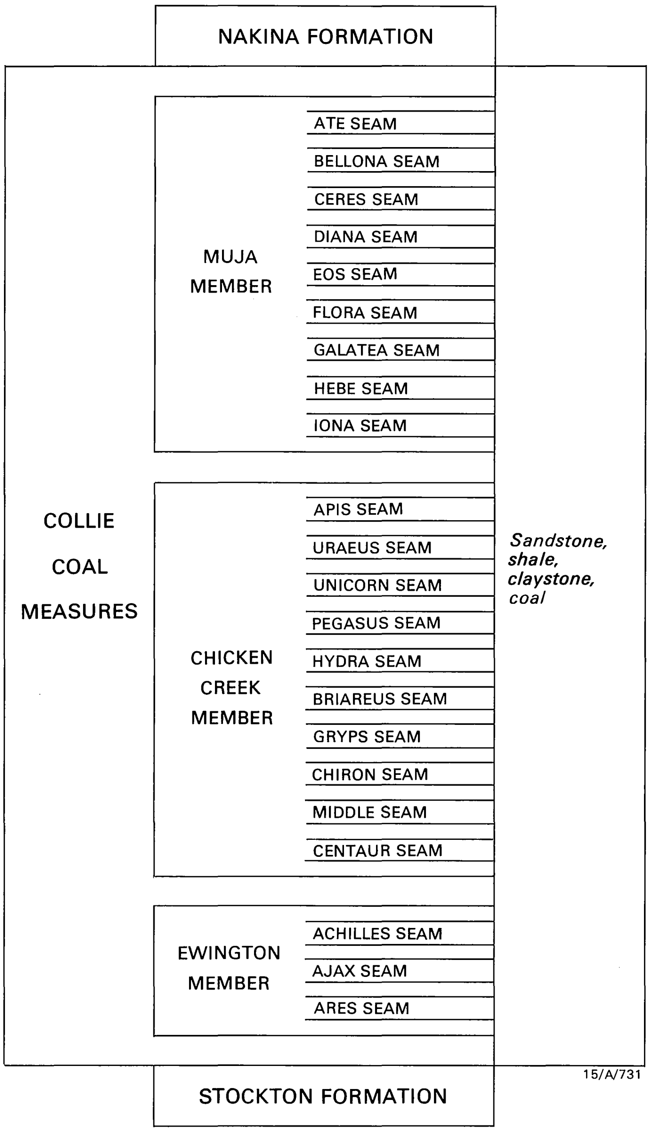

Fig. 80. Stratigraphy and lithology, Collie Coal Measures, southeastern part of the Premier Sub-basin (based on Wilson, 1990).

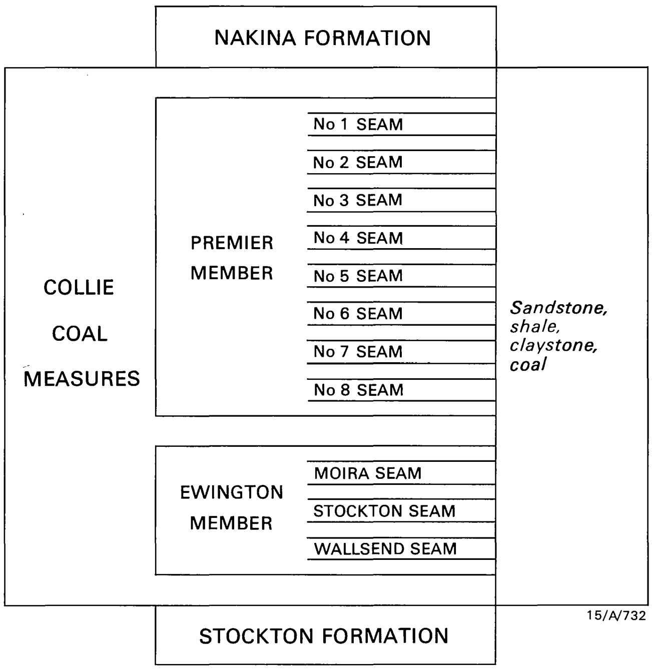

Fig. 81. Stratigraphy and lithology, Collie Coal Measures, northwestern and central parts of the Premier Sub-basin (based on Wilson, 1990).

Hill River Coalfield

The Hill River Coalfield is near Jurien Bay, some 210 km north of Perth. It was discovered in 1961 during petroleum exploration.

Coal occurs in the Early Jurassic Cattamarra Member. Le Blanc Smith (1990a) notes that there are four main deposits in the coalfield: Eneabba, Gairdner Range, Brazier, and Wongonderrah. There are three coal zones with a maximum cumulative coal thickness of 16 m and a maximum observed seam thickness of 11 m. Reported coal properties are: ash 13–17%, volatile matter 28–34%, specific energy 17–25 MJ/kg, sulphur 1.0–1.5%, and an ash fusion temperature of over 1400°C. Le Blanc Smith (1990a) reports unclassified resources of about 366 Mt of sub-bituminous coal.

Wilga and Boyup Basins

(Le Blanc Smith, 1990b)

The Wilga and Boyup Basins are south of the Collie Basin and are of Permian age. Le Blanc Smith (1990b) has briefly described the geology and the history of exploration.

The strata are similar to those of the Collie Basin. The principal coal occurrence is in the equivalent of the Ewington Member of the Collie Coal Measures. The following coal properties are reported: Wilga Basin, ash 6–9%, volatile matter 28–36%, specific energy 18–22MJ/kg, and sulphur 0.5%; Boyup Basin, ash 5%, volatile matter 29%, and specific energy 22 MJ/kg. Coals in both basins are sub-bituminous.

Part 2

Indicative analyses, selected coal seams

Part 2 lists the properties of coals in the more important seams from which saleable products are or may be derived. Because the properties of coals won from a seam may vary from place to place (and therefore also over time as different parts of the seam are worked), the analytical data presented are indicative only. All data were derived from the published sources cited. For Queensland, the reader is particularly referred to the 1990 edition of 'Queensland Coals' published by the Queensland Coal Board. For additional information, please refer to the mining authority in the relevant State (Appendix 1).

Abbreviations

AA	Ash analysis
AFD	Ash fusion temperature in degrees C, reducing atmosphere, initial deformation
AFH	Ash fusion temperature in degrees C, reducing atmosphere, hemispherical deformation
AFF	Ash fusion temperature in degrees C, reducing atmosphere, flow
C	Carbon, dry ash-free basis
Cl	Chlorine, dry basis
CSN	Crucible swelling number
E	Exinite group, % by volume
F	All other inertinite macerals, % by volume
FC	Fixed carbon, dry basis
GF ddpm	Gieseler plastometer value measured as maximum number of dial divisions per minute
GKCT	Gray-King coke type
H	Hydrogen, dry ash-free basis
HGI	Hardgrove grindability index
M	Moisture, air-dried basis
MI	Micrinite, % by volume
MM	Mineral matter, % by volume
N	Nitrogen, dry ash-free basis
O	Oxygen, dry ash-free basis
P	Phosphorus, dry basis
RO(max)	% mean maximum reflectance of all vitrinite
S	Sulphur, dry basis
SE	Specific energy, air-dried basis, MJ/kg
V	Vitrinite group, % by volume
VM	Volatile matter, dry basis

Contents, Part 2

QUEENSLAND

SEAM: UNNAMED SEAMS, CULLIN-LA-RINGO PROSPECT

Geological Sequence: Reids Dome beds
District: South-southwest of Emerald, Cullin-la-ringo area
Basin: Bowen
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	4.1	3.7	3.1	AFD	1370	1220	1260
Ash %	4.5	6.5	6.6	AFH	1600	1380	1460
VM %	32.4	31.8	31.7	AFF	>1600	1420	1500
FC %	59.0	58.0	58.6				
				AA			
C %	82.4	82.4	83.3	SiO_2 %	62.0	54.3	55.9
H %	5.21	5.29	5.18	Al_2O_3 %	28.6	25.8	27.4
N %	2.30	2.16	2.04	Fe_2O_3 %	2.0	4.3	5.9
O %	9.8	9.7	9.2	TiO_2 %	1.54	1.17	1.24
				CaO %	1.8	5.1	3.9
P %				MgO %	0.3	2.4	1.2
Cl %				Na_2O %	0.6	0.5	0.5
S %	0.30	0.40	0.26	K_2O %	0.59	0.46	0.28
				P_2O_5 %	1.61	1.67	1.18
CSN	1	1	1.5				
GKCT				V %	57.9	52.1	56.9
GF ddpm				E %	5.0	5.2	4.8
				MI %			
SE	30.54	30.20	30.48	F %	34.7	39.0	44.8
HGI	43	44	43	MM %	2.4	3.7	3.5
				RO(max)	0.81	0.83	0.84

Source: D'Arcy, 1990; all samples are from the 'relative density 1.60 floats' fraction and are from drill core.

SEAM: UNNAMED SEAMS, GINDIE PROSPECT

Geological Sequence: Reids Dome beds
District: South-southwest of Emerald, Cullin-la-ringo area
Basin: Bowen
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	3.6	3.4	3.5	AFD	1350	1410	1280
Ash %	5.1	4.3	12.6	AFH	1590	1590	1570
VM %	37.6	33.9	30.2	AFF	>1600	>1600	1590
FC %	53.7	58.4	53.7				
				AA			
C %	81.30	82.50	82.00	SiO_2 %	52.6	58.5	64.8
H %	5.70	5.31	5.34	Al_2O_3 %	30.2	28.6	25.3
N %	2.75	2.49	2.56	Fe_2O_3 %	5.1	2.9	1.4
O %	9.80	9.40	9.60	TiO_2 %	1.36	1.55	1.37
				CaO %	1.5	0.7	1.5
P %				MgO %	0.5	0.3	0.4
Cl %				Na_2O %	0.8	0.5	0.3
S %	0.45	0.31	0.43	K_2O %	0.94	0.57	1.56
				P_2O_5 %	2.52	1.36	1.71
CSN	1	1	1				
GKCT				V %	68.9	55.0	56.8
GF ddpm				E %	7.4	6.1	7.5
				MI %			
SE	31.14	31.16	28.34	F %	20.8	36.5	28.2
HGI	36	49		MM %	2.9	2.4	7.5
				RO(max)	0.76	0.83	0.88

Source: D'Arcy, 1990; all samples are from the 'relative density 1.60 floats' fraction and are from drill core.

SEAM: 1 = LA POULE; 2 = KETTLE; 3 = ANAKIE

Geological Sequence: Reids Dome beds
District: Southwest of Capella
Basin: Bowen
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	4.5	3.1	2.2	V %	45	53	68
VM %	37.8	40.5	41.4	E %	6	11	7
				F %	49	36	25
C %	81.98	82.13		RO(max)	0.77	0.76	0.77
H %	5.10	5.83					
O %	10.59	8.50					
CSN	1	0.5	7.5				

Source: Edenborough (1985); 1 and 2 are from the 'relative density 2.00 floats' fraction, 3 is from the 'relative density 1.50 floats' fraction.

SEAM: BLAKE

Geological Sequence: Collinsville Coal Measures
District: Bowen
Basin: Bowen
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.3	1.0	1.5	AFD	1340	1410	1530
Ash %	22.1	24.0	20.0	AFH	>1560	>1550	1600
VM %	19.1	19.6	18.7	AFF	>1560	>1550	1600
FC %	58.8	56.4	59.8				
				AA			
C %	85.7	87.3	85.6	SiO_2 %	71.7	62.5	53.10
H %	4.72	4.00	4.70	Al_2O_3 %	17.0	26.1	36.60
N %	1.4	1.8	1.9	Fe_2O_3 %	5.29	3.72	1.40
O %	6.7	6.2	7.0	TiO_2 %	1.47	2.19	2.20
				CaO %	1.51	0.90	0.80
P %	0.032	0.124	0.08	MgO %	0.57	0.21	0.40
Cl %	0.05	0.03	0.08	Na_2O %	0.20	0.11	0.20
S %	0.82	0.43		K_2O %	0.75	1.02	0.30
				P_2O_5 %	0.33	2.08	1.30
CSN	2		1.5				
GKCT	F–G		C	V %	36	24	
GF ddpm	2			E %	1	1	
				MI %	17	11	
SE	27.05	26.30	27.00	F %	1	0	
HGI	77	76	84	MM %	13	14	
				RO(max)	1.23	1.14	

Source: Joint Coal Board & Queensland Coal Board (1987); Queensland Coal Board (1986).

SEAM: BOWEN

Geological Sequence: Collinsville Coal Measures
District: Bowen
Basin: Bowen
Age: Early Permian

	1	*2*		*1*	*2*
M %	1.3	1.3	AFD	1280	1350
Ash %	14.5	14.5	AFH	1430	1410
VM %	20.2	20.2	AFF	1550	1550
FC %	65.3	64.0			
			AA		
C %	87.8	87.60	SiO_2 %	57.8	56.70
H %	4.88	4.90	Al_2O_3 %	20.4	26.90
N %	1.9	1.80	Fe_2O_3 %	9.14	10.50
O %	4.0	4.30	TiO_2 %	1.08	2.40
			CaO %	8.68	1.10
P %	0.062	0.07	MgO %	0.54	0.30
Cl %	0.04	0.03	Na_2O %	0.09	0.20
S %	1.29	0.80	K_2O %	0.28	0.20
			P_2O_5 %	0.97	1.20
CSN	3	4–5			
GKCT	F–G	G	V %	42	39
GF ddpm	5	60	E %	Tr	
			MI %	18	
SE	30.0	30.6	F %	33	57
HGI	89	84	MM %	7	4
			RO(max)	1.21	1.14

Source: Joint Coal Board & Queensland Coal Board (1987); Queensland Coal Board (1986).

SEAM: DENISON

Geological Sequence: Collinsville Coal Measures
District: Bowen
Basin: Bowen
Age: Early Permian

M %	1.5	AFD	>1560
Ash %	8.3	AFH	>1560
VM %	27.6	AFF	>1560
FC %	64.1		
		AA	
C %	86.7	SiO_2 %	60.0
H %	5.3	Al_2O_3 %	32.5
N %	1.5	Fe_2O_3 %	3.94
O %	5.7	TiO_2 %	0.91
		CaO %	0.33
P %	0.008	MgO %	0.18
Cl %		Na_2O %	0.29
S %	0.69	K_2O %	0.71
		P_2O_5 %	0.06
CSN	8.5		
GKCT	G6	V %	70
GF ddpm	1800	E %	2
		MI %	7
SE	32.28	F %	17
HGI	88	MM %	4
		RO(max)	1.07

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: GARRICK

Geological Sequence: Collinsville Coal Measures
District: Bowen
Basin: Bowen
Age: Early Permian

	1	*2*		*1*	*2*
M %	1.6	1.6	AFD	>1560	1380
Ash %	9.4	9.6	AFH	>1560	1520
VM %	24.8	23.2	AFF	>1560	>1560
FC %	65.8	67.2			
			AA		
C %	86.7	86.9	SiO_2 %	56.2	51.0
H %	4.98	4.78	Al_2O_3 %	34.4	29.2
N %	1.7	1.4	Fe_2O_3 %	5.49	14.29
O %	5.8	5.4	TiO_2 %	1.05	1.18
			CaO %	0.74	0.50
P %	0.44	0.037	MgO %	0.25	0.48
Cl %			Na_2O %	0.30	0.33
S %	0.74	1.42	K_2O %	0.64	0.67
			P_2O_5 %	0.74	0.76
CSN	5.5	3.5			
GKCT	F–G	E–F	V %	36	39
GF ddpm	580	8	E %	1	1
			MI %	15	17
SE	31.73	31.70	F %	44	40
HGI	83	94	MM %	4	4
			RO(max)	1.10	1.12

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: GOONYELLA LOWER

Geological Sequence: Moranbah Coal Measures
District: Mackay (northern area of Moranbah Coal Measures)
Basin: Bowen
Age: Late Permian

	1	*2*		*1*	*2*
M %	1.7	1.2	AFD	1580	1540
Ash %	9.8	10.1	AFH	>1600	>1560
VM %	23.9	25.7	AFF	>1600	>1560
FC %	64.6	66.8			
			AA		
C %	87.94	87.9	SiO_2 %	64.50	70.4
H %	5.00	5.06	Al_2O_3 %	28.90	18.8
N %	1.86	1.9	Fe_2O_3 %	1.47	5.22
O %	4.57	4.7	TiO_2 %	1.77	1.15
			CaO %	0.20	1.03
P %	0.006	0.007	MgO %	0.43	0.22
Cl %	0.09	0.05	Na_2O %	0.54	0.17
S %	0.63	0.53	K_2O %	0.90	0.34
			P_2O_5 %	0.10	0.60
CSN	7.5	6.5			
GKCT	G1–G4	G1	V %	55	57
GF ddpm	1000	117	E %	1	1
			MI %	10	8
SE	35.90	31.75	F %	29	28
HGI	78	78	MM %	5	6
			RO(max)	1.23	1.19

Source: Queensland Coal Board (1986); Joint Coal Board & Queensland Coal Board (1987).

SEAM: GOONYELLA MIDDLE

Geological Sequence: Moranbah Coal Measures
District: Mackay (Northern area of the Moranbah Coal Measures)
Basin: Bowen
Age: Late Permian

M %	1.6	AFD	>1560
Ash %	7.8	AFH	>1560
VM %	25.3	AFF	>1560
FC %	66.9		
		AA	
C %	87.80	SiO_2 %	56.5
H %	5.12	Al_2O_3 %	35.2
N %	1.17	Fe_2O_3 %	3.15
O %	4.70	TiO_2 %	1.17
		CaO %	1.3
P %	0.034	MgO %	0.56
Cl %	0.38	Na_2O %	0.44
S %	0.54	K_2O %	0.44
		P_2O_5 %	0.98
CSN	8		
GKCT	G4	V %	52
GF ddpm	2300	E %	
		MI %	10
SE	33.40	F %	37
HGI	85	MM %	5
		RO(max)	1.10

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: DYSART

Geological Sequence: Moranbah Coal Measures
District: Mackay (Southern area of the Moranbah Coal Measures)
Basin: Bowen
Age: Late Permian

	1	*2*		*1*	*2*
M %	1.3	1.5	AFD	1460	1410
Ash %	10.0	9.5	AFH	>1550	>1550
VM %	17.0	18.8	AFF	>1550	>1550
FC %	73.0	71.7			
			AA		
C %	89.2	89.1	SiO_2 %	57.0	61.5
H %	4.76	4.77	Al_2O_3 %	33.9	31.3
N %	2.0	1.96	Fe_2O_3 %	3.63	3.15
O %	3.3	3.5	TiO_2 %	1.84	1.72
			CaO %	1.40	0.62
P %	0.044	0.017	MgO %	0.51	0.56
Cl %	0.03	0.03	Na_2O %	0.24	0.41
S %	0.63	0.58	K_2O %	0.78	0.97
			P_2O_5 %	0.91	0.39
CSN	9	9			
GKCT	G5	G5	V %	67	63
GF ddpm	21	100	E %		
			MI %	2	
SE	32.22	32.23	F %	28	30
HGI	95	92	MM %	5	5
			RO(max)	1.63	1.54

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: HARROW CREEK

Geological Sequence: Moranbah Coal Measures
District: Mackay (Southern area of the Moranbah Coal Measures)
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.4	1.6	1.8	V %	67	59	60
Ash %	11.3	12.9	12.3	E %	Tr	1	1
VM %	24.0	23.6	25.3	MI %			
FC %	63.3	61.9	60.6	F %	21	27	27
				MM %	11	13	12
CSN	>9	9	7.5	RO(max)	1.24	1.18	1.03
GKCT	G7	G6	G6				
GF ddpm	669	313	2300				
SE	31.42	30.63	30.83				

Source: Dash (1987); all samples are from the 'relative density 1.5 floats' fraction.

SEAM: P

Geological Sequence: Moranbah Coal Measures
District: Mackay (Southern area of Moranbah Coal Measures)
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.3	1.4	1.4	V %	70	69	68
Ash %	10.1	11.3	10.6	E %	Tr	Tr	Tr
VM %	24.3	24.8	24.9	MI %			
FC %	64.3	62.5	63.1	F %	20	21	20
				MM %	10	11	11
CSN	9	9	8.5	RO(max)	1.18	1.13	1.14
GKCT	G6	G9	G6				
GF ddpm	817	923	750				
SE	32.02	31.53	31.39				

Source: Dash (1987); results are from the 'relative density 1.45 floats' fractions.

SEAM: Q

Geological Sequence: Moranbah Coal Measures
District: Mackay (Southern area of Moranbah Coal Measures)
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.7	3.7	1.8	V %	59	59	73
Ash %	11.6	8.2	13.8	E %	1	1	1
VM %	23.9	23.8	25.4	MI %			
FC %	62.8	64.3	59.0	F %	28	26	12
				MM %	12	14	14
CSN	8.5	3.5	9	RO(max)	1.16	1.14	1.09
GKCT	G5	B	G8				
GF ddpm	395	0	1403				
SE	31.09	30.37	30.50				

Source: Dash (1987); results are from the 'relative density 1.45 floats' fractions, Q Upper and Q Lower seams.

SEAM: LILYVALE

Geological Sequence: German Creek Formation
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.0	2.0	2.2	AFD		>1550	1300
Ash %	8.5	8.5	8.6	AFH		>1550	>1550
VM %	32.1	32.0	32.2	AFF		>1550	>1550
FC %	57.8	57.5	59.2				
				AA			
C %	84.6	85.0	85.2	SiO_2 %	52.3	52.00	52.9
H %	5.36	5.2	5.54	Al_2O_3 %	38.0	38.90	39.4
N %	2.06	2.2	2.2	Fe_2O_3 %	3.85	3.20	3.97
O %	6.13	6.9	6.4	TiO_2 %	1.67	1.90	1.81
				CaO %	0.78	1.00	0.63
P %		0.03	0.017	MgO %	0.34	0.30	0.43
Cl %			0.05	Na_2O %	0.33	0.30	0.06
S %	0.53	0.65	0.60	K_2O %	0.77	0.80	0.78
				P_2O_5 %	0.64	0.70	0.91
CSN	8.5	8–9	8.5				
GKCT	G6	G7	G8	V %	68	69	68
GF ddpm	1880	3500	>5000	E %		4	7
				MI %	3.2		Tr
SE		32.30	31.59	F %	17.4	25	22
HGI		65	58	MM %	4.5	2	3
				RO(max)	0.98	0.98	0.94

Source: Dampier Mining Co. Ltd (undated); Queensland Coal Board (1986); Joint Coal Board & Queensland Coal Board (1987).

SEAM: GERMAN CREEK

Geological Sequence: German Creek Formation
District: Blackwater
Basin: Bowen
Age: Late Permian

M %	1.4	AFD	>1550
Ash %	8.4	AFH	>1550
VM %	30.9	AFF	>1550
FC %	63.3		
		AA	
C %	87.0	SiO_2 %	55.3
H %	5.56	Al_2O_3 %	34.0
N %	2.2	Fe_2O_3 %	3.82
O %	4.5	TiO_2 %	2.77
		CaO %	0.64
P %	0.006	MgO %	0.57
Cl %		Na_2O %	0.46
S %	0.62	K_2O %	0.79
		P_2O_5 %	0.16
CSN	8		
GKCT	G8	V %	67
GF ddpm	>5000	E %	3
		MI %	Tr
SE	33.03	F %	26
HGI	76	MM %	4
		RO(max)	1.11

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: POLLUX

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	3.0	2.4	5.0	AFD	1150	1540	1150
Ash %	10.0	7.0	6.8	AFH	1220	>1560	1240
VM %	8.0	28.3	11.0	AFF	1340	>1560	1340
FC %	79.0	64.7	82.2				
				AA			
C %	91.7	85.9	87.8	SiO_2 %	47.00	53.5	45.7
H %	3.6	5.11	3.4	Al_2O_3 %	24.30	33.3	23.3
N %	1.8	2.1	1.8	Fe_2O_3 %	9.70	4.96	11.9
O %	2.1	6.3	6.5	TiO_2 %	1.10	0.27	5.98
				CaO %	6.70	2.55	1.41
P %		0.061	0.113	MgO %	0.10	0.53	0.55
Cl %		0.03	0.10	Na_2O %	4.10	0.27	9.23
S %	0.5	0.47	0.53	K_2O %	1.40	0.87	0.55
				P_2O_5 %	1.80	1.87	0.52
CSN	0	6.5	0				
GKCT	A	G1	A	V %	39	43	68
GF ddpm		61		E %	0	3	
				MI %		15	5
SE	35.45	35.17	34.05	F %	56	35	23
HGI	68	65	68	MM %	5	4	4
				RO(max)	2.59	1.0	2.43

Source: Joint Coal Board & Queensland Coal Board (1987); Queensland Coal Board (1986).

SEAM: CASTOR LOWER

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	6.8	6.7	6.4	AFD	1130	1110	1100
Ash %	12.1	10.3	13.4	AFH	1190	1140	1140
VM %	27.0	28.0	27.5	AFF	1200	1180	1240
FC %	54.1	55.0	52.7				
				AA			
C %	83.29	82.62		SiO_2 %	57.30	44.60	55.10
H %	4.80	4.92		Al_2O_3 %	16.50	18.90	11.70
N %	2.03	2.01		Fe_2O_3 %	11.90	28.30	12.30
O %	9.08	9.82		TiO_2 %	0.74	0.83	0.57
				CaO %	8.26	2.50	12.90
P %	0.077	0.056	0.026	MgO %	2.31	3.54	3.13
Cl %				Na_2O %	0.42	0.25	0.26
S %	0.80	0.63	0.32	K_2O %	0.78	0.33	0.58
				P_2O_5 %	1.45	1.20	0.44
CSN	1	1	1				
				V %	47	50	42
SE	28.38	28.26	26.66	E %	2	2	3
HGI	56	53		MI %			
				F %	46	42	47
				MM %	7	6	8
				RO(max)	0.83	0.81	0.81

Source: Coffey & others (1983).

SEAM: CASTOR UPPER

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*		*1*	*2*
M %	5.7	6.5	AFD	1500	1470
Ash %	17.8	14.0	AFH	1520	1530
VM %	24.1	24.9	AFF	1560	>1600
FC %	52.4	54.6			
			V %	29	32
C %		83.62	E %	3	4
H %		4.65	MI %		
N %		1.98	F %	57	56
O %		9.31	MM %	11	8
			RO(max)	0.82	
P %	0.032	0.003			
S %	0.37	0.44			
CSN	1	1			
SE	26.06	26.94			

Source: Coffey & others (1983).

SEAM: CASTOR

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	5.1	6.4	6.9	AFD	1220	1370	1160
Ash %	9.7	12.9	12.6	AFH	1270	1500	1200
VM %	25.7	24.2	27.4	AFF	1310	1540	1260
FC %	59.5	56.5	53.1				
				AA			
C %	84.19	84.46	84.47	SiO_2 %	54.40	64.80	42.9
H %	4.58	4.52	4.68	Al_2O_3 %	21.30	22.40	22.80
N %	2.07	2.00	2.05	Fe_2O_3 %	15.70	7.58	15.40
O %	8.80	8.25	8.18	TiO_2 %	0.80	1.00	1.02
				CaO %	1.94	1.08	8.61
P %	0.079	0.043	0.113	MgO %	0.83	0.56	1.79
Cl %				Na_2O %	0.41	0.38	0.40
S %	0.36	0.63	0.62	K_2O %	0.22	0.36	0.36
				P_2O_5 %	1.86	0.76	2.05
CSN	1	1	1				
				V %	35	30	38
SE	28.80	27.50	26.82	E %	2	3	2
HGI	55	56	56	MI %			
				F %	57	59	53
				MM %	6	8	7
				RO(max)	0.84	0.85	0.83

Source: Coffey & others (1983).

SEAM: ARIES–CASTOR

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	5.5	4.9	5.7	AFD	1320	1380	1310
Ash %	12.2	12.4	12.3	AFH	1440	1510	1340
VM %	25.4	25.3	26.5	AFF	1490	1530	1380
FC %	56.9	57.4	55.5				
				AA			
C %	84.21	83.81	84.25	SiO_2 %	48.00	53.10	45.20
H %	5.05	4.80	4.72	Al_2O_3 %	28.20	29.80	26.40
N %	2.03	2.03	2.02	Fe_2O_3 %	5.93	9.72	6.47
O %	8.08	8.78	8.39	TiO_2 %	1.09	1.16	1.08
				CaO %	2.94	3.50	11.00
P %	0.051	0.080	0.081	MgO %	0.53	0.31	1.31
Cl %	0.07	0.07	0.06	Na_2O %	0.38	0.37	0.61
S %	0.63	0.58	0.62	K_2O %	0.73	1.06	0.47
				P_2O_5 %	0.95	1.48	1.51
CSN	1	0.5	1				
				V %	35	29	32
SE	27.98	27.86	27.38	E %	3	3	3
HGI	60	62		MI %			
				F %	55	61	58
				MM %	7	7	7
				RO(max)	0.80	0.80	0.80

Source: Coffey & others (1983).

SEAM: ARIES II UPPER

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	4.0	6.9	6.3	AFD	1220	1330	1430
Ash %	10.7	15.7	15.0	AFH	1350	1460	1570
VM %	25.8	26.8	26.8	AFF	1370	1530	1590
FC %	59.5	50.6	51.9				
				AA			
C %	84.29			SiO_2 %	56.20		
H %	4.39			Al_2O_3 %	21.70		
N %	2.00			Fe_2O_3 %	13.50		
O %	8.91			TiO_2 %	0.96		
				CaO %	1.54		
P %	0.072	0.023	0.009	MgO %	1.66		
Cl %				Na_2O %	0.32		
S %	0.41	0.55	0.40	K_2O %	0.20		
				P_2O_5 %	1.54		
CSN	1	1	1				
				V %	28	59	49
SE	28.92	25.86	26.46	E %	3	2	2
HGI	53			MI %			
				F %	63	30	40
				MM %	6	9	9
				RO(max)	0.89	0.84	0.83

Source: Coffey & others (1983).

