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1986/43. Coal in Tasmania.

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INTRODUCTION

Coal was discovered in Tasmania by French explorers in 1793. After settlement in 1803 coal was found and mined on a small scale in many places over the eastern half of the State. The first mine was at Saltwater River on the Tasman Peninsula, which opened in 1834, where convicts were employed to mine the coal. Currently two collieries are operating in Tasmania to supply coal to a number of local secondary industries.

Whereas coal has been found at three stratigraphic intervals within the Tasmania Basin, all the economically important coal reserves are hosted in the Late Triassic coal measures. Two smaller intervals of coal-bearing strata are of Early Permian and Late Permian age.

The Late Triassic black coals formed in a dry forest environment and are predominantly composed of oxidised woody tissue. The coals are banded with mudstone and claystone, attesting to frequent inundation of the peat. The coals have an ash content of 25-30%, a low sulphur content (0.5%) and a specific energy value of 22-24 MJ/kg.

The Late Permian coals are similar to the Late Triassic coals whereas the Early Permian coals are quite different, having been formed in a back-barrier environment with paralic influence. These coals are high in sulphur, up to 5%, low in ash (8-12%) with a high specific energy (29-30 MJ/kg) although the seams are very thin.

Small deposits of brown coal of Tertiary age and localised developments of oil shale (Late Carboniferous age) are also known from Tasmania.

GEOLOGICAL SETTING

Coal seams have been found in three stratigraphic intervals within the Tasmania Basin. The term Tasmania Basin refers to a structural basin which contains the remnants of a thick sequence of flat lying rocks ranging in age from Late Carboniferous to Late Triassic known as the Parmeener Super-Group (Banks, 1973). The Parmeener Super-Group is up to 2 km thick and has been further divided into two divisions (Forsyth, *et al.*, 1974), the Lower Division being predominantly marine and the Upper Division being wholly of freshwater origin. In the north-east the Parmeener Super-Group overlies a folded basement of Siluro-Devonian metaquartzite and greywacke, and granite. Elsewhere the basement is varied, being composed of a suite of rocks ranging from Precambrian to Devonian in age.

The Lower (Division of the) Parmeener Super-Group is Late Carboniferous to Permian in age, and often commences with a thick basal tillite followed by mostly marine and glaciomarine rocks and contains one freshwater interval - the Early Permian coal bearing strata: (Preolenna and Mersey Coal Measures). This interval is known as the Lower Freshwater Sequence (LFS). The marine rocks underlying this sequence are known as the Lower Marine Sequence while the series of marine rocks overlying the LFS are called the Upper Marine Sequence (fig. 1).

The Upper Division of the Parmeener Super-Group conformably overlies the marine rocks, and is mostly Triassic in age. The Permian-Triassic time boundary occurs within the lower portion of the Upper Parmeener Super-Group except where hiatuses are present, such as in the north-east. This Division is composed entirely of non-marine, lithic and siliceous clastic rocks. The lowest member of the Division is the Late Permian Cygnet Coal Measures and equivalent Adventure Bay Coal Measures, (known as the Upper Freshwater sequence). These are overlain by a sequence of non-coal bearing siliclastics. The upper part of the Upper Division is a lithic sandstone sequence hosting all the economically important coal occurrences known in Tasmania.

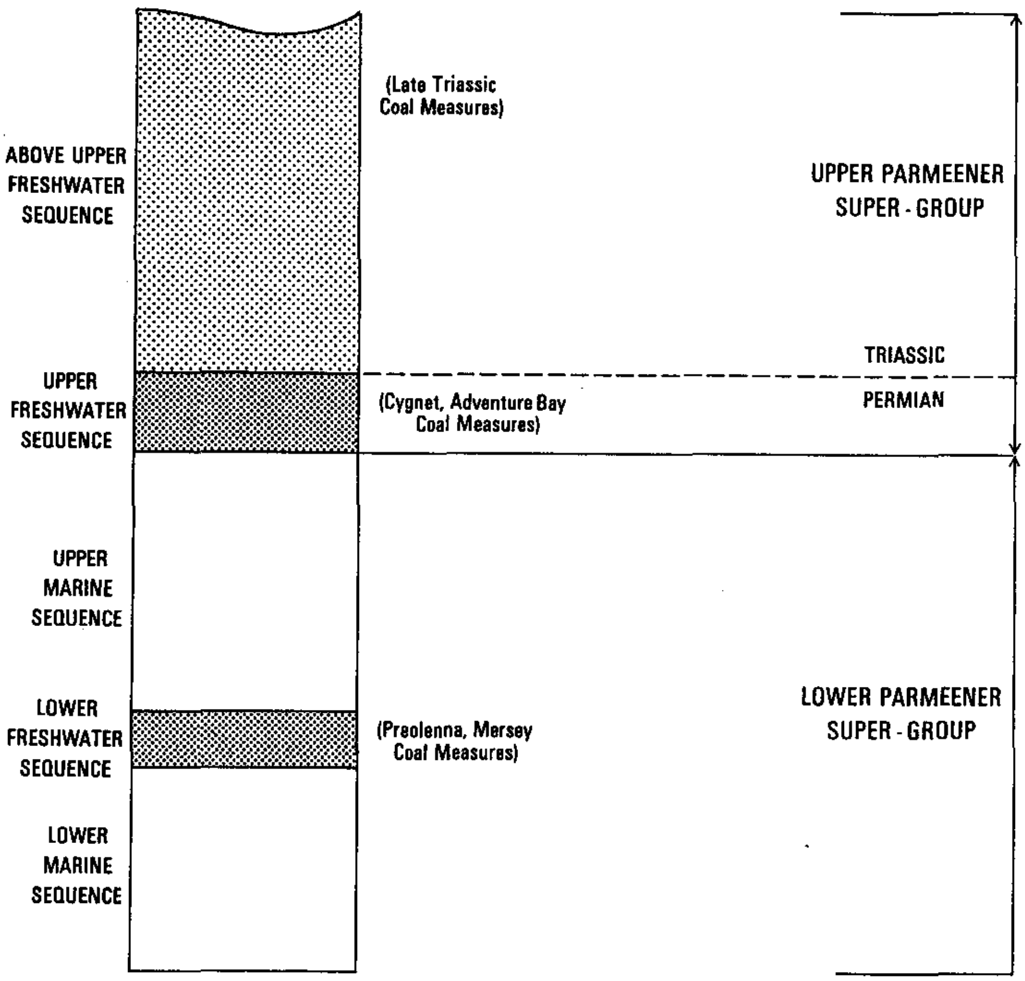

Figure 1. *Subdivision of the Parmeener Super-Group (after Forsyth* et al., *1974).*

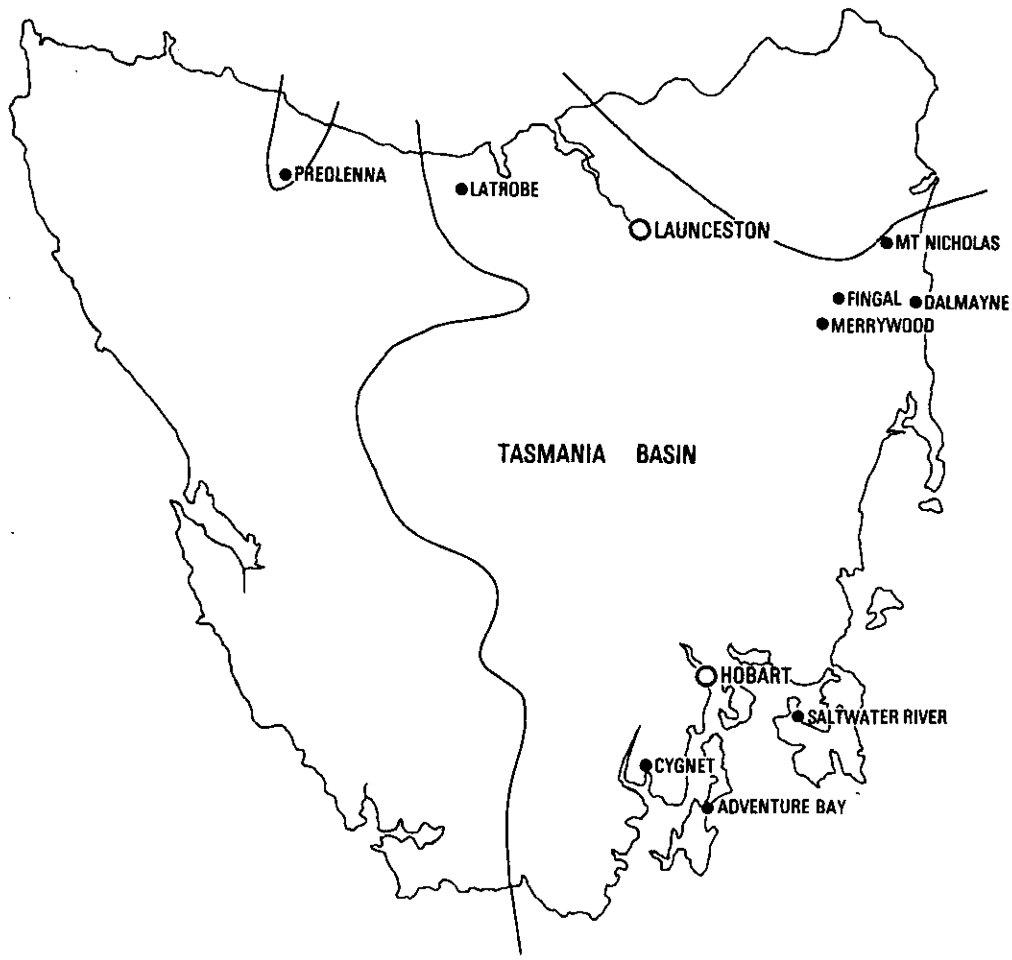

Figure 2. *Locality map.*

This lithic sandstone sequence is known as the R1 unit in the St Marys area (Calver, 1986) Rg in the Midlands area (Forsyth, 1984*a*), the upper part of the Brady Formation (McKellar, 1957) at Poatina and the New Town Coal Measures in southern Tasmania.

