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THE SHELL COMPANY OF AUSTRALIA LIMITED

EXPLORATION LICENCE 18/77, AVOCA

TASMANIA

A REVIEW OF THE COAL RESOURCES AND PROSPECTIVITY

BY

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SUMMARY

Exploration Licence 18/77 covers an area of 1473 km<sup>2</sup> of northeastern Tasmania. It constitutes the western part of the main coal mining province of Tasmania, and has, in the past, supported small scale mining. The only currently productive mines in Tasmania are in the area immediately to the east of the licence area.

Relatively discontinuous coal seams occur in the uppermost 200 m of a gently dipping Permo-Triassic sequence which is overlain with regional concordance by intrusive Jurassic dolerite generally several hundred metres thick. Local discordance between the dolerite and the underlying sediments has resulted in the removal of the coal measures in many parts of the licence area.

A relatively small number of holes have been drilled in the course of exploration over the past five years by three companies. Although individual holes have intersected seams of economic thickness and quality, none of the intersections have been sufficiently encouraging to prompt the proving of reserves. Over the whole of the area however inferred reserves may be in the large category. Sparse quality data indicate that, given acceptable ash contents, the coal has good steaming coal characteristics.

The present knowledge of the coal geology of the licence area suggests that it is prospective only for small to medium sized deposits, several of which could be distributed throughout the area. Two specific exploration targets are indicated, in the northwest Avoca area, and in the area to the south of Royal George.

Regional gravity surveys have proved to provide the most effective method of identifying areas of minimal dolerite transgression. Future exploration should make the best possible use of this guidance and in the reconnaissance stage follow-up drilling using geophysically logged open-holes is recommended.

## 1. INTRODUCTION

### 1.1 Scope

This report reviews the prospectivity for coal of Exploration Licence (EL) 18/77 AVOCA, drawing on all of the available geological and geophysical data, and taking into account the impact on potential mine developments of existing infrastructure. Previous exploration activity is reviewed and, in the light of the perceived prospectivity of the EL, recommendations are made for future approaches to exploration.

### 1.2 Tenure

EL 18/77 has been held by the Shell Company of Australia Limited since 26th January 1978, and has been progressively renewed with some relinquishments and additions until 26th July 1981.

### 1.3 Location and Access

EL 18/77 occupies an area of 1473 km<sup>2</sup> in northeastern Tasmania within AMG co-ordinates 540000 mE - 590000 mE and 5350000 mN - 5390000 mN (figure 1) (enclosure 1).

The township of Avoca (population 207) lies within the EL while the larger centre of Campbell Town (population 936) straddles the southwestern EL boundary.

A network of mainly unsealed roads and numerous logging and farm roads provide reasonable access to most of the licence area. Access for drilling equipment to specific sites generally requires the construction of new roads, the maintenance of which is often difficult during periods of heavy rainfall.

A 1067 mm gauge railway used only for freight purposes links the licence area with Hobart and the north coast centres of Bell Bay, Devonport and Burnie.