SEAM: ARIES II

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	4.8	5.8	7.3	AFD	1110	1450	1300
Ash %	10.4	12.7	13.8	AFH	1250	1570	1350
VM %	25.4	24.5	25.0	AFF	1310	1600	1420
FC %	59.4	57.0	53.9				
				AA			
C %	84.66	83.49		SiO_2 %	53.90	59.70	
H %	4.57	4.79		Al_2O_3 %	18.20	25.80	
N %	2.01	1.98		Fe_2O_3 %	19.70	7.40	
O %	7.50	9.11		TiO_2 %	0.66	1.15	
				CaO %	2.23	1.80	
P %	0.040	0.039	0.014	MgO %	1.02	0.69	
Cl %				Na_2O %	0.48	0.59	
S %	1.26	0.63	0.57	K_2O %	0.16	0.35	
				P_2O_5 %	0.88	0.70	
CSN	1	1	0.5				
				V %	34	26	34
SE	29.08	27.36	26.46	E %	2	3	3
HGI	59	58		MI %			
				F %	58	63	55
				MM %	6	8	8
				RO(max)	0.84	0.86	0.81

Source: Coffey & others (1983).

SEAM: ARIES I

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	5.5	4.7	5.6	AFD	1220	1270	1340
Ash %	15.1	15.6	15.0	AFH	1450	1450	1440
VM %	26.6	27.6	26.2	AFF	1520	1500	1480
FC %	52.8	52.1	53.2				
				AA			
C %	83.40	82.64	82.60	SiO_2 %	61.70	64.50	54.90
H %	4.98	5.04	4.94	Al_2O_3 %	23.30	21.70	28.20
N %	1.90	2.11	2.11	Fe_2O_3 %	6.32	3.96	6.42
O %	9.22	9.53	9.87	TiO_2 %	1.04	0.77	0.98
				CaO %	2.23	5.68	6.40
P %	0.053	0.020	0.006	MgO %	0.98	1.24	1.35
Cl %				Na_2O %	0.29	0.30	0.28
S %	0.40	0.68	0.48	K_2O %	0.74	1.11	0.86
				P_2O_5 %	1.31	0.30	0.09
CSN	1	1	1				
				V %		60	50
SE	25.56	27.00	26.56	E %		2	3
HGI		60	55	MI %			
				F %		29	38
				MM %		9	9
				RO(max)		0.86	0.85

Source: Coffey & others (1983).

SEAM: ARIES

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

M %	2.3	AFD	>1560
Ash %	9.1	AFH	>1560
VM %	28.6	AFF	>1560
FC %	62.3		
		AA	
C %	85.2	SiO_2 %	60.0
H %	5.11	Al_2O_3 %	29.6
N %	2.1	Fe_2O_3 %	4.95
O %	6.8	TiO_2 %	0.81
		CaO %	0.80
P %	0.035	MgO %	0.37
Cl %	0.04	Na_2O %	0.24
S %	0.71	K_2O %	1.14
		P_2O_5 %	0.88
CSN	5.5		
GKCT	F–G	V %	48
GF ddpm	32	E %	4
		MI %	15
SE	35.24	F %	29
HGI	68	MM %	4
		RO(max)	0.99

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: GEMINI

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

M %	0.9	AFD	1380
Ash %	9.7	AFH	1540
VM %	21.2	AFF	1550
FC %	69.1		
		AA	
C %	88.6	SiO_2 %	59.7
H %	4.77	Al_2O_3 %	27.1
N %	1.7	Fe_2O_3 %	4.49
O %	4.4	TiO_2 %	0.93
		CaO %	2.61
P %	0.025	MgO %	0.79
Cl %	0.04	Na_2O %	0.60
S %	0.28	K_2O %	0.79
		P_2O_5 %	0.38
CSN	3.5		
GKCT	D	V %	32
GF ddpm	7	E %	1
		MI %	11
SE	35.63	F %	52
HGI	84	MM %	4
		RO(max)	1.22

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: MAMMOTH

Geological Sequence: Rangal Coal Measures
District: Blackwater
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.0	2.0	2.7	AFD	1350	1350	>1600
Ash %	7.2	11.5	10.2	AFH	>1600	>1600	>1600
VM %	28.4	25.8	16.6	AFF	>1600	>1600	>1600
FC %	62.4	60.7	70.5				
				AA			
C %	86.2	86.2		SiO_2 %	54.50	54.60	
H %	4.8	4.8		Al_2O_3 %	31.20	30.70	
N %	2.1	2.1		Fe_2O_3 %	7.40	7.00	
O %	6.4	6.0		TiO_2 %	1.20	1.20	
				CaO %	2.00	1.15	
P %	0.04	0.04	0.057	MgO %	0.20	0.42	
Cl %	0.05	0.05		Na_2O %	0.20	0.14	
S %	0.45	0.80	0.53	K_2O %	1.30	0.94	
				P_2O_5 %	1.20	0.90	
CSN	6.5	2					
GKCT	G3			V %	56	40	
GF ddpm	500			E %	3	3	
				MI %			
SE	35.55	34.38	30.98	F %	38	52	
HGI	70	67		MM %	3	5	
				RO(max)	1.06	1.05	

Source: Queensland Coal Board (1986); Staines (1987); analyses 1 & 2 are for product coals from the seam; 3 is from drill core.

SEAM: VERMONT

Geological Sequence: Rangal Coal Measures
District: Mackay (Red Hill–Lake Vermont area)
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.0	2.0	2.1	AFD	1130	1370	1420
Ash %	20.2	14.5	13.2	AFH	1210	1460	1590
VM %	18.8	19.7	19.4	AFF	1370	1540	>1600
FC %	59.0	63.8	65.3				
				AA			
C %	86.73	87.03		SiO_2 %	47.0	46.4	55.7
H %	4.33	4.52		Al_2O_3 %	24.6	29.7	30.2
N %	1.85	1.82		Fe_2O_3 %	17.7	13.7	2.95
O %	6.12	6.14		TiO_2 %	0.77	0.87	0.98
				CaO %	5.29	3.44	4.47
P %	0.185	0.119	0.162	MgO %	0.95	2.06	0.83
Cl %				Na_2O %	0.29	0.30	0.26
S %	0.97	0.49		K_2O %	1.30	1.21	1.05
				P_2O_5 %	2.10	1.88	2.81
CSN	1.5	2	1.5				
				V %	23	22	20
SE	26.90	29.50	29.96	E %	1	1	
HGI	81	80		MI %			
				F %	71	72	74
				MM %	5	5	6

Source: Sorby & others (1983).

SEAM: LEICHHARDT

Geological Sequence: Rangal Coal Measures
District: Mackay (Red Hill–Lake Vermont area)
Basin: Bowen
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.2	2.4	2.5	AFD	1220	1270	1340
Ash %	11.3	14.6	10.9	AFH	1390	1340	1530
VM %	19.8	19.0	23.9	AFF	1430	1460	>1600
FC %	66.7	64.0	62.7				
				AA			
C %	87.79	87.60	86.83	SiO_2 %	43.3	50.1	50.2
H %	4.43	4.43	4.91	Al_2O_3 %	27.7	27.7	33.44
N %	1.68	1.76	1.64	Fe_2O_3 %	17.4	10.5	6.89
O %	5.72	5.18	6.22	TiO_2 %	1.00	1.05	1.46
				CaO %	4.60	5.98	3.75
P %	0.112	0.222	0.113	MgO %	2.67	0.63	1.24
Cl %				Na_2O %	0.30	0.30	0.23
S %	0.38	1.03	0.40	K_2O %	0.45	0.74	0.35
				P_2O_5 %	2.28	3.49	2.37
CSN	2	2					
				V %	21	20	45
SE	30.60	29.54	30.44	E %	1	1	4
HGI	81	83	58	MI %			
				F %	72	73	46
				MM %	6	6	5
				RO(max)			1.09

Source: Sorby & others (1983).

SEAM: UPPER NEWLANDS

Geological Sequence: Rangal Coal Measures
District: Mackay (Glenden area)
Basin: Bowen
Age: Late Permian

M %	2.7	AFD	1550
Ash %	14.0	AFH	
VM %	25.8	AFF	1600
FC %	57.5		
		AA	
C %	85.9	SiO_2 %	53.50
H %	4.9	Al_2O_3 %	37.50
N %	1.7	Fe_2O_3 %	2.40
O %	3.8	TiO_2 %	1.80
		CaO %	0.70
S %	0.50	MgO %	0.40
		Na_2O %	0.40
CSN	0–1	K_2O %	0.50
GKCT	B–C	P_2O_5 %	1.10
SE	34.20	V %	30
HGI	54	E %	9
		MI %	
		F %	55
		MM %	6
		RO(max)	0.90

Source: Queensland Coal Board (1986); analysis is for product coal derived from seam.

SEAM: MAIN

Geological Sequence: Rangal Coal Measures
District: Mackay (Nebo area)
Basin: Bowen
Age: Late Permian

M %	1.4	AFD	1350
Ash %	16.1	AFH	1420
VM %	13.7	AFF	1450
FC %	68.7		
		AA	
C %	88.96	SiO_2 %	45.00
H %	4.12	Al_2O_3 %	37.00
N %	1.54	Fe_2O_3 %	5.75
O %	4.78	TiO_2 %	0.78
		CaO %	4.30
P %	0.076	MgO %	0.90
Cl %	0.02	Na_2O %	0.40
S %	0.56	K_2O %	0.97
		P_2O_5 %	1.02
CSN	0.5		
GKCT	A		
SE	29.01		
HGI	95		

Source: Queensland Coal Board (1986).

SEAM: HYNDS

Geological Sequence: Rangal Coal Measures
District: Mackay (Nebo area)
Basin: Bowen
Age: Late Permian

M %	1.0	AFD	1450
Ash %	9.8	AFH	1550
VM %	19.6	AFF	>1560
FC %	70.6		
		AA	
C %	89.2	SiO_2 %	60.7
H %	4.97	Al_2O_3 %	26.5
N %	1.5	Fe_2O_3 %	7.16
O %	3.9	TiO_2 %	0.65
		CaO %	2.00
P %	0.063	MgO %	0.33
Cl %	0.07	Na_2O %	0.13
S %	0.30	K_2O %	0.93
		P_2O_5 %	1.38
CSN	7.5		
GKCT	F	V %	48
GF ddpm	6	E %	
		MI %	12
SE	32.75	F %	34
HGI	88	MM %	6
		RO(max)	1.31

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: ELPHINSTONE

Geological Sequence: Rangal Coal Measures
District: Mackay (Nebo area)
Basin: Bowen
Age: Late Permian

M %	1.5	AFD	1260
Ash %	9.9	AFH	>1560
VM %	20.6	AFF	>1560
FC %	69.5		
		AA	
C %	88.6	SiO_2 %	35.7
H %	4.70	Al_2O_3 %	39.8
N %	1.7	Fe_2O_3 %	13.9
O %	4.6	TiO_2 %	0.54
		CaO %	2.99
P %	0.87	MgO %	1.76
Cl %		Na_2O %	0.21
S %	0.62	K_2O %	0.68
		P_2O_5 %	1.89
CSN	5.5		
GKCT	F	V %	40
GF ddpm	6	E %	
		MI %	14
SE	32.40	F %	40
		MM %	6
		RO(max)	1.31

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: UNSPECIFIED SEAM AT MOURA

Geological Sequence: Baralaba Coal Measures
District: Moura
Basin: Bowen
Age: Late Permian

M %	2.6	AFD	1180
Ash %	8.2	AFH	>1560
VM %	30.7	AFF	>1560
FC %	61.1		
		AA	
C %	84.7	SiO_2 %	60.4
H %	5.29	Al_2O_3 %	24.0
N %	1.3	Fe_2O_3 %	5.75
O %	7.7	TiO_2 %	0.91
		CaO %	1.86
P %	0.011	MgO %	0.84
Cl %	0.02	Na_2O %	0.32
S %	0.54	K_2O %	3.53
		P_2O_5 %	0.14
CSN	8		
GKCT	G4	V %	74
GF ddpm	250	E %	3
		MI %	3
SE	31.35	F %	16
HGI	59	MM %	4
		RO(max	0.88

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: UNSPECIFIED SEAM AT BARALABA

Geological Sequence: Baralaba Coal Measures
District: Moura
Basin: Bowen
Age: Late Permian

M %	1.8	AFD	1100
Ash %	13.5	AFH	1230
VM %	11.9	AFF	1320
FC %	74.6		
		AA	
C %	90.0	SiO_2 %	45.9
H %	4.09	Al_2O_3 %	20.6
N %	1.6	Fe_2O_3 %	14.37
O %	3.6	TiO_2 %	0.54
		CaO %	6.37
P %	0.077	MgO %	1.32
Cl %	0.04	Na_2O %	0.26
S %	0.65	K_2O %	5.87
		P_2O_5 %	1.13
CSN	0		
GKCT	A	V %	62
		E %	
		MI %	5
SE	30.05	F %	24
HGI	81	MM %	9
		RO(max)	2.04

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: No. 3

Geological Sequence: Blair Athol Coal Measures
District: Clermont
Basin: Blair Athol
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	7.5	7.5	8.0	AFD	1550	1490	>1550
Ash %	8.0	8.2	6.0	AFH	1570	>1550	
VM %	27.2	27.6	25.4	AFF	1580	1560	>1550
FC %	57.3	56.7	64.6				
				AA			
C %	81.2	82.2	82.4	SiO_2 %	61.30	62.4	58.4
H %	4.4	4.6	4.32	Al_2O_3 %	30.20	31.7	35.7
N %	1.7	1.9	1.8	Fe_2O_3 %	4.20	2.0	1.09
O %				TiO_2 %	1.58	1.4	1.63
				CaO %	0.54	1.1	1.06
P %	0.008	0.01	0.011	MgO %	0.50	0.3	0.65
Cl %	0.07		0.02	Na_2O %	0.21	0.2	0.38
S %	0.3	0.3	0.22	K_2O %	0.30	0.2	0.07
				P_2O_5 %	0.24	0.3	0.46
CSN	0.5		0				
GKCT	B			V %	29		28
				E %	3		4
				MI %			18
SE	32.28	27.4	32.77	F %	66		50
HGI	60		65	MM %	2		5
				RO(max)	0.69		

Source: Queensland Coal Board (1986); Joint Coal Board & Queensland Coal Board (1987).

SEAM: F

Geological Sequence:
District: Clermont
Basin: Galilee (Central area)
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	10.7	8.2	9.3				
Ash %	17.5	19.7	16.7	AA			
VM %	24.2	24.4	23.6	SiO_2 %	50.5	68.5	55.4
FC %	47.6	47.5	50.4	Al_2O_3 %	31.4	26.0	27.5
				Fe_2O_3 %	12.2	1.0	10.4
C %	77.32	78.85	78.74	TiO_2 %	1.01	1.82	1.79
H %	4.16	4.55	4.34	CaO %	1.31	0.71	1.31
N %	1.59	1.57	1.55	MgO %	0.85	0.24	1.37
O %	16.54	14.58	15.14	Na_2O %	0.19	0.17	0.16
				K_2O %	0.20	0.15	0.13
S %	0.39	0.45	0.23	P_2O_5 %	0.09	0.04	0.11
SE	22.77	22.64	23.20				
HGI	60	55	58				

Source: Matheson (1987b); all samples are from the 'relative density 1.90 floats' fraction.

SEAM: E

Geological Sequence:
District: Clermont
Basin: Galilee (Central area)
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	10.1	11.0	8.7	AFD			
Ash %	13.6	17.3	16.0	AFH			
VM %	27.9	22.5	27.9	AFF			
FC %	48.5	49.3	47.4				
				AA			
C %	78.54	78.03	78.24	SiO_2 %	60.2	56.6	61.4
H %	4.55	4.34	4.53	Al_2O_3 %	27.7	30.5	29.5
N %	1.49	1.59	1.55	Fe_2O_3 %	4.85	6.58	4.65
O %	15.05	15.82	15.44	TiO_2 %	1.88	2.32	1.51
				CaO %	1.08	1.31	1.01
S %	0.39	0.58	0.24	MgO %	0.95	0.60	0.38
				Na_2O %	1.43	0.13	0.23
SE	24.50	22.53	23.50	K_2O %	0.61	0.12	0.29
HGI	53	62	54	P_2O_5 %	0.30	0.09	0.12

Source: Matheson (1978b); all samples are from the 'relative density 1.90 floats' fraction.

SEAM: D

Geological Sequence:
District: Clermont
Basin: Galilee (Central area)
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	7.6	8.4	10.7	AFD			
Ash %	18.8	15.9	14.4	AFH			
VM %	29.4	27.5	27.0	AFF			
FC %	44.2	48.0	47.9				
				AA			
C %	78.90	79.20	78.85	SiO_2 %	72.4	74.3	73.5
H %	4.25	4.63	4.50	Al_2O_3 %	21.0	19.5	20.7
N %	1.57	1.54	1.63	Fe_2O_3 %	2.73	1.72	0.78
O %	14.86	14.30	14.19	TiO_2 %	1.08	0.79	1.11
				CaO %	0.96	1.97	0.78
S %	0.42	0.33	0.41	MgO %	0.26	0.53	0.22
				Na_2O %	0.22	0.13	0.21
SE	23.24	23.64	23.75	K_2O %	0.34	0.12	0.11
HGI	54	50	51	P_2O_5 %	0.26	0.07	0.08

Source: Matheson (1987b); all samples are from the 'relative density 1.90 floats' fraction.

SEAM: C

Geological Sequence:
District: Clermont
Basin: Galilee (Central area)
Age: Late Permian

M %	11.6	AFD	
Ash %	21.2	AFH	
VM %	28.0	AFF	
FC %	39.5		
		AA	
C %	76.53	SiO_2 %	79.9
H %	5.05	Al_2O_3 %	10.0
N %	1.61	Fe_2O_3 %	3.87
O %	16.25	TiO_2 %	0.53
		CaO %	1.82
S %	0.56	MgO %	0.33
		Na_2O %	0.17
SE	21.36	K_2O %	0.48
HGI	45	P_2O_5 %	0.08

Source: Matheson (1987b); all samples are from the 'relative density 1.90 floats' fraction.

SEAM: UNNAMED SEAMS

Geological Sequence: Betts Creek beds
District: Pentland–Milray (Northern area)
Basin: Galilee
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	8.5	9.6	9.3	AFD	>1600	>1600	>1600
Ash %	17.6	14.5	12.3	AFH	>1600	>1600	>1600
VM %	27.1	29.0	26.7	AFF	>1600	>1600	>1600
FC %	46.8	46.9	51.7				
				AA			
C %	76.09	74.71	76.12	SiO_2 %	70.1	63.9	62.3
H %	4.12	3.92	4.45	Al_2O_3 %	25.6	31.4	30.0
N %	1.66	1.57	1.40	Fe_2O_3 %	0.76	0.85	2.58
O %	17.75	19.23	17.70	TiO_2 %	1.33	1.71	1.47
				CaO %	0.48	0.62	0.96
S %	0.30	0.45	0.26	MgO %	0.39	0.18	0.86
				Na_2O %	0.08	0.08	0.17
SE	22.48	22.71		K_2O %	0.39	0.20	0.34
				P_2O_5 %	0.06	0.10	0.19

Source: Matheson (1987a); results are from the 'relative density 1.90 floats' fraction.

SEAM: CALLIDE

Geological Sequence: Callide Coal Measures
District: Callide
Basin: Callide
Age: Triassic

	1	*2*	*3*		*1*	*2*	*3*
M %	11.7	10.9	7.6	AFD	1300	1380	1460
Ash %	12.8	16.4	22.9	AFH	1470	1543	>1550
VM %	25.1	24.6	26.6	AFF	1500	1570	>1550
FC %	50.4	48.1	50.5				
				AA			
C %	76.77	78.06	76.6	SiO_2 %	38.10	43.53	42.6
H %	3.81	3.91	4.03	Al_2O_3 %	33.80	32.19	35.6
N %	1.18	1.15	1.1	Fe_2O_3 %	15.55	16.49	15.48
O %	17.88	16.66	18.1	TiO_2 %	1.29	1.65	2.09
				CaO %	2.83	0.78	1.56
P %	0.06	0.02	0.04	MgO %	2.02	0.28	0.81
Cl %	0.02	0.02	0.06	Na_2O %	0.25	0.13	0.19
S %	0.36	0.22	0.13	K_2O %	0.10	0.30	0.07
				P_2O_5 %	0.92	0.26	0.39
CSN	0	0	0				
GKCT	A	A		V %	19	29	16
				E %	14	1	4
SE	29.42	29.24	29.42	MI %			16
HGI	89	85		F %	60	59	48
				MM %	7	11	16
				RO(max)	0.47	0.49	0.58

Source: Queensland Coal Board (1986); Joint Coal Board & Queensland Coal Board (1987).

SEAM: MULGILDIE B

Geological Sequence: Mulgildie Coal Measures
District: Monto
Basin: Mulgildie
Age: Jurassic

	1	*2*
M %	5.6	7.1
Ash %	10.7	26.0
VM %	43.4	35.1
FC %	40.3	31.8
S %	0.41	0.48
CSN	0.5	0.5
SE	27.46	21.40

Source: Svenson & Rayment (1975); *1* is weighted mean of samples of raw coal, *2* is weighted mean of samples from the 'relative density 1.60 floats' fraction.

SEAM: ELLANGOWAN

Geological Sequence: Burrum Coal Measures
District: Maryborough
Basin: Maryborough
Age: Cretaceous

M %	2.2	AFD	1100
Ash %	12.5	AFH	1290
VM %	30.0	AFF	1460
FC %	55.3		
		AA	
C %	84.6	SiO_2 %	45.4
H %	5.5	Al_2O_3 %	19.7
N %	1.7	Fe_2O_3 %	5.2
O %	7.4	TiO_2 %	1.3
		CaO %	20.0
P %	0.17	MgO %	0.8
Cl %	0.03	Na_2O %	0.4
S %	0.67	K_2O %	0.4
		P_2O_5 %	4.0
CSN	8.5		
GKCT	G7	V %	79
GF ddpm	2320	E %	
		MI %	
SE	29.28	F %	10
HGI	82	MM %	11
		RO(max)	0.99

Source: Chiu Chong (1965).

SEAM: KING

Geological Sequence : Tarong beds
District: Nanango
Basin: Tarong
Age: Late Triassic

	1	*2*		*1*	*2*
M %	6.4	6.4	AFD	1590	1430
Ash %	28	38	AFH		
VM %	29.9	27.2	AFF		
S %	0.35	0.3			
SE	23.3	19.5			
HGI	54	55			

Source: Barden & others (undated).

SEAM: IPSWICH BASIN (typical properties)

Geological Sequence: Ipswich Coal Measures
District: West Moreton
Basin: Ipswich
Age: Late Triassic

	1	*2*	*3*		*1*	*2*	*3*
M %	2.6	2.3	1.9	AFD	1500	>1550	1260
Ash %	18.1	19.6	11.7	AFH	>1550	>1550	>1560
VM %	29.7	29.8	32.7	AFF	>1550	>1550	>1560
FC %	52.2	50.6	55.6				
				AA			
C %	82.7	83.8	84.2	SiO_2 %	56.4	62.5	48.0
H %	5.19	5.54	5.4	Al_2O_3 %	29.3	28.4	36.8
N %	1.4	1.6	1.3	Fe_2O_3 %	4.48	2.15	2.73
O %	10.4	8.5	8.7	TiO_2 %	2.03	1.44	0.30
				CaO %	2.45	1.47	5.01
P %	0.14	0.006	0.097	MgO %	1.84	0.59	1.47
Cl %	0.03			Na_2O %	1.18	0.25	0.24
S %	0.25	0.39	0.42	K_2O %	1.02	0.36	0.34
				P_2O_5 %	0.27	0.04	0.35
CSN	2	2	3.5				
GKCT			G1	V %	65	48	61
GF ddpm			40	E %	5	7	7
				MI %	4	9	11
SE	27.65	28.03	27.4	F %	18	29	17
HGI	52	52	52	MM %	8	7	4
				RO(max)	0.87	0.83	0.86

Source: Joint Coal Board & Queensland Coal Board (1987).

NEW SOUTH WALES

SEAM: ASHFORD

Geological Sequence: Ashford Coal Measures
District: Ashford
Basin: Ashford
Age: Permian

M %	1.1	AFD	1530
Ash %	9.1	AFH	>1560
VM %	25.9	AFF	>1560
FC %	65.0		
		AA	
C %	87.4	SiO_2 %	56.6
H %	4.77	Al_2O_3 %	28.9
N %	1.9	Fe_2O_3 %	6.5
O %	5.5	TiO_2 %	1.03
		CaO %	2.37
P %	0.031	MgO %	0.45
Cl %		Na_2O %	0.35
S %	0.46	K_2O %	1.09
		P_2O_5 %	0.77
CSN	6.5		
GKCT	G4	V %	57
GF ddpm	2400	E %	Tr
		MI %	13
SE	32.56	F %	25
HGI	72	MM %	5
		RO(max)	1.02

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: HOSKISSONS

Geological Sequence: Black Jack Formation
District: Gunnedah Coalfield
Basin: Gunnedah Basin
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	3.1	3.4	3.5	AFD	1240	1170	1210
Ash %	7.8	10.0	10.6	AFH	1320	1390	1350
VM %	34.7	33.5	33.5	AFF	1360	1440	1450
FC %	57.5	56.5	55.9				
				AA			
C %	83.0	83.3	83.3	SiO_2 %	57.1	56.4	59.4
H %	5.33	5.30	5.25	Al_2O_3 %	22.7	24.0	22.4
N %	1.72	1.62	1.70	Fe_2O_3 %	6.80	8.70	6.60
O %	9.5	9.3	9.3	TiO_2 %	0.97	0.91	0.94
				CaO %	6.70	5.50	6.00
P %	0.003	0.003	0.005	MgO %	0.91	0.74	0.70
Cl %	0.01	0.01	0.01	Na_2O %	0.54	0.50	0.48
S %	0.45	0.45	0.44	K_2O %	0.46	0.50	0.51
				P_2O_5 %	0.09	0.07	0.11
CSN	1	1	1				
GKCT	C	C	C	V %	49	45	46
GF ddpm	8	10	9	E %	9	9	9
				MI %			
SE	31.15	30.45	30.17	F %	25	29	28
HGI	48	45	46	MM %	5	4	5
				RO(max)	0.65	0.65	0.65

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: MELVILLES

Geological Sequence: Black Jack Formation
District: Gunnedah
Basin: Gunnedah
Age: Late Permian

M %	2.5	AFD	1520
Ash %	8.4	AFH	>1550
VM %	38.4	AFF	>1550
FC %	53.2		
		AA	
C %	82.1	SiO_2 %	65.6
H %	5.78	Al_2O_3 %	27.6
N %	1.84	Fe_2O_3 %	3.36
O %	9.6	TiO_2 %	1.50
		CaO %	0.56
P %	0.004	MgO %	0.14
Cl %		Na_2O %	0.66
S %	0.74	K_2O %	1.33
		P_2O_5 %	0.11
CSN	5		
GKCT	G1	V %	64
GF ddpm	1600	E %	10
		MI %	
SE	30.83	F %	23
HGI	38	MM %	3
		RO(max)	0.68

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: GUNDAWARRA

Geological Sequence: Maules Creek Formation
District: Gunnedah
Basin: Gunnedah
Age: Late Permian

M %	5.2	AFD	1230
Ash %	4.3	AFH	>1550
VM %	35.8	AFF	>1550
FC %	59.9		
		AA	
C %	83.4	SiO_2 %	74.0
H %	5.23	Al_2O_3 %	20.6
N %	1.87	Fe_2O_3 %	2.40
O %	9.2	TiO_2 %	1.60
		CaO %	0.40
P %	0.003	MgO %	0.42
Cl %	0.01	Na_2O %	0.26
S %	0.32	K_2O %	1.09
		P_2O_5 %	0.16
CSN	1		
GKCT	D	V %	50
GF ddpm	7	E %	6
		MI %	
SE	30.89	F %	42
HGI	47	MM %	2
		RO(max)	0.70

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: HOMEVILLE

Geological Sequence: Greta Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Early Permian

M %	1.7	AFD	1120
Ash %	5.3	AFH	1390
VM %	42.9	AFF	1510
FC %	51.8		
		AA	
C %	81.9	SiO_2 %	45.1
H %	5.83	Al_2O_3 %	29.8
N %	2.0	Fe_2O_3 %	8.21
O %	9.3	TiO_2 %	1.33
		CaO %	5.70
P %	0.024	MgO %	2.26
Cl %	0.06	Na_2O %	1.32
S %	0.83	K_2O %	0.51
		P_2O_5 %	0.78
CSN	5		
GKCT	G4	V %	59
GF ddpm	1250	E %	13
		MI %	10
SE	33.33	F %	15
HGI	30	MM %	3

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: GRETA

Geological Sequence: Greta Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.2	2.2	2.1	AFD	1120	1369	1400
Ash %	5.0	7.8	7.9	AFH	>1560	>1560	>1560
VM %	42.2	41.0	41.3	AFF	>1560	>1560	>1560
FC %	52.8	51.2	50.8				
				AA			
C %	82.8	82.4	81.9	SiO_2 %	47.4	50.0	42.8
H %	5.73	5.92	5.91	Al_2O_3 %	32.8	34.6	31.6
N %	2.0	2.0	2.0	Fe_2O_3 %	7.14	4.58	6.0
O %	8.5	8.7	9.1	TiO_2 %	1.4	1.48	1.29
				CaO %	3.25	2.49	5.39
P %	0.015	0.03	0.063	MgO %	1.44	1.25	3.23
Cl %	0.00	0.04	0.01	Na_2O %	1.17	1.55	1.80
S %	0.83	0.82	0.94	K_2O %	0.74	0.78	0.84
				P_2O_5 %	0.68	0.85	1.71
CSN	5	4	4.5				
GKCT	G3	G1	G	V %	70	67	61
GF ddpm	620	18	52	E %	10	11	13
				MI %	5	7	9
SE	32.63	31.28	31.49	F %	13	12	12
HGI	32	32	33	MM %	2	3	5
				RO(max)	0.66	0.63	0.69

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: LEWIS

Geological Sequence: Greta Coal Measures
District: Hunter Coalfield (Skeletar area)
Basin: Sydney
Age: Early Permian

	1	*2*		*1*	*2*
M %	3.4	3.0	AFD	1420	1510
Ash %	7.1	7.6	AFH	1560	>1550
VM %	34.7	37.2	AFF	>1560	>1560
FC %	58.2	55.2			
			AA		
C %	83.9	81.0	SiO_2 %	56.8	52.0
H %	4.98	5.08	Al_2O_3 %	33.3	33.2
N %	1.7	1.6	Fe_2O_3 %	6.49	8.90
O %	9.1	11.7	TiO_2 %	0.51	2.33
			CaO %	1.12	0.64
P %	0.011	0.025	MgO %	0.48	0.35
Cl %		0.02	Na_2O %	0.14	0.30
S %	0.84	0.86	K_2O %	0.19	0.88
			P_2O_5 %	0.45	0.88
CSN	1	2			
GKCT	C–D		V %	36	49
GF ddpm	9		E %	10	14
			MI %	19	9
SE	31.75	31.91	F %	30	25
HGI	48	40	MM %	5	3
			RO(max)	0.63	0.63