The Parmeener Super-Group was deposited in a largely stable environment. Banks (1962) suggests that the sheet-like formation of the Lower Parmeener Super-Group indicates deposition in a shelf environment, with the rate of deposition being 0.003 mm/annum. Poor sorting of the Lower Parmeener Super-Group, an unusual feature for shelf sediments, may be partly due to deposition from drifting icebergs. Some tectonic instability is recorded in the Lower Parmeener Super-Group in Middle or Upper Artinskian time, coinciding with a major orogenic movement in N.S.W. (part of the Hunter-Bowen orogeny). The instability resulted in uplift and downwarping, and movement of the zone of maximum thickness.

The Upper Parmeener Super-Group is of fluviatile origin. Sedimentation began west of a line from Richmond to Pipers River. The floor sank rapidly at first, becoming slower in the Late Triassic. The eastern edge of the sedimentation migrated east until reaching the granite of the central east coast, which may or may not at one stage have had a Permian cover (Hale *in* Spry and Banks, 1962).

The Parmeener Super-Group was extensively intruded by tholeiitic magma during the mid Jurassic. Parts of these intrusions have been dated at 170Ma (Schmidt and McDougall, 1961). More than 8000 km^3 of magma formed a nearly continuous body through the Permian and Triassic sediments over almost the whole island. The dolerite occurs most commonly as discordant sheets or sills although dykes are also seen. The sheets reach a maximum thickness of around 500 m, and being resistant to erosion dolerite tends to dominate the landscape of the eastern part of the State, capping all of the high mountains and underlying the great Central Plateau (Spry *in* Spry and Banks, 1962).

The east coast coalfields are covered by a dolerite sheets 100-300 m thick. A regional gravity survey (Leaman and Richardson, 1981) has helped define target zones for coal exploration by delineating areas where the coal-bearing section is thickest, faults, dolerite feeders and areas where dolerite intrusion has foreshortened or terminated the section.

From the cessation of Triassic sedimentation until Recent times Tasmania has been subject to normal faulting with a NNW trend (Solomon *in* Spry and Banks, 1962). Horst and graben structures of major dimensions developed during the Late Cretaceous to early Tertiary. As a result of this faulting coalfields have been fragmented and dislocated. In southern Tasmania two phases of faulting, a compressional event in the Mesozoic which was active both before and after the intrusion of dolerite and a later phase during Early to Middle Tertiary time (Berry and Banks, 1985).

A locality map is shown in Figure 2 and a section showing the Parmeener Super-Group across Tasmania in Figure 3.

MINING HISTORY

The first recorded discovery of coal in Tasmania was made by the French explorer Labillardière and his party in 1793, during an attempt to climb Mt La Perouse on the south coast of Tasmania. After settlement in 1803 numerous discoveries of coal were made in various parts of the island. A shipwrecked sailor found coal on Schouten Island south of Freycinet Peninsula on the east coast of Tasmania in 1809, while in 1815 James Kelly found an 'immense bed' of (brown) coal on the northern shores of Macquarie Harbour, whilst rowing around Tasmania in a whaleboat. Despite the very numerous discoveries of coal on the south coast, at Adventure Bay and in the headwaters of the Coal River, no successful mining occurred until 1834 when the colonial Government opened a coal mine at Saltwater River on Tasman Peninsula. Prior to this a small scale mining attempt at Coal Head, Macquarie Harbour was made by the prison authorities, and mentioned in the narrative of the convict Alexander Pearce.

The first commercial coal mining venture was made by a syndicate led by Charles Swanston (one of two Attorneys General of the day) at Southport. Whilst the syndicate received some Government assistance to sink the shaft, and the company achieved a measure of short-lived paper prosperity, the venture failed.

During the 1840s coal mining started on Schouten Island and near Jerusalem (Colebrook) in the headwaters of the Coal River, while in the 1850s work was begun on a grand scale near the Denison Rivulet by the Douglas River Coal Company, urged on by the eminent Dr Joseph Milligan. This venture also failed, like many of the early mining activities, due to a massive expenditure on infrastructure, leaving no funds for underground

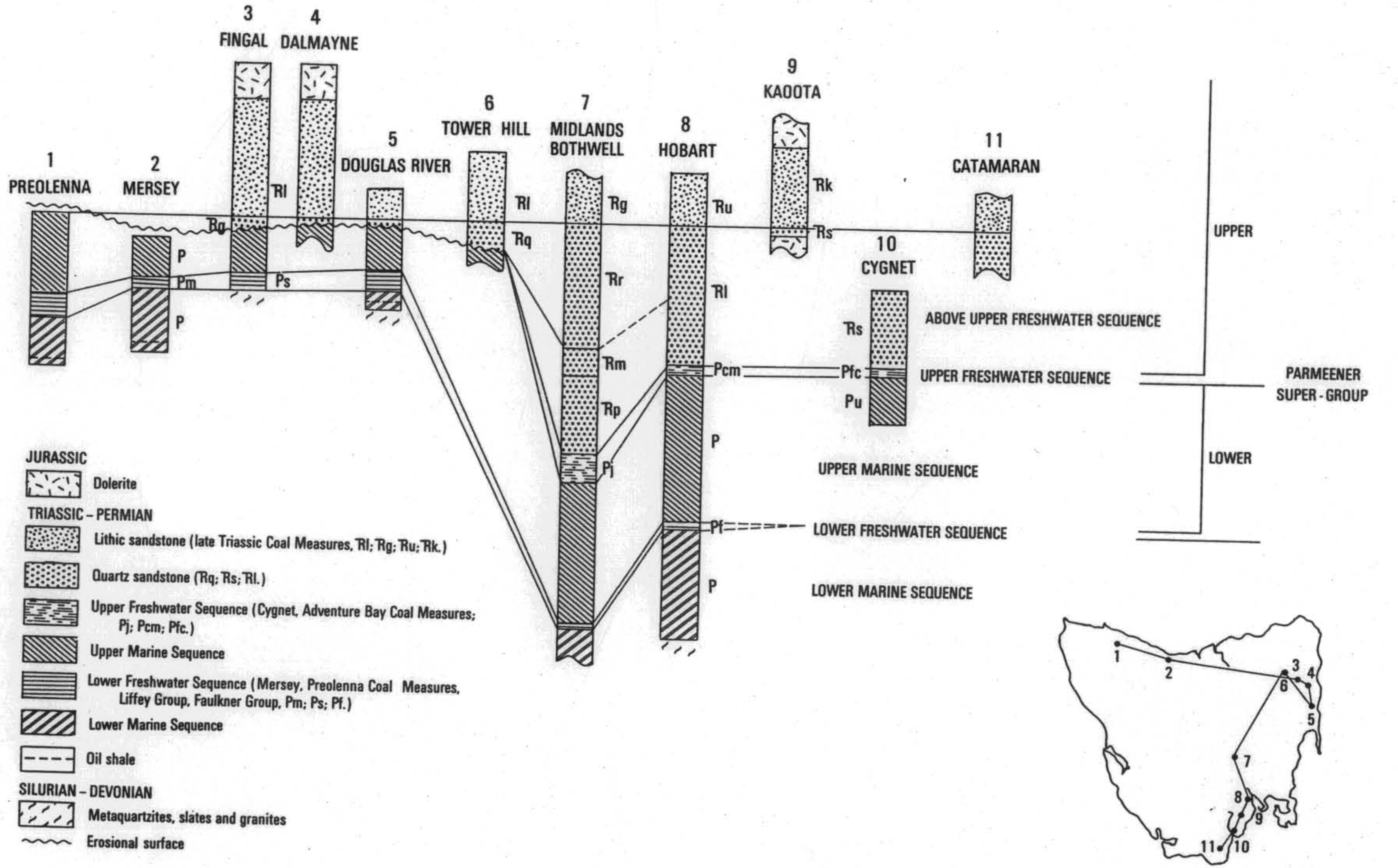

Figure 3. *Schematic section through Tasmania showing the Parmeener Super-Group.*

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development. The Mersey Valley coalfield was opened up in the 1850s and many small mines worked in this field intermittently, the last one, the Illamatha No. 2 closing in 1962. The New Town coalfield, near Hobart was also worked in the 1850s, sporadic activity finally ceasing around 1910.