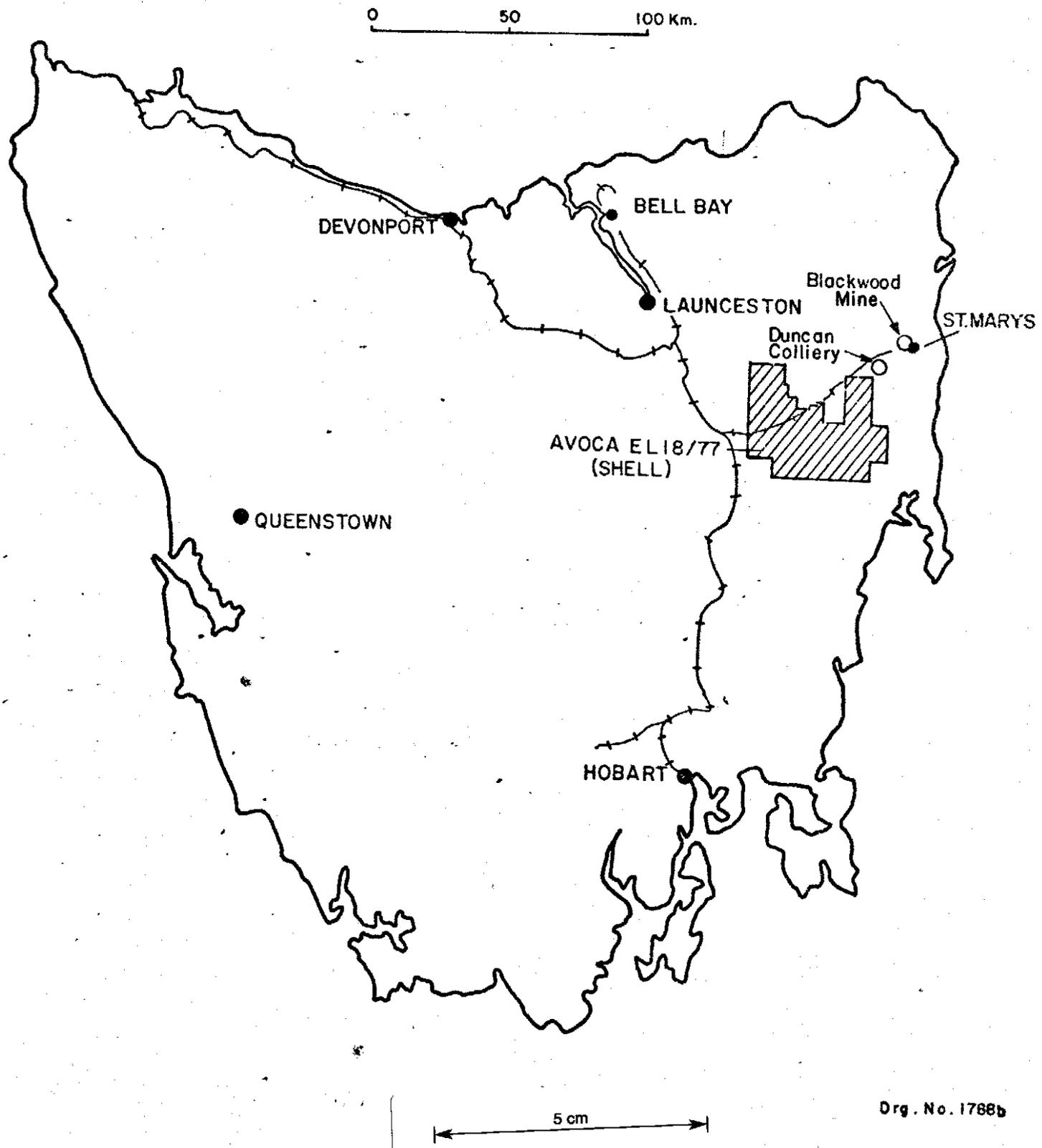
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Fig. 1

# LOCATION OF EL 18/77 AVOCA -TASMANIA



Drg. No. 1788b

#### 1.4 Topography and Climate

The topography of the EL is dominated by an extensive plateau with an average elevation of 650 m above sea level. River valleys, generally bounded by steep scarps, have been incised to elevations of 100-200 m above sea level. The basic topographic form of the area reflects the widespread occurrence of thick hard dolerite cover which has been removed only where there has been strong and persistent erosion.

The temperature and rainfall are significantly influenced by the local topography. In the valleys rain falls on approximately 100 days per year, but on the plateau there are about twice as many rain fall days (Bureau of Meteorology, 1977). Almost all rain falls during the months May to November, the highest rainfall being during July and August. Average winter temperatures range from  $-5^{\circ}\text{C}$  to  $5^{\circ}\text{C}$ , and snow-falls are common above 600 m from June to August.

Combined with rugged topography, the high rainfall increases the difficulty and cost of exploration operations during the winter months. Access can be maintained much more economically during summer and whenever practicable drilling is confined to the November to May period.

## 2. GEOLOGY

### 2.1 Regional Setting

The EL area lies within the Permo-Triassic Tasmania Basin which extends over most of the eastern half of Tasmania. Unconformably underlying the basin is a basement of Siluro-Devonian sediments and Upper Devonian granite. Intruded into the basin, but now effectively overlying it, are dolerite sills and dykes emplaced during the Jurassic concurrent with an episode of major tensional faulting. Further tensional faulting during the Tertiary was accompanied by limited extrusion of basalts. Surficial deposits of alluvium and dolerite talus have accumulated during recent phases of topographic evolution (figure 2).