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BALMORAL

Geological Sequence: Greta Coal Measures
District: Hunter Coalfield (Savoy area)
Basin: Sydney
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.9	4.5	3.8	AFD	1460	1190	1410
Ash %	5.3	6.6	5.0	AFH	>1560	>1550	1470
VM %	37.8	38.3	39.7	AFF	>1560	>1550	1520
FC %	56.9	55.1	55.3				
				AA			
C %	81.5	83.4	82.8	SiO_2 %	55.2	50.5	62.2
H %	5.62	5.41	5.48	Al_2O_3 %	29.6	35.0	24.1
N %	1.8	1.65	1.63	Fe_2O_3 %	8.17	6.40	9.60
O %	10.6	8.7	8.8	TiO_2 %	0.65	2.67	2.52
				CaO %	1.77	3.62	0.68
P %	0.063	0.060	0.003	MgO %	0.34	0.13	0.12
Cl %	0.05			Na_2O %	0.16	0.12	0.24
S %	0.74	0.78	1.26	K_2O %	0.62	0.10	0.12
				P_2O_5 %	0.47	1.98	0.14
CSN	1.5	1	1.5				
GKCT	E	C	D–E	V %	48	35	42
GF ddpm	10	60	50	E %	8	11	12
				MI %	15	Tr	Tr
SE	31.54	32.34	32.92	F %	26	33	30
HGI	44	44	43	MM %	3	3	3
				RO(max)	0.63	0.66	0.62

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: PUXTREES

Geological Sequence: Greta Coal Measures
District: Hunter Coalfield (Savoy area)
Basin: Sydney
Age: Early Permian

M %	3.9	AFD	1320
Ash %	5.2	AFH	>1550
VM %	39.1	AFF	>1550
FC %	55.7		
		AA	
C %	82.5	SiO_2 %	63.8
H %	5.57	Al_2O_3 %	23.9
N %	1.76	Fe_2O_3 %	6.30
O %	9.4	TiO_2 %	2.33
		CaO %	0.28
P %	0.022	MgO %	0.31
Cl %		Na_2O %	0.23
S %	0.77	K_2O %	0.47
		P_2O_5 %	0.93
CSN	2.5		
GKCT	E	V %	52
GF ddpm	14	E %	14
		MI %	Tr
SE	32.66	F %	20
HGI	40	MM %	1
		RO(max)	0.68

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: TANGORIN

Geological Sequence: Greta Coal Measures
District: Newcastle Coalfield, Cranky Corner Basin
Basin: Sydney
Age: Early Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.5	1.3	1.2	AFD	1160	1160	1140
Ash %	9.3	13.0	16.1	AFH	1320	1250	1320
VM %	48.9	48.2	47.2	AFF	1490	1350	1380
FC %	41.8	38.8	36.7				
				AA			
C %	83.6	81.4	81.4	SiO_2 %	25.6	28.1	35.4
H %	6.18	6.33	6.34	Al_2O_3 %	27.2	27.0	25.5
N %	1.3	1.19	1.17	Fe_2O_3 %	7.81	10.30	8.7
O %	3.2	5.45	4.62	TiO_2 %	1.25	1.10	1.15
				CaO %	12.60	8.20	8.3
P %	0.03	0.041	0.052	MgO %	8.07	4.22	2.66
Cl %		0.02	0.03	Na_2O %	2.05	1.06	0.94
S %	5.71	4.91	5.40	K_2O %	0.18	0.22	0.21
				P_2O_5 %	0.76	0.07	0.726
CSN	6	5	3.5				
GKCT	G5			V %	63		
GF ddpm	>5000			E %	8		
				MI %	9		
SE	31.77	30.57	29.14	F %	16		
HGI	51	39	39	MM %	4		
				RO(max)	0.44	0.45	

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BIG BEN

Geological Sequence: Tomago Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Permian

	1	*2*		*1*	*2*
M %	1.9	2.8	AFD	>1560	1420
Ash %	9.7	10.5	AFH	>1560	>1560
VM %	35.3	36.0	AFF	>1560	>1560
FC %	55.0	53.5			
			AA		
C %	83.7	83.0	SiO_2 %	61.9	61.6
H %	5.56	5.61	Al_2O_3 %	28.8	28.6
N %	2.1	2.0	Fe_2O_3 %	3.8	3.98
O %	7.8	7.9	TiO_2 %	1.24	1.03
			CaO %	0.45	1.6
P %	0.001	0.017	MgO %	0.37	0.51
Cl %	0.01		Na_2O %	0.3	0.67
S %	0.82	1.32	K_2O %	0.71	0.92
			P_2O_5 %	0.21	0.36
CSN	6	6.5			
GKCT	G	G2	V %	67	74
GF ddpm	135	100	E %	5	5
			MI %	11	6
SE	30.56	30.1	F %	13	9
HGI	49	53	MM %	4	6
			RO(max)	0.73	0.76

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: RATHLUBA

Geological Sequence: Tomago Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Permian

M %	2.3	AFD	1400
Ash %	11.1	AFH	>1560
VM %	36.5	AFF	>1560
FC %	52.4		
		AA	
C %	82.7	SiO_2 %	56.9
H %	5.64	Al_2O_3 %	28.3
N %	2.0	Fe_2O_3 %	3.81
O %	8.8	TiO_2 %	1.50
		CaO %	2.90
P %	0.039	MgO %	0.33
Cl %	0.02	Na_2O %	1.15
S %	0.74	K_2O %	0.96
		P_2O_5 %	0.84
CSN	5.5		
GKCT	G	V %	80
GF ddpm	205	E %	5
		MI %	4
SE	30.24	F %	5
HGI	49	MM %	6
		RO(max)	0.73

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: ELWELLS CREEK

Geological Sequence: Tomago Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Permian

M %	2.3	AFD	1440
Ash %	11.8	AFH	>1560
VM %	34.8	AFF	>1560
FC %	53.4		
		AA	
C %	83.6	SiO_2 %	75.2
H %	5.66	Al_2O_3 %	19.4
N %	2.0	Fe_2O_3 %	2.24
O %	7.8	TiO_2 %	0.74
		CaO %	1.13
P %	0.009	MgO %	0.63
Cl %		Na_2O %	0.20
S %	0.92	K_2O %	0.82
		P_2O_5 %	0.11
CSN	5		
GKCT	G	V %	59
GF ddpm	64	E %	8
		MI %	14
SE	29.4	F %	15
HGI	46	MM %	4
		RO(max)	0.77

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: WHITES CREEK

Geological Sequence: Tomago Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.6	2.5	2.4	AFD	1320	1310	1400
Ash %	15.1	14.7	20.3	AFH	>1560	>1550	>1550
VM %	33.0	33.3	31.1	AFF	>1560	>1550	>1550
FC %	51.9	52.0	48.6				
				AA			
C %	82.7	82.5	82.5	SiO_2 %	80.1	68.1	76.5
H %	5.59	5.71	5.56	Al_2O_3 %	14.7	22.9	20.4
N %	2.1	2.08	1.95	Fe_2O_3 %	1.96	5.8	1.14
O %				TiO_2 %	0.60	1.39	0.80
				CaO %	1.12	0.27	0.11
P %	0.014	0.015	0.031	MgO %	0.47	0.26	0.21
Cl %				Na_2O %	0.13	0.18	0.12
S %	0.80	1.29	0.68	K_2O %	0.47	0.89	0.60
				P_2O_5 %	0.09	0.24	0.34
CSN	2	1.5	1				
GKCT	E–F			V %	59		
GF ddpm	8			E %	10		
				MI %	10		
SE	28.84	29.52	27.44	F %	16		
HGI	45	42	43	MM %	4		
				RO(max)	0.74		

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BOREHOLE

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.5	2.1	2.7	AFD	1280	1520	1240
Ash %	10.4	9.1	8.3	AFH	1450	>1560	>1550
VM %	36.0	35.9	34.9	AFF	1510	>1560	>1550
FC %	53.6	55.0	56.8				
				AA			
C %	83.3	83.4	83.7	SiO_2 %	52.6	58.6	61.5
H %	5.47	5.63	5.49	Al_2O_3 %	24.4	28.4	26.1
N %	2.0	2.0	1.98	Fe_2O_3 %	13.40	4.59	4.49
O %	8.6	8.4	8.3	TiO_2 %	0.85	0.32	1.18
				CaO %	3.19	2.54	2.83
P %	0.061	0.052	0.068	MgO %	1.13	0.77	0.71
Cl %		0.01		Na_2O %	0.63	0.62	0.38
S %	0.47	0.44	0.48	K_2O %	0.77	0.56	0.39
				P_2O_5 %	1.39	1.78	1.91
CSN	6.5	7.5	7				
GKCT	G4	G5	G3	V %	72	74	77
GF ddpm	250	600	290	E %	5	5	6
				MI %	3	6	Tr
SE	30.35	30.89	31.76	F %	15	10	10
HGI	52	53	54	MM %	5	5	1
				RO(max)	0.79	0.85	0.82

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: YARD

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

M %	2.2	AA	
Ash %	7.6	SiO_2 %	48.6
VM %	35.6	Al_2O_3 %	29.7
FC %	56.7	Fe_2O_3 %	4.2
		CaO %	4.6
C %	84.8	MgO %	0.9
H %	5.5		
N %	1.9	V %	67
O %	7.4	E %	14
		MI %	
P %	0.10	F %	15
S %	0.5	MM %	3
CSN	7.5		
GKCT	G5		
SE	33.52		

Source: Crapp & Nolan (1975).

SEAM: DUDLEY

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.6	2.8	2.6	AFD	1160	1220	
Ash %	9.8	10.1	10.0	AFH	1560	1500	
VM %	36.2	35.7	33.8	AFF	>1560	1550	
FC %	54.0	54.2	55.9				
				AA			
C %	84.1	83.6	84.6	SiO_2 %	60.0	65.8	58.7
H %	5.74	5.57	5.4	Al_2O_3 %	27.0	21.9	24.9
N %	2.2	2.2	2.2	Fe_2O_3 %	3.8	4.14	3.9
O %	7.5	8.3	7.4	TiO_2 %	0.77	0.6	
				CaO %	3.63	2.49	4.1
P %	0.063	0.051	0.05	MgO %	1.01	0.79	1.1
Cl %				Na_2O %	1.33	1.24	
S %	0.45	0.45	0.4	K_2O %	1.89	1.56	
				P_2O_5 %	1.27	1.05	
CSN	7.5	7	6				
GKCT	G4	G3	G3	V %	74	76	64
GF ddpm	822	630		E %	5	5	13
				MI %	5	5	
SE	31.17	30.98	34.28	F %	12	10	17
HGI	56	55		MM %	4	4	6
				RO(max)	0.79	0.79	

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: NOBBYS

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1		*1*
M %	2.4	AA	
Ash %	15.5	SiO_2 %	76.0
VM %	32.1	Al_2O_3 %	15.7
FC %	52.2	Fe_2O_3 %	2.1
		CaO %	1.9
C %	84.8	MgO %	0.5
H %	5.5		
N %	2.2	V %	56
O %	7.7	E %	28
		MI %	
P %	0.07	F %	10
S %	0.4	MM %	6
CSN	7		
GKCT	G5		
SE	34.70		

Source: Crapp & Nolan (1975).

SEAM: VICTORIA TUNNEL

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.8	2.9	3.4	AFD	1240	1160	1240
Ash %	13.4	11.3	11.7	AFH	>1560	1490	1480
VM %	32.7	34.4	34.2	AFF	>1560	>1560	>1560
FC %	53.9	54.3	54.4				
				AA			
C %	82.9	84.4	83.3	SiO_2 %	65.2	69.7	73.9
H %	5.56	5.9	5.11	Al_2O_3 %	23.6	28.9	15.8
N %	1.6	2.0	2.0	Fe_2O_3 %	3.95	3.48	4.15
O %	9.4	7.4	9.3	TiO_2 %	0.54	0.54	1.52
				CaO %	0.45	2.62	1.13
P %	0.011	0.04	0.011	MgO %	0.78	0.74	0.48
Cl %				Na_2O %	0.48	1.82	1.39
S %	0.39	0.37	0.36	K_2O %	3.21	2.15	1.09
				P_2O_5 %	0.10	0.57	0.07
CSN	5.5	6.5	6.5				
GKCT	G2	G5	G3	V %	75	85	82
GF ddpm	60	273	204	E %	4	2	4
				MI %	4	2	2
SE	29.61	30.54	30.38	F %	9	6	5
HGI	59	60	56	MM %	8	5	6
				RO(max)	0.80	0.82	0.82

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: WAVE HILL

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

M %	2.7	AA	
Ash %	15.5	SiO_2 %	78.2
VM %	31.9	Al_2O_3 %	13.7
FC %	52.3	Fe_2O_3 %	2.1
		CaO %	1.4
C %	83.7	MgO %	0.3
H %	5.4		
N %	2.0	V %	65
O %	9.1	E %	10
		MI %	
P %	0.02	F %	7
S %	0.3	MM %	19
CSN	1.5		
GKCT	C		
SE	33.95		

Source: Crapp & Nolan (1975).

SEAM: FASSIFERN

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.9	3.3	3.0	AFD	1240	1280	
Ash %	14.5	18.6	16.4	AFH	>1560	1470	1460
VM %	33.0	27.9	29.2	AFF	>1560	1520	1540
FC %	52.5	53.5	54.4				
				AA			
C %	81.48	83.8	84.7	SiO_2 %	64.0	80.5	67.4
H %	5.02	4.95	5.15	Al_2O_3 %	23.3	11.2	20.1
N %	1.48	1.78	1.37	Fe_2O_3 %	6.30	2.44	4.54
O %	11.64	9.0	8.4	TiO_2 %	0.95	0.98	0.78
				CaO %	0.43	0.82	2.34
P %	0.008	0.018	0.014	MgO %	0.86	0.32	0.41
Cl %	0.02			Na_2O %	0.26	0.38	1.29
S %	0.41	0.40	0.35	K_2O %	1.90	1.8	1.32
				P_2O_5 %	0.06	0.222	0.196
CSN	1.5	1	1				
GKCT	C			V %	58		
GF ddpm	4			E %	4		
				MI %	6		
SE	33.89	27.68	28.70	F %	24		
HGI	49	49	48	MM %	8		
				RO(max)	0.69		

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: GREAT NORTHERN

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	3.3	2.8	2.5	AFD	>1560	>1560	>1560
Ash %	15.3	13.0	11.0	AFH	>1560	>1560	>1560
VM %	30.2	30.2	31.6	AFF	>1560	>1560	>1560
FC %	54.5	56.8	57.4				
				AA			
C %	82.6	82.8	82.3	SiO_2 %	63.5	63.9	56.9
H %	5.29	5.37	4.99	Al_2O_3 %	26.0	26.6	34.4
N %	1.7	1.6	1.7	Fe_2O_3 %	4.81	4.23	3.11
O %	9.9	9.9	10.7	TiO_2 %	0.78	0.54	1.11
				CaO %	0.99	0.4	0.85
P %	0.3	0.007	0.004	MgO %	0.31	0.82	0.65
Cl %			0.05	Na_2O %	0.26	0.31	0.57
S %	0.38	0.36	0.41	K_2O %	1.47	0.84	1.85
				P_2O_5 %			
CSN	1	1	1.5				
GKCT	B	C	D	V %	48	42	57
GF ddpm	2	5	15	E %	6	5	4
				MI %	10	11	10
SE	28.21	29.38	30.47	F %	31	38	24
HGI	44	45	50	MM %	5	4	5
				RO(max)	0.72	0.74	0.73

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: WALLARAH

Geological Sequence: Newcastle Coal Measures
District: Newcastle Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.9	3.0	2.5	AFD	1240	1420	1290
Ash %	10.5	10.0	15.2	AFH	>1560	>1560	>1550
VM %	31.4	30.7	30.3	AFF	>1560	>1560	>1550
FC %	58.1	59.3	54.5				
				AA			
C %	82.7	83.4	82.8	SiO_2 %	56.5	54.2	58.5
H %	4.71	5.09	5.22	Al_2O_3 %	31.9	21.8	30.6
N %	1.6	1.6	1.2	Fe_2O_3 %	5.77	8.32	2.48
O %	10.6	9.6	10.1	TiO_2 %	0.95	1.27	1.26
				CaO %	2.81	8.17	1.88
P %	0.015	0.012	0.01	MgO %	1.34	2.57	0.81
Cl %				Na_2O %	0.54	0.34	0.46
S %	0.35	0.31	0.29	K_2O %	0.51	0.46	0.61
				P_2O_5 %	0.13	0.19	0.15
CSN	1	1	1				
GKCT	C	C		V %	46	38	42
GF ddpm	6	2		E %	4	4	4
				MI %	10	10	9
SE	30.33	30.21	28.70	F %	35	43	39
HGI	49	48	49	MM %	5	5	6
				RO(max)	0.74	0.73	0.74

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: LIDDELL

Geological Sequence: Wittingham Coal Measures (Vane Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.7	2.6	2.3	AFD	>1560	1180	1280
Ash %	9.9	8.3	10.1	AFH	>1560	1380	1390
VM %	36.8	36.9	38.9	AFF	>1560	1530	1480
FC %	53.3	54.8	51.0				
				AA			
C %	81.2	82.7	82.4	SiO_2 %	57.4	50.1	54.4
H %	4.43	5.83	5.79	Al_2O_3 %	30.9	28.4	26.6
N %	1.8	1.9	2.0	Fe_2O_3 %	6.68	5.19	4.42
O %	12.0	9.1	9.3	TiO_2 %	1.10	0.25	1.12
				CaO %	1.40	2.13	6.63
P %	0.042	0.098	0.046	MgO %	0.36	1.08	1.78
Cl %	0.19	0.02	0.03	Na_2O %	0.73	0.72	0.82
S %	0.56	0.53	0.46	K_2O %	0.52	0.93	0.90
				P_2O_5 %	0.01	1.18	0.98
CSN	6	7	7				
GKCT	G	G4	G4	V %	74	75	76
GF ddpm	36	700	385	E %	6	5	5
				MI %	5	5	4
SE	29.91	30.84	30.45	F %	10	10	7
HGI	52	54	45	MM %	5	5	7
				RO(max)	0.70	0.73	0.72

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: PIKES GULLY

Geological Sequence: Wittingham Coal Measures (Vane Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

M %	3.1	AFD	1140
Ash %	9.1	AFH	1520
VM %	36.3	AFF	1540
FC %	54.6		
		AA	
C %	80.9	SiO_2 %	81.8
H %	5.55	Al_2O_3 %	16.4
N %	1.8	Fe_2O_3 %	0.07
O %	11.3	TiO_2 %	0.88
		CaO %	0.54
P %	0.11	MgO %	0.19
Cl %		Na_2O %	0.17
S %	0.70	K_2O %	0.21
		P_2O_5 %	0.08
CSN	5		
GKCT	G	V %	70
GF ddpm	39	E %	6
		MI %	5
SE	31.19	F %	13
HGI	53	MM %	6
		RO(max)	0.77

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BAYSWATER

Geological Sequence: Wittingham Coal Measures (Jerrys Plains Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*		*1*	*2*
M %	3.3	4.0	AFD	>1560	1360
Ash %	15.3	15.7	AFH	>1560	>1560
VM %	28.1	28.3	AFF	>1560	>1560
FC %	56.6	56.0			
			AA		
C %	82.5	82.3	SiO_2 %	56.1	62.4
H %	5.10	5.41	Al_2O_3 %	32.6	27.0
N %	1.8	1.8	Fe_2O_3 %	6.65	5.37
O %	9.8	10.0	TiO_2 %	1.09	0.90
			CaO %	1.00	0.80
P %	0.014	0.027	MgO %	0.70	1.13
Cl %			Na_2O %	0.23	0.34
S %	0.41	0.61	K_2O %	0.63	0.52
			P_2O_5 %	0.10	0.25
CSN	1	1			
GKCT	B	B	V %	33	34
GF ddpm	2	2	E %	8	9
			MI %	20	20
SE	29.28	28.17	F %	31	30
HGI	48	49	MM %	8	7
			RO(max)	0.71	0.76

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: RAVENSWORTH

Geological Sequence: Wittingham Coal Measures (Jerrys Plains Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*		*1*	*2*
M %	4.0	4.5	AFD	>1560	1500
Ash %	10.4	10.0	AFH	>1560	>1560
VM %	33.0	33.5	AFF	>1560	>1560
FC %	56.6	56.5			
			AA		
C %	82.6	82.2	SiO_2 %	61.6	63.0
H %	5.65	5.72	Al_2O_3 %	30.2	27.6
N %	1.9	1.9	Fe_2O_3 %	1.35	2.20
O %	9.7	9.8	TiO_2 %	0.88	1.06
			CaO %	2.02	2.74
P %	0.052	0.017	MgO %	0.15	0.46
Cl %			Na_2O %	0.25	0.19
S %	0.46	0.60	K_2O %	0.43	0.93
			P_2O_5 %	1.06	0.27
CSN	1.5	2			
GKCT	D	D	V %	46	52
GF ddpm	8	12	E %	8	9
			MI %	13	11
SE	29.12	29.19	F %	27	24

HGI	50	48	MM %	6	4
			RO(max)	0.70	0.70

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: MOUNT ARTHUR

Geological Sequence: Wittingham Coal Measures (Jerrys Plains Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	3.2	3.2	3.1	AFD	1500	1300	1290
Ash %	8.4	8.0	8.2	AFH	>1560	>1550	>1550
VM %	34.8	31.2	36.1	AFF	>1560	>1550	>1550
FC %	56.8	60.8	55.7				
				AA			
C %	83.1	84.5	83.3	SiO_2 %	67.0	69.1	78.6
H %	5.34	5.06	5.61	Al_2O_3 %	24.5	23.7	16.3
N %	1.8	1.92	1.73	Fe_2O_3 %	4.11	1.07	1.82
O %	9.4	8.0	8.9	TiO_2 %	0.68	1.29	1.67
				CaO %	0.19	0.71	0.19
P %	0.006	0.001	0.008	MgO %	0.43	0.48	0.26
Cl %	0.02			Na_2O %	0.35	0.22	0.34
S %	0.39	0.52	0.42	K_2O %	0.71	3.34	0.66
				P_2O_5 %	0.12	0.04	0.23
CSN	5	4	6.5				
GKCT	F	D	G1	V %	63	60	74
GF ddpm	12	24	400	E %	4	5	7
				MI %	9	3	
SE	31.70	31.70	31.90	F %	20	23	10
HGI	52	51	50	MM	4	1	4
				RO(max)	0.67	0.77	0.73

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BLAKEFIELD

Geological Sequence: Wittingham Coal Measures (Jerrys Plains Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.5	2.5	2.5	AFD	1470	1400	1460
Ash %	7.9	15.6	11.9	AFH	>1550	>1550	>1550
VM %	35.7	29.8	31.9	AFF	>1550	>1550	>1550
FC %	56.4	54.6	56.2				
				AA			
C %	83.5	83.2	83.7	SiO_2 %	73.2	82.8	76.0
H %	5.45	5.35	5.51	Al_2O_3 %	20.5	13.3	18.0
N %	1.51	1.54	1.56	Fe_2O_3 %	2.73	1.10	3.14
O %	9.0	9.4	8.8	TiO_2 %	1.11	0.48	0.83
				CaO %	0.21	0.14	0.17
P %	0.002	0.005	0.005	MgO %	0.50	0.52	0.49
Cl %				Na_2O %	0.21	0.13	0.08
S %	0.45	0.43	0.42	K_2O %	0.38	1.04	0.40
				P_2O_5 %	0.05	Tr	0.03
CSN	7	3	5.5				
GKCT	F			V %	73		
GF ddpm	140			E %	6		
				MI %	1		
SE	31.84	28.88	30.30	F %	12		
HGI	51	54	51	MM %	2		
				RO(max)	0.73		

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: WAMBO

Geological Sequence: Wittingham Coal Measures (Jerrys Plains Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*		*1*	*2*
M %	3.2	3.2	AFD	1320	1420
Ash %	7.7	8.3	AFH	>1560	>1550
VM %	35.1	33.0	AFF	>1560	>1550
FC %	57.2	58.7			
			AA		
C %	82.4	83.2	SiO_2 %	62.3	68.4
H %	5.07	5.56	Al_2O_3 %	27.2	26.6
N %	1.7	1.76	Fe_2O_3 %	3.50	1.22
O %	10.3	9.0	TiO_2 %	0.94	1.58
			CaO %	1.31	0.21
P %	0.011	0.004	MgO %	1.12	0.61
Cl %			Na_2O %	0.82	0.31
S %	0.46	0.46	K_2O %	0.76	1.75
			P_2O_5 %	0.40	0.04
CSN	4.5	4.5			
GKCT	F	F	V %	74	62
GF ddpm	7	65	E %	5	7
			MI %	2	1
SE	30.19	31.48	F %	14	19
HGI	51	47	MM %	5	4
			RO(max)	0.74	0.72

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: WHYBROW

Geological Sequence: Wittingham Coal Measures (Jerrys Plains Subgroup)
District: Hunter Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	4.1	3.5	3.4	AFD	1460	1260	1280
Ash %	7.4	9.6	11.6	AFH	>1560	1380	1440
VM %	37.1	34.8	34.3	AFF	>1560	1480	1530
FC %	55.5	55.6	54.1				
				AA			
C %	81.6	82.2	82.0	SiO_2 %	67.5	78.2	78.3
H %	5.40	5.61	5.32	Al_2O_3 %	22.0	14.6	13.3
N %	2.0	1.93	1.87	Fe_2O_3 %	3.23	3.20	3.90
O %	10.0	9.8	10.4	TiO_2 %	0.61	0.59	0.50
				CaO %	0.42	2.12	1.98
P %	0.017	0.014	0.014	MgO %	1.62	1.41	1.40
Cl %				Na_2O %	0.82	0.73	0.66
S %	0.45	0.40	0.39	K_2O %	0.76	0.51	0.52
				P_2O_5 %	0.40	0.33	0.276
CSN	4.5	4	3				
GKCT	F	F		V %	81	74	
GF ddpm	5	9		E %	4	6	
				MI %	3		
SE	31.47	30.52	29.78	F %	9	11	
HGI	51	50	50	MM %	3	4	
				RO(max)	0.69	0.73	

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: LITHGOW

Geological Sequence: Illawarra Coal Measures
District: Western Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.5	2.6	2.9	AFD	>1560	>1560	1320
Ash %	10.1	14.3	14.3	AFH	>1560	>1560	>1560
VM %	31.2	30.6	32.3	AFF	>1560	>1560	>1560
FC %	58.7	55.1	53.4				
				AA			

C %	84.3	82.0	83.6	SiO_2 %	55.9	58.2	64.5
H %	4.67	5.32	5.33	Al_2O_3 %	33.2	25.1	25.0
N %	1.7	1.8	1.8	Fe_2O_3 %	0.62	6.37	4.32
O %	8.6	10.1	8.5	TiO_2 %	1.16	0.91	0.7
				CaO %	1.96	2.71	0.92
P %	0.026	0.011	0.009	MgO %	0.15	1.92	0.26
Cl %		0.01	0.03	Na_2O %	0.32	0.80	0.36
S %	0.69	0.67	0.70	K_2O %	5.42	1.71	1.63
				P_2O_5 %	0.98	1.03	0.76
CSN	3	1	1				
GKCT	F	C	D	V %	56	40	40
GF ddpm	30	8	35	E %	4	6	6
				MI %	11	19	18
SE	30.35	28.49	28.68	F %	25	28	31
HGI	47	41	44	MM %	4	7	5
				RO(max)	0.82	0.67	0.68

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: ULAN

Geological Sequence: Illawarra Coal Measures
District: Western Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	2.6	2.8	2.0	AFD	1480	1140	1360
Ash %	9.2	10.0	15.9	AFH	>1560	>1550	>1550
VM %	32.6	33.2	30.7	AFF	>1560	>1550	>1550
FC %	58.2	56.8	53.4				
				AA			
C %	83.6	84.0	83.6	SiO_2 %	58.8	70.6	80.8
H %	4.93	5.14	5.28	Al_2O_3 %	27.1	21.7	17.1
N %	1.7	1.8	1.75	Fe_2O_3 %	3.32	7.07	0.64
O %	9.2	8.0	8.8	TiO_2 %	0.56	0.97	0.79
				CaO %	4.08	0.09	0.41
P %	0.005	0.006	0.010	MgO %	1.36	0.06	0.07
Cl %		0.01	0.04	Na_2O %	0.17	0.06	0.58
S %	0.65	0.86	0.60	K_2O %	0.48	0.30	0.43
				P_2O_5 %	0.14	0.05	0.14
CSN	1	1	1				
GKCT	E–F			V %	30	27	
GF ddpm	124			E %	7	6	
				MI %	23	15	
SE	30.31	31.24	28.87	F %	34	48	
HGI	50	47	45	MM %	6	4	
				RO(max)	0.65	0.62	

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: IRONDALE

Geological Sequence: Illawarra Coal Measures
District: Western Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*		*1*	*2*
M %	2.0	2.0	AFD	1220	1140
Ash %	10.8	9.2	AFH	1450	1360
VM %	35.7	37.4	AFF	1520	1420
FC %	53.6	53.4			
			AA		
C %	82.9	84.0	SiO_2 %	71.1	66.8
H %	5.69	5.14	Al_2O_3 %	15.1	18.2
N %	2.1	1.8	Fe_2O_3 %	8.19	9.36
O %	8.8	8.0	TiO_2 %	0.48	0.97
			CaO %	0.47	0.98
P %	0.58	0.006	MgO %	0.68	0.60
Cl %		0.01	Na_2O %	0.49	0.55
S %	0.65	0.86	K_2O %	1.02	1.31
			P_2O_5 %	0.44	1.05
CSN	7.5	7.5			
GKCT	G4		V %	67	67
GF ddpm	7650		E %	7	10
			MI %	8	5
SE	30.56	31.24	F %	13	15
HGI	47	47	MM %	5	3
			RO(max)	0.77	0.74