An ambitious project began at Seymour in 1861 with the aim of mining coal and using the 'slack' or waste coal to retort kerosene. Whereas the retorting project failed, coal was mined at Seymour intermittently until 1964, and at Dalmayne, north-east of Seymour from 1915-1954. The Dalmayne colliery boasted a modern self-acting tramway which ran to Piccaninny Point, 15 km north of Seymour.

The largest deposits of coal are in the north-eastern area of the State. Whereas coal was known from the Fingal-Mt Nicholas area from around 1840 the lack of any suitable access prevented mining activities of any size from starting. However, in 1886 a railway line was laid from St Marys to Conara, connecting with the Hobart-Launceston railway and a means of transport became available. Mining began in earnest on Mt Nicholas in 1888. There have been several collieries in this area, although today, the Blackwood Colliery (opened in 1980) is the only colliery to work on Mt Nicholas.

At Fingal, south-west of Mt Nicholas, mining began intermittently in the 1920s. The Duncan Colliery opened in 1945 and is currently still in operation.

Plates 1-2 show scenes of former mining activities.

DEPOSITIONAL ENVIRONMENTS

LATE TRIASSIC COAL MEASURES

The Late Triassic lithic sandstone sequence is found over most of eastern and southern Tasmania (fig. 4), although usually obscured by a thick cover of dolerite. The lithic sandstone is of fluvial origin. Alluvial fining-upwards cycles were noted in drill core by Threader (1968). Using Markov chain analysis of the cycles, Bacon (1979) suggested that a meandering stream fluvial system of moderate to high sinuosity existed during the deposition of the lithic sandstone sequence.

The arenites are thought to represent channel deposits, the lutites and coals overbank deposits on extensive floodplains whereas intraclastic breccias and pebbly horizons represent channel lags.

The sequence has a higher proportion of arenite to lutite than is usually found in classical high-sinuosity meandering streams. This may be attributed to repeated erosion of upper (over-bank) parts of cycles formed during channel migration, producing the common and relatively thick (>20 m) sections composed only of channel sandstones in which incomplete fining up cyclicity may still be discerned.

Lateral and vertical changes in the gross arenite-lutite proportion suggest temporal and spatial variation in the fluvial regime, lutites being more significant in the lowest and highest parts of the sequence.

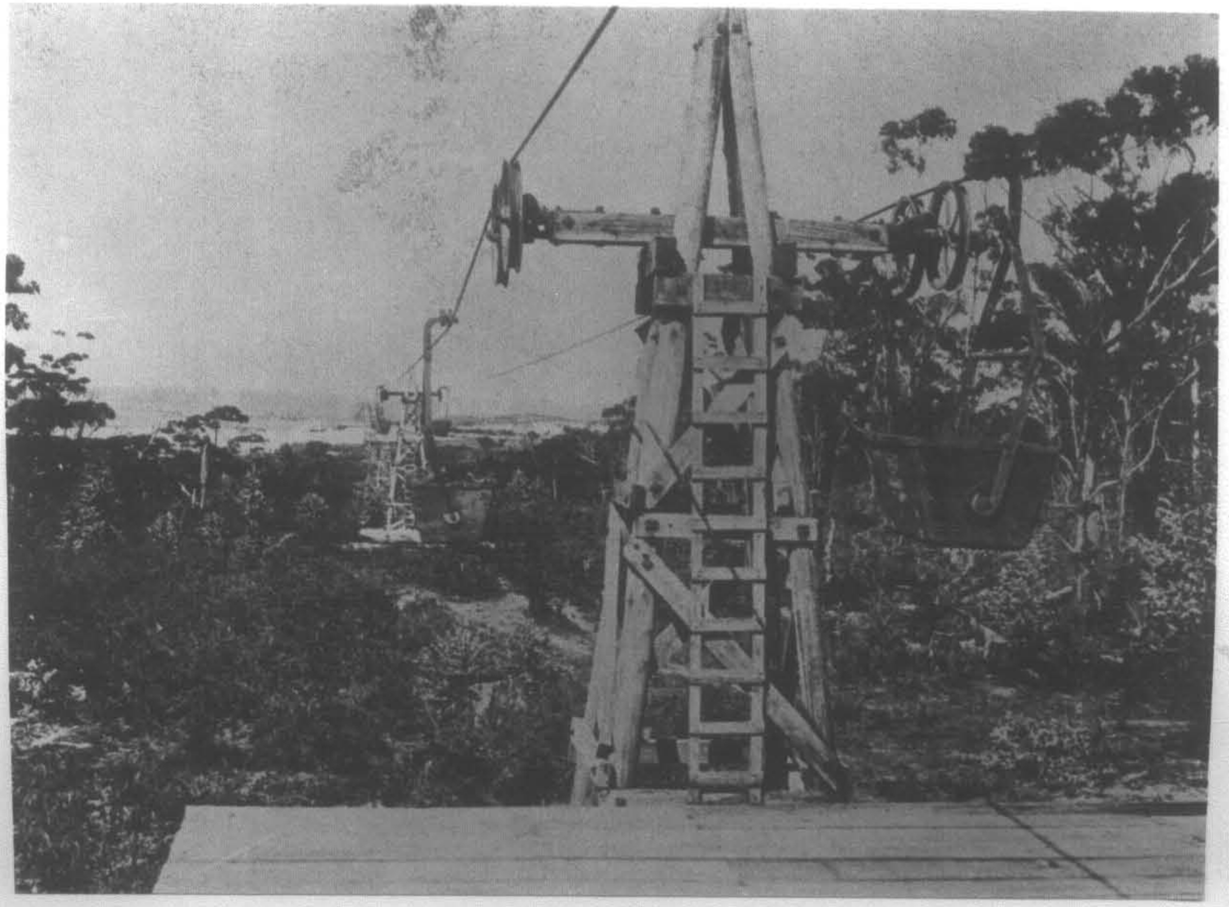

Plate 1. *Aerial ropeway at Dalmayne colliery, 1915.*

Plate 2. *Entrance to adit at Mt Nicholas coal mine, showing horse-drawn tramway.*

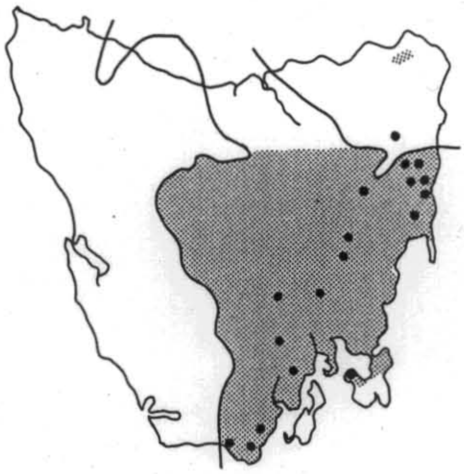

Figure 4. *Distribution map of the Late Triassic lithic sandstone sequence. Coal seams ›1.5 m thick indicated by a solid circle.*

The lithic sandstone sequence (Rl in the St Marys area) overlies a quartz-dominated sequence which has been further subdivided in other parts of the State. This quartz-dominated sequence overlies the Lower Parmeener Super-Group, which is largely marine. In the north-eastern part of the State the quartz-dominated sequence (Rq) is around 10 m thick, but this unit thickens rapidly to the south and west.

In central and southern Tasmania the base of the Upper Parmeener Super-Group is much older (Late Permian) and considerable thicknesses of quartzarenite predominate in the lower part of the section. In the Midlands, a unit of interbedded quartzarenite, lutite and carbonaceous beds (Rsq') occurs near the top of this interval (Forsyth, 1984*a*) and is similar in age and lithology to Rq of St Marys Quadrangle.

The lithic arenite-dominated unit in the north-east is a lithological correlate of the volcanic lithic arenite (Rg) of the Midlands area (Forsyth, 1984*a*), the upper part of the Brady Formation at Poatina (McKellar, 1957), the New Town Coal Measures, and similar lithic arenite-coal measure sequences widespread in eastern and central Tasmania.

Age of the Late Triassic Coals

In the Fingal Tier-Mt Nicholas region the coal bearing sequence has been dated by both palynological and radiometric means.

On Mt Nicholas, a basalt at the base of the coal bearing sequence has been dated by both palynological and radiometric means. The basalt has been radiometrically dated with a whole-rock K-Ar analysis giving a minimum age 233±5 Ma (Calver and Castleden, 1981). Samples from above and below the basalt have yielded a microflora that can be correlated with the *Aratrisporites parvispinosus* Assemblage Zone and the *Duplexisporites problematicus* microflora of de Jersey (1975) (Forsyth, 1984*b*), considered to be Anisian or Ladinian (Middle Triassic) in age (Calver, 1986).

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Miospore assemblages from several coal seams from the sequence on Fingal Tier and Mt Nicholas were examined by Playford *in* Threader (1968). All assemblages were qualitatively similar, and showed close affiliation with the Brady Formation. All belong to the *Craterisporites rotundus* zone (Forsyth, 1984*b*) which in the Bowen Basin is considered to represent the Karnian (early Late Triassic) (de Jersey, 1975).

Biotite extracted from a Triassic tuff exposed in the Denison Rivulet has been radiometrically dated at 214±1 Ma (Bacon and Green, 1984), approximating the 215±5 Ma Karnian/Norian boundary age proposed by Webb (1981). This tuff crops out in the upper part of the lithic arenite sequence. On Fingal Tier, similar acid tuffs are restricted to that part of the sequence above the 'B' seam. A spore assemblage from about 50 m stratigraphically below the dated tuff belongs again to the *Craterisporites rotundus* zone (Forsyth *in* Bacon and Green, 1984).