### 2.2 Stratigraphy

#### 2.2.1 Pre-Permian basement

The Siluro-Devonian basement in this area consists of the Mathinna Beds with dominant lithologies being quartzites, phyllites, siltstones and slates of Ordovician/Silurian to early Devonian age. The thickness of this sequence is unknown in this area. Sedimentation was terminated by the Tabberabberan Orogeny during which folding of the sediments along a northwesterly axis occurred. During the late Devonian these sediments were intruded by granites and granodiorites, followed by a period of erosion extending to the late Carboniferous (Brown et al., 1968; Investigator Coal Exploration, 1978).

#### 2.2.2 Permo-Triassic Tasmania Basin

The name Parmeener Super-Group (Banks, 1973) has been introduced to define sediments of essentially Permo-Triassic age but extending in age from the late Carboniferous to the late Triassic. This Permo-Triassic sequence contains two broad lithological units differentiated on the basis of depositional environments and includes a lower division of glacial and glaciomarine beds (Lower Parmeener Super-Group), and an upper essentially freshwater sequence (Upper Parmeener Super-Group). This lithological boundary has been

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**LEGEND**

-  Quaternary Alluvium & Talus
-  Tertiary Basalt
-  Jurassic Dolerite
-  Upper  
Parmeener Super-Group  
Lower
-  Devonian Granite
-  Mathinna Beds



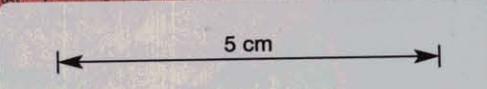
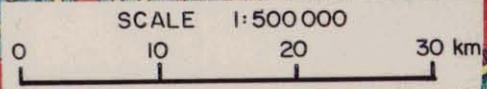
41°30'

41°30'

42°00'

42°00'

**REGIONAL GEOLOGY OF  
NORTHEASTERN TASMANIA**



After: Dept. of Mines 1976

CEPR 8/81

147°30'

148°00'

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equated in the past with the Permian-Triassic System boundary, a practice which is no longer followed due to insufficient supporting fossil evidence (Forsyth et al., 1973).

The Permo-Triassic sequence in Tasmania can be correlated with the lithologically similar sedimentary sequences of the Hunter Valley although the latter are much thicker. The similarities support the concept that Tasmania was structurally part of the Western shelf of the Newcastle Geosyncline (Brown et al., 1968).

The Lower Parmeener Super-Group has been subdivided into a 'Lower Marine sequence', a 'Lower Freshwater sequence' and an 'Upper Marine sequence', and the Upper Parmeener Super-Group into an 'Upper Freshwater sequence' and a 'Triassic' sequence (Forsyth et al., 1973).

The basal sediments of the Lower Parmeener Super-Group consist of the Wynyard Tillite, a unit unconformably overlying the basement but which does not occur in the exploration licence area. These tillites with interstratified sandstones and conglomerates occasionally contain marine fossils indicating that the ice must have reached sea level in places. Following the melting of the ice, mudstones, siltstones and thin limestones were deposited containing numerous marine fossils and erratic blocks indicating the presence of floating ice blocks.

During Late Artinskian times regional warping brought most of Tasmania out of the sea and wide areas were covered with sediments from a series of coalescing deltas (Brown et al; 1968). The widespread conglomerates at the base of this sequence form the base of the Permo-Triassic sequence in the licence area, unconformably overlying the basement and varying in thickness from 1-5 m. In some parts of the area to the north outside the licence area this conglomerate is overlain by a freshwater sequence (part of the 'Lower Freshwater sequence' of Forsyth et al.) comprising the Mersey

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Coal Measures and consisting of fine to medium grained lithic sandstones, mudstones, carbonaceous mudstones and minor shaley coal. These measures are up to 15 m thick and the fossil assemblage indicates a correlation with the Greta Coal Measures of New South Wales (Brown et al., 1968). Overlying the conglomerate in the licence area are shallow water marine sediments including the Cascades and Ferntree Groups. The dominant lithologies are dark siltstones, mudstones, calcareous sandstones and limestones indicating local transgressions and regressions. Marine fossils are abundant in these sequences and although no complete section exists in outcrop it is regarded as being 100-150 m thick in this area.