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: KATOOMBA

Geological Sequence: Illawarra Coal Measures
District: Western Coalfield
Basin: Sydney
Age: Late Permian

M %	1.3	AFD	>1560
Ash %	13.2	AFH	>1560
VM %	26.5	AFF	>1560
FC %	60.3		
		AA	
C %	82.6	SiO_2 %	53.2
H %	4.91	Al_2O_3 %	26.8
N %	1.6	Fe_2O_3 %	5.71
O %	10.1	TiO_2 %	0.91
		CaO %	6.27
P %	0.66	MgO %	1.07
Cl %		Na_2O %	0.3
S %	0.38	K_2O %	0.46
		P_2O_5 %	1.42
CSN	1		
GKCT	B	V %	29
GF ddpm	1	E %	3
		MI %	21
SE	28.59	F %	42
HGI	48	MM %	5
		RO(max)	0.78

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: TONGARRA

Geological Sequence: Illawarra Coal Measures
District: Southern Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.4	1.3	1.4	AFD	1420	1300	1360
Ash %	15.6	13.6	20.4	AFH	1530	1550	>1550
VM %	28.0	29.6	21.6	AFF	>1560	1550	>1550
FC %	60.8	60.8	58.0				
				AA			
C %	87.2	89.0	87.6	SiO_2 %	67.8	75.9	77.5
H %	5.06	5.28	4.98	Al_2O_3 %	19.5	18.0	18.1
N %	1.9	1.77	1.77	Fe_2O_3 %	7.3	3.36	3.18
O %	5.4	3.1	4.9	TiO_2 %	0.70	1.65	0.88
				CaO %	0.22	0.29	0.26
P %	0.100	0.007	0.006	MgO %	1.34	0.30	0.32
Cl %				Na_2O %	0.25	0.08	0.08
S %	0.63	0.72	0.60	K_2O %	1.22	0.96	1.06
				P_2O_5 %	0.06	0.12	0.67
CSN	5.5	6.5	4.5				
GKCT	G1	G5		V %	51	63	
GF ddpm	3210	>5000		E %		2	
				MI %	11		
SE	30.10	31.04	28.28	F %	29	21	
HGI	76	76	68	MM %	9	5	

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: WONGAWILLI

Geological Sequence: Illawarra Coal Measures
District: Southern Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.2	1.3	1.2	AFD	1440	1300	1420
Ash %	17.8	10.5	13.5	AFH	>1560	>1560	>1560

VM %	25.9	27.8	26.9	AFF	>1560	>1560	>1560
FC %	56.3	61.7	59.6				
				AA			
C %	86.3	87.3	86.6	SiO_2 %	74.9	80.6	75.8
H %	5.42	5.39	5.29	Al_2O_3 %	19.0	14.0	17.7
N %	1.9	1.8	1.8	Fe_2O_3 %	4.35	2.14	3.63
O %	5.7	4.8	5.6	TiO_2 %	0.64	0.97	0.68
				CaO %	0.14	0.20	0.26
P %	0.5	0.004	0.007	MgO %	0.78	0.62	0.37
Cl %	0.01	0.02	0.01	Na_2O %	0.64	0.62	0.71
S %	0.48	0.59	0.54	K_2O %	0.93	0.93	0.68
				P_2O_5 %	0.05	1.44	0.05
CSN	8.5	8.5	8				
GKCT	G7	G9	G7	V %	66	79	67
GF ddpm	14000	6800	11500	E %	1	1	1
				MI %	2	5	6
SE	29.54	32.52	31.31	F %	18	11	18
HGI	76	79	74	MM %	13	4	8
				RO(max)	1.03	1.11	1.07

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BALGOWNIE

Geological Sequence: Illawarra Coal Measures
District: Southern Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*		*1*	*2*
M %	1.4	1.1	AFD	>1560	1220
Ash %	11.1	10.9	AFH	>1560	>1560
VM %	22.2	23.0	AFF	>1560	>1560
FC %	66.7	66.1			
			AA		
C %	87.6	89.0	SiO_2 %	58.4	65.6
H %	4.8	5.0	Al_2O_3 %	29.6	22.6
N %	1.7	1.6	Fe_2O_3 %	4.3	4.9
O %	5.5	3.9	TiO_2 %	1.07	0.77
			CaO %	0.13	0.07
P %	0.009	0.008	MgO %	0.46	0.71
Cl %			Na_2O %	0.90	0.57
S %	0.43	0.42	K_2O %	3.18	3.05
			P_2O_5 %	0.07	0.05
CSN	6.5	7			
GKCT	G3	G4	V %	53	61
GF ddpm	210	4500	E %	Tr	Tr
			MI %	9	5
SE	31.96	32.03	F %	32	30
HGI	80	79	MM %	6	4
			RO(max)	1.19	1.22

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BULLI

Geological Sequence: Illawarra Coal Measures
District: Southern Coalfield
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.0	0.9	1.0	AFD	>1560	>1560	1340
Ash %	8.2	10.7	12.6	AFH	>1560	>1560	1440
VM %	21.6	20.2	21.1	AFF	>1560	>1560	1490
FC %	70.2	69.1	66.3				
				AA			
C %	88.6	88.9	88.1	SiO_2 %	49.5	56.5	50.3
H %	4.79	4.78	4.74	Al_2O_3 %	39.2	22.9	28.4
N %	1.8	1.6	1.6	Fe_2O_3 %	4.43	4.12	11.8
O %	4.5	4.2	5.3	TiO_2 %	0.91	0.72	1.5
				CaO %	3.71	1.85	3.25
P %	0.068	0.047	1.3	MgO %	0.4	0.61	1.88
Cl %				Na_2O %	0.47	0.61	0.39
S %	0.62	0.39	0.32	K_2O %	0.33	0.31	1.27
				P_2O_5 %	0.26	0.56	0.12
CSN	7.5	5.5	4				
GKCT	G2	F–G	F	V %	46	45	42
GF ddpm	550	400	14	E %			
				MI %	Tr	Tr	Tr
SE	32.98	32.12	31.24	F %	37	37	37
HGI	83	79	80	MM %	4	6	6
				RO(max)	1.28	1.24	1.23

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: BULLI

Geological Sequence: Illawarra Coal Measures
District: Southern Coalfield (Burragorang Valley)
Basin: Sydney
Age: Late Permian

	1	*2*	*3*		*1*	*2*	*3*
M %	1.6	1.9	2.4	AFD	1400	>1560	>1560
Ash %	8.9	9.3	10.0	AFH	>1560	>1560	>1560
VM %	27.7	27.6	27.2	AFF	>1560	>1560	>1560
FC %	63.4	63.1	62.8				
				AA			
C %	85.4	85.4	85.2	SiO_2 %	55.9	57.1	53.3
H %	4.99	5.06	4.61	Al_2O_3 %	35.9	35.3	40.9
N %	1.6	1.6	1.6	Fe_2O_3 %	3.99	2.96	0.88
O %	7.6	7.6	8.1	TiO_2 %	0.21	0.19	0.51
				CaO %	0.55	0.52	0.93
P %	0.073	0.071	0.061	MgO %	0.31	0.26	0.34
Cl %	0.01	0.01		Na_2O %	0.72	0.6	0.07
S %	0.38			K_2O %	0.89	0.88	1.01
				P_2O_5 %	1.63	0.05	0.51
CSN	6	5.5	3				
GKCT	G2	G	F–G	V %	49	50	45
GF ddpm	431	300	16	E %	2	2	4
				MI %	13	16	15
SE	32.03	31.94	31.08	F %	30	26	31
HGI	59	57	54	MM %	4	6	5
				RO(max)	0.99	0.98	0.92

Source: Joint Coal Board & Queensland Coal Board (1987).

SEAM: LANES SHAFT

Geological Sequence: Coorabin Coal Measures
District: Southern NSW
Basin: Oaklands
Age: Late Permian

M %	10.9	V %	17
Ash %	18.0	E %	19
VM %	29.4	MI %	
FC %	52.6	F %	53
		MM %	11
C %	74.4	RO(max)	0.36
H %	3.98		
N %	1.5		
O %	19.7		
S %	0.34		
SE	23.66		
HGI	118		

Source: Joint Coal Board & Queensland Coal Board (1987).

TASMANIA

SEAM: RUN-OF-MINE COAL, DUNCAN COLLIERY

Geological Sequence: Parmeener Supergroup
District: Fingal
Basin: Tasmania
Age: Late Triassic

	1	*2*	*3*		*1*	*2*	*3*
M %	4.44	6.5	5.9	AFD		1160	1160
Ash %	35.45	48.4	20.4	AFH		1390	1330
VM %	21.10	18.6	26.5	AFF		1480	1430
FC %	51.72	33.0	53.1				
				AA			
C %	80.12	79.6	83.6	SiO_2 %	57.24	62.7	63.0
H %	4.52	5.01	4.86	Al_2O_3 %	26.43	22.9	20.2
N %	1.41	1.51	1.39	Fe_2O_3 %	4.04	4.66	6.70
O %	7.53	13.4	9.7	TiO_2 %	1.13	1.01	1.19
				CaO %	7.47	4.31	4.63
Cl %	0.004			MgO %	1.13	1.01	1.19
S %	0.77	0.24	0.39	Na_2O %	0.43	0.23	0.05
				K_2O %	1.61	1.19	0.36
SE	28.97	15.88	26.68	P_2O_5 %	0.02	0.01	<0.01

Source: Bacon (in prep.).

SEAM: BLUE SEAM

Geological Sequence: Parmeener Supergroup
District: Mount Nicholas
Basin: Tasmania
Age: Late Triassic

	1	*2*	*3*		*1*	*2*	*3*
M %	5.3	6.7	5.19	AFD	1060	1060	
Ash %	41.4	16.8	38.35	AFH	1380	1380	
VM %	25.0	31.1	23.93	AFF	1480	1430	
FC %	33.6	52.1					
				AA			
C %	78.3	81.6	78.12	SiO_2 %	58.9	60.6	57.82
H %	5.15	4.93	5.08	Al_2O_3 %	24.4	20.2	26.66
N %	1.44	1.49	1.46	Fe_2O_3 %	8.9	12.2	5.60
O %	14.6	11.4	8.55	TiO_2 %	0.96	0.73	0.88
				CaO %	3.50	2.13	4.68
P %				MgO %	1.19	1.12	1.97
Cl %			0.005	Na_2O %	0.98	0.59	0.32
S %			0.33	K_2O %	1.40	0.52	1.11
				P_2O_5 %	0.160	0.082	0.05
SE	17.94	25.56	19.22				

Source: Bacon (in prep.).

SEAM: DALMAYNE COALFIELD

Geological Sequence: Parmeener Supergroup
District: Mount Nicholas
Basin: Tasmania
Age: Late Triassic

	1	*2*	*3*		*1*	*2*	*3*
M %	5.0	3.8	4.0	AFD	>1600	1280	>1600
Ash %	25.0	29.2	24.4	AFH	>1600	1585	>1600
VM %	22.8	24.3	23.8	AFF	>1600	>1600	>1600
FC %	47.2	42.7	47.8				
				AA			
C %	81.60	82.20	82.00	SiO_2 %	59.60	67.60	
H %	4.57	5.12	4.76	Al_2O_3 %	32.00	24.10	
N %	1.46	1.42	1.38	Fe_2O_3 %	3.04	3.14	
O %	11.96	10.97	11.77	TiO_2 %	1.36	0.81	
				CaO %	0.50	0.79	
P %				MgO %	0.81	0.98	
Cl %				Na_2O %	0.35	0.27	
S %	0.29	0.33	0.35	K_2O %	0.69	1.83	
				P_2O_5%	0.03	0.02	
SE	23.03	22.13	23.77				

Source: Bacon (in prep.); *1* raw coal DD seam, *2* raw coal DDU seam, *3* raw coal DDL seam.

SOUTH AUSTRALIA

SEAM: WINTINNA DEPOSIT COMBINED SEAMS

Geological Sequence: Mount Toondina Formation
District:
Basin: Arckaringa
Age: Permian

M %	37.8 (as received)	AA	
Ash %	9.8	SiO_2 %	33.00
VM %	37.5	Al_2O_3 %	14.20
FC %	52.6	Fe_2O_3 %	22.60
		TiO_2 %	0.77
C %	77.11	CaO %	9.60
H %	4.84	MgO %	3.14
N %	1.87	Na_2O %	1.83
O %	14.23	K_2O %	0.93
		P_2O_5 %	0.40
Cl %	0.07		
S %	1.77		
SE	28.14		

Source: Meekatharra Minerals Ltd via South Australia Department of Mines & Energy.

SEAM: WESTFIELD DEPOSIT COMBINED SEAMS

Geological Sequence: Mount Toondina Formation
District:
Basin: Arckaringa
Age: Permian

M %	37.8 (as received)	AA	
Ash %	10.3	SiO_2 %	25.7
VM %	34.6	Al_2O_3 %	11.7
FC %	55.1	Fe_2O_3 %	31.0
		TiO_2 %	0.57
C %	74.90	CaO %	10.40
H %	4.55	MgO %	3.44
N %	1.73	Na_2O %	1.16
O %	14.51	K_2O %	0.48
		P_2O_5 %	0.10
Cl %	0.09		
S %	3.9		
SE	26.76		

Source: Meekatharra Minerals Ltd via South Australia Department of Mines & Energy.

SEAM: EAST WINTINNA COMBINED SEAMS

Geological Sequence: Mount Toondina Formation
District:
Basin: Arckaringa
Age: Permian

M %	37.8 (as received)	AA	
Ash %	8.0	SiO_2 %	27.26
VM %	37.0	Al_2O_3 %	15.53
FC %	56.0	$FeVO_3$ %	22.22
		TiO_2 %	0.63
Cl %	0.02	CaO %	15.03
S %	0.79	MgO %	4.11
		Na_2O %	0.94
SE	28.24	K_2O %	0.19
		P_2O_5 %	0.34

Source: Meekatharra Minerals Ltd via South Australia Department of Mines & Energy.

SEAM: MURLOOCOPPIE DEPOSIT COMBINED SEAMS

Geological Sequence: Mount Toondina Formation
District:
Basin: Arckaringa
Age: Permian

M %	37.4 (as received)	AA	
Ash %	14.5	SiO_2 %	38.4
VM %	35.7	Al_2O_3 %	16.0
FC %	49.8	Fe_2O_3 %	19.6
		TiO_2 %	0.78
C %	74.00	CaO %	7.6
H %	4.80	MgO %	2.84
N %	1.61	Na_2O %	1.99
O %	16.91	K_2O %	0.93
		P_2O_5 %	0.54
S %	2.9		
SE	25.71		

Source: Meekatharra Minerals Ltd via South Australia Department of Mines & Energy.

SEAM: WEEDINA DEPOSIT COMBINED SEAMS

Geological Sequence: Mount Toondina Formation
District:
Basin: Arckaringa
Age: Permian

M %	38.16 (as received)	AA	
Ash %	12.21	SiO_2 %	41.80
VM %	36.02	Al_2O_3 %	15.39
FC %	51.61	Fe_2O_3 %	14.59
		TiO_2 %	0.73
C %	76.62	CaO %	9.94
H %	4.71	MgO %	3.39
N %	1.72	Na_2O	1.60
O %	16.11	K_2O %	1.42
		P_2O_5 %	0.21
Cl %	0.07		
S %	0.75		
SE	26.66		

Source: Cyprus Minerals Australia Company via South Australia Department of Mines & Energy.

SEAM: LAKE PHILLIPSON DEPOSIT

Geological Sequence: Mount Toondina Formation
District:
Basin: Arckaringa
Age: Permian

M %	36.4 (as received)	AA	
Ash %	19.5	SiO_2 %	46.1
VM %	35.4	Al_2O_3 %	13.6
FC %	45.3	Fe_2O_3 %	10.1
		TiO_2 %	0.64
C %	74.5	CaO %	2.45
H %	4.8	MgO %	4.37
N %	1.9	Na_2O %	9.68
O %	17.2	K_2O %	1.72
		P_2O_5 %	0.09
Cl %	1.5		
S %	1.2		
SE	23.9		

Source: Utah Development Company via South Australia Department of Mines & Energy.

SEAM: LEIGH CREEK LOBE B COMBINED SEAMS

Geological Sequence: Leigh Creek Coal Measures
District:
Basin: Telford
Age: Triassic

M %	31.0 (as received)	AA	
Ash %	19.1	SiO_2 %	37.9
VM %	30.2	Al_2O_3 %	17.5
FC %	50.8	Fe_2O_3 %	7.7
		TiO_2 %	1.4
C %	58.0	CaO %	11.7
H %	3.34	MgO %	3.7
N %	1.45	Na_2O %	5.5
O %	16.97	P_2O_5 %	3.0
Cl %	0.44		
S %	0.73		
SE	22.04		

Source: Electricity Trust of South Australia via South Australia Department of Mines & Energy.

SEAM: LEIGH CREEK UNSPECIFIED SEAM

Geological Sequence: Leigh Creek Coal Measures
District:
Basin:
Age: Triassic

M %	18.2	AFD	1100
Ash %	23.6	AFH	1200
VM %	32.0	AFF	1260
FC %	44.4		
C %	70.4	AA %	
H %	3.81	SiO_2%	47.5
N %	1.4	Al_2O_3%	22.1
O %	23.6	Fe_2O_3%	6.65
P %	0.171	TiO_2%	1.67
Cl %	0.54	CaO%	6.00
S %	0.61	MgO%	1.88
CSN	0	Na_2O%	5.57
GKCT		K_2O%	1.07
GF ddpm		P_2O_5%	3.80
SE	20.68 (as received)	V%	44

Source: Joint Coal Board and Queensland Coal Board (1987)

SEAM: LOCK DEPOSIT COMBINED SEAMS

Geological Sequence: Polda Formation
District:
Basin: Polda
Age: Jurassic

M %	26.7 (as received)	AA	
Ash %	30.7	SiO_2 %	47.4
VM %	41.4	Al_2O_3 %	33.1
FC %	27.9	Fe_2O_3 %	4.21
		TiO_2 %	1.38
C %	48.7	CaO %	2.76
H %	4.5	MgO %	2.88
N %	0.6	Na_2O %	2.94
		K_2O %	0.82
Cl %	0.3	P_2O_5 %	0.62
S %	0.6		
SE	20.0		

Source: Electricity Trust of South Australia via South Australia Department of Mines & Energy.

WESTERN AUSTRALIA

SEAM: TYPICAL PRODUCT COAL MUJA OPEN CUT

Geological Sequence: Collie Coal Measures
District: Collie
Basin: Collie
Age: Permian

M %	27.0	AFD	1200
Ash %	6.0	AFH	1350
VM %	26.0	AFF	1400
FC %	41.0		
C %	76.0		
H %	4.0		
N %	1.4		
O %	17.8		
S %	0.6		
SE	20.3 (as received)		
HGI	50		

Source: The Griffin Coal Mining Company Ltd pamphlet 'Griffin Coal Collie Basin Operations'.

SEAM: WESTERN COLLIERIES TYPICAL PRODUCT COAL

Geological Sequence: Collie Coal Measures
District: Collie
Basin: Collie
Age: Permian

M %	25	AFD	1300
Ash %	6	AFH	1400
VM %	26	AFF	1500
FC %	43		
S %	0.5		
SE	20.0		
HGI	50		

Source: Western Collieries Ltd pamphlet.

SEAM: COLLIE BASIN UNSPECIFIED SEAM

Geological Sequence: Collie Coal Measures
District:
Age: Permian

M %	18.8	AFFD	1500
Ash %	20.6	AFH	> 1550
VM %	37.9	AFF	> 1550
C %	77.2	AA	
H %	3.85	SiO_2%	33.8
N %	1.4	Al_2O_3%	42.9
O %	17.3	Fe_2O_3%	12.37
P %	0.014	TiO_2%	2.42
Cl %	0.01	CaO%	1.96
S %	0.32	MgO%	1.80
CSN	O	Na_2O%	0.89
GKCT		K_2O%	0.26
GF ddpm		P_2O_5%	1.29
SE	29.21 (as received)	V %	42
HGI		E %	4
		MI %	15
		F %	37
		MM %	2
		RO (max)	0.38

Source: Joint Coal Board & Queensland Coal Board (1987).

Part 3

Indicative properties, product coals

The data in Part 3 have been derived from a number of sources, including many coal producers. For Queensland, the reader is particularly referred to the 1990 edition of 'Queensland Coals' published by the Queensland Coal Board.

Coals can generally be produced to various specifications and the properties reported here do not necessarily reflect the full range of product coals. The specifications for any one coal product may vary with time, and thus the data reported here are indicative only. Specific information on the range of coals currently available or a company's ability to produce coal to a particular specification should be obtained directly from the relevant company.

Changes in mine ownership are intermittent and ongoing. For current information, please consult the mining authority in the relevant State (Appendix 1).

Abbreviations

ad	air-dried
ar	as received
daf	dry, ash-free
db	dry basis
ddpm	dial divisions per minute
dmmf	dry-mineral-matter-free
mmf	mineral-matter-free
RO(max)	% mean maximum reflectance of all vitrinite

Contents, Part 3

QUEENSLAND

BOWEN DISTRICT

Company	**Collinsville Coal Company Pty Ltd**
Mine	Bocum, Collinsville No. 2; Bowen Central No. 3, Garrick West, Scott Denison
Mine type	Underground; open cut
Mining method	Bord & pillar; dragline, truck, loader
Geological sequence	Collinsville Coal Measures
Seam(s) mined	Garrick, Scott, Denison, Bowen, Blake

	Coking	*Bowen Thermal*	*Blake Thermal*
Proximate analysis (% ad)			
moisture	1.5	1.3	1.5
ash	9.0	14.5	20.0
volatile matter	26.0	20.2	18.7
fixed carbon	63.5	64.0	59.8
Specific energy			
gross MJ/kg (ad)	32.00	30.57	27.00
Ultimate analysis (% daf)			
carbon	87.50	87.60	85.60
hydrogen	5.16	4.90	4.70
nitrogen	1.70	1.80	1.90
sulphur	0.85	1.40	0.80
oxygen	4.85	4.30	7.00
Chlorine (%)	0.03	0.03	0.08
Phosphorus (%)	0.05	0.07	0.08
Coking properties			
crucible swelling number	6	4–5	1
Gray–King coke type	G3–G5		G
Max. fluidity (ddpm)	1000–2000	60	
Hardgrove grindability	70	84	84
Ash fusion temperature (reducing atmosphere, degrees C)			
deformation	1600	1350	1530
hemisphere	1600	1410	1600
flow	1600	1550	1600
Ash analysis (%)			
SiO_2	58.00	56.70	53.10
Al_2O_3	31.10	26.90	36.60
Fe_2O_3	6.20	10.50	1.40
CaO	0.80	1.10	0.80
MgO	0.40	0.30	0.40
TiO_2	1.45	2.40	2.20
Na_2O	0.15	0.20	0.20
K_2O	0.25	0.20	0.30
Mn_3O_4	0.03	0.02	0.00
P_2O_5	0.60	1.20	1.30
SO_3	0.80	0.30	0.30
Petrography (%)			
vitrinite	52	39	
semi-inertinite	37	51	
inertinites	6	6	
mineral	5	5	
R0(max)	1.05–1.10	1.14	

Source: Queensland Coal Board (1986)

MACKAY DISTRICT

Company	**BHP-Utah Coal Ltd**
Mine	Goonyella
Mine type	Open cut
Mining method	Bucketwheel, dragline, truck, loader
Geological sequence	Moranbah Coal Measures
Seam(s) mined	Goonyella Middle, Goonyella Lower

Proximate analysis (% ad)	
moisture	1.0
ash	8.0
volatile matter	25.5
fixed carbon	65.5
Specific energy	
gross MJ/kg (ad)	33.10
Ultimate analysis (% daf)	
carbon	87.9
hydrogen	5.1
nitrogen	1.8
sulphur	0.5
oxygen	4.7
Phosphorus	0.02
Coking properties	
crucible swelling number	8
Gray–King coke type	G7
max. fluidity (ddpm)	1750
Hardgrove grindability	90
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1550
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	55.20
Al_2O_3	35.70
Fe_2O_3	3.30
CaO	0.80
MgO	0.60
TiO_2	2.00
Na_2O	0.40
K_2O	0.70
Mn_3O_4	0.04
P_2O_5	0.60
SO_3	0.20
Petrography (%)	
vitrinite	60
semi-inertinite	26
inertinites (others)	9
others	1
mineral	4
R0(max)	1.12

Source: Queensland Coal Board (1986)

Company	**BHP-Utah Coal Ltd**
Mine	Riverside
Mine type	Open cut
Mining method	Dragline, truck, loaders
Geological sequence	Moranbah Coal Measures
Seam(s) mined	Goonyella Middle, Goonyella Lower

	Coking
Proximate analysis (% ad)	
moisture	1.7
ash	9.8
volatile matter	23.9
fixed carbon	64.6
Specific energy	
gross MJ/kg (ad)	31.77
Ultimate analysis (% daf)	
carbon	87.94
hydrogen	5.00
nitrogen	1.86
sulphur	0.63
oxygen	4.57
Chlorine (%)	0.09
Phosphorus (%)	0.006
Coking properties	
crucible swelling number	7.5
Gray–King coke type	G1–G4
max. fluidity (ddpm)	600–1000
Hardgrove grindability	78

Ash fusion temperature (reducing atmosphere) (degrees C)	
deformation	1580
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	64.50
Al_2O_3	28.90
Fe_2O_3	1.47
CaO	0.20
MgO	0.43
TiO_2	1.77
Na_2O	0.54
K_2O	0.90
Mn_3O_4	0.02
P_2O_5	0.10
SO_3	0.05
Petrography (%)	
vitrinite	55
inertinites	39
others	1
mineral	5
R0(max)	1.23

Source: Queensland Coal Board (1986) and Thiess Dampier Mitsui Coal Pty Ltd.

Company	**Newlands Coal Pty Ltd**	
Mine	Newlands	
Mine type	Open cut	
Mining method	Dragline, truck, loader	
Geological sequence	Rangal Coal Measures	
Seam(s) mined	Upper Newlands	
Proximate analysis (% ad)		
moisture		2.3
ash		14.0
volatile matter		26.4
fixed carbon		57.2
Specific energy		
MJ/kg (ad)		28.63
Ultimate analysis (% daf)		
carbon		84.46
hydrogen		4.98
nitrogen		1.76
sulphur		0.62
oxygen		8.17
Hardgrove grindability		54
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation		>1600
hemisphere		>1600
flow		>1600
Ash analysis (%)		
SiO_2		52.9
Al_2O_3		36.9
Fe_2O_3		4.22
CaO		1.28
MgO		0.43
TiO_2		1.77
Na_2O		0.27
K_2O		0.41
Mn_3O_4		0.05
P_2O_5		0.071
SO_3		0.37

Source: Newlands Coal Pty Ltd

Company	**Central Queensland Coal Associates**	
Mine	Peak Downs	
Mine type	Open cut	
Mining method	Dragline, truck, loader	
Geological sequence	Moranbah Coal Measures	
Seam(s) mined	Harrow Creek, Dysart	
Proximate analysis (% ad)		
moisture		1.0
ash		9.5
volatile matter		21.0
fixed carbon		68.5
Specific energy		
gross MJ/kg (ad)		32.60
Ultimate analysis (% daf)		
carbon		88.8
hydrogen		4.9
nitrogen		2.1
sulphur		0.6
oxygen		3.6
Phosphorus (%)		0.03
Coking properties		
crucible swelling number		8–9
Gray–King coke type		G7
max. fluidity (ddpm)		275
Hardgrove grindability		95
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation		1550
hemisphere		1600
flow		1600
Ash analysis (%)		
SiO_2		58.60
Al_2O_3		30.70
Fe_2O_3		3.70
CaO		1.40
MgO		0.50
TiO_2		1.59
Na_2O		0.41
K_2O		1.28
Mn_3O_4		0.04
P_2O_5		0.93
SO_3		0.18
Petrography (%)		
vitrinite		69
semi-inertinite		18
inertinites (others)		8
mineral		5
R0(max)		1.5

Source: Queensland Coal Board (1986) and BHP-Utah Coal Ltd.

Company	**Central Queensland Coal Associates**	
Mine	Saraji	
Mine type	Open cut	
Mining method	Dragline, truck, loader	
Geological sequence	Moranbah Coal Measures	
Seam(s) mined	Dysart	
Proximate analysis (% ad)		
moisture		1.0
ash		9.3
volatile matter		19.5
fixed carbon		70.2
Specific energy		
gross MJ/kg (ad)		32.70
Ultimate analysis (% daf)		
carbon		89.4
hydrogen		4.9
nitrogen		2.0
sulphur		0.6
oxygen		2.5

Phosphorus (%)	0.02
Coking properties	
crucible swelling number	8–9
Gray–King coke type	G6
max. fluidity (ddpm)	125
Hardgrove grindability	95
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1550
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	60.10
Al_2O_3	30.90
Fe_2O_3	3.50
CaO	0.70
MgO	0.50
TiO_2	1.65
Na_2O	0.50
K_2O	1.00
Mn_3O_4	0.04
P_2O_5	0.50
SO_3	0.16
Petrography (%)	
vitrinite	70
semi-inertinite	17
inertinites (others)	8
mineral	5
R0(max)	1.5

Source: Queensland Coal Board (1986) and BHP-Utah Coal Ltd.