Macroflora

Coalified plant remains of fair preservation are quite common in the coal-bearing sequence. The flora is dominated by filicales (ferns), pteridosperms (seed ferns) and ginkgoales (maidenhair trees). Cycad leaves and scouring rushes are also common. Taxa found include *Cladophlebis, Dicroidium, Xylopteris, Halleophyllum, Ginkgoites, Sphenobaeria (Czekanowskia)* (Townrow *in* Spry and Banks, 1962). The plant association is compatible with the Broadleaf Forest Association of Retallack (1977).

The environment of deposition of the Late Triassic coal measures was a terrestrial flood plain with many streams of moderate to low sinuosity frequently changing direction and eroding existing overbank deposits. Areas in which peat accumulated were subject to frequent flooding and drying out. The remains of a variety of reptiles, fish and amphibians recovered from rocks of Early Triassic age near Hobart have been listed by Banks, Cosgriff and Kemp (1978), and growth rings indicating seasonal growth in fossilised wood from the coal measures at Langloh and Fingal (Morrison and Bacon, 1986) suggest that conditions during the Triassic were not freezing. Although Tasmania was within 20° of the south pole during the Triassic (Embleton, 1973) the climate at high latitudes was warmer than at present. Studies on the distribution of fossil flora (Barnard, 1973), the range of some species of the lamellibranch *Monotis* (Westermann, 1973) and examination of oxygen and deuterium isotope compositions in cherts in central U.S.A (Knauth and Epstein, 1976) all conclude that Triassic temperatures were globally warmer than at present.

The Tasmanian Triassic coal measures were deposited in a cold temperate environment which supported a broadleaf forest. Coal swamps were laterally restricted and shortlived, giving rise to thin, discontinuous seams.

LATE PERMIAN (CYGNET, ADVENTURE BAY COAL MEASURES AND EQUIVALENTS)

The Cygnet Coal Measures and correlates are considered by Banks and Clarke (in press) to have been deposited in fluviatile or upper delta plain conditions. These rocks are overlain by sandstones containing the Early Triassic *Kraeuselisporites saeptatus* Assemblage (Forsyth, 1984).

The Cygnet Coal Measures and equivalents are absent from the north-eastern part of the basin, and may be discontinuous elsewhere possibly due to pre-Triassic erosion (fig. 5).

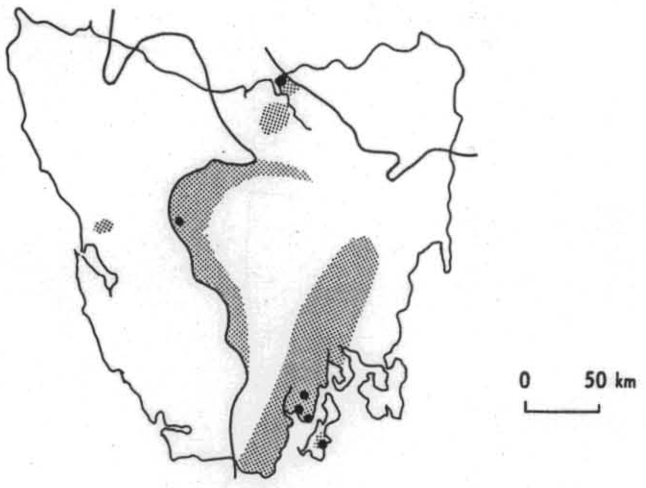

Figure 5. *Distribution of the Upper Freshwater Sequence (Cygnet Coal Measures and equivalents); coal accumulations indicated by a solid circle (after Banks, 1962).*

The dominant rock type is a well sorted siliceous to arkosic cross-bedded and ripple-marked sandstone, which is pebbly in places. Carbonaceous and siliceous siltstones are commonly interbedded with the sandstones, and are often micaceous (Banks, 1962). During the Late Permian a sandy plain extended across part of the Tasmania Basin, which was flanked on the east and west, and also broken up, by hills. Whilst initially sandy, the overall general fining upwards suggests a gradual lowering of the source area.

The flora at this time evidently consisted of the scouring rush *Phyllotheca*, and the plants *Schizoneura*, *Gangamopteris*, *Glossopteris* and *Vertebraria*. The vegetation preserved is dominantly pteridospermatous but there is evidence of rushes and larger woody gymnosperms (Banks, *in* Spry and Banks, 1967). The only animal remains are worm tubes and castings.

EARLY PERMIAN (MERSEY, PREOLENNA COAL MEASURES AND EQUIVALENTS)

The Mersey Coal Measures and equivalents were deposited as a thin sheet of fluviatile sands which covered both earlier Permian highland areas and the earlier Permian sea floor. The sheet ranges from 6-50 m in thickness, with marked local thinning out against residual basement highs (Banks and Clarke, in press). Some syndepositional faulting has been recognised near Sassafras (Banks, 1979). The dominant rock type is a well-sorted siliceous, micaceous, cross-bedded or ripple-marked sandstone with either no fossils or worm castings and some coaly debris. The distribution is shown in Figure 6.

Interbedding with grey siltstone is common. Thin coals were deposited around the margins of the depositional basin (Banks *in* Spry and Banks, 1962). The environment of deposition of the sand sheet is considered to be a wide sandy coastal plain. Further into the basin strongly bioturbated siltstone with dropstones, presumably glaciomarine deposits, rarely with a shelly fauna, occur interbedded in the sand sheet. In these areas, for instance near Gould Sugarloaf, Bothwell, Ross and further south no coal seams are known. At Ross the sand sheet cross-bedding sets are usually no more than 100-150 mm high, suggesting they are not the deposits of a major river. At some localities some poorly sorted beds in the sequence are considered to be littoral deposits, representing beaches where deposition was comparatively rapid.

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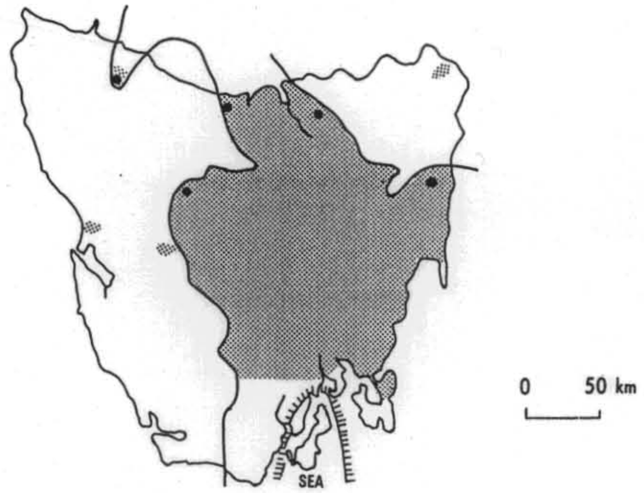

Figure 6. *Distribution of the Lower Freshwater Sequence (Mersey Coal Measures and equivalents); coal occurrences indicated by a solid circle.*

In south-eastern Tasmania the non-marine sequence contains a thin marine intercalation which produces two cyclothems.

The flora of this period is represented by the plants *Glossopteris*, *Gangamopteris* and *Noeggerathiopsis*. Where sampled, the Mersey Coal Measures yield a Substage 3b microflora, which means that these coal measures are significantly older than the Greta Coal Measures in N.S.W and the Collinsvale Coal Measures in Queensland.

The alga *Reinschia* occurs in coals and carbonaceous shales and at Mt Pelion is common enough to form torbanite.

DESCRIPTION OF THE MAJOR COALFIELDS

FINGAL-MT NICHOLAS-DALMAYNE

The bulk of the State's coal reserves are in the north-eastern part of the State, in the Fingal-Mt Nicholas-Dalmayne coalfields.

The basement rocks here are folded and cleaved Siluro-Devonian quartzwacke turbidite and Devonian granite, which are unconformably overlain by the largely marine Lower Parmeener Super-Group, which is about 120 m thick around Fingal and Dalmayne but of variable thickness due to erosion prior to the deposition of the freshwater Upper Parmeener Super-Group.

At the base of the Upper Parmeener Super-Group is a thin unit of dominantly quartz arenite, only 2-3 m thick over most of the area. The rest of the Triassic sequence, about 350 m thick, consists dominantly of medium-grained lithic arenite, interbedded with mudstone, carbonaceous mudstone and coal. The lithic arenite is typically thick-bedded, often showing trough cross-bedding. Intraformational breccia, with rip-up clasts of mudstone and coal, is common at the base of sandstone beds.

Seams can be correlated across Fingal Tier into the adjoining Dalmayne coalfield to the east although some seams split and in parts are represented by mudstone intervals; faulting is common (fig. 7).

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There are eight major coal seams on Fingal Tier, these have been designated seams A-H. Some, notably the A and B seams, are better described as carbonaceous intervals, as they consist of plies of coal less than 0.5 m thick interbedded with carbonaceous mudstone and claystone over intervals of 5-10 m. All the seams are characterised by a high inherent ash content, and have only a small (10%) component of bright coal. The coal is of medium rank, with a high ash and low sulphur content, and is suitable for steam raising purposes.

No satisfactory marker horizons have been recognised in the fluvial sequence on Fingal Tier. In order to obtain a reliable correlation of coal seams it has been necessary to drill to the glacio-marine sequences of the Lower Parmeener Super-Group. This basement dips gently to the east and forms a known horizon from which correlation of coal seams may be more confidently undertaken. Drill holes must commonly be 500-600 m deep in order to reach the glacio-marine basement.

On parts of Fingal Tier a conglomerate horizon (1-3 m thick) has proved to be a reasonably good marker where present. The conglomerate band (informally called the Dalmayne Conglomerate) is composed of well-rounded pebbles and cobbles of green and white quartzite, acid pyroclastic rocks, and slate, elongate to spherical in shape, and set in a matrix of coarse-grained lithic sandstone. The conglomerate band is, however, too patchy in areal distribution to be a significant marker bed.

A number of tuff intersections have been recorded in the eastern part of the Fingal Tier. The tuff is an acid, air-fall vitric tuff, with the intersections one metre thick. However, the patchy areal distribution of the tuffs makes them of little use as a marker horizon.

The two seams which are of greatest economic interest on Fingal Tier are the Duncan (seam F) and the East Fingal (seam G).

The Duncan Seam is currently mined at the Duncan Colliery and is the only seam to have been extensively worked. Typically the seam consists of 2-3 m of dull coal with minor clay and mudstone partings. The raw ash content is approximately 30% and the specific energy 22-24 MJ/kg.

The East Fingal Seam is about 30 m stratigraphically below the Duncan Seam, and is commonly split. The Upper and Lower Splits (Gu and Gl) of the East Fingal Seam are commonly 1-2 m in thickness, with the intra-seam sediments 0-10 m in thickness. The coal quality is similar to that of the Duncan Seam.

Thick sill of dolerite covers the coal-bearing sediments of the Dalmayne and Fingal Tier coalfields. This dolerite is commonly 100-300 m thick and forms an extensive plateau, part of the central eastern highlands.

The Mt Nicholas coalfield, north-east of Fingal Tier is confined to the Nicholas Ranges which like Fingal Tier is capped by dolerite. The sedimentary sequence is equivalent to that of Fingal Tier and Dalmayne, although the coal seams are found in three intervals within the lithic sandstone sequence on Mt Nicholas.

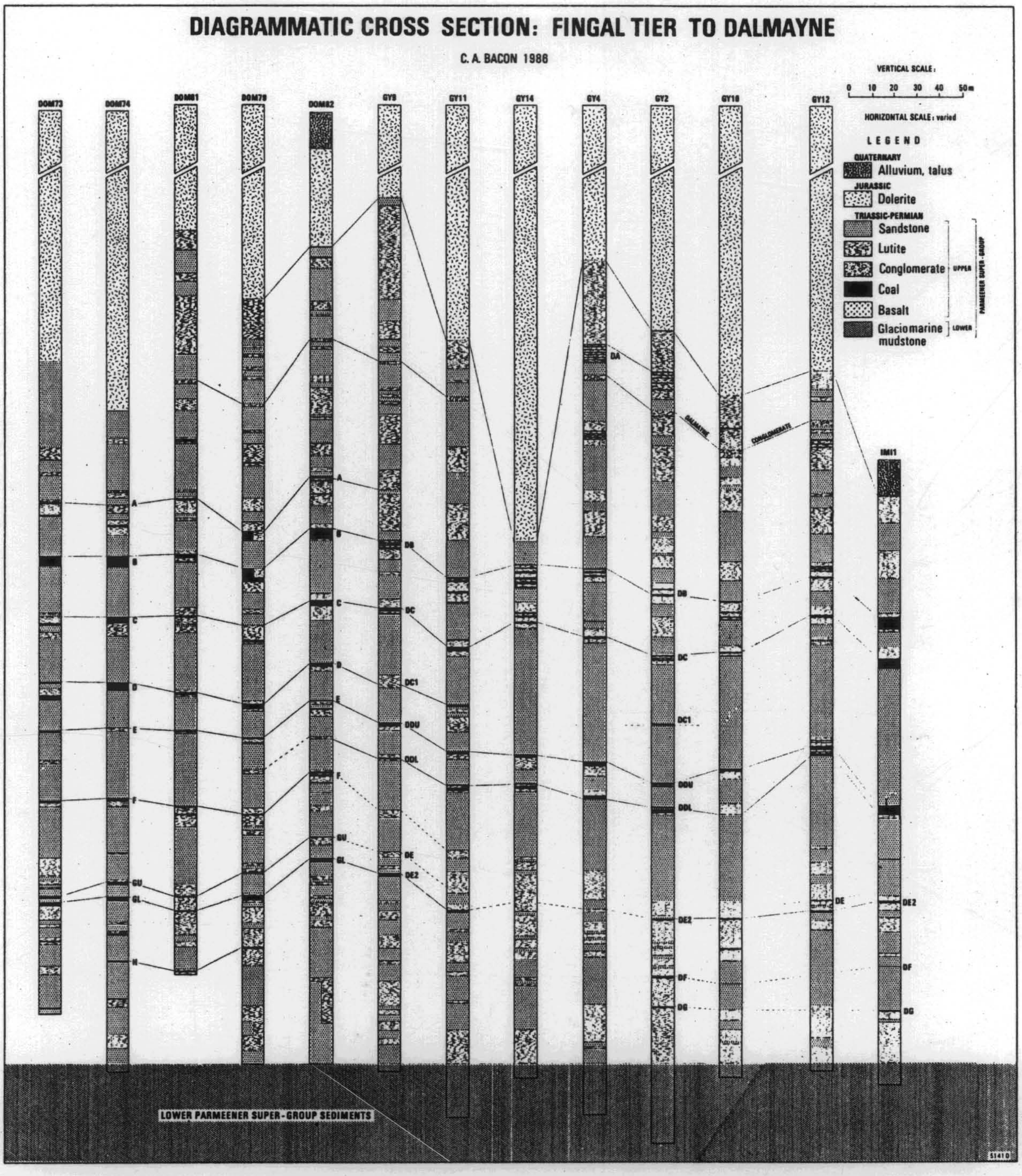

Figure 7. *Diagrammatic cross section: Fingal Tier to Dalmayne.*

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The upper group of seams are of poor quality coal interbedded with claystone and mudstone. The middle and lower groups of seams contain the seams which have been mined previously. The lower group of seams on Mt Nicholas are equivalent to the East Fingal interval further south.

DESCRIPTION OF THE MINOR COALFIELDS

LATE TRIASSIC COALFIELDS

Triassic coal has been mined from a large number of places in the eastern part of Tasmania. At Saltwater River the colonial government ran a mine using convict labour. The coalfield here is confined to a small downfaulted wedge-shaped block of lithic sandstone, surrounded by barren quartzose sandstones.

South of Dalmayne, near the Douglas River, Triassic coal was mined from shafts sunk into the coastal plain in the 1850s and further north at Seymour also from shafts in the 1880s.

Shafts were sunk at New Town, near Hobart, in the 1880s. These shafts were all sunk directly into lithic sandstone.

At Kaoota, south of Hobart, and at Langloh in the Upper Derwent Valley the coal has been mined from adits driven from outcrop. The coal-bearing section, around 100 m thick in both instances, rests on a dolerite floor. The area of these two coalfields is quite small - 1 km^2 for Kaoota, 10 km^2 for Langloh. Both have been formed by the rafting up of the lithic sandstone sequence by intrusive dolerite.

Significant finds of coal have been made near Ben Lomond (Stanhope-Mt Christie coalfield), in the Midlands area and in the south of Tasmania around Catamaran.

LATE PERMIAN COALFIELDS

The Cygnet Coal Measures is the lowest unit of the Upper Parmeener Super-Group, underlain by glacio-marine mudstones of the Lower Parmeener Super-Group and overlain by quartzose sandstones.

At Cygnet the coal measure sequence is about 30 m thick and crops out along the slopes of Mt Cygnet and Mt Heeney, near the township of Cygnet. Two seams, each less than 1.0 m thick have been mined from a number of adits driven in on outcrops. The small area of the Cygnet Coal Measures at Cygnet is badly disrupted by faulting. Jurassic dolerite caps Mt Cygnet and is faulted against the sedimentary sequence to the east of Heeneys Bluff.

These coal measures also crop out on Bruny Island at Adventure Bay where they were mined briefly in the 1880s.

EARLY PERMIAN COALFIELDS

The Preolenna coalfield is located 20 km south-west of Wynyard. The Preolenna Coal Measures are equivalents of the Mersey Coal Measures further east, and overlie a marine siltstone of the Inglis Siltstone and correlates (part of the Lower Marine Sequence) in which is found a Tasmanite Oil Shale horizon. The Preolenna Coal Measures are overlain by a marine sandstone sequence, the Flowerdale Sandstone (part of the Upper Marine Sequence). The

Preolenna Coal Measures crop out in the valley of the Jesse Gorge, in rough country, in parts inaccessible.

Four thin seams of coal 0.2-0.6 m thick are known from the area. The coal measures reach a maximum thickness of 50 m, have been extensively faulted. The seams near Preolenna dip at 14-25°. Historic mining activity was unsuccessful due to the thin nature of the seams which frequently thin out and are disrupted by faulting.