Company	**Central Queensland Coal Associates**
Mine	Norwich Park
Mine type	Open cut
Mining method	Dragline, truck, loader
Geological sequence	Moranbah Coal Measures
Seam(s) mined	Dysart

Proximate analysis (% ad)	
moisture	0.9
ash	9.5
volatile matter	17.2
fixed carbon	72.4
Specific energy	
gross MJ/kg (ad)	32.50
Ultimate analysis (% daf)	
carbon	89.5
hydrogen	4.8
nitrogen	1.6
sulphur	0.7
oxygen	3.4
Phosphorus (%)	0.03
Coking properties	
crucible swelling number	8–9
Gray–King coke type	G3
max. fluidity (ddpm)	25
Hardgrove grindability	95
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1550
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	57.10
Al_2O_3	33.20
Fe_2O_3	3.50
CaO	1.10
MgO	0.40
TiO_2	1.90
Na_2O	0.40
K_2O	0.90
Mn_3O_4	0.03
P_2O_5	0.70
SO_3	0.20
Petrography (%)	
vitrinite	73
semi-inertinite	14
inertinites (others)	8
mineral	5
R0(max)	1.6

Source: Queensland Coal Board and BHP-Utah Coal Ltd

BLACKWATER DISTRICT

Company	**Capricorn Coal Management Pty Ltd**
Mine	German Creek
Mine type	Open cut; underground
Mining method	Dragline, truck, loaders; longwall
Geological sequence	German Creek Formation
Seam(s) mined	Aquila, Tieri 1, Upper Tieri 1, Lower Tieri 2, Corvus 2, German Creek, German

Proximate analysis (% ad)	
moisture	1.2
ash	8.5
volatile matter	21.0
fixed carbon	69.3
Specific energy	
gross MJ/kg (ad)	32.32
Ultimate analysis (% daf)	
carbon	88.6
hydrogen	4.9
nitrogen	2.1
sulphur	1.0
oxygen	3.4
Phosphorus (%)	0.05
Coking properties	
crucible swelling number	9
Gray–King coke type	G9
max. fluidity (ddpm)	400
Hardgrove grindability	94
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	>1600
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	52.7
Al_2O_3	33.9
Fe_2O_3	4.7
CaO	2.1
MgO	0.3
TiO_2	1.7
Na_2O	0.4
K_2O	1.0
Mn_3O_4	<0.1
P_2O_5	1.9
SO_3	0.3
Petrography (%)	
vitrinite	73
semi-inertinite	14
inertinites (others)	5
mineral	8
R0(max)	1.45

Source: Queensland Coal Board (1986)

Company	**Oaky Creek Coal Pty Ltd**
Mine	Oaky Creek
Mine type	Open cut; underground
Mining method	Dragline, truck, loader; longwall
Geological sequence	German Creek Formation
Seam(s) mined	Aquila, German Creek

Proximate analysis (% ad)	
moisture	1.2
ash	8.0
volatile matter	28.9
fixed carbon	61.9
Specific energy	
gross MJ/kg (ad)	32.50
Ultimate analysis (% daf)	
carbon	86.84
hydrogen	5.46
nitrogen	2.05
sulphur	0.81
oxygen	4.84
Phosphorus (%)	0.06
Coking properties	
crucible swelling number	8.5
Gray–King coke type	G9
max. fluidity (ddpm)	5000–10000
Hardgrove grindability	77
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1600
hemisphere	1600
flow	1600
Ash analysis (%)	
SiO_2	49.70
Al_2O_3	34.50
Fe_2O_3	7.00
CaO	2.20
MgO	0.99
TiO_2	1.76
Na_2O	0.47
K_2O	0.67
Mn_3O_4	0.03
P_2O_5	1.79
Petrography (%)	
vitrinite	75
semi-inertinite	17
inertinites (others)	4
others	1
mineral	3
R0(max)	1.07

Source: Queensland Coal Board (1986)

Company	**BHP-Utah Coal Ltd**
Mine	Gregory
Mine type	Open cut
Mining method	Dragline, truck, loader
Geological sequence	German Creek Formation
Seam(s) mined	Lilyvale

Proximate analysis (% ad)	
moisture	2.0
ash	8.5
volatile matter	32.0
fixed carbon	57.5
Specific energy	
gross MJ/kg (ad)	31.70
Ultimate analysis (% daf)	
carbon	85.0
hydrogen	5.2
nitrogen	2.2
sulphur	0.7
oxygen	6.9
Phosphorus (%)	0.03
Coking properties	
crucible swelling number	8–9
Gray–King coke type	G7
max. fluidity (ddpm)	3500
Hardgrove grindability	65
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	>1550
hemisphere	>1550
flow	>1550
Ash analysis (%)	
SiO_2	52.00
Al_2O_3	38.90
Fe_2O_3	3.20
CaO	1.00
MgO	0.30
TiO_2	1.90
Na_2O	0.30
K_2O	0.80
Mn_3O_4	0.01
P_2O_5	0.70
SO_3	0.04
Petrography (%)	
vitrinite	69
exinite	4
semi-inertinite	14
inertinites (others)	11
mineral	2
R0(max)	0.98

Source: Queensland Coal Board (1986)

Company	**Yarrabee Mining Pty Ltd**
Mine	Yarrabee
Mine type	Open cut
Mining method	Truck, loader
Geological sequence	Rangal Coal Measures
Seam(s) mined	Pollux

Proximate analysis (% ad)	
moisture	3.0
ash	10.0
volatile matter	8.9
fixed carbon	79.0
Specific energy	
gross MJ/kg (ad)	30.84
Ultimate analysis (% daf)	
carbon	91.7
hydrogen	3.6
nitrogen	1.8
sulphur	0.8
oxygen	2.1
Chlorine (%)	0.08
Phosphorus (%)	0.07
Coking properties	
crucible swelling number	0
Gray–King coke type	A
Hardgrove grindability	68
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1150
hemisphere	1220
flow	1340
Ash analysis (%)	
SiO_2	47.00
Al_2O_3	24.30
Fe_2O_3	9.70
CaO	6.70

MgO	0.10
TiO_2	1.10
Na_2O	4.10
K_2O	1.40
Mn_3O_4	0.10
P_2O_5	1.80
SO_3	3.70
Petrography (%)	
vitrinite	39
semi-inertinite	53
inertinites (others)	3
mineral	5
R0(max)	2.59

Source: Queensland Coal Board (1986)

Company	**Curragh Queensland Mining Ltd**
Mine	Curragh
Mine type	Open cut
Mining method	Dragline, truck, loader
Geological sequence	Rangal Coal Measures
Seam(s) mined	Aries, Castor, Orion

	Coking	*Thermal*
Proximate analysis (% ad)		
moisture	1.5	2.1
ash	7.0	16.0
volatile matter	22.0	18.6
fixed carbon	69.5	63.3
Specific energy		
gross MJ/kg ad)	32.92	29.34
Ultimate analysis (% daf)		
carbon	88.5	88.3
hydrogen	4.8	4.7
nitrogen	1.8	1.7
sulphur	0.6	0.8
oxygen	4.3	4.5
Phosphorus (%)	0.01	0.09
Coking properties		
crucible swelling number	6.5–9	1.5
Gray–King coke type	G1–G7	F
max. fluidity (ddpm)	>100	
Hardgrove grindability	78	75–85
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation	1260	1175
hemisphere	1410	1300
flow	1460	1360
Ash analysis (%)		
SiO_2	56.70	51.10
Al_2O_3	22.10	22.80
Fe_2O_3	13.80	14.20
CaO	1.72	3.90
MgO	2.39	1.40
TiO_2	1.47	1.00
Na_2O	0.01	0.20
K_2O	0.96	0.90
Mn_3O_4	0.09	0.10
P_2O_5	0.96	1.50
SO_3	0.04	1.20
Petrography (%)		
vitrinite	55–70	
exinite	0–2	
semi-inertinite	24–38	
inertinites (others)	6–10	
mineral	2–5	
R0(max)	1.22–1.36	

Source: Queensland Coal Board (1986)

Company	**Central Queensland Coal Associates**
Mine	Blackwater
Mine type	Open cut
Mining method	Dragline, truck, loader
Geological sequence	Rangal Coal Measures
Seam(s) mined	Aries, Taurus

	Coking	*Thermal*
Proximate analysis (% ad)		
moisture	2.0	2.0
ash	7.8	13.5
volatile matter	27.0	23.4
fixed carbon	63.2	61.1
Specific energy		
gross MJ/kg (ad)	31.90	29.64
Ultimate analysis (% daf)		
carbon	86.6	85.5
hydrogen	4.9	4.8
nitrogen	2.1	1.7
sulphur	0.5	0.6
oxygen	5.9	7.4
Chlorine (%)		0.05
Phosphorus (%)	0.03	0.09
Coking properties		
crucible swelling number	6–6.5	0.5
Gray–King coke type	G1	
max. fluidity (ddpm)	150	
Hardgrove grindability	75	78
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation	1220	1130
hemisphere	1430	1320
flow	1500	1370
Ash analysis (%)		
SiO_2	52.10	55.40
Al_2O_3	24.00	22.20
Fe_2O_3	13.30	8.80
CaO	2.80	4.30
MgO	1.20	2.00
TiO_2	1.20	1.20
Na_2O	0.30	0.20
K_2O	2.00	1.90
Mn_3O_4	0.20	0.10
P_2O_5	1.40	1.30
SO_3	0.70	2.60
Petrography (%)		
vitrinite	57	
exinite	2	
semi-inertinite	25	
inertinites (others)	12	
mineral	4	
R0(max)	1.05	

Source: Queensland Coal Board (1986)

Company	**South Blackwater Mines Ltd**
Mine	South Blackwater
Mine type	Open cut
Mining method	Dragline, truck, loader
Geological sequence	Rangal Coal Measures
Seam(s) mined	Mammoth

	Coking	*Thermal*
Proximate analysis (% ad)		
moisture	2.0	2.0
ash	7.2	11.5
volatile matter	28.4	25.8
fixed carbon	62.4	60.7
Specific energy		
gross MJ/kg (ad)	32.30	29.80

Ultimate analysis (% daf)		
carbon	86.2	86.2
hydrogen	4.8	4.8
nitrogen	2.1	2.1
sulphur	0.5	0.9
oxygen	6.4	6.0
Chlorine (%)	0.05	0.05
Phosphorus (%)	0.04	0.04
Coking properties		
crucible swelling number	6.5	2
Gray–King coke type	G3	
max. fluidity (ddpm)	500	
Hardgrove grindability	70	67
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation	1350	1350
hemisphere	>1600	>1600
flow	>1600	>1600
Ash analysis (%)		
SiO_2	54.50	54.60
Al_2O_3	31.20	30.70
Fe_2O_3	7.40	7.00
CaO	2.00	1.15
MgO	0.20	0.42
TiO_2	1.20	1.20
Na_2O	0.20	0.14
K_2O	1.30	0.94
Mn_3O_4	0.05	0.02
P_2O_5	1.20	0.90
SO_3	0.30	0.20
Petrography (%)		
vitrinite	56	40
exinite	3	3
semi-inertinite	29	40
inertinites (others)	9	12
mineral	3	5
R0(max)	1.06	1.05

Source: Queensland Coal Board (1986)

Company	**Coal Resources of Queensland Pty Ltd**
Mine	Cook
Mine type	Underground
Mining method	Bord & pillar, longwall
Geological sequence	Rangal Coal Measures
Seam(s) mined	Castor

	Coking	*Thermal*
Total moisture (% ar)	8.8approx.	8.5
Proximate analysis (% ad)		
moisture	1.4	1.6
ash	7.0	13.2
volatile matter	27.5	24.5
fixed carbon	64.1	60.7
Specific energy		
gross MJ/kg	32.8	29.5
Ultimate analysis (% daf)		
carbon	87.88	86.9
hydrogen	4.98	4.85
nitrogen	2.10	1.96
sulphur	0.41	0.41
oxygen	4.63	5.88
Chlorine (% ad)	0.01	0.04
Phosphorus (% ad)	0.055	0.08
Coking properties		
crucible swelling number	7–8	1
Gray–King coke type	G5	
max. fluidity (ddpm)	5000	
Hardgrove grindability	74	70
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation		1250
hemisphere		1350
flow		1450
Ash analysis (%)		
SiO_2	52.90	51.50
Al_2O_3	24.90	26.90
Fe_2O_3	8.80	7.89
CaO	4.80	6.71
MgO	1.30	1.40
TiO_2	1.20	1.23
Na_2O	0.50	0.23
K_2O	0.90	1.12
Mn_3O_4	0.10	0.10
P_2O_5	1.30	1.32
SO_3	1.20	1.04
Petrography (%)		
vitrinite	60	34
exinite	2	3
inertinites (all)	35	57
mineral	3	6
R0(max)	1.06–1.15	

Source: Coal Resources of Queensland Pty Ltd

Company	**BHP-Utah Coal Ltd**
Mine	Moura
Mine type	Open cut; underground
Mining method	Dragline, truck, loader; bord & pillar
Geological sequence	Baralaba Coal Measures
Seam(s) mined	A, B, C, D, E

		Thermal		*PCI/*
	Coking	*Std*	*High vol.*	*B'tte*
Proximate analysis (% ad)				
moisture	2.0	2.2	2.1	2.1
ash	8.2	12.9	9.6	8.2
volatile matter	29.9	27.9	30.6	31.3
fixed carbon	59.9	57.0	57.7	58.4
Specific energy				
gross MJ/kg (ad)	31.80	29.57	30.76	31.33
Ultimate analysis (% daf)				
carbon	85.83	84.92	84.95	84.44
hydrogen	5.29	5.21	5.21	5.24
nitrogen	1.84	1.78	1.85	1.87
sulphur	0.51	0.59	0.50	0.46
oxygen	6.53	7.50	7.49	7.99
Chlorine (%)	0.09	0.08	0.09	0.11
Phosphorus (%)	0.027	0.04	0.037	0.035
Coking properties				
crucible swelling number	7.5	2–4	2–4	3
Gray–King coke type	G1–G2	E–C	E–C	E–C
max. fluidity (ddpm)				
Hardgrove grindability	65	60	58	59
Ash fusion temperature (reducing atmosphere,				
deformation		1230	1300	1330
hemisphere		1430	1470	1490
flow		1470	1500	1510
Ash analysis (%)				
SiO_2		54.63	53.28	51.46
Al_2O_3		26.09	28.42	29.78
Fe_2O_3		9.00	8.15	9.12
CaO		2.14	2.44	2.12
MgO		1.09	1.11	1.20
TiO_2		1.27	1.43	1.52
Na_2O		0.53	0.46	0.39
K_2O		2.87	2.33	2.15
Mn_3O_4		0.07	0.04	0.03
P_2O_5		0.65	1.02	1.18
SO_3		0.88	0.70	0.26

Petrography (%)		
vitrinite	59	59
exinite	2	2
inertinite	35	36
mineral	4	3
R0(max)	0.90	0.79

Source: Queensland Coal Board (1986) and Thiess Dampier Mitsui Coal Pty Ltd

BLAIR ATHOL DISTRICT

Company	**Pacific Coal Pty Ltd**
Mine	Blair Athol
Mine type	Open cut
Mining method	Truck, shovel
Geological sequence	Blair Athol Coal Measures
Seam(s) mined	No. 3

Proximate analysis (% ad)	
moisture	7.5
ash	8.0
volatile matter	27.2
fixed carbon	57.3
Specific energy	
gross MJ/kg (ad)	27.28
Ultimate analysis (% daf)	
carbon	81.2
hydrogen	4.4
nitrogen	1.7
sulphur	0.3
oxygen	12.4
Chlorine (%)	0.07
Phosphorus (%)	0.008
Coking properties	
crucible swelling number	0.5
Gray–King coke type	B
Hardgrove grindability	60
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1550
hemisphere	1570
flow	1580
Ash analysis (%)	
SiO_2	61.30
Al_2O_3	30.20
Fe_2O_3	4.20
CaO	0.54
MgO	0.50
TiO_2	1.58
Na_2O	0.21
K_2O	0.30
Mn_3O_4	0.10
P_2O_5	0.24
SO_3	0.15
Petrography (%)	
vitrinite	29
exinite	3
semi-inertinite	53
inertinites (others)	13
mineral	2
R0(max)	0.69

Source: Queensland Coal Board (1986)

CALLIDE DISTRICT

Company	**Callide Coalfields Pty Ltd**
Mine	Boundary Hill, Callide
Mine type	Both open cut
Mining method	Dragline, truck, shovel
Geological sequence	Callide Coal Measures
Seam(s) mined	Callide

	Boundary Hill	*Callide*
Proximate analysis (% ad)		
moisture	11.7	10.9
ash	12.8	16.4
volatile matter	25.1	24.6
fixed carbon	50.4	48.1
Specific energy		
gross MJ/kg (ad)	22.21	21.74
Ultimate analysis (% daf)		
carbon	76.77	78.06
hydrogen	3.81	3.91
nitrogen	1.18	1.15
sulphur	0.36	0.22
oxygen	17.88	16.66
Chlorine (%)	0.02	0.02
Phosphorus (%)	0.06	0.02
Coking properties		
crucible swelling number	0	0
Gray–King coke type	A	A
Hardgrove grindability	89	85
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation	1300	1380
hemisphere	1470	1543
flow	1500	1570
Ash analysis (%)		
SiO_2	38.10	43.53
Al_2O_3	33.80	32.19
Fe_2O_3	15.55	16.49
CaO	2.83	0.78
MgO	2.02	0.28
TiO_2	1.29	1.65
Na_2O	0.25	0.13
K_2O	0.10	0.30
Mn_3O_4	0.30	1.25
P_2O_5	0.92	0.26
SO_3	2.52	1.33
Petrography (%)		
vitrinite	19	29
exinite	14	1
semi-inertinite	47	50
inertinites (others)	13	9
mineral	7	11
R0(max)	0.47	0.49

Source: Queensland Coal Board (1986)

NANANGO DISTRICT

Company	**Pacific Coal Pty Ltd**
Mine	Meandu (Tarong)
Mine type	Open cut
Mining method	Dragline, truck, loader
Geological sequence	Tarong Coal Measures
Seam(s) mined	King

Proximate analysis (% ad)	
moisture	5.3
ash	28.0
volatile matter	27.5
fixed carbon	39.2
Specific energy	
gross MJ/kg (ad)	

Ultimate analysis (% daf)	
carbon	80.5
hydrogen	5.3
nitrogen	1.5
sulphur	0.4
oxygen	12.3
Chlorine (%)	0.04
Phosphorus (%)	0.012
Coking properties	
crucible swelling number	1
Gray–King coke type	C
Hardgrove grindability	53
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1485
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	72.3
Al_2O_3	23.3
Fe_2O_3	0.9
CaO	0.1
MgO	0.2
TiO_2	1.4
Na_2O	0.1
K_2O	0.3
Mn_3O_4	0.1
P_2O_5	0.1
SO_3	0.1

Source: Queensland Coal Board (1986)

MARYBOROUGH DISTRICT

Company	**Burgowan Collieries Pty Ltd**
Mine	Burgowan No. 12
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Burrum Coal Measures
Seam(s) mined	Ellangowan

Proximate analysis (% ad)	
moisture	2.2
ash	12.5
volatile matter	30.0
fixed carbon	55.3
Specific energy	
gross MJ/kg (ad)	29.28
Ultimate analysis (% daf)	
carbon	84.6
hydrogen	5.5
nitrogen	1.7
sulphur	0.8
oxygen	7.4
Chlorine (%)	0.03
Phosphorus (%)	0.17
Coking properties	
crucible swelling number	8.5
Gray–King coke type	G7
max. fluidity (ddpm)	2320
Hardgrove grindability	82
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1100
hemisphere	1290
flow	1460
Ash analysis (%)	
SiO_2	45.4
Al_2O_3	19.7
Fe_2O_3	5.2
CaO	20.0
MgO	0.8
TiO_2	1.3
Na_2O	0.4
K_2O	0.4
Mn_3O_4	0.0
P_2O_5	4.0
SO_3	1.5
Petrography (%)	
vitrinite	79
semi-inertinite	8
inertinites	2
mineral	11
R0(max)	0.99

Source: Queensland Coal Board (1986)

WEST MORETON DISTRICT

Company	**Allied Queensland Coalfields Ltd**
Mine	New Whitwood
Mine type	Open cut
Mining method	Truck, loader
Geological sequence	Ipswich Coal Measures
Seam(s) mined	Numerous

Proximate analysis (% ad)	
moisture	2.2
ash	16.0
volatile matter	30.0
fixed carbon	51.5
Specific energy	
gross MJ/kg	28.05
Ultimate analysis (% daf)	
carbon	84.09
hydrogen	5.50
nitrogen	1.52
sulphur	0.32
oxygen	8.57
Chlorine (%)	0.02
Phosphorus (%)	0.02
Coking properties	
crucible swelling number	<2
Hardgrove grindability	53
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	>1600
hemisphere	>1600
flow	>1600
Ash analysis (%)	
SiO_2	63.91
Al_2O_3	30.49
Fe_2O_3	0.78
CaO	0.48
MgO	0.19
TiO_2	2.10
Na_2O	0.13
K_2O	0.38
Mn_3O_4	0.01
P_2O_5	0.11
SO_3	0.12

Source: Queensland Coal Board (1986)

Company	**Idemitsu South Queensland Coal Pty Ltd**
Mine	Ebenezer
Mine type	Open cut
Mining method	Truck, loader
Geological sequence	Walloon Coal Measures
Seam(s) mined	

Typical analyses:	
total moisture (%)	10.0
moisture (% ad)	3.0
ash (% ad)	13.4–15.3
volatile matter (% ad)	37.9–42.2
fixed carbon (% ad)	39.0–45.7
Specific energy	
MJ/kg	28.05

Source: Queensland Coal Board (1989)

Company	**New Hope Corporation Ltd**
Mine	Various
Mine type	Open cut, underground
Mining method	Truck, loader; bord & pillar
Geological sequence	Ipswich Coal Measures
Seam(s) mined	Various

Proximate analysis (% ad)			
moisture	3.0	4.0	5.0
ash	16.0	17.0	15.0
volatile matter	29.5	32.0	39.0
fixed carbon	51.5	47.0	41.0
Specific energy			
gross MJ/kg (ad)	27.21	26.80	26.59
Chlorine (%)	0.01	0.020	0.020
Coking properties			
crucible swelling number	1.5	1	0.5
Hardgrove grindability	53	50	39
Ash fusion temperature (reducing atmosphere, degrees C)			
deformation	>1400	>1400	>1450
hemisphere	>1600	>1600	>1600
flow	>1600	>1600	>1600
Ash analysis (%)			
SiO_2	59.3	60.0	61.9
Al_2O_3	31.2	30.6	28.9
Fe_2O_3	2.1	2.0	1.8
CaO	1.2	1.4	1.9
MgO	0.9	0.9	0.9
TiO_2	2.1	2.0	1.8
Na_2O	0.4	0.4	0.6
K_2O	0.4	0.4	0.6
Mn_3O_4	0.1	0.1	0.1
P_2O_5	0.4	0.3	0.3
SO_3	0.7	1.1	0.8

Source: Queensland Coal Board (1986)

Company	**Oakleigh Colliery Pty Ltd**
Mine	Oakleigh
Mine type	Open cut; underground
Mining method	Trucks, loaders; bord & pillar
Geological sequence	Walloon Coal Measures
Seam(s) mined	Various

Proximate analysis (% ad)	
moisture	5.7
ash	17.0
volatile matter	38.6
fixed carbon	38.7
Specific energy	
gross MJ/kg (ad)	26.28
Ultimate analysis (% daf)	
carbon	78.5
hydrogen	6.4
nitrogen	1.7
sulphur	0.8
oxygen	12.6
Chlorine (%)	0.01
Phosphorus (%)	0.01
Coking properties	
crucible swelling number	1.5
Gray–King coke type	C
Hardgrove grindability	40
Ash fusion temperature (reducing atmosphere, degrees C)	
deformation	1500
hemisphere	1640
flow	1600
Ash analysis (%)	
SiO_2	60.3
Al_2O_3	29.9
Fe_2O_3	2.4
CaO	2.0
MgO	1.1
TiO_2	1.6
Na_2O	0.6
K_2O	0.6
Mn_3O_4	0.1
P_2O_5	0.1
SO_3	0.7
Petrography (%)	
vitrinite	76
semi-inertinite	1
inertinites (others)	0
others	4
mineral	19
R0(max)	0.54

Source: Queensland Coal Board (1986)

Company	**FAI Mining Ltd**
Mine	Box Flat, Wattle Glen Ext., M.W. Haenke
Mine type	Open cut; underground
Mining method	Truck, shovel; bord & pillar
Geological sequence	Ipswich Coal Measures
Seam(s) mined	Numerous

Proximate analysis (% ad)		
moisture	2.5	2.2
ash	17.0	15.9
volatile matter	30.5	30.9
fixed carbon	50.0	51.0
Specific energy		
gross MJ/kg (ad)	27.50	28.54
Ultimate analysis (% daf)		
carbon	82.5–83.5	83.61
hydrogen	5.4–5.6	5.41
nitrogen	1.4–1.8	1.55
sulphur	0.3–0.5	0.32
oxygen		9.11
Chlorine (%)	0.03	0.030
Phosphorus (%)	0.025	0.045
Coking properties		
crucible swelling number		1–2.5
Hardgrove grindability	50–54	50
Ash fusion temperature (reducing atmosphere, degrees C)		
deformation	1350–1450	1220
hemisphere	>1600	>1600
flow	>1600	>1600
Ash analysis (%)		
SiO_2	57.0–61.0	61.30
Al_2O_3	28.0–31.0	25.30

Fe_2O_3	2.5–5.0	2.47
CaO	1.1–1.5	2.10
MgO	0.8–1.2	1.56
TiO_2	2.0–2.4	2.17
Na_2O	0.2–0.3	0.42
K_2O	0.3–0.5	0.55
Mn_3O_4	0.1	0.03
P_2O_5	0.25–0.35	0.65
SO_3	0.4–0.8	1.61

Source: Queensland Coal Board (1986)

NEW SOUTH WALES

GUNNEDAH COALFIELD

Company	**Preston Coal Holdings Pty Ltd**
Mine	Preston Extended
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Black Jack Formation
Seam(s) mined	Hoskisson

Total moisture (%)	8.0–10.0
Proximate analysis (%ad)	
ash	11.0–12.0
volatile matter	30.0
Specific energy	
MJ/kg	29.4–29.7
kcal/kg	7010–7090
Ultimate analysis (% daf)	
sulphur	0.5
Phosphorus (%)	0.005
Coking properties	
Crucible swelling number	1
Hardgrove grindability	48
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1510
hemisphere	
flow	>1600

Source: NSW Department of Minerals & Energy (1989)

Company	**Gunnedah Coal Co. Ltd**	
Mines	Gunnedah No. 2	Gunnedah
Mine type	Underground	Open cut
Mining method	Bord & pillar	Scraper, dozer, loader, truck
Geological sequence	Black Jack Formation	Black Jack Formation
Seam(s) mined	Hoskisson	Melvilles

	Hoskisson Coking	*Hoskisson Thermal*	*Gunnedah Semi-Coking*	*Melville Coking*	*Melville Thermal*
Total moisture	9.5	9.5	9.5	9.5	9.5
Proximate analysis (% ad)					
moisture	3.4	3.4	3.4	2.5	2.5
ash	7.2	12.1	9.2	10.0	13.7
volatile matter	35.3	32.0	34.8	35.5	32.4
fixed carbon	54.1	52.5	52.6	52.0	51.4
Specific energy					
MJ/kg	30.84	28.72	30.06	30.73	27.92
kcal/kg	7 360	6 860	7 180	7 340	6 670
btu/lb	13 260	12 340	12 920	13 210	12 000
Ultimate analysis (% daf)					
carbon	83.0	83.3	83.5	82.8	83.3
hydrogen	5.30	5.10	4.80	5.40	5.40
nitrogen	1.80	1.80	1.80	2.00	1.90
sulphur	0.60	0.60	0.60	0.80	0.80
oxygen	9.3	9.2	9.30	9.0	8.6
Chlorine (%)		0.01			0.02
Phosphorus (%)	0.005	0.005	0.005	0.005	0.005
Coking properties					
crucible swelling number	4	1	2	5	1.5
Gray-King coke type	F		D	F	
max. fluidity (ddpm)	100		35	1000	
Ash fusion temperature (reducing atmosphere degrees C)					
deformation		1250			1500
hemisphere		1310			>1600
flow		1380			>1600
Ash analysis (%)					
SiO_2	61.0	60.0	58.0	60.0	62.0
Al_2O_3	23.0	21.0	21.0	33.0	30.0
Fe_2O_3	6.00	6.50	6.50	2.50	3.40
CaO	3.00	5.50	6.00	0.30	0.30
MgO	1.40	2.00	2.00	0.30	0.50
TiO_2	1.20	1.20	1.20	1.90	1.80
Na_2O	0.30	0.50	0.50	0.20	0.20
K_2O	0.20	1.00	1.00	1.30	1.40
Mn_3O_4	0.10	0.10	0.10	0.10	0.10
P_2O_5	0.10	0.10	0.10	0.10	0.10
SO_3	3.40	2.10	3.00	0.10	0.10
Petrography (%)					
vitrinite	55			66	
inertinites	40			27	
others	5			7	
mineral					
RO max (%)	0.71			0.75	

Source: Joint Coal Board (1989)

Company	**Novacoal Australia Pty Ltd**
Mine	Vickery
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Maules Creek Formation
Seam(s) mined	Gundawarra

Proximate analysis (% ad)	
moisture	3.5
ash	10.0
volatile matter	31.0
Specific energy	
MJ/kg	29.4
kcal/kg	7020
Ultimate analysis (% daf)	
sulphur (% ad)	0.40
Phosphorus (% ad)	0.005
Coking properties	
crucible swelling number	1
Hardgrove grindability	45–50
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1250
flow	1500

Source: NSW Department of Minerals & Energy (1989)

HUNTER COALFIELD

Company	**Bayswater Colliery Co. Pty Ltd**
Mine	Bayswater No.2
Mine type	Open cut
Mining method	Loader, shovel, trucks
Geological sequence	Greta Coal Measures
Seam(s) mined	Brougham, Grasstrees, Thiess, Puxtrees, Balmoral

	Export Steaming	*PCI*
Total moisture (% ar)	9.5	9.0
Proximate analysis (% ad)		
moisture	2.5	3.0
ash	13.5	8.5

volatile matter	33.0	34.5
fixed carbon	51.0	54.0
Specific energy		
MJ/kg	28.54	30.56
kcal/kg	6 820	7 300
btu/lb	12 270	13 140
Ultimate analysis (% daf)		
carbon	83.1	83.0
hydrogen	5.36	5.61
nitrogen	1.78	1.75
sulphur	1.10	1.01
oxygen	8.7	8.6
Chlorine (%)	0.03	0.03
Phosphorus (%)	0.068	0.050
Coking properties		
crucible swelling number	1	1.5
Hardgrove grindability	48	49
Ash fusion temperature (reducing atmosphere degrees C)		
deformation	1300	1300
hemisphere	1430	1390
flow	1470	1410
Ash analysis (%)		
SiO_2	49.5	50.8
Al_2O_3	29.5	29.0
Fe_2O_3	5.30	5.50
CaO	7.00	7.50
MgO	0.50	0.60
TiO_2	2.00	1.70
Na_2O	0.34	0.30
K_2O	0.25	0.30
Mn_3O_4	0.04	0.04
P_2O_5	1.90	1.10
SO_3	3.30	3.10

Source: Joint Coal Board (1989)

Company **Drayton Coal Pty Ltd**
Mine Drayton
Mine type Open cut
Mining method Dragline, truck, shovel, loader
Geological sequence Greta Coal Measures
Seam(s) mined Brougham, Grasstrees, Thiess, Puxtrees, Balmoral

Total moisture (% ar)	9.5
Proximate analysis (% ad)	
moisture	2.5
ash	14.0
volatile matter	34.0
fixed carbon	49.5
Specific energy	
MJ/kg	28.26
kcal/kg	6 750
btu/lb	12 150
Ultimate analysis (% daf)	
carbon	82.7
hydrogen	5.40
nitrogen	1.80
sulphur	1.14
oxygen	9.0
Chlorine (%)	0.03
Phosphorus (%)	0.058
Coking properties	
crucible swelling number	1.5
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1350
hemisphere	1450
flow	1500
Ash analysis (%)	
SiO_2	54.5
Al_2O_3	27.5
Fe_2O_3	7.50
CaO	4.50
MgO	0.60
TiO_2	1.9
Na_2O	0.15
K_2O	0.35
Mn_3O_4	0.06
P_2O_5	1.20
SO_3	1.80

Source: Joint Coal Board (1989)

Company **Novacoal Australia Pty Ltd**
Mine Howick
Mine type Open cut
Mining method Dragline, truck, shovel, loader
Geological sequence Wittingham Coal Measures
Seam(s) mined Arties, Liddell, Barrett

	Newdell Coking	*Northern Thermal*
Total moisture (% ar)	8.0	9.0
Proximate analysis (% ad)		
moisture	2.3	3.5
ash	8.5	14.0
volatile matter	37.5	34.2
fixed carbon	51.7	48.3
Specific energy		
gross kcal/kg (ad)	7395	6370
gross kcal/kg (ar)	6960	6350
net kcal/kg (ar)	6675	6070
Chlorine (%)	0.03	0.04
Phosphorus (%)	0.015	0.020
Coking properties		
crucible swelling number	5–6	3
Gray–King coke type	G3	
max. fluidity (ddpm)	220	
Hardgrove grindability		48
Ash fusion temperature (reducing atmosphere degrees C)		
deformation		1400
flow		>1560
RO max (%)	0.7	

Source: BP Coal Australia

Company **Coal & Allied Industries Ltd**
Mine Hunter Valley No.1
Mine type Open cut
Mining method Loader, shovel, truck
Geological sequence Wittingham Coal Measures
Seam(s) mined Vaux, Piercefield, Mount Arthur

	Coking	*Semi-Soft Coking*	*Steam*
Total moisture (% ar)	9.0	9.0	9.0
Proximate analysis (% ad)			
moisture	3.0	3.5	2.5
ash	7.0	9.5	13.5
volatile matter	35.0	32.0	34.0
fixed carbon	55.0	55.0	50.0
Specific energy			
gross MJ/kg	30.98	29.31	28.47
gross kcal/kg	7 400	7 000	6 800
gross btu/lb	13 320	12 600	12 240

Ultimate analysis (% daf)			
carbon	84.0	83.1	82.2
hydrogen	5.30	5.20	5.10
nitrogen	1.70	1.70	1.80
sulphur	0.50	0.40	0.60
oxygen	8.5	9.6	10.3
Chlorine (%)			0.05
Phosphorus (%)	0.010	0.014	0.020
Coking properties			
crucible swelling number	5	3	2
Gray–King coke type	G	E	
max. fluidity (ddpm)	100	24	
Hardgrove grindability		55	50
Ash fusion temperature (reducing atmosphere degrees C)			
deformation		1500	1500
hemisphere		>1560	>1560
flow	>1560	>1560	>1560
Ash analysis (%)			
SiO_2	68.5	66.8	68.6
Al_2O_3	24.0	26.0	24.0
Fe_2O_3	2.80	2.70	2.70
CaO	0.70	0.70	0.70
MgO	0.60	0.60	0.60
TiO_2	1.10	1.10	1.10
Na_2O	0.50	0.50	0.50
K_2O	1.10	1.10	1.10
Mn_3O_4	0.10	0.10	0.10
P_2O_5	0.30	0.30	0.30
SO_3	0.30	0.30	0.30
Petrography (% dmmf)			
vitrinite	72	60	
inertinites	26	35	
others	2	5	
RO max (%)	0.71	0.77	

Source: Joint Coal Board (1989)

Company	**Lemington Coal Mines Ltd**		
Mines	Lemington		Lemington No. 1
Mine type	Open cut		Underground
Mining method	Shovel, truck, loaders		Bord and pillar
Geological sequence	Wittingham Coal Measures		
Seam(s) mined	Mount Arthur		
	Coking	*Steaming*	*Steaming*
Total moisture (% ar)	8.5	9.0	9.0
Proximate analysis (% ad)			
moisture	2.5	3.0	3.0
ash	8.0	11.9	14.0
volatile matter	35.3	33.0	32.0
fixed carbon	54.2	52.1	51.0
Specific energy (ad)			
gross MJ/kg	30.35	29.53	28.47
gross kcal/kg	7 250	7 050	6 800
gross btu/lb	13 050	12 690	12 240
Ultimate analysis (% daf)			
carbon	83.2	83.1	83.1
hydrogen	5.41	5.55	5.55
nitrogen	1.73	1.80	1.80
sulphur	0.39	0.63	0.48
oxygen	9.3	8.9	9.1
Chlorine (%)	0.05	0.06	0.06
Phosphorus (%)	0.015	0.015	0.015
Coking properties			
crucible swelling number	5.5	3	3
Gray–King coke type	G1		
max. fluidity (ddpm)	400		
Hardgrove grindability		50	50

Ash fusion temperature (reducing atmosphere degrees C)			
deformation		1440	1440
hemisphere		1530	1530
flow		1550	1550
Ash analysis (%)			
SiO_2	67.6	74.3	74.3
Al_2O_3	22.5	17.0	17.0
Fe_2O_3	4.25	3.56	3.56
CaO	0.77	0.94	0.94
MgO	0.56	0.63	0.63
TiO_2	1.18	0.75	0.75
Na_2O	0.39	0.30	0.30
K_2O	0.67	0.69	0.69
Mn_3O_4	0.03	0.04	0.04
P_2O_5	0.44	0.25	0.25
SO_3	0.69	0.17	0.17
Petrography (%)			
vitrinite	66		
inertinites	30		
others	4		
mineral			
RO max (%)	0.73		

Source: Joint Coal Board (1989)

Company	**Liddell Joint Venture**	
Mine	Liddell	
Mine type	Underground	
Mining method	Bord & pillar	
Geological sequence	Wittingham Coal Measures	
Seam(s) mined	Liddell	
	Coking	*Steaming*
Total moisture (% ar)	9.0	9.0
Proximate analysis (% ad)		
moisture	2.5	2.5
ash	8.0	15.0
volatile matter	36.0	34.0
fixed carbon	53.5	48.5
Specific energy (ad)		
gross MJ/kg	30.35	28.05
gross kcal/kg	7 250	6 700
gross btu/lb	13 050	12 060
Ultimate analysis (% daf)		
carbon	82.5	82.5
hydrogen	5.90	5.90
nitrogen	2.10	2.10
sulphur	0.50	0.72
oxygen	9.0	8.8
Chlorine (%)		0.02
Phosphorus (%)	0.068	0.060
Coking properties		
crucible swelling number	6	2
Gray–King coke type	G5	
max. fluidity (ddpm)	1000	
Hardgrove grindability		50
Ash fusion temperature (reducing atmosphere degrees C)		
deformation		1350
hemisphere		>1560
flow		>1560
Ash analysis (%)		
SiO_2	49.0	49.0
Al_2O_3	29.0	29.0
Fe_2O_3	5.50	5.50
CaO	6.50	6.50
MgO	1.40	1.40
TiO_2	1.10	1.10
Na_2O	1.00	1.00

K_2O	0.80	0.80
Mn_3O_4	0.10	0.10
P_2O_5	1.80	1.80
SO_3	3.80	3.80
Petrography (%)		
vitrinite	78	
inertinites	18	
others	4	
RO max (%)	0.74	

Source: Joint Coal Board (1989)

Company	**Electricity Commission of NSW**
Mine	Liddell State
Mine type	Underground
Mining method	Longwall
Geological sequence	Wittingham Coal Measures
Seam(s) mined	Liddell, Barrett

Proximate analysis (% ad)	
moisture	3.9
ash	13.4
volatile matter	36.8
Specific energy	
gross MJ/kg	29.6
gross kcal/kg	7100
Ultimate analysis (% daf)	
Sulphur	0.57
Coking properties	
crucible swelling number	6.5
Hardgrove grindability	50
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	>1550
flow	>1550

Source: Department of Minerals & Energy (1989)

Company	**Coal & Allied Industries Ltd**
Mine	Mount Thorley
Mine type	Open cut
Mining method	Dragline, truck, shovel, loaders
Geological sequence	Wittingham Coal Measures
Seam(s) mined	Wambo, Whynot, Blakefield, Glen Munro, Woodlands Hill

	Coking	*Semi-Soft Coking*	*Steaming*
Total moisture (% ar)	9.0	9.0	9.0
Proximate analysis (% ad)			
moisture	2.5	2.5	2.5
ash	8.5	9.5	15.5
volatile matter	34.0	33.5	31.5
fixed carbon	55.0	54.5	50.5
Specific energy (ad)			
gross MJ/kg	30.44	29.94	27.84
gross kcal/kg	7 270	7 150	6 650
gross btu/lb	13 090	12 870	11 970
Ultimate analysis (% daf)			
carbon	82.3	82.2	81.6
hydrogen	5.54	5.42	5.26
nitrogen	1.80	1.78	1.65
sulphur	0.51	0.52	0.49
oxygen	9.9	10.1	10.9
Chlorine (%)			0.03
Phosphorus (%)	0.006	0.010	0.010
Coking properties			
crucible swelling number	5	3	2
Gray-King coke type	G1	F	
max. fluidity (ddpm)	100	43	
Hardgrove grindability		52	50
Ash fusion temperature (reducing atmosphere degrees C)			
deformation		1450	1450
hemisphere		>1560	>1560
flow	>1500	>1560	>1560
Ash analysis (%)			
SiO_2	69.9	70.2	71.6
Al_2O_3	23.9	23.5	21.4
Fe_2O_3	2.76	3.00	4.45
CaO	0.29	0.29	0.12
MgO	0.38	0.38	0.40
TiO_2	1.15	1.10	0.88
Na_2O	0.50	0.60	0.26
K_2O	0.59	0.59	0.62
Mn_3O_4	0.01	0.01	0.02
P_2O_5	0.22	0.21	0.15
SO_3	0.00	0.10	0.10
Petrography (% dmmf)			
vitrinite	77		
inertinites	21		
others	2		
RO max (%)	0.78		

Source: Joint Coal Board (1989)

Company	**Muswellbrook Coal Co. Ltd**	
Mines	Muswellbrook No. 2	Muswellbrook No. 2
Mine type	Open cut	Underground
Mining method	Truck, shovel, loader	Bord and pillar
Geological sequence	Greta Coal Measures	
Seam(s) mined	Fleming, Hallet, Lewis Muswellbrook, St Heliers	Lewis

	Steaming A	*Steaming B*	*Steaming C*	*Steaming D*
Total moisture (% ar)	9.0	9.0	9.0	9.0
Proximate analysis (% ad)				
moisture	2.5	2.5	2.5	2.5
ash	10.6	11.5	12.5	16.0
volatile matter	34.5	34.5	34.0	32.0
fixed carbon	52.4	51.5	51.0	49.5
Specific energy (ad)				
gross MJ/kg	29.64	29.10	28.68	27.21
gross kcal/kg	7 080	6 950	6 850	6 500
gross btu/lb	12 740	12 510	12 330	11 700
Ultimate analysis (% daf)				
carbon	80.5	81.7	81.3	81.0
hydrogen	5.03	5.08	5.08	5.08
nitrogen	1.90	1.60	1.60	1.60
sulphur	1.14	1.19	1.21	1.23
oxygen	11.4	10.4	10.8	11.1
Chlorine (%)	0.02	0.02	0.02	0.02
Phosphorus (%)	0.023	0.023	0.023	0.023
Coking properties				
crucible swelling number	1	1	1	1
Hardgrove grindability	45	45	45	45
Ash fusion temperature (reducing atmosphere degrees C)				
deformation	1300	1300	1300	1300
flow	>1550	>1550	>1550	>1550
Ash analysis (%)				
SiO_2	52.0	52.0	52.0	52.0
Al_2O_3	33.2	33.2	33.2	33.2
Fe_2O_3	8.90	8.90	8.90	8.90
CaO	0.64	0.64	0.64	0.64
MgO	0.35	0.35	0.35	0.35
TiO_2	2.33	2.33	2.33	2.33
Na_2O	0.30	0.30	0.30	0.30
K_2O	0.88	0.88	0.88	0.88
Mn_3O_4	0.03	0.03	0.03	0.03
P_2O_5	0.88	0.88	0.88	0.88
SO_3	0.15	0.15	0.15	0.15

Source: Joint Coal Board (1989)

Company	**Costain Australia Ltd**	
Mine	Ravensworth	
Mine type	Open cut	
Mining method	Dragline, shovel, truck	
Geological sequence	Wittingham Coal Measures	
Seam(s) mined	Ravensworth, Bayswater	
Total moisture (% ar)	10.0 (max)	10.0 (max)
Proximate analysis (% ad)		
ash	28 (max)	35 (max)
volatile matter	23–34	20–34
Specific energy		
MJ/kg	20.8	18.5
Ultimate analysis (% daf)		
sulphur	1 max	1 max
Hardgrove grindability	44–54	44–54
Ash fusion temperature (reducing atmosphere degrees C)		
hemisphere	1250	1250

Source: NSW Department of Minerals & Energy (1989)

Company	**Saxonvale Coal Pty Ltd**
Mine	Saxonvale
Mine type	Open cut
Mining method	Shovel, truck, dozer, loaders
Geological sequence	Wittingham Coal Measures
Seam(s) mined	Whynot, Blakefield, Glen Munro, Woodlands Hill, Mount Arther, Piercefield, Vaux
	Steaming
Total moisture (% ar)	9.0
Proximate analysis (2.5% moisture)	
moisture	2.5
ash	16.0
volatile matter	29.0
fixed carbon	52.5
Specific energy (2.5% moisture)	
gross MJ/kg	28.05
gross kcal/kg	6 700
gross btu/lb	12 060
Ultimate analysis (% daf)	
carbon	84.2
hydrogen	5.20
nitrogen	1.76
sulphur	0.60
oxygen	8.2
Chlorine (2.5% moisture)	0.02
Phosphorus (2.5% moisture)	0.006
Coking properties	
crucible swelling number	2.5
Gray–King coke type	C
max. fluidity (ddpm)	14
Hardgrove grindability	53
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1240
hemisphere	>1550
flow	>1550
Ash analysis (%)	
SiO_2	72.5
Al_2O_3	20.0
Fe_2O_3	3.4
CaO	0.4
MgO	0.4
TiO_2	0.9
Na_2O	0.3
K_2O	2.0
Mn_3O_4	0.05
P_2O_5	0.08
SO_3	0.20
Petrography (%)	
vitrinite	47
semi-inertinite	15
inertinites	24
others	6
mineral	8
RO max (%)	0.81

Source: The Newcastle Wallsend Coal Company Pty Ltd

Company	**Hebden Mining Co.**
Mine	Swamp Creek
Mine type	Open cut
Mining method	Dragline, shovel, loader, truck
Geological sequence	Wittingham Coal Measures
Seam(s) mined	Ravensworth, Bayswater
Total moisture (%)	8.0
Proximate analysis	
ash	27.0
volatile matter	24.0
Specific energy	
MJ/kg	20.5
kcal/kg	4900
Ultimate analysis	
Sulphur	0.4
Phosphorus (%)	0.049
Hardgrove grindability	53
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1300

Source: NSW Department of Minerals & Energy (1989)

Company	**United Collieries Pty Ltd**			
Mine	United			
Mine type	Open cut			
Mining method	Scraper, trucks, loader			
Geological sequence	Wittingham Coal Measures			
Seam(s) mined	Wambo			
	Coking A	*Coking B*	*Thermal A*	*Thermal B*
Total moisture (% ar)	8.0	8.0	9.0	9.0
Proximate analysis (% ad)				
moisture	2.3	4.1	2.1	5.0
ash	7.5	7.5	8.0	13.2
volatile matter	32.0	37.0	35.0	30.4
fixed carbon	58.2	51.4	54.9	51.4
Specific energy (ad)				
gross MJ/kg (ad)	30.48	30.38	31.85	28.28
gross kcal/kg (ar)	7 280	7 260	7 610	6 760
gross btu/lb (ar)	13 100	13 060	13 690	12 160
Ultimate analysis (% daf)				
carbon	83.5	82.5	83.5	81.2
hydrogen	5.59	5.59	5.59	5.16
nitrogen	1.76	1.76	1.76	1.92
sulphur	0.34	0.34	0.34	0.50
oxygen	8.8	9.8	8.8	11.2
Chlorine (% ad)			0.01	0.01
Phosphorus (% ad)	0.002	0.013	0.002	0.015
Coking properties				
crucible swelling number	6	3	2	3
Gray-King coke type	G4	D		
max. fluidity (ddpm)	560	60		
Hardgrove grindability			47	47

Ash fusion temperature (reducing atmosphere degrees C)				
deformation			1110	1110
flow			>1600	>1560
Ash analysis (%)				
SiO_2	62.6	62.6	62.6	62.6
Al_2O_3	27.3	27.3	27.3	27.3
Fe_2O_3	2.93	2.93	2.93	2.93
CaO	1.51	1.51	1.51	1.51
MgO	1.26	1.26	1.26	1.26
TiO_2	1.25	1.25	1.25	1.25
Na_2O	0.74	0.74	0.74	0.74
K_2O	1.22	1.22	1.22	1.22
Mn_3O_4	0.02	0.02	0.02	0.02
P_2O_5	0.11	0.11	0.11	0.11
SO_3	1.08	1.08	1.08	1.08
Petrography (% dmmf)				
vitrinite	70	50		
RO max (%)	0.77	0.65		

Source: Joint Coal Board (1989)

Company	**Wambo Mining Corporation Pty Ltd**		
Mines	Wambo		Wambo
Mine type	Open cut		Underground
Mining method	Loaders, trucks		Bord & pillar
Geological sequence	Wittingham Coal Measures		
Seam(s) mined	Wambo		Whybrow

	1	*2*	*3*
Total moisture (% ar)	9.0	9.0	9.0
Proximate analysis (% ad)			
moisture	2.5	2.5	2.5
ash	7.5	12.0	9.5
volatile matter	36.6	33.0	34.0
fixed carbon	53.4	52.5	53.0
Specific energy (ad)			
gross kcal/kg	7300	6900	7150
Ultimate analysis (% daf)			
carbon	82.0	82.5	82.5
hydrogen	5.5	5.5	5.5
nitrogen	1.9	2.0	2.0
oxygen	10.0	10.0	10.0
Phosphorus (%)	0.007		
Coking properties			
crucible swelling number	5	3	4
max. fluidity (ddpm)	10		10
Hardgrove grindability	50	50	50
Ash fusion temperature (reducing atmosphere degrees C)			
deformation	1350	1300	1300
hemisphere	>1500	1400	1400
Ash analysis (%)			
SiO_2	62.9	71.9	68.4
Al_2O_3	25.4	15.2	17.0
Fe_2O_3	4.15	3.88	4.25
CaO	1.40	2.57	2.92
MgO	1.05	1.43	1.51
TiO_2	1.21	0.63	0.72
Na_2O	0.97	0.85	0.88
K_2O	1.52	0.64	0.65
Mn_3O_4	0.023	0.024	0.026
P_2O_5	0.095	0.536	0.680
SO_3	1.07	1.85	2.06
Petrography (%)			
vitrinite	75	67	73
inertinites	17	24	19
others	5	6	4
mineral	3	3	4
RO max (%)	0.72	0.72	0.73

Source: Wambo Mining Corporation Pty Ltd

Company	**Warkworth Mining Ltd**
Mine	Warkworth
Mine type	Open cut
Mining method	Dragline, shovels, loader, truck
Geological sequence	Wittingham Coal Measures
Seam(s) mined	Woodlands Hill, Arrowfield, Bowfield Warkworth, Mount Arthur, Peircefield Vaux, Broonie

	Soft Coking	*Semi-Soft Coking*	*Steam*
Total moisture (% ar)	8.0	8.0	8.0
Proximate analysis (% ad)			
moisture	2.5	2.5	2.5
ash	7.5	9.5	15.0
volatile matter	36.0	34.5	29.0
fixed carbon	54.0	53.5	53.5
Specific energy (ad)			
gross MJ/kg	31.61	30.14	28.47
gross kcal/kg	7 550	7 200	6 800
gross btu/lb	13 590	12 960	12 240
Ultimate analysis (% daf)			
carbon	84.0	84.8	82.8
hydrogen	5.63	5.67	5.32
nitrogen	1.84	1.77	1.77
sulphur	0.54	0.55	0.70
oxygen	8.0	7.2	9.4
Chlorine (% ad)			0.03
Phosphorus (% ad)	0.005	0.049	0.008
Coking properties			
crucible swelling number	6	4.5	4
Gray-King coke type	G3	G1	
max. fluidity (ddpm)	800	200	
Hardgrove grindability			52
Ash fusion temperature (reducing atmosphere degrees C)			
deformation			1400
hemisphere			>1550
flow			>1550
Ash analysis (%)			
SiO_2	63.5	69.8	75.0
Al_2O_3	29.5	24.2	18.5
Fe_2O_3	1.94	2.20	2.50
CaO	0.64	0.40	0.16
MgO	0.44	0.40	0.35
TiO_2	1.28	1.30	1.32
Na_2O	0.30	0.24	0.18
K_2O	0.77	0.60	0.44
Mn_3O_4	0.01	0.01	0.00
P_2O_5	0.15	0.10	0.06
SO_3	1.17	0.60	0.01
Petrography (% mmf)			
vitrinite	81	60	
inertinites	13	32	
others	6	7	
RO max (%)	0.75	0.75	

Source: Joint Coal Board (1989)

NEWCASTLE COALFIELD

Company	**Bloomfield Collieries Pty Ltd**	
Mines	Bloomfield	Bloomfield
Mine type	Open cut	Underground
Mining method	Dragline, shovel, dozer, loader, truck	Bord & pillar
Geological sequence	Tomago Coal Measures	Tomago Coal Measures
Seam(s) mined	'A','B','C',Whites Creek Elwells Creek, Donaldsons, Big Ben	Rathluba

	Rathluba Coking	*Donaldson Coking*	*Steam 6700*	*Steam 6400*	*Steam 6300*
Total moisture (% ar)	7.0	8.0	8.0	8.0	8.0
Proximate analysis (% ad)					
moisture	2.5	2.5	2.5	2.3	2.5
ash	8.0	9.5	15.0	18.5	19.0
volatile matter	36.0	37.0	33.0	32.0	31.0
fixed carbon	53.5	51.0	49.5	47.2	47.5
Specific energy (ad)					
gross MJ/kg	31.15	30.17	28.05	26.80	26.38
gross kcal/kg	7 440	7 210	6 700	6 400	6 300
gross btu/lb	13 390	12 970	12 060	11 520	11 340
Ultimate analysis (% daf)					
carbon	82.7	83.0	83.2	82.0	81.8
hydrogen	5.64	5.60	5.51	5.57	5.53
nitrogen	2.00	2.00	2.12	1.95	1.95
sulphur	0.80	1.40	1.52	1.90	1.60
oxygen	8.9	8.0	7.7	8.6	9.2
Chlorine (% ad)			0.04	0.04	0.07
Phosphorus (% ad)	0.007	0.007	0.012	0.009	0.009
Coking properties					
crucible swelling number	5.5	5	1.5	1	1
Gray–King coke type	G2	G2			
max. fluidity (ddpm)	400	800			
Hardgrove grindability			48	48	48
Ash fusion temperature (reducing atmosphere degrees C)					
deformation			1450	1450	1530
hemisphere			+1560	+1560	+1560
flow			+1560	+1560	+1560
Ash analysis (%)					
SiO_2	56.9	61.6	69.0	66.3	67.4
Al_2O_3	28.3	28.6	22.0	24.1	24.5
Fe_2O_3	3.81	3.98	0.33	5.31	3.38
CaO	2.90	1.60	0.67	0.27	0.27
MgO	0.33	0.51	0.54	0.49	0.46
TiO_2	1.50	1.03	1.19	1.07	1.23
Na_2O	1.15	0.67	0.19	0.20	0.21
K_2O	0.96	0.92	1.01	1.16	1.17
Mn_3O_4	0.01	0.01	0.01	0.01	0.02
P_2O_5	0.84	0.36	0.20	0.10	0.11
SO_3	1.35	0.42	0.45	0.18	0.13
Petrography (% mmf)					
vitrinite	81	81			
inertinites	14	14			
others	5	5			
RO max (%)	0.81	0.78			

Source: Joint Coal Board (1989)

Company	**Coal & Allied Industries Ltd**		
Mines	Chain Valley	Moonee	Wallarah
Mine type	Underground		
Mining method	Bord & pillar		
Geological sequence	Newcastle Coal Measures		
Seam(s) mined	Wallarah Great Northern	Wallarah	Wallarah Great Northern

	Wallarah Steaming	*Chain Valley Steaming*	*C&A Blend Steaming*
Total moisture (% ar)	9.0	9.0	9.0
Proximate analysis (% ad)			
moisture	3.5	2.5	2.5
ash	13.5	17.0	20.0
volatile matter	30.0	30.0	30.0
fixed carbon	53.0	50.5	47.5
Specific energy (ad)			
gross MJ/kg	28.26	27.00	26.38
gross kcal/kg	6 750	6 450	6 300
gross btu/lb	12 150	11 610	11 340
Ultimate analysis (% daf)			
carbon	83.4	83.0	81.6
hydrogen	5.10	5.50	5.30
nitrogen	1.60	1.60	1.70
sulphur	0.34	0.42	1.29
oxygen	9.6	9.5	10.1
Chlorine (% ad)	0.04	0.04	0.03
Phosphorus (% ad)	0.010	0.010	0.068
Coking properties			
crucible swelling number	2	2	2
Hardgrove grindability	50	50	50
Ash fusion temperature (reducing atmosphere degrees C)			
deformation	1450	1450	1450
hemisphere	1560	1560	1560
flow	>1560	>1560	>1560
Ash analysis (%)			
SiO_2	61.0	61.0	72.4
Al_2O_3	27.0	27.0	18.9
Fe_2O_3	6.00	6.00	3.95
CaO	1.50	1.50	0.72
MgO	1.00	1.00	0.51
TiO_2	1.30	1.30	0.79
Na_2O	0.50	0.50	0.40
K_2O	0.50	0.50	1.42
Mn_3O_4	0.10	0.10	0.03
P_2O_5	0.10	0.10	0.46
SO_3	1.00	1.00	0.42

Source: Joint Coal Board (1989)

Company	**Electricity Commission of NSW**
Mines	Awaba, Cooranbong, Munmorah
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Newcastle Coal Measures
Seam(s) mined	Great Northern

	Awaba	*Cooranbong*	*Munmorah*
Total moisture (%)	7.0	7.5	4.5
Proximate analysis (% ad)			
moisture	2.8		2.8
ash	18.1	20.8	19.4
volatile matter	29.4	26.4	27.7
Specific energy			
MJ/kg	26.8	24.0	26.3
kcal/kg	6400	5730	6290
Ultimate analysis (% ad)			
sulphur	0.39	0.34	0.37
Phosphorus (% ad)	0.06		
Coking properties			
crucible swelling number	1		1
Hardgrove grindability	48		48
Ash fusion temperature (reducing atmosphere degrees C)			
deformation	1200		
hemisphere			1550
flow	>1600	>1660	

Source: NSW Department of Minerals & Energy (1989)

Company	**Electricity Commission of NSW**
Mines	Myuna, Newvale No.1, Newvale No.2
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Newcastle Coal Measures
Seam(s) mined	
Myuna mine	*Wallarah, Great Northern, Fassifern*
Newvale No. 1 mine	*Great Northern, Fassifern*
Newvale No. 2 mine	*Great Northern*

	Myuna	*Newvale No.1*	*Newvale No.2*
Total moisture (% ad)	7.0	7.5	7.0
Proximate analysis (% ad)			
moisture		2.3	3.1
ash	22.0	23.8	21.1
volatile matter	24.9	27.5	27.0
Specific energy (db)			
kcal/kg	5620	5920	6120
MJ/kg	23.5	24.8	25.6
Ultimate analysis (% ad)			
Sulphur	0.44	0.35	0.38
Coking properties			
crucible swelling number		1	1
Hardgrove grindability		49	49
Ash fusion temperature (reducing atmosphere degrees C)			
deformation	1270		1500
hemisphere		1350	
flow	1550		

Source: NSW Department of Minerals & Energy (1989)

Company	**Electricity Commission of NSW**	
Mines	Newstan	Wyee
Mine type	Underground	
Mining method	Longwall	
Geological sequence	Newcastle Coal Measures	
Seam(s) mined	Great Northern, Fassifern, Young Wallsend	Great Northern, Fassifern

	Newstan	*Wyee*
Total moisture (%)	8.5	7.5
Proximate analysis (% ad)		
moisture	2.8	2.0
ash	25.4	24.7
volatile matter	25.4	27.4
Specific energy		
MJ/kg	5800	5830
kcal/kg	24.3	24.4
Ultimate analysis (% ad)		
Sulphur	0.44	0.31
Phosphorus	0.04	
Coking properties		
crucible swelling number	1	1
Hardgrove grindability	50	49
Ash fusion temperature (reducing atmosphere degrees C)		
deformation	1240	
hemisphere		1520
flow	1580	

Source: NSW Department of Minerals & Energy (1989)

Company	**FAI Mining Ltd**		
Mines	Teralba,	West Wallsend,	Lambton
Mine type	Underground		
Mining method	Longwall	Longwall	Bord & pillar
Geological sequence	Newcastle Coal Measures		
Seam(s) mined	Young Wallsend, Borehole	Young Wallsend, Borehole	Dudley, Borehole