In an area between the Mersey and Don Rivers, a number of small collieries have won coal intermittently from the Mersey Coal Measures over the period 1850-1962.

The seams are thin (<1.0 m thick), faulted, and are not laterally extensive. Mining was done by hand using both bord and pillar and longwall methods of extraction. A total of 21 small collieries have operated in this area. The coal measures are 19-29 m thick and are underlain by siltstones and mudstones (Spreyton Beds) of the Lower Marine Sequence and overlain by the Kelcey Tier beds of the Upper Marine Sequence.

PETROGRAPHY

The petrographic composition of coal has been related to factors prevailing in the environment of deposition. Both the type of vegetation contributing material to the peat and the amount of moisture in the peat swamp are important in determining the final composition of the coal. Earlier workers (Hacquebard, *et al.*, 1967; Hacquebard and Donaldson, 1969) examined microlithotypes to determine coal facies and the palaeoenvironments.

The technique of relating vegetation zones to coal composition has been refined further by Diessel (1986), to a stage where the distribution and abundance of certain macerals, not microlithotypes, can be used to determine the palaeoenvironmental conditions of peat deposition.

Similar source materials may produce quite different maceral products in different conditions of peat formation. Wet conditions, usually associated with fast subsidence, will produce gelified residual tissue, (tellinite and tellocollinite) while under conditions of slow subsidence a drier environment is more likely and the tissue products may become fusinitised, producing fusinite and semifusinite. The ratio between these two groups of macerals can be used as an indication of the level of moisture in the peat swamp. This ratio, defined by Diessel (1986) as the Gelification Index. High ratios represent wet limnotelmatic forest moors while low ratios reveal that the coal formed in a dry terrestrial moor (Diessel, 1986). The macerals derived from woody tissue (tellinite and tellocollinite in wet habitats, fusinite and semifusinite in dry habitats) can be combined and contrasted with macerals derived from the destruction of cell tissue, to give a measure of the amount of wood to non-wood derived material in a coal. This ratio is defined by Diessel (1986) as the Tissue Preservation Index. A low TPI indicates the absence of woody tissue in the coal, due to either the absence of suitable habitats (such as the forest moor habitat) or the near-complete destruction of woody tissue due to oxidation

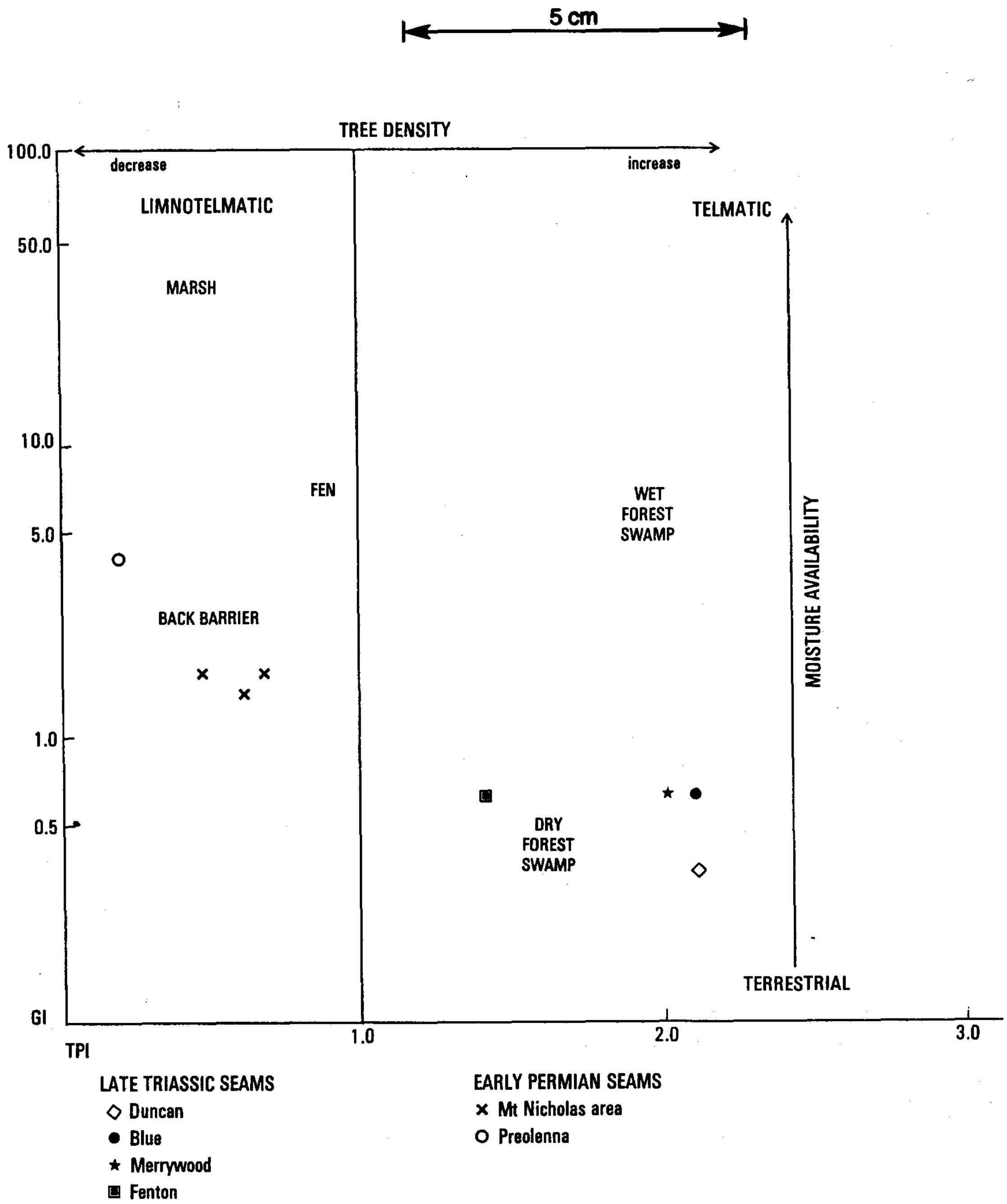

Figure 8. *Coal facies diagram showing environments of formation of some coal seams (graph construction after Diessel, 1986).*

of the peat (Diessel, 1983). Coal from a treeless moor may contain an abundance of exinite (especially sporinite) and inertodetrinite, but also some alginite and other evidence of a subaqueous nature, such as cross-lamination or graded bedding. In the case of the woody tissues being destroyed by oxidation, the coal would also contain a high proportion of exinite and the detritus of the fusinite and semifusinite in the form of inertodetrinite, but no alginite or evidence of subaqueous deposition.

Coal facies can be identified using the two indices and different environments of formation for the various seams or plies determined.

Coal facies for the various seams are shown in Figure 8 and graphic representation of the facies of coal plies of three Late Triassic seams are shown in Figure 9.

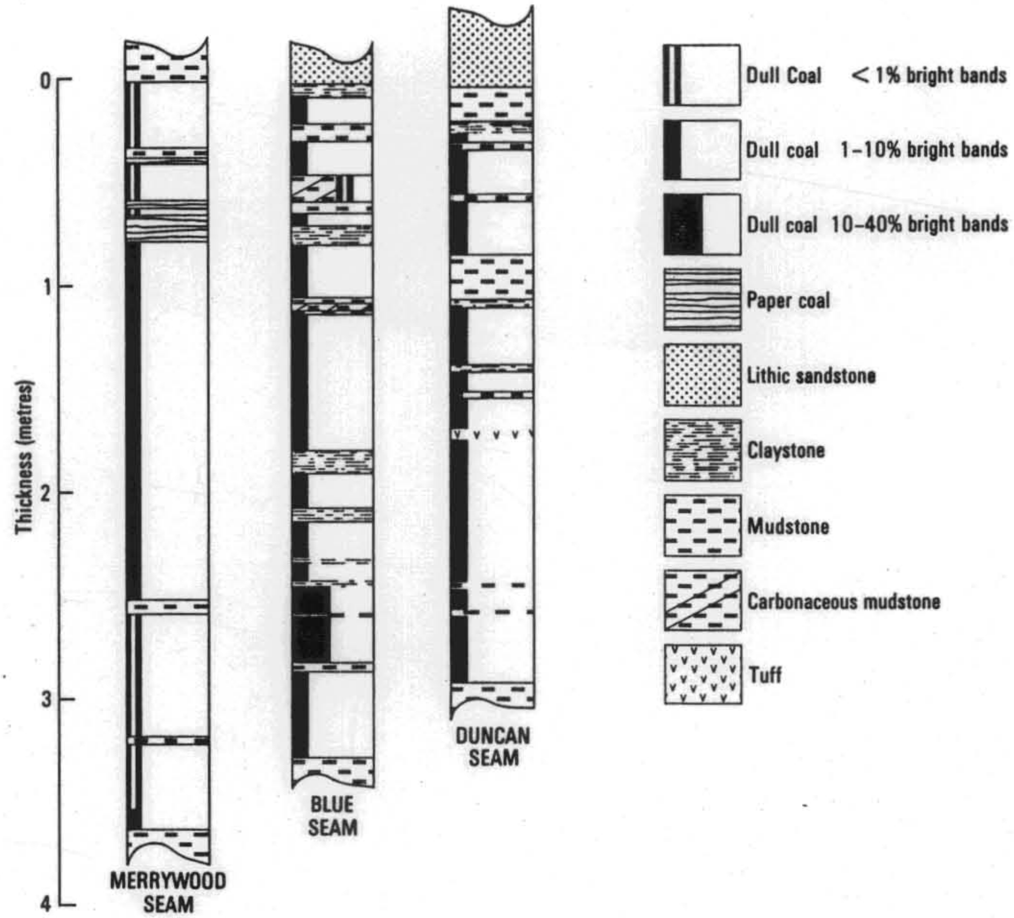

Figure 9. *Graphic representation of the Merrywood, Blue and Duncan seams.*

LATE TRIASSIC SEAMS

The Late Triassic coals are very dull, with high raw ash contents of 25-30%, and low sulphur (0.5%). The specific energy of the raw coals is 20-24 MJ/kg.