	Macquarie Coking	*Macquarie Energy*
Total moisture (% ar)	9.0	9.0
Proximate analysis (% ad)		
moisture	2.3	2.3
ash	7.5	16.5
volatile matter	35.0	30.5
fixed carbon	55.2	50.7
Specific energy (ad)		
gross MJ/kg	31.35	28.05
gross Kcal/kg	7 490	6 700
gross Btu/lb	13 480	12 060
Ultimate analysis (% daf)		
carbon	84.7	84.5
hydrogen	5.50	5.50
nitrogen	2.10	2.00
sulphur	0.55	0.40
oxygen	7.2	7.6
Chlorine (% ad)		0.03
Phosphorus (% ad)	0.049	0.059
Coking properties		
crucible swelling number	7	2
Gray-King coke type	G6	
max. fluidity (ddpm)	1500	
Hardgrove grindability		60
Ash fusion temperature (reducing atmosphere degrees C)		
deformation		1300
hemisphere		1450
flow		1500
Ash analysis (%)		
SiO_2	65.0	65.0
Al_2O_3	22.0	25.0
Fe_2O_3	4.20	2.50
CaO	2.50	3.00
MgO	1.00	0.80
TiO_2	1.00	1.00
Na_2O	0.70	0.70
K_2O	1.00	0.90
Mn_3O_4	0.05	0.02
P_2O_5	1.20	1.50
SO_3	0.20	0.15
RO max (%)	0.92	

Source: Joint Coal Board (1989)

Company	**FAI Mining Ltd**
Mine	Great Greta
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Greta Coal Measures
Seam(s) mined	Tangorin

	Steam coal
Total moisture (% ar)	7.0
Proximate analysis (% ad)	
moisture	2.5
ash	15.0
volatile matter	43.0
fixed carbon	41.0
Specific energy (ad)	
gross MJ/kg	28.47

gross kcal/kg	6 800
gross btu/lb	12 240
Ultimate analysis (% daf)	
carbon	81.4
hydrogen	6.34
nitrogen	1.18
sulphur	6.42
oxygen	4.7
Chlorine (% ad)	0.01
Phosphorus (% ad)	0.050
Coking properties	
crucible swelling number	4
Hardgrove grindability	41
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1250
hemisphere	1310
flow	1360
Ash analysis (%)	
SiO_2	26.1
Al_2O_3	23.6
Fe_2O_3	7.63
CaO	18.95
MgO	5.02
TiO_2	1.12
Na_2O	0.75
K_2O	0.16
Mn_3O_4	0.19
P_2O_5	0.58
SO_3	14.97

Source: Joint Coal Board (1989)

Company	**The Newcastle Wallsend Coal Co. Pty Ltd**	
Mines	Gretley	Pelton/Ellalong
Mine type	Underground	
Mining method	Longwall	
Geological sequence	Newcastle Coal Measures	Greta Coal Measures
Seam(s) mined	Dudley	Greta

	Daiyon Soft Coking	*Semi-Coking*	*Thermal*	*Ellalong Low Ash Coking*
Total moisture (%)	8.3	8.0	8.0	8.0
Proximate analysis (2.5% moisture)				
moisture	2.5	2.5	2.5	2.5
ash	7.4	9.7	16.0	5.7
volatile matter	37.5	36.0	32.6	40.2
fixed carbon	52.6	51.8	48.9	51.6
Specific energy				
gross MJ/kg	31.65	30.77	28.22	32.30
gross kcal/kg	7 560	7 350	6 740	7 715
gross btu/lb	13 610	13 230	12 130	13 890
Ultimate analysis (% daf)				
carbon	83.4	83.0	83.0	83.6
hydrogen	5.80	5.70	5.62	5.99
nitrogen	2.04	1.90	1.97	2.08
sulphur	0.68	0.63	0.59	0.71
oxygen	8.1	8.8	8.8	7.6
Chlorine (2.5% moisture)	0.02	0.02	0.02	0.01
Phosphorus (2.5% moisture)	0.039	0.047	0.059	0.024
Coking properties				
crucible swelling number	6	4.5	4	6
Gray-King coke type	G5	G3	G	G5
max. fluidity (ddpm)	2600	600	280	7500
Hardgrove grindability	39	45	48	30
Ash fusion temperature (reducing atmosphere degrees C)				
deformation	1350	1350	1260	1240
hemisphere	1480	1500	1530	1520
flow	1510	1530	1550	1530
Ash analysis (%)				
SiO_2	57.0	59.5	68.3	51.5
Al_2O_3	29.0	27.5	23.0	32.9
Fe_2O_3	4.3	4.1	2.9	5.2
CaO	3.0	2.5	1.4	2.5
MgO	0.9	0.7	0.7	1.0
TiO_2	1.4	1.3	1.0	1.8
Na_2O	1.2	1.0	0.7	1.6
K_2O	1.0	1.1	1.5	0.9
Mn_3O_4	0.04	0.03	0.03	0.04
P_2O_5	1.22	1.10	0.84	0.95
SO_3	1.29	1.10	0.53	1.68
Petrography (%)				
vitrinite	66	65	57	64
inertinite	21	22	26	23
others	10	9	9	11
mineral	3	4	8	2
RO max (%)	0.72	0.74	0.78	0.67

Source: The Newcastle Wallsend Coal Co. Pty Ltd

WESTERN COALFIELD

Company	**BCSC Collieries Pty Ltd**
Mines	Charbon, Ivanhoe
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Lithgow

	Semi-Soft Coking	*Lithgow Sm Steaming*	*ROM & Middling*	*Lithgow Sm Thermal*	*ROM*
Total moisture (% ar)	9.0	2.5	2.5	9.0	8.0
Proximate analysis (% ad)					
moisture	2.5	2.5	2.5	2.5	2.5
ash	9.5	14.0	19.0	14.0	19.0
volatile matter	32.0	31.0	28.5	31.0	28.5
Specific energy					
kcal/kg	7200	6800	6350	6800	6350
MJ/kg	30.1	28.5	26.6	28.5	26.6
Ultimate analysis (% ad)					
sulphur	0.6	0.6	0.6	0.6	0.6
Phosphorus (2.5% moisture)	0.006	0.006	0.01	0.006	0.007
Coking properties					
crucible swelling number	1–2	1	1	1	1
max. fluidity (ddpm)	10–20				
Hardgrove grindability	45–50	45–50	45–50	45–50	45–50
Ash fusion temperature (reducing atmosphere degrees C)					
deformation	1500	1500	1500	1500	1500
flow	>1560	>1560	>1560	>1560	>1560

Source: NSW Department of Minerals & Energy (1989)

Company	**Coalex Pty Ltd**	
Mines	Baal Bone,	Clarence
Mine type	Underground	
Mining method	Longwall	Bord & pillar
Geological sequence	Illawarra Coal Measures	
Seam(s) mined	Lithgow	Katoomba

	Baal Bone Thermal	*Clarence Thermal*
Total moisture (% ar)	9.0	9.0
Proximate analysis (% ad)		
moisture	2.5	2.2
ash	15.9	15.4
volatile matter	30.2	26.2
fixed carbon	51.4	56.2
Specific energy		
gross kcal/kg	6700	6700

Ultimate analysis (% daf)		
carbon	83.6	84.3
hydrogen	5.1	5.0
nitrogen	1.8	1.7
sulphur	0.6	0.4
oxygen	8.9	8.6
Chlorine (% ad)	0.01	0.01
Phosphorus (% ad)	0.03	0.03
Coking properties		
crucible swelling number	1	1
Hardgrove grindability	50	48
Ash fusion temperature (reducing atmosphere degrees C)		
deformation	1400	1400
hemisphere	>1550	>1550
flow	>1550	>1550
Ash analysis (%)		
SiO_2	69.5	68.0
Al_2O_3	24.5	28.0
Fe_2O_3	1.1	1.8
CaO	0.6	0.1
MgO	0.4	0.1
TiO_2	1.3	0.8
Na_2O	0.1	0.1
K_2O	2.2	0.4
Mn_3O_4	0.02	0.01
P_2O_5	0.2	0.6
SO_3	0.1	0.1

Source: Coalex Pty Ltd

Company	**Coalpac Pty Ltd**
Mine	Invincible
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Lithgow

Thermal coal produced from Invincible is to be sold to Austen & Butta for export.

Source: Joint Coal Board (1989)

Company	**Electricity Commission of NSW**
Mine	Angus Place
Mine type	Underground
Mining method	Longwall
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Lithgow

Proximate anaysis (% ad)	
moisture	2.4
ash	19–23
volatile matter	31.6
Specific energy (daf)	
kcal/kg	8120
MJ/kg	34
Ultimate analysis (% ad)	
sulphur	0.55
Phosphorus (% ad)	0.006
Coking properties	
crucible swelling number	1
Hardgrove grindability	40
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1380
flow	>1600

Source: NSW Department of Minerals & Energy (1989)

Company	**Hartley Valley Coal Co. Pty Ltd**
Mine	Blue Mountains
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Lithgow

Proximate analysis (% ad)	
moisture	2.5
ash	11–12
volatile matter	30
Specific energy	
kcal/kg	6900–7000
MJ/kg	28.9–29.3
Ultimate analysis (% ad)	
sulphur	0.7
Phosphorus (% ad)	0.008
Coking properties	
crucible swelling number	1.5–2
Gray-King coke type	F
Hardgrove grindability	45
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	>1600
flow	>1600

Source: NSW Department of Minerals & Energy (1989)

Company	**Kandos Collieries Pty Ltd**
Mine	Kandos No. 3
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Lithgow

Proximate analysis (% ad)		
moisture	3.2	2.0
ash	24.5	35.0
volatile matter	25.3	24.3
Specific energy		
kcal/kg	5460	4791
MJ/kg	24.54	20.1
Ultimate analysis (% ad)		
sulphur	0.4	0.39
Chlorine (%)	0.1	0.01
Hardgrove grindability	49.0	45.5

Source: NSW Department of Minerals & Energy (1989)

Company	**Novacoal Australia Pty Ltd**	
Mines	Western Main	Western Main
Mine type	Open cut	Underground
Mining method	Scraper,dozer,loader,truck	Bord & pillar
Geological sequence	Illawarra Coal Measures	Illawarra Coal Meas.
Seam(s) mined	Irondale, Lidsdale, Lithgow	Lithgow

	Western Thermal
Total moisture (% ar)	9.0
Proximate analysis (% ad)	
moisture	2.5
ash	14.0
volatile matter	29.0
fixed carbon	54.5
Specific energy (ad)	
gross MJ/kg	28.34
gross kcal/kg	6 770
gross btu/lb	12 190
Ultimate analysis (% daf)	
carbon	84.2

hydrogen	4.90
nitrogen	1.50
sulphur	0.70
oxygen	8.7
Chlorine (% ad)	0.01
Phosphorus (% ad)	0.010
Coking properties	
crucible swelling number	0.5
Hardgrove grindability	49
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1500
hemisphere	>1560
flow	>1560
Ash analysis (%)	
SiO_2	61.4
Al_2O_3	31.3
Fe_2O_3	1.60
CaO	0.40
MgO	0.30
TiO_2	1.40
Na_2O	0.10
K_2O	3.20
Mn_3O_4	0.02
P_2O_5	0.13
SO_3	0.10

Source: BP Coal Australia Ltd

Company	**Ulan Coal Mines Ltd**	
Mines	Ulan	Ulan No. 2
Mine type	Open cut	Underground
Mining method	Scraper, loader, trucks	Longwall
Geological sequence	Illawarra Coal Measures	
Seam(s) mined	Ulan	

	Ulan A Steam	*Ulan B Steam*
Total moisture (% ar)	9.5	9.5
Proximate analysis (% ad)		
moisture	2.5	2.5
ash	12.4	17.5
volatile matter	31.6	30.0
fixed carbon	53.5	50.0
Specific energy (ad)		
gross MJ/kg	29.10	27.42
gross kcal/kg	6 950	6 550
gross btu/lb	12 510	11 790
Ultimate analysis (% daf)		
carbon	84.1	84.1
hydrogen	5.20	5.20
nitrogen	1.80	1.80
sulphur	0.95	0.87
oxygen	8.0	8.0
Chlorine (% ad)	0.02	0.02
Phosphorus (% ad)	0.029	0.029
Coking properties		
crucible swelling number	1.5	1
Hardgrove grindability	50	50
Ash fusion temperature (reducing atmosphere degrees C)		
deformation	1400	1400
hemisphere	>1500	>1500
flow	>1600	>1560
Ash analysis (%)		
SiO_2	74.0	80.0
Al_2O_3	17.8	14.0
Fe_2O_3	4.40	3.00
CaO	0.80	0.70
MgO	0.20	0.20
TiO_2	0.80	0.60
Na_2O	0.01	0.10
K_2O	0.40	0.30
Mn_3O_4	0.20	0.10
P_2O_5	0.01	0.01
SO_3	1.30	1.00

Source: Joint Coal Board (1989)

SOUTHERN COALFIELD

Company	**Austen & Butta Pty Ltd**
Mine	South Bulli
Mine type	Underground
Mining method	Longwall
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Bulli

	South Bulli Coking Coal	*Low Ash Thermal*	*Thermal*
Total moisture (% ar)	9.0	5.0	6.0
Proximate analysis (% ad)			
moisture	1.0	1.0	1.0
ash	9.5	13.0	15.0
volatile matter	22.0	21.0	20.0
fixed carbon	67.5	65.0	64.0
Specific energy (ad)			
gross MJ/kg	32.49	30.98	30.14
gross kcal/kg	7 760	7 400	7 200
gross btu/lb	13 970	13 320	12 960
Ultimate analysis (% daf)			
carbon	88.7	88.7	88.7
hydrogen	4.61	4.61	4.61
nitrogen	1.53	1.53	1.53
sulphur	0.44	0.47	0.48
oxygen	4.7	4.7	4.7
Chlorine (% ad)		0.05	0.05
Phosphorus (% ad)	0.037	0.037	0.050
Coking properties			
crucible swelling number	6	1.5	1
Gray-King coke type	G1		
max. fluidity (ddpm)	1500		
Hardgrove grindability		65	62
Ash fusion temperature (reducing atmosphere degrees C)			
deformation		1560	1560
hemisphere		>1600	>1600
flow		>1600	>1600
Ash analysis (%)			
SiO_2	54.2	54.2	54.2
Al_2O_3	36.2	36.2	36.2
Fe_2O_3	4.22	4.22	4.22
CaO	0.69	0.69	0.69
MgO	0.38	0.38	0.38
TiO_2	1.25	1.25	1.25
Na_2O	0.38	0.38	0.38
K_2O	1.49	1.49	1.49
Mn_3O_4	0.04	0.04	0.04
P_2O_5	1.00	1.00	1.00
SO_3	0.10	0.10	0.10
Petrography (% mmf)			
vitrinite	48		
semi-inertinites	36		
inertinite	16		
RO max (%)	1.27		

Source: Joint Coal Board (1989)

Company	**Avon Colliery Pty Ltd**
Mine	Avon
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Wongawilli

Total moisture (% ar)	8.0
Proximate analysis (% ar)	
ash	22–24
volatile matter	23–24
Specific energy	
MJ/kg	25.6
kcal/kg	6100
Ultimate analysis	
Sulphur (% ar)	0.6
Phosphorus (% ar)	0.003
Hardgrove grindability	65
Ash fusion temperature (reducing atmosphere degrees C)	
deformation	1440
flow	>1550

Source: NSW Department of Minerals & Energy (1989)

Company	**BCSC Collieries Pty Ltd**
Mine	Berrima
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Wonganwilli

	ROM	*Thermal*
Total moisture (% ar)	5.5	9.0
Proximate analysis (% ad)		
moisture	1.5	1.5
ash	30.0	16.5
volatile matter	27.0	30.0
Specific energy		
MJ/kg	23.2	28.5
kcal/kg	5550	6800
Ultimate analysis		
Sulphur (% ad)	0.5	0.55
Phosphorus (% ad)	0.002	0.001
Coking properties		
crucible swelling number	4	5–7
Gray-King coke type		G4
max. fluidity (ddpm)		1000
Hardgrove grindability	55	55–66
Ash fusion temperature (reducing atmosphere degrees C)		
deformation	1500	1500
flow	>1560	>1560

Source: NSW Department of Minerals & Energy (1989)

Company	**Clutha Ltd**
Mine	Brimstone No.1, Oakdale, Nattai
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Bulli

	Wollondilly Coking	*Brimstone Coking*	*Burragorang Valley Coking Blend*	*Clutha Thermal*
Total moisture (% ar)	8.0	8.0	9.0	8.0
Proximate analysis (% ad)				
moisture	1.5	1.5	1.5	1.5
ash	7.9	8.2	9.8	16.0
volatile matter	27.0	27.5	27.0	26.0
fixed carbon	63.6	62.8	61.7	56.5
Specific energy (ad)				
gross MJ/kg	31.48	31.74	32.45	28.69
gross kcal/kg	7 520	7 580	7 750	6 850
gross btu/lb	13 540	13 640	13 950	12 330
Ultimate analysis (% daf)				
carbon	86.1	86.3	86.4	85.8
hydrogen	5.17	4.82	4.85	4.92
nitrogen	1.90	1.54	1.75	1.50
sulphur	0.38	0.42	0.43	0.48
oxygen	6.5	6.9	6.6	7.3
Chlorine (% ad)	0.01	0.01	0.01	0.03
Phosphorus (% ad)	0.059	0.039	0.059	0.059
Coking properties				
crucible swelling number	5	5.5	4	2
Gray-King coke type	G1	G2	G	
max. fluidity (ddpm)	1000	1200	200	
Hardgrove grindability				55
Ash fusion temperature (reducing atmosphere degrees C)				
deformation				1420
hemisphere				>1600
flow				>1600
Ash analysis (%)				
SiO_2	55.2	57.8	55.8	49.5
Al_2O_3	34.2	33.2	32.3	37.1
Fe_2O_3	4.72	2.34	4.27	4.10
CaO	0.61	1.34	1.61	1.75
MgO	0.61	0.29	0.60	0.79
TiO_2	0.67	1.47	0.31	0.82
Na_2O	0.10	0.17	0.10	0.53
K_2O	0.42	0.87	0.73	0.95
Mn_3O_4	0.06	0.03	0.05	0.12
P_2O_5	0.23	1.58	4.23	1.37
SO_3	0.27	0.35	0.52	1.00
Petrography (% mmf)				
vitrinite	40	40	40	
semi-inertinite	35	40	32	
inertinite	22	18	25	
others	3	2	3	
RO max (%)	0.98	0.93	0.96	

Source: Joint Coal Board (1989)

Company	**Kembla Coal & Coke Pty Ltd**	
Mines	Coal Cliff	West Cliff
Mine type	Underground	
Mining method	Bord & pillar	Longwall
Geological sequence	Illawarra Coal Measures	
Seam(s) mined	Bulli	

	Coal Cliff	*West Cliff*
Total moisture (% ar)	8.0	8.0
Proximate analysis (% ad)		
moisture	1.0	1.0
ash	9.8	9.8
volatile matter	20.5	22.0
fixed carbon	68.7	67.2
Specific energy (ad)		
gross MJ/kg	32.07	32.03
gross kcal/kg	7 660	7 650
gross btu/lb	13 790	13 770
Ultimate analysis (% daf)		
carbon	89.0	88.6
hydrogen	4.70	4.80
nitrogen	1.60	1.60
sulphur	0.40	0.40
oxygen	4.3	4.6
Chlorine (% ad)	0.01	0.01
Phosphorus (% ad)	0.050	0.069
Coking properties		
crucible swelling number	7	7
Gray-King coke type	G2	G3
max. fluidity (ddpm)	1000	2000

Ash analysis (%)		
SiO_2	53.8	52.2
Al_2O_3	34.5	35.9
Fe_2O_3	4.65	3.39
CaO	0.89	0.09
MgO	1.24	0.71
TiO_2	1.69	0.85
Na_2O	0.43	0.59
K_2O	0.55	1.07
Mn_3O_4	0.06	0.01
P_2O_5	0.83	1.72
SO_3	0.87	0.58
Petrography (% mmf)		
vitrinite	46	51
semi-inertinite	39	38
inertinite	14	10
others	1	1
mineral	—	—
RO max (%)	1.33	1.29

Source: Joint Coal Board (1989)

Company	**Kembla Coal & Coke Pty Ltd**
Mine	Tahmoor
Mine type	Underground
Mining method	Longwall
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Bulli

	Coking
Total moisture	8.0
Proximate analysis (% ad)	
moisture	1.2
ash	8.5
volatile matter	27.5
fixed carbon	62.8
Specific energy	
gross MJ/kg	31.92
gross kcal/kg	7620
gross btu/lb	13720
Ultimate analysis (% daf)	
carbon	87.1
hydrogen	5.00
nitrogen	1.80
sulphur	0.40
oxygen	5.7
Chlorine	0.02
Phosphorus	0.05
Coking properties	
crucible swelling number	7
Gray-King coke type	G5
max. fluidity (ddpm)	4000
Ash analysis (%)	
SiO_2	54.4
Al_2O_3	31.0
Fe_2O_3	5.50
CaO	3.0
MgO	0.40
TiO_2	1.40
Na_2O	0.20
K_2O	0.80
Mn_3O_4	0.05
P_2O_5	1.80
SO_3	0.80
RO max (%)	1.1

Source: Joint Coal Board (1989)

Company	**Metropolitan Collieries Ltd**
Mine	Metropolitan
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Bulli

	Hard Coking	*Semi-Coking*	*Premium Steaming*	*Standard Steaming*
Total moisture	9.0	8.0	7.0	7.0
Proximate analysis (% ad)				
moisture	1.0	1.0	1.0	1.0
ash	9.8	11.5	11.5	15.0
volatile matter	21.5	21.0	21.0	20.0
fixed carbon	67.7	66.5	66.5	64.0
Specific energy				
gross kcal/kg	—	—	7400	7100
Ultimate analysis (% dmmf)				
carbon	90.0	90.0	90.0	90.0
hydrogen	4.6	4.6	4.6	4.6
nitrogen	1.6	1.6	1.6	1.6
sulphur	0.4	0.4	0.4	0.4
oxygen	3.4	3.4	3.4	3.4
Chlorine (% ad)	0.02	0.02	0.02	0.02
Phosphorus (% ad)	0.05	0.05	0.05	0.05
Coking properties				
crucible swelling number	5–6	3–4	3	1–2
max. fluidity (ddpm)	500	50–100	—	—
Hardgrove grindability	70	70	70	70
Ash fusion temperature (reducing atmosphere degrees C)				
flow			>1600	>1600
Ash analysis (%)				
SiO_2	49.5	49.5	49.5	49.5
Al_2O_3	36.0	36.0	36.0	36.0
Fe_2O_3	4.7	4.7	4.7	4.7
CaO	3.5	3.5	3.5	3.5
MgO	1.9	1.9	1.9	1.9
TiO_2	1.4	1.4	1.4	1.4
Na_2O	0.4	0.4	0.4	0.4
K_2O	0.8	0.8	0.8	0.8
Mn_3O_4	0.1	0.1	0.1	0.1
P_2O_5	1.2	1.2	1.2	1.2
SO_3	0.3	0.3	0.3	0.3

Source: Metropolitan Collieries Ltd

Company	**BHP Steel International Group, Collieries Dvn**			
Mines	Appin	Cordeaux	Kemira	Tower
Mine type	Underground			
Mining method	Longwall			
Geological sequence	Illawarra Coal Measures			
Seam(s) mined	Bulli	Bulli	Wongawilli	Bulli

	Illawarra Coking	*Illawarra Energy 1*	*Illawarra Energy 2*
Total moisture (% ad)	9.0	6.0	6.0
Proximate analysis (% ad)			
moisture	1.0	1.0	1.0
ash	9.0	17.0	21.0
volatile matter	22.0	21.0	21.0
fixed carbon	68.0	61.0	57.0
Specific energy (ad)			
gross MJ/kg	32.45	29.31	27.84
gross kcal/kg	7 750	7 000	6 650
gross btu/lb	13 950	12 600	11 970
Ultimate analysis (% daf)			
carbon	88.5	88.5	87.5
hydrogen	5.20	5.00	5.50
nitrogen	1.70	1.50	1.50

sulphur	0.45	0.50	0.50
oxygen	4.1	4.5	5.0
Chlorine (% ad)		0.01	0.01
Phosphorus (% ad)	0.040	0.050	0.020
Coking properties			
crucible swelling number	7	2	3
Gray-King coke type	G5		
max. fluidity (ddpm)	2000		
Hardgrove grindability		75	75
Ash fusion temperature (reducing atmosphere degrees C)			
deformation		1400	1420
hemisphere		1560	1560
flow		+1560	+1560
Ash analysis (%)			
SiO_2	58.0	63.0	67.0
Al_2O_3	28.0	25.0	24.0
Fe_2O_3	3.50	5.00	5.00
CaO	2.00	2.00	0.60
MgO	0.50	0.50	0.50
TiO_2	1.40	1.00	1.00
Na_2O	0.30	0.30	0.15
K_2O	1.50	1.00	1.10
Mn_3O_4	0.50	0.10	0.15
P_2O_5	1.00	1.00	0.15
SO_3	0.30	0.50	1.05
Petrography (% mmf)			
vitrinite	55		
semi-inertinite	29		
inertinite	16		
others	2		
RO max (%)	1.25		

Source: Joint Coal Board (1989)

Company	**BHP Steel International Group, Collieries Dvn**
Mines	Nebo, Wongawilli
Mine type	Underground
Mining method	Bord & pillar
Geological sequence	Illawarra Coal Measures
Seam(s) mined	Wongawilli

Total moisture (% ad)	9.0	6.0	6.0
Proximate analysis			
moisture	1.0	1.0	1.0
ash	9.0	17.0	21.0
volatile matter	22.0	21.0	21.0
fixed carbon	68.0	61.0	57.0
Specific energy			
gross MJ/kg	32.45	29.31	27.84
gross kcal/kg	7 750	7 000	6 650
gross btu/lb	13 950	12 600	11 970
Ultimate analysis			
carbon	88.5	88.5	87.5
hydrogen	5.20	5.00	5.50
nitrogen	1.70	1.50	1.50
sulphur	0.45	0.50	0.50
oxygen	4.1	4.5	5.0
Chlorine		0.01	0.01
Phosphorus	0.040	0.050	0.020
Coking properties			
crucible swelling number	7	2	3
Gray King coke type	G5		
max. fluidity (ddpm)	2000		
Hardgrove grindability		75	75
Ash fusion temperature (reducing atmosphere degrees C)			
deformation		1400	1420
hemisphere		1560	1560
flow		+1560	+1560
Ash analysis (%)			
SiO_2	58.0	63.0	67.0
Al_2O_3	28.0	25.0	24.0
Fe_2O_3	3.50	5.00	5.00
CaO	2.00	2.00	0.60
MgO	0.50	0.50	0.50
TiO_2	1.40	1.00	1.00
Na_2O	0.30	0.30	0.15
K_2O	1.50	1.00	1.10
Mn_3O_4	0.50	0.10	0.15
P_2O_5	1.00	1.00	0.15
SO_3	0.30	0.50	1.05
Petrography (% mmf)			
vitrinite	55		
semi-inertinite	29		
inertinite	16		
others	2		
RO max (%)	1.25		

Source: Joint Coal Board (1989)

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APPENDIX 1. STATE GOVERNMENT MINING AUTHORITIES

Department of Minerals & Energy 29–57 Christie Street, St Leonards, NSW 2065 PO Box 536, St Leonards, NSW 2065	Telephone (02) 901 8888 Fax (02) 901 8777
Department of Resource Industries 61 Mary Street, Brisbane 4000 GPO Box 194, Brisbane 4001	Telephone (07) 22 4211 Fax (07) 229 7770
Department of Resources & Energy Cnr Bligh & Gordons Hill Road, Rosny Park, Tas. 7018 PO Box 56, Rosny Park, Tas. 7018	Telephone (002) 30 8033 Fax (002) 44 2117
Department of Mines & Energy 191 Greenhill Road, Parkside, SA 5063 PO Box 151, Parkside, SA 5063	Telephone (08) 274 7500 Fax (08) 272 7597
Department of Mines 100 Plain Street, Perth 6000	Telephone (09) 222 3333 Fax (09) 222 3430

APPENDIX 2. MINES PRODUCING BLACK COAL IN AUSTRALIA IN 1988–89

Mine	*Type*	*District*	*Major company*
QUEENSLAND			
Blackwater	Open-cut	Blackwater	Central Qld Coal Associates
Blair Athol	Open-cut	Blair Athol	Pacific Coal Pty Ltd
Bocum	Underground	Bowen	Collinsville Coal Co. Pty Ltd
Boundary Hill	Open-cut	Callide	Callide Coalfields Ltd
Bowen Central	Open-cut	Bowen	Collinsville Coal Co. Pty Ltd
Burgowan No.12	Underground	Maryborough	Burgowan Collieries Pty Ltd
Callide	Open-cut	Callide	Callide Coalfields Ltd
Collinsville No.2	Underground	Bowen	Collinsville Coal Co. Pty Ltd
Cook	Underground	Blackwater	Coal Resources of Queensland
Curragh	Open-cut	Blackwater	Curragh Qld Mining Ltd
Ebenezer	Open-cut	West Moreton	Allied Qld Coal Fields Ltd
German Creek	Open-cut	Blackwater	Capricorn Coal Management Pty Ltd
German Ck Central	Underground	Blackwater	Capricorn Coal Management Pty Ltd
German Ck South	Underground	Blackwater	Capricorn Coal Management Pty Ltd
Goonyella	Open-cut	Mackay	BHP-Utah Coal Ltd
Gregory	Open-cut	Blackwater	BHP-Utah Coal Ltd
Jeebropilly	Underground	West Moreton	Jeebropilly Collieries Pty Ltd
Meandu (Tarong)	Open-cut	Nanango	Pacific Coal Pty Ltd
Moura	Open-cut	Moura	BHP-Utah Coal Ltd
Moura	Underground	Moura	BHP-Utah Coal Ltd
New Hope	Open-cut	West Moreton	New Hope Corporation Ltd
New Hope	Underground	West Moreton	New Hope Corporation Ltd
Newlands	Open-cut	Mackay	Newlands Coal Pty Ltd
New Whitwood	Open-cut	West Moreton	Allied Qld Coalfields Ltd
Norwich Park	Open-cut	Mackay	Central Qld Coal Associates
Oakleigh	Open-cut	West Moreton	Oakleigh Colliery Pty Ltd
Oakleigh	Underground	West Moreton	Oakleigh Colliery Pty Ltd
Oaky Creek	Open-cut	Blackwater	Oaky Creek Coal Pty Ltd
Peak Downs	Open-cut	Mackay	Central Qld Coal Associates
Riverside	Open-cut	Mackay	BHP-Utah Coal Ltd
Rhondda	Open-cut	West Moreton	FAI Mining Ltd
Rhondda	Underground	West Moreton	FAI Mining Ltd
Saraji	Open-cut	Mackay	Central Qld Coal Associates
South Blackwater	Open-cut	Blackwater	South Blackwater Mines Ltd
South Blackwater	Underground	Blackwater	South Blackwater Mines Ltd
Yarrabee	Open-cut	Blackwater	Yarrabee Mining Pty Ltd
NEW SOUTH WALES			
Angus Place	Underground	Western	Electricity Commission of NSW
Appin	Underground	Southern	BHP Co. Ltd
Avon	Underground	Southern	Avon Colliery Pty Ltd
Awaba	Underground	Newcastle	Electricity Commission of NSW
Baal Bone	Underground	Western	Coalex Pty Ltd
Bayswater No. 2	Open-cut	Hunter	Bayswater Colliery Co. Pty Ltd
Berrima	Underground	Southern	BCSC Collieries Pty Ltd
Bloomfield	Underground	Newcastle	Bloomfield Collieries Pty Ltd
Bloomfield	Open-cut	Newcastle	Bloomfield Collieries Pty Ltd
Blue Mountains	Underground	Western	Hartley Valley Coal Co. Pty Ltd
Brimstone No. 1	Underground	Southern	Clutha Ltd
Chain Valley	Underground	Newcastle	Coal & Allied Industries Ltd
Charbon	Underground	Western	BCSC Collieries Pty Ltd
Clarence	Underground	Western	Coalex Pty Ltd
Coal Cliff	Underground	Southern	Kembla Coal & Coke Pty Ltd
Cooranbong	Underground	Newcastle	Electricity Commission of NSW
Cordeaux	Underground	Southern	BHP Co. Ltd
Drayton	Open-cut	Hunter	Drayton Coal Pty Ltd
Great Greta	Underground	Hunter	FAI Mining Ltd
Gretley	Underground	Newcastle	The Newcastle Wallsend Coal Co. Pty Ltd
Gunnedah	Open-cut	Gunnedah	Gunnedah Coal Co. Ltd
Gunnedah No. 2	Underground	Gunnedah	Gunnedah Coal Co. Ltd

Mine	*Type*	*District*	*Major company*
Howick	Open-cut	Hunter	Kembla Coal & Coke Pty Ltd
Hunter Valley No. 1	Open-cut	Hunter	Coal & Allied Industries Ltd
Ivanhoe No. 2	Underground	Western	BCSC Collieries Pty Ltd
Kandos No. 3	Underground	Western	Kandos Collieries Pty Ltd
Kemira	Underground	Southern	BHP Co. Ltd
Lambton	Underground	Newcastle	FAI Mining Ltd
Lemington	Open-cut	Hunter	Lemington Coal Mines Ltd
Lemington No. 1	Underground	Hunter	Lemington Coal Mines Ltd
Liddell	Underground	Hunter	Liddell Joint Venture
Liddell State	Underground	Hunter	Electricity Commission of NSW
Metropolitan	Underground	Southern	Metropolitan Collieries Ltd
Moonee	Underground	Newcastle	Coal & Allied Industries Ltd
Mount Thorley	Open-cut	Hunter	Coal & Allied Industries Ltd
Munmorah	Underground	Newcastle	Electricity Commission of NSW
Muswellbrook	Open-cut	Hunter	Muswellbrook Coal Co. Ltd
Muswellbrook No.2	Underground	Hunter	Muswellbrook Coal Co. Ltd
Myuna	Underground	Newcastle	Electricity Commission of NSW
Nattai	Underground	Southern	Clutha Ltd
Nebo	Underground	Southern	BHP Co. Ltd
Newstan	Underground	Newcastle	Electricity Commission of NSW
Newvale No. 1	Underground	Newcastle	Electricity Commission of NSW
Newvale No. 2	Underground	Newcastle	Electricity Commission of NSW
Oakdale	Underground	Southern	Clutha Ltd
Pelton-Ellalong	Underground	Newcastle	The Newcastle Wallsend Coal Co. Pty Ltd
Preston Extended	Underground	Gunnedah	Preston Coal Holdings Pty Ltd
Ravensworth	Open-cut	Hunter	Costain Australia Ltd
Saxonvale	Open-cut	Hunter	Saxonvale Coal Pty Ltd
South Bulli	Underground	Southern	Austen & Butta Pty Ltd
Swamp Creek	Open-cut	Hunter	Hebden Mining Co.
Tahmoor	Underground	Southern	Kembla Coal & Coke Pty Ltd
Teralba	Underground	Newcastle	FAI Mining Ltd
Tower	Underground	Southern	BHP Co. Ltd
Ulan	Open-cut	Western	Ulan Coal Mines Ltd
Ulan No. 2	Underground	Western	Ulan Coal Mines Ltd
United	Open-cut	Hunter	United Collieries Pty Ltd
Vickery (trial)	Underground	Gunnedah	Novacoal Australia Pty Ltd
Wallarah	Underground	Newcastle	Coal & Allied Industries Ltd
Wambo	Underground	Hunter	Wambo Mining Corporation Pty Ltd
Wambo	Open-cut	Hunter	Wambo Mining Corporation Pty Ltd
Warkworth No. 1	Open-cut	Hunter	Warkworth Mining Ltd
West Cliff	Underground	Southern	Novacoal Australia Pty Ltd
Western Main	Underground	Western	Novacoal Australia Pty Ltd
Western Main	Open-cut	Western	Novacoal Australia Pty Ltd
West Wallsend	Underground	Newcastle	FAI Mining Ltd
Wongawilli	Underground	Southern	BHP Co. Ltd
Wyee	Underground	Newcastle	Electricity Commission of NSW
TASMANIA			
Blackwood	Underground		Goliath Cement Holdings Ltd
Blackwood	Open-cut		Goliath Cement Holdings Ltd
Duncan	Underground		Goliath Cement Holdings Ltd
Merrywood	Open-cut (intermittent)		Avoca Transport Co. Pty Ltd
SOUTH AUSTRALIA			
Leigh Creek	Open-cut		Electricity Trust of South Australia
WESTERN AUSTRALIA			
Chicken Creek	Open-cut		The Griffin Coal Mining Co. Ltd
Muja	Open-cut		The Griffin Coal Mining Co. Ltd
Western	Underground		Western Collieries Pty Ltd
Western	Open-cut		Western Collieries Pty Ltd

APPENDIX 3. COAL MINING COMPANY ADDRESSES

QUEENSLAND

Allied Queensland Coalfields Ltd
410 Queen St GPO Box 1692
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 229 7277 Fax (07) 221 7952

BHP-Utah Coal Ltd
167 Eagle St GPO Box 1389
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 226 0600 Fax (07) 229 2575

Burgowan Collieries Pty Ltd
Gympie St
TORBANLEA QLD 4662
Telephone (071) 29 4919

Callide Coalfields Ltd
GPO Box 3109
BRISBANE QLD 4001
Telephone (07) 839 0522 Fax (07) 832 6879

Capricorn Coal Management Pty Ltd
444 Queen St GPO Box 1410
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 839 6038 Fax (07) 832 5751

Central Queensland Coal Associates
167 Eagle St GPO Box 1389
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 226 0600 Fax (07) 229 2575

Coal Resources of Queensland Pty Ltd
PO Box 10
BLACKWATER QLD 4728
Telephone (079) 86 0211 Fax (079) 86 0220

Collinsville Coal Company Pty Ltd
410 Ann St GPO Box 1433
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 833 8000 Fax (07) 832 2430

Curragh Queensland Mining Ltd
15–23 Adelaide St GPO Box 807
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 229 9000 Fax (07) 229 1741

FAI Mining Ltd
PO Box 109
IPSWICH QLD 4305
Telephone (07) 282 1311 Fax (07) 282 6695

Idemitsu South Queensland Coal Pty Ltd
Level 14
Riverside Centre
123 Eagle St
BRISBANE QLD 4000
Telephone (07) 834 3577 Fax (07) 834 3572

Jeebropilly Collieries Pty Ltd
PO Box 47
IPSWICH QLD 4305
Telephone (07) 202 1100 Fax (07) 202 4315

New Hope Corporation Ltd
11–17 Lowry St PO Box 47
IPSWICH QLD 4305 IPSWICH QLD 4305
Telephone (07) 202 1100 Fax (07) 202 4315

Newlands Coal Pty Ltd
410 Ann St GPO Box 1433
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 833 8000 Fax (07) 832 2430

Oakleigh Colliery Pty Ltd
PO Box 25
ROSEWOOD QLD 4340
Telephone (075) 64 1600 Fax (075) 64 2201

Oaky Creek Coal Pty Ltd
410 Ann St GPO Box 1433
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 833 8000 Fax (07) 832 2426

Pacific Coal Pty Ltd
10 Eagle St GPO Box 391
BRISBANE QLD 4000 BRISBANE QLD 4001
Telephone (07) 223 7200 Fax (07) 229 5087

South Blackwater Mines Ltd
PO 201
TOOWONG QLD 4066
Telephone (07) 368 3233 Fax (07) 368 4016

Yarrabee Coal Company Pty Ltd
PO Box 173
BLACKWATER QLD 4717
Telephone (079) 82 5400 Fax (079) 82 5793

NEW SOUTH WALES

Austen & Butta Pty Ltd
221 Miller St PO Box 1228
NORTH SYDNEY NSW 2060 NORTH SYDNEY NSW 2059
Telephone (02) 968 0888 Fax (02) 968 0808

Avon Colliery Pty Ltd
Bong Bong Road PO Box 220
WEST DAPTO NSW 2530 WOLLONGONG EAST NSW 2520
Telephone (042) 61 1388 Fax (042) 76 1384

Bayswater Colliery Company Pty Ltd
167 Kent St GPO Box 1517
SYDNEY NSW 2000 SYDNEY NSW 2001
Telephone (02) 250 5000 Fax (02) 250 5702

BCSC Collieries Pty Ltd
1 McLaren St GPO Box 1571
NORTH SYDNEY NSW 2060 SYDNEY NSW 2001
Telephone (02) 925 9888 Fax (02) 929 4520

BHP Steel International Group
Collieries Division
90 Crown St PO Box 431
WOLLONGONG NSW 2500 WOLLONGONG EAST NSW 2520
Telephone (042) 24 2300 Fax (042) 26 1846

Bloomfield Collieries Pty Ltd
Four Mile Creek Road PO Box 4
EAST MAITLAND NSW 2323 EAST MAITLAND NSW 2323
Telephone (049) 33 7077 Fax (049) 33 8940

Clutha Ltd
Level 18
1 York St
SYDNEY NSW 2000
Telephone (02) 251 2866 Fax (02) 251 2821

Coalex Pty Ltd
L9 100 Christie St PO Box 30
ST LEONARDS NSW 2065 ST LEONARDS NSW 2065
Telephone (02) 436 0555 Fax (02) 438 4630

Coal & Allied Industries Ltd
Royal Insurance House
1 York St GPO Box 1554
SYDNEY NSW 2000 SYDNEY NSW 2001
Telephone (02) 233 4122 Fax (02) 251 3395

Coalpac Pty Ltd
Astrolabe
Rutherford Lane
LITHGOW NSW 2790
Telephone (063) 51 2281 Fax (063) 52 1339

Costain Australia Ltd
2 Dind St PO Box 231
MILSONS POINT NSW 2061 MILSONS POINT NSW 2061
Telephone (02) 922 6444 Fax (02) 959 5418

Drayton Coal Pty Ltd
Greta Road Private Mail Bag 9
MUSWELLBROOK NSW 2333 MUSWELLBROOK NSW 2333
Telephone (065) 43 1733 Fax (065) 42 5009

Electricity Commission of New South Wales
Hyde Park Tower
Cnr Park & Elizabeth St — GPO Box 5257
SYDNEY NSW 2000 — SYDNEY NSW 2001
Telephone (02) 268 8111

FAI Mining Ltd
Corner Scott & Market Sts — PO Box 481
NEWCASTLE NSW 2300 — NEWCASTLE NSW 2300
Telephone (049) 29 6477 Fax (049) 29 6025

Gunnedah Coal Co. Ltd
69 Pitt St — GPO Box 5134
SYDNEY NSW 2000 — SYDNEY NSW 2001
Telephone (02) 27 4841 Fax (02) 251 1269

Hartley Valley Coal Company Pty Ltd
Gap Road — PO Box 57
HARTLEY NSW 2790 — LITHGOW NSW 2790
Telephone (063) 55 2202 Fax (063) 55 1100

Hebden Mining Co.
PO Box 269
MUSWELLBROOK NSW 2333
Telephone (065) 76 1190 Fax (065) 76 1064

Kandos Collieries Pty Ltd
KANDOS NSW 2848
Telephone (063) 79 4007

Kembla Coal & Coke Pty Ltd
Cnr Crown & Keira Streets — PO Box 1770
WOLLONGONG NSW 2500 — WOLLONGONG NSW 2500
Telephone (042) 28 7455 Fax (042) 28 4410

Lemington Coal Mines Ltd
Comleroi Road — PO Box 225
WARKWORTH NSW 2330 — SINGLETON NSW 2330
Telephone (065) 74 4566 Fax (065) 74 4610

Liddell Joint Venture
C/- Yieldex Pty Ltd
Level 14 Norwich House
6–10 O'Connell St
SYDNEY NSW 2000
Telephone (02) 223 6455 Fax (02) 223 6524

Metropolitan Collieries Ltd
Level 7 The Denison
65 Berry St
NORTH SYDNEY NSW 2060
Telephone (02) 223 6455 Fax (02) 956 7463

Muswellbrook Coal Company Ltd
32–34 Queen St — PO Box 123
MUSWELLBROOK NSW 2333 — MUSWELLBROOK NSW 2333
Telephone (065) 43 2799 Fax (065) 42 5010

The Newcastle Wallsend Coal Co. Pty Ltd
Level 9
100 Christie St — PO Box 309
ST LEONARDS NSW 2065 — ST LEONARDS NSW 2065
Telephone (02) 436 0555 Fax (02) 438 4630

Novacoal Australia Pty Ltd
110 Alfred St — PO Box 354
MILSONS POINT NSW 2061 — MILSONS POINT NSW 2061
Telephone (02) 900 0444 Fax (02) 959 4197

Preston Coal Holdings Pty Ltd
PO Box 1A
CURLEWIS NSW 2381
Telephone (067) 42 0366 Fax (067) 42 1983

Saxonvale Coal Pty Ltd
Level 9
100 Christie St — PO Box 309
ST LEONARDS NSW 2065 — ST LEONARDS NSW 2065
Telephone (02) 436 0555 Fax (02) 438 4630

Ulan Coal Mines Ltd
Level 5
60 Miller St — PO Box 1059
NORTH SYDNEY NSW 2060 — NORTH SYDNEY NSW 2059
Telephone (02) 922 4000 Fax (02) 959 4619

United Collieries Pty Ltd
134 Jerrys Plains Road — PO Box 478
WARKWORTH NSW 2330 — SINGLETON NSW 2330
Telephone (065) 74 4502 Fax (065) 74 4606

Wambo Mining Corporation Pty Ltd
Jerrys Plains Road — PMB
SINGLETON NSW 2330 — SINGLETON NSW 2330
Telephone (065) 74 4532
Facsimile (065) 74 4618

Warkworth Mining Ltd
Putty Road
Mount Thorley — PO Box 267
SINGLETON NSW 2330 — SINGLETON NSW 2330
Telephone (065) 78 9200 Fax (065) 78 9258

TASMANIA

Avoca Transport Co. Pty Ltd
16 Montague St — PO Box 402
INVERMAY Tas. 7248 — MOWBRAY HEIGHTS Tas. 7248
Telephone (003) 31 6477 Fax (003) 31 5003

Goliath Cement Holdings Ltd
99 George St — PO Box 62
LAUNCESTON Tas. 7250 — LAUNCESTON Tas. 7250
Telephone (003) 31 9522 Fax (003) 34 1167

SOUTH AUSTRALIA

Electricity Trust of South Australia
220 Greenhill Road — PO Box 6
EASTWOOD SA 5063 — EASTWOOD SA 5063
Telephone (08) 223 0383 Fax (08) 274 5808

WESTERN AUSTRALIA

The Griffin Coal Mining Co. Ltd
PO Box 218
COLLIE WA 6225
Telephone (097) 34 2700 Fax (097) 34 2682

Western Collieries Ltd
40 The Esplanade — GPO Box X2231
PERTH WA 6000 — PERTH WA 6001
Telephone (09) 327 4511 Fax (09) 327 4519

APPENDIX 4. AUSTRALIAN CODE FOR REPORTING IDENTIFIED COAL RESOURCES AND RESERVES

Following a request from the Australian Minerals & Energy Council (AMEC) for the development of a national approach to the reporting of coal resources and reserves, the Government Geologists' Conference in 1984 established a subcommittee to examine the issue and report back to the Conference on its findings. The subcommittee consisted of A.G. Galligan, Chief Coal Geologist, New South Wales Department of Mineral Resources, and D.C. Mengel, Director, Fossil Fuels, Geological Survey of Queensland.

The subcommittee used the 'Code for Calculating Coal Resources & Reserves' (5th Edition, June 1984) of the Standing Committee on Coalfield Geology of New South Wales as the base document, and modified this Code to meet the requirements of both industry and government in other states, and the Bureau of Mineral Resources. The new Code was ratified by the Government Geologists' Conference in April 1986 and AMEC in November 1986.

INTRODUCTION

This Code outlines general concepts for reporting identified coal resources and reserves. It is broad in nature to accommodate the wide range of coal deposits, in terms of rank, quality, and geological environment, that are present in Australia.

In this Code, the term Resources is used to refer to all of the coal in-situ which may have potential for use, and the various categories indicate the level of confidence of the assessment. Reserves are those resources which are planned to be mined and for which such planning has been undertaken. The Code sets only minimum guidelines for evaluating resources and reserves and the estimator is required to state clearly the criteria used in any assessment.

Additional guidelines and parameters may be required for reporting coal resources and reserves from specific basins or regions.

DEFINITIONS

Coal resources

Coal resources are all of the potentially useable coal in a defined area and are based on points of observation and extrapolations from those points.

Potentially useable coal is defined as coal which has been, or could be, beneficiated to give a quality acceptable for commercial use in the foreseeable future and excludes minor coal occurrences. The estimator should state both the quality and thickness limits used to define potentially useable coal in any resource evaluation.

Coal reserves

Coal reserves are those parts of the coal resources for which sufficient information is available to enable detailed or conceptual mine planning and for which such planning has been undertaken.

Points of observation

A point of observation is an intersection, at a known location, of coal-bearing strata, which provides information about the strata by one or more of the following methods:

— Observation, measurement, and testing of surface or underground exposures.
— Observation, measurement, and testing of borecore.
— Observation, and testing of cuttings, and use of downhole geophysical logs of non-cored boreholes.

A point of observation for coal quantity may not be used necessarily for coal quality. The most reliable quality information is provided by testing of surface or underground exposures or by testing of borecore.

Geophysical techniques such as seismic surveys are not direct points of observation but may increase confidence in the continuity of seams between points of observation, especially in the broader resource categories.

The distances between points of observation and extrapolations from points of observation quoted for each resource category are normally the maximum under favourable geological conditions. Closer spacing will be required in areas where faulting, intrusion, seam splitting and other breaks in seam continuity are known to occur, or where the seam is subject to significant variation in thickness or quality.

CATEGORIES OF RESOURCES

Measured resources are those for which the density and quality of points of observation are sufficient to allow for a reliable estimate of the coal thickness, quality, depth and in-situ tonnage. Points of observation should provide a level of confidence sufficient to allow detailed planning, costing of extraction and specification of a marketable product.

The points of observation generally should not be more than 1 km apart. Where geological conditions are favourable it may be possible to extrapolate known trends a maximum distance of 0.5 km from points of observation.

Indicated resources are those for which the density and quality of points of observation are sufficient to allow for a realistic estimate of the coal thickness, quality, depth, and in-situ tonnage and for which there is reasonable expectation that the estimate of resources will not vary significantly with more detailed exploration.

Points of observation should provide a level of confidence sufficient to enable conceptual planning of extraction and to determine the likely quality of the product coal.

Points of observation generally should be not more than 2 km apart. Where geological conditions are favourable, it may be possible to extrapolate known trends a maximum distance of 1 km from points of observation.

Inferred resources are those for which the points of observation are widely spaced and, as a result, assessment of this type of resource may be unreliable.

Points of observation should allow the presence of coal to be unambiguously determined.

Inferred Resources Class 1 are those resources for which the points of observation allow an estimate of the coal thickness and general coal quality to be made, and the geological conditions indicate continuity of seams between the points of observation.

Points of observation generally should be not more than 4 km apart. Extrapolations of trends should extend not more than 2 km from points of observation.

Inferred Resources Class 2 are those for which there is limited information and as a result the assessment of this type of resource may be unreliable.

Provided the coal thickness can be determined, the order of magnitude of Inferred Resources Class 2 may be expressed within the following ranges:

1–10 million tonnes
10–100 million tonnes
100–500 million tonnes
500–1000 million tonnes
greater than 1000 million tonnes

If a more specific quantitative estimate is made to determine exploration priorities, etc., it should not be quoted in public reports or in any prospectus.

TYPES OF RESERVES

Mineable in-situ reserves are the tonnages of in-situ coal contained in seams or sections of seams for which sufficient information is available to enable detailed or conceptual mine planning and for which such planning has been undertaken.

Mineable in-situ reserves may be calculated only from measured and indicated resources. Measured resources are required for detailed mine planning and are the preferred basis for mineable in-situ reserves. Indicated resources may be used for conceptual mine planning. In general, further exploration will be required prior to the commencement of mining operations.

Mineable in-situ reserves should be quoted separately for surface and underground mines and an outline of the proposed mining method(s) should be provided.

Recoverable reserves are the tonnages of mineable in-situ reserves that are expected to be recovered; i.e. that proportion of the seam(s) which will be extracted. If dilution is added to the recoverable reserves tonnage, the total equates to the 'run-of-mine' tonnage. If allowance is made for dilution it should be stated.

In calculating recoverable reserves a mining recovery factor must be applied to the mineable in-situ reserves. This factor will depend on the mining method to be used. Unless a specific factor has been determined for conceptual studies, the historically proven mining recovery factor should be used. If such information is not available, a mining recovery factor of 50% for underground reserves and 90% for surface reserves may be applied. An outline of the proposed mining method should accompany any statement of recoverable reserves.

Marketable reserves are the tonnages of coal that will be available for sale.

If the coal is to be marketed raw, the marketable reserves will be the same as the recoverable reserves plus dilution; i.e. the 'run-of-mine' tonnage. If the coal is to be beneficiated, marketable reserves are calculated by applying the predicted yield to the recoverable reserves. The basis of the predicted yield should be stated; e.g. 200 mm cores, slim cores, pretreated cores.

REPORTING OF RESOURCES AND RESERVES

All factors used to limit resources and reserves are necessary to verify the calculations (including the types of observations, e.g. cored hole, outcrop) and must be stated explicitly. The relative density value adopted in calculating the coal tonnage should be noted, together with the evidence on which it is based. Tonnage estimates always should be rounded, commensurate with the accuracy of estimation.

Resources and Reserves should be stated:

— for each seam
— on a depth basis, in regular depth increments if sufficient information is available
— on a seam thickness basis; the minimum thickness used should be stated and separate tonnages should be quoted for seams less than 1.5 m thick and seams equal to or greater than 1.5 m thick (this limit may be greater for brown coal, e.g. 3 m). The maximum thickness of any included bands should be stated. Normally where a seam contains non-coal bands thicker than 0.3 m the two coal splits should be considered as separate seams, and tonnages should be reported for each (the limit for non-coal bands may be greater for brown coal sequences, e.g. 1 m)
— on a quality basis; maximum raw coal ash should be stated and only that coal which can be used or beneficiated at an acceptable yield (to be stated) should be included in the estimate. Other raw coal quality parameters, particularly those which affect utilisation behaviour, should be stated and further subdivision of the resources made if significant variations occur; e.g. heat affected coal, oxidised coal.

In addition, for reporting of reserves the following information is required, as a minimum:

— an outline of the proposed mining method
— physical criteria limiting mining such as maximum and minimum working section thickness, minimum separation of seams, maximum dip, geological structures, areas of prohibition
— quality criteria limiting mining such as ash content, volatile matter, yield, etc.
— for recoverable reserves, the mining recovery factor used
— for marketable reserves, the predicted yield if the coal is to be beneficiated and the quality specification of the product coal
— the overburden ratio expressed as bank cubic metres of overburden to tonnes of coal in-situ for reserves amenable to surface mining
— the depth of planned mining
— the percentage of the resources contained in the mineable in-situ reserves within the area(s) proposed to be mined.

MAPS

Any report of resources and/or reserves must be substantiated to the relevant Government authority by maps at scales appropriate to the accuracy claimed for the resources and/or reserves, showing all relevant data including the areas considered for each category of resources and/or reserves, the limits imposed (e.g. cover lines, seam isopachs, isoashes), the areas of prohibition, and seam thicknesses at points of observation.

PUBLIC STATEMENT

A public statement of resources and/or reserves claiming the authority of this Code should be in the format described in the section 'Reporting of Resources and Reserves'. The qualifications of the person(s) responsible for this 'Reporting' should be stated.

REFERENCES

For guidance in determining coal quality from borecores, reference should be made to Australian Standard 2519–1982: 'Guide to the evaluation of hard coal deposits using borehole techniques'.

APPENDIX 5. BMR RESOURCE CLASSIFICATION SYSTEM

Classification principles

BMR classifies known (identified) mineral resources according to two parameters: degree of assurance of occurrence (degree of geological assurance) and degree of economic feasibility of extraction. The former takes account of information on quantity (tonnage) and chemical composition (grade); the latter takes account of changing economic factors such as commodity prices, operating costs, capital costs, and discount rates.

Resources are classified in accordance with circumstances at the time of classification. Resources that are not available for development at the time of classification because of legal and/or land use factors are classified without regard to such factors; however, the amount of resource thus affected will, wherever possible, be stated for each classification category.

The classification framework is designed to accommodate all naturally-ocurring metals, non-metals, and fossil fuels, and to provide a means of comparing data on different resources which may have a similar end use (e.g. petroleum, coal and uranium as energy sources).

Terminology and definitions

Resource — a concentration of naturally-occurring solid, liquid, or gaseous materals in or on the earth's crust and in such form that its economic extraction is presently or potentially (within a 20–25 year time frame) feasible.

Categories of resources based on degree of assurance of occurrence

Identified resources — specific bodies of mineral-bearing material whose location, quantity, and quality are known from specific measurements or estimated from geological evidence. Identified resources include economic and subeconomic components. To reflect degrees of geological assurance, identified resources can be subdivided into the following categories:

Measured — resources for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill-holes, and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely, and the geological character is so well defined that size, shape, and mineral content are well established.

Indicated — resources for which tonnage and grade are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than for resources in the measured category, is high enough to assume continuity between points of observation.

Demonstrated — a collective term for the sum of measured and indicated resources.

Inferred — resources for which quantitative estimates are based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition, of which there is geological evidence. This evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geological evidence of their presence. Estimates of inferred resources should be stated separately and not combined in a single total with measured or indicated resources. Because of inadequate knowledge it may not be feasible to differentiate between economic and subeconomic inferred resources.

Undiscovered resources — unspecified bodies of mineral-bearing material surmised to exist on the basis of broad geological knowledge and theory. Undiscovered resources include the following categories:

Hypothetical — resources which may reasonably be expected to exist in a known mining district or mineral province under known geological conditions. As exploration confirms their existence and reveals information about tonnage and grade, such resources would be reclassified in the appropriate subdivision of identified resources.

Speculative — resources which may occur either in known types of deposits in a favourable geological setting where no discoveries have previously been made, or in as yet unknown types of deposits which remain to be recognised. As exploration confirms their existence and reveals information about tonnage and grade, such resources would be reclassified in the appropriate subdivision of identified resources.

Categories of resources based on economic considerations

Economic — This term implies that, at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated or assumed with reasonable certainty.

Subeconomic — This term refers to those resources which do not meet the criteria for 'economic'; subeconomic resources include paramarginal and submarginal categories.

Paramarginal — that part of subeconomic resources which, at the time of determination, almost satisfies the criteria for economic. The main characteristics of this category are economic uncertainty and/or failure (albeit just) to meet the criteria which define economic. Included are resources which would be producible given postulated changes in economic or technologic factors.

Submarginal — that part of subeconomic resources that would require a substantially higher commodity price, or some major cost-reducing advance in technology, to render them economic.

The definition of 'economic' is based on the important assumption that markets exist for the commodity concerned. All deposits which are judged to be exploitable economically at the time of assessment, whether or not exploitation is commercially practical, are included in the economic-resources category. It is also assumed that producers or potential producers will operate at optimum rates of output, and will receive the 'going market price' for their production. The classification is therefore based on the concept of what is judged to be **economic** rather than what is considered to be **commercial** at any particular time.

The information required to make detailed assessments of economic viability of a particular deposit is commercially sensitive (e.g. a company's costs and required internal rate of return), and these data may not be available to organisations such as BMR. Furthermore, as corporate strategies are likely to be different, individual companies will have different criteria for what is considered to be 'economic'. Thus, to standardise the approach for national or regional resource assessments, the following mineral deposits/situations are accepted by BMR, as a general guide, as **economic**:

(a) the resources (published or unpublished) of operating enterprises, whether or not such operations are sustained by long or short term, direct or indirect, government subsidies;
(b) resources in a deposit which is being developed for production (i.e. where there is a corporate commitment to production);
(c) undeveloped resources which are judged to be economic on the basis of a financial analysis using actual, estimated or assumed variables, viz: the tax rate, capital and operating costs, discount rate (such as reflects the long-term bond rate), commodity prices, and depreciation schedules; the values for the economic variables used in an assessment must be realistic for the circumstances prevailing at the time of the assessment;
(d) resources at mines on care-and-maintenance, meeting the criteria outlined in (c) above.

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