The main component of the coals is inertinite which makes up 60-70% of most of the Triassic coals. Vitrinite, usually in the form of a collinite makes up no more than 10% of the coal. The exinite content is similarly low (5-10%). The dominant exinite maceral is cutinite. Finely-dispersed mineral matter, mostly clays and quartz, fills cell lumens and is well dispersed throughout the plant material. The coal cannot be washed to an ash content of below 20% as the finely disseminated mineral matter cannot be removed.

The petrographic composition of three Late Triassic coal seams is shown in Figures 10-12.

Most of the seams are banded; mudstone or claystone attesting to periodic inundation of the peat swamps with sediment-bearing floodwaters. Some of the bands are derived from ash-fall material.

5 cm

Duncan Seam

This seam is mined at the Duncan Colliery near Fingal. The dominant maceral group of this seam is inertinite, and overall the seam composition does not vary greatly from ply to ply. The vitrinite content is low throughout the whole seam with most of the vitrinite being various forms of collinite. The vitrinite content is slightly higher at the base of the seam (30%) possibly indicating the existence of wetter conditions at the time the peat swamp became established. The dominant inertinite maceral is semifusinite in all plys of the seam. The content of inertodetrinite is also quite high. Exinite is distributed evenly throughout the seam with cutinite being the dominant exinite maceral.

All coal plies of the Duncan Seam have a GI of 0.25, which indicates that the environment of coal formation was dry. The TPI (wood ratio) for most plys of the seam has a value of 3-4 which indicates that a substantial proportion of wood-derived macerals are present in the coal.

The two indices indicate that the peat formed from accumulated woody material in a relatively dry environment.

The peat was subject to frequent drying and oxidation which resulted in the abundance of inertinite. Periodical flooding of the peat swamp is indicated by the presence of a number of claystone bands.

Blue Seam

This seam is mined at the Blackwood Colliery on Mt Nicholas in north-eastern Tasmania

The Blue Seam is similar to the Duncan Seam, inertinite (mainly semifusinite) but has a higher vitrinite content. The vitrinite content is highest at the base of the seam (40%), generally decreasing towards the top of the seam (10%). The seam is extremely banded, containing about nine claystone and mudstone bands. The dominant exinite maceral is cutinite.

The GI for the plys of the Blue Seam indicates that the environment was relatively dry, but not as dry as that in which the Duncan Seam was deposited. The wood ratio shows that about 50% of the macerals in the seam are derived from woody tissue.

Merrywood Seam

The Merrywood Seam is mined intermittently at a small open-cut south-west of Fingal.

The most distinctive feature of the seam is three plys of 'paper coal' found towards the top of the seam. These paper coals are composed of tightly compacted '*Johnstonia*' leaves.
The dominant maceral group in all plys excepting the paper coals is inertinite, mainly semifusinite. The dominant exinite maceral is cutinite.

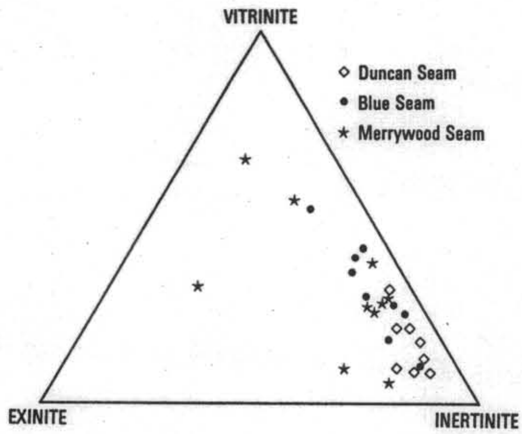

Figure 10. *Petrographic composition of the Late Triassic coal seam plies.*

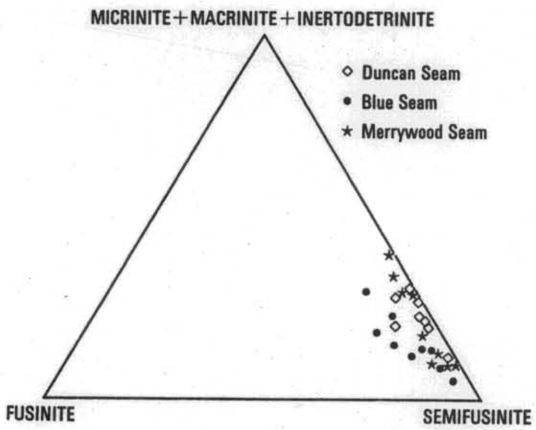

Figure 11. *Inertinite composition of the Late Triassic coal seam plies.*

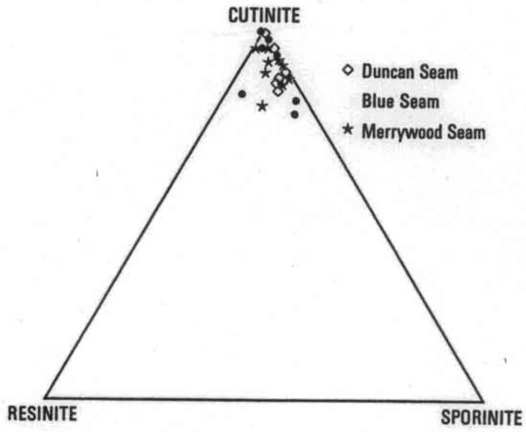

Figure 12. *Exinite composition of the Late Triassic coal seam plies.*

5 cm

The paper coals are composed of exinite (mainly cutinite), vitrinite and large quantities of clay particles. The *Johnstonia* leaves which have a very thin cuticle are found clumped together, and matted with mineral matter. The leaves may have been from a type of water-weed, carpeting a shallow pond during times when the peat swamp was inundated. When the swamp dried out, the matted water-weed was deposited on top of the peat. An influx of muddy water may also have caused the water-weed mat to break up and be deposited with the mud, as one of the paper coal plys contains 90% of clay material.

Summary

A considerable proportion of the coal in all three seams has evidently been derived from woody tissue as shown by the TPI indices (wood ratio) for the various plies of each seam, and the woody component is fusinitised. Figure 8 shows the seams plotted on a coal facies diagram.

From a study of Australian Permian and Triassic coals, Gould and Shibaoka (1980) conclude that a high inertinite content can be considered to form during periods of low water table or during an influx of aerated surface water causing partial oxidation of the peat, or even by burning of the peat prior to burial.

The three seams are considered to have formed from peat which collected in a dry forest-moor environment. No evidence, such as graded bedding in inertodetrinite concentrations, has been found for subaqueous deposition of any of the coals. Pyrite is rare in the coals, indicating that the peat did not form in stagnant reducing waters.

The variable but high concentrations of semifusinite and inertodetrinite point to periodic oxidation of the peat, while the presence of a great many dirt bands (predominantly in the Blue Seam) are the result of periodic flooding of the swamp. The paper coals at the top of the Merrywood Seam are possibly analogous with an 'open moor' facies and represent periods of flooding and 'algal bloom' type conditions over the swamp surface.

LATE PERMIAN SEAMS

Few analyses are available for these coal measures. The coal appears to be petrographically similar to the Late Triassic coals with a high proportion of the coal being derived from wood which has become fusinitised.

EARLY PERMIAN SEAMS

These coals, from the Mersey and Preolenna Coal Measures are typically low in ash (8.12%), high in sulphur (3.5%) with a specific energy of 29-30 MJ/kg.

These are characterised by a high vitrinite content of between 40.60%, although most is in the form of varieties of collinite and not preserved as woody tissue. The exinite content is considerably higher than that of the Late Triassic coals, being around 15-20%. The dominant exinite maceral is sporinite, and alginite has been noted in some samples, indicating that the coal swamp was flooded for part or all of the peat formation. The petrographic composition is shown in Figures 13-15.

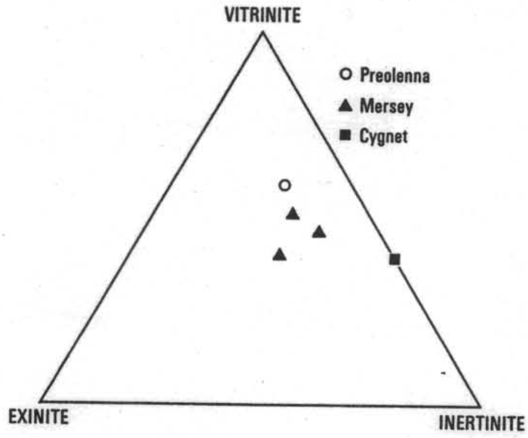

Figure 13. *Petrographic composition of the Early Permian and Late Permian coal seams.*

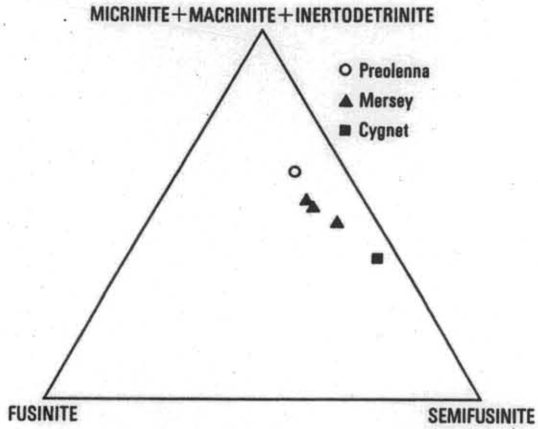

Figure 14. *Inertinite composition of the Early Permian and Late Permian coal seams.*

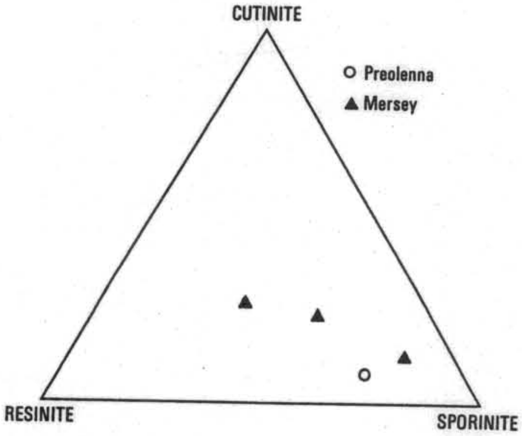

Figure 15. *Exinite composition of the Early Permian coal seams.*

5 cm

These coals have a low wood ratio 0.25-0.75), suggesting that they formed in a habitat which did not produce significant quantities of woody tissue. The moisture index of around 1 suggests a relatively wet environment. These coals probably formed in an open moor habitat. This conclusion is supported by the presence of alginite, indicating a subaqueous environment of deposition, large quantities of sporinite as spores tend to collect in lakes and ponds and the high proportion of collinite which would be derived from the decomposition of soft-tissued leaves, and possibly from grasses and reed-like plants.

The coals commonly contain pyrite, found as coatings on the cleat.

CURRENT MINING OPERATIONS

Two collieries currently produce coal in Tasmania: the Duncan Colliery at Fingal and the Blackwood Colliery on Mt Nicholas near St Marys. Both are owned and operated by the Cornwall Coal Company N.L. At each colliery coal is mined using the bord and pillar system of extraction.

At the Duncan Colliery, which has operated since 1945, coal is produced from the Duncan Seam, which ranges from 2.0-5.0 m in thickness. A workforce of 80 men are employed on a 24 hour cycle nine days per fortnight. Face equipment consists of 'Joy' 12 cm-11, 1000 volt continuous miners, each with two 12 tonne capacity shuttle cars discharging raw coal through 'Hannaford' breaker feeders onto 900 mm width belt conveyors, totalling some 5 km in length. Geological conditions in the mine vary as over most of the seam the original roof (laminite and claystone) has been eroded. Compaction and faulting are not uncommon and occasional dolerite intrusions have disrupted parts of the seam. Mining of the seam occurs from outcrop to a depth of 420 m, leading to features such as floor heave in some parts of the mine.

The Blackwood Colliery, on Mt Nicholas, opened in 1980, works the Blue Seam which is approximately 5.0 m thick. Of this 3.6 m is mined. A crew of 21 men are employed using similar machinery and mining methods as used at the Duncan Colliery. Coal is mined from outcrop to a total depth of around 300 m under part of the Nicholas Range. Vertical loading stress as expressed in floor heave is more common in the areas of thick overburden.

Coal from both these collieries is treated at a jig washery near Fingal. The washed coal is used in a variety of domestic secondary industries as boiler fuel and in the making of cement. Raw coal production for 1983-1984 was 275 716 tonnes.

BROWN COAL

Lignite of Tertiary age has been found in small deposits in many places within Tasmania. The largest deposit is at Rosevale, near Westbury, in northern Tasmania, where an indicated *in situ* reserve of 118 Mt of brown coal has recently been defined. Other, smaller deposits of lignite are known from the northern shore of Macquarie Harbour, the Tamar and Derwent Valleys, King Island and from a number of localities along the North West Coast. The distribution of brown coal in Tasmania is shown in Figure 16.

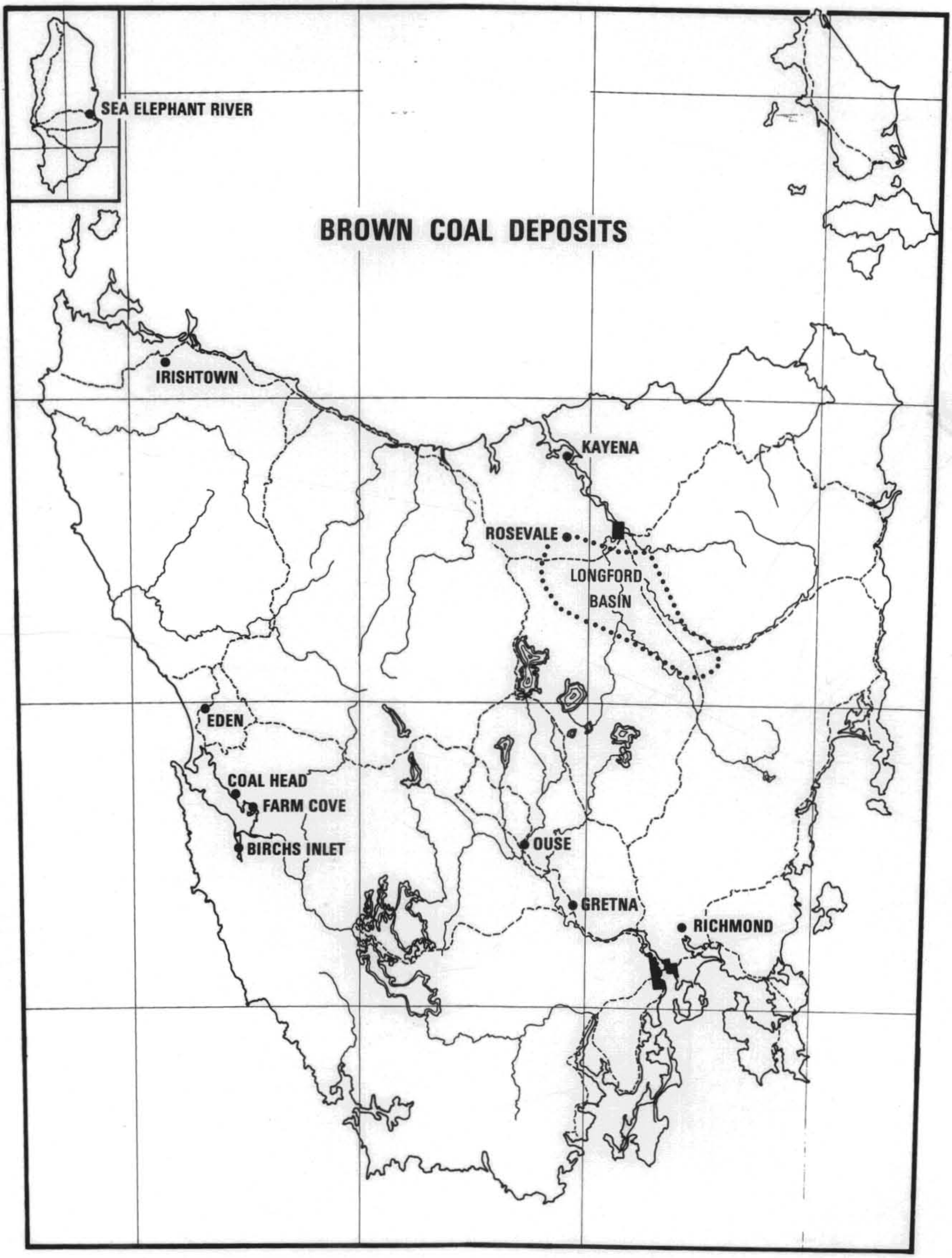

Figure 16.

5 cm

OIL SHALE

One horizon of oil shale is known in Tasmania. This is of Late Carboniferous age, stratigraphically below the Mersey Coal Measures and equivalents. The shale does not pass either laterally or vertically into coal. The shale horizon which is about 2 m thick (max.) is composed of large numbers of bodies of *Tasmanites punctatus* (probably a green alga) in a matrix of very fine-grained sand and silt. The oil shale was deposited in a close to shore, shallow marine environment. The oil shale was mined for a brief period during the 1920s and 1930s, and attempts made to extract a fuel from the shale. These efforts were non-commercial. More recently the shale has been examined as a potential source of road-making bitumen.

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