The Upper Parmeener Super-Group consists of the 'Upper Freshwater sequence' at the base comprising the Cygnet Coal Measures which are not developed in the EL area. These coal measures occur south of Hobart with minor outcrops in Western Tasmania. The contact between the Upper and Lower Parmeener Super-Groups within the licence area is represented by a conglomerate consisting of pebbles of quartz, quartzite, mudstone and volcanic material often in a sandy kaolinitic matrix. Overlying this conglomerate is a thick sequence of freshwater quartzose sandstones. They are well sorted, medium grained and have a low lithic content at the base increasing towards the top. Cross bedding can commonly be seen and this unit varies in thickness over the licence area from about 100 m in the east outside the EL to 60-80 m at Red Rock in the Royal George area (AMG 581000 mE, 5372000 mN).

The Upper 'Triassic' part of the sequence is 200 m thick on average and consists of interbedded lithic sandstones, siltstones, mudstones, carbonaceous shales and coal seams. This sequence exhibits the characteristic rapid vertical and horizontal facies changes that typifies sediments deposited in a floodplain environment (enclosure 1).

The Upper Parmeener Super-Group varies in thickness from a maximum of 350 m outside the licence area to the east at

Coal Rivulet-Meadstone Saddle to approximately 300 m in the vicinity of Royal George and apparently thinning further to the west (Investigator Coal Exploration, 1978; Taylor, 1979) (enclosures 6A, 6B).

### 2.2.3 Jurassic Dolerite

During the middle Jurassic the Upper Parmeener Super-Group and to a lesser extent the Lower Parmeener were intruded by dolerite in the form of sills and dykes. A regional gravity survey by the Department of Mines over parts of the licence area has indicated a complex intrusive history with numerous feeder centres (enclosure 2) and possible complete removal of the coal measure sequence of the Upper Parmeener Super-Group in numerous areas by erosion following dilation (Leaman & Richardson, 1980). The overall dip trend of the base of the dolerite is to the southwest in the Avoca area and to the southeast in the Royal George-Fingal area (Kind, 1978) (enclosure 3).

### 2.2.4 Cainozoic

The Cainozoic sequence consists of Tertiary sediments and basalts in the St. Paul's and South Esk Valleys and Quaternary sediments over most of the licence area.

The basalts consist of two flows, a lower vesicular flow and an upper homogenous flow, and is approximately 40 m in thickness.

Quaternary sediments occur in the river valleys as alluvium and on the valley slopes and plateau as dolerite talus. The alluvium is considered to be up to 85 m thick and consists of silt and sand as well as loam on the plateau. The dolerite talus varies in thickness from a thin cover to an estimated 100 m on the northern slopes of Mount Foster (Investigator Coal Exploration, 1978).

## 2.3 Structure

The Mathinna Beds in this area are structurally complex being folded along a northwest axis. The basement surface is reported to be

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planar with a  $1^{\circ}$  dip or less to the south where the Mathinna Beds are exposed north of Fingal (Threader, 1968). In the vicinity of Royal George where the basement consists of granite there was some residual relief during deposition of the Lower Parmeener Super-Group sediments.

The Lower Parmeener Super-Group in the Royal George-Fingal area appears to have a regional dip to the southeast of  $3-4^{\circ}$ . The overlying Upper Parmeener Super-group dips  $3-5^{\circ}$  to the southeast here although it dips to the southwest in the Avoca area (enclosure 4). The dips are very variable and often reversed which can probably be attributed to the effects of the intrusion of the dolerite. In some areas, such as the Merrywood open-cut mine, steep dips are apparent near the dolerite contact.

No folding has been observed in the Permo-Triassic sequences apart from local warping due to dolerite intrusion. Faulting in the licence area is tensional and appears to have been associated with the intrusion of the dolerite and Tertiary block movements. The major structural feature in the area is the Castle Carey Fault northeast of Avoca with a downthrow of approximately 500 m to the southwest. The throw apparently decreases further south along the fault line (enclosure 4). In the Mt. Christie area where maximum movement is implied, Upper Parmeener Super-Group sediments have been brought in contact with Devonian granites. In the Royal George area there is a fault trending northeast - southwest extending from Meadstone Saddle through Red Rock and south of Royal George. The displacement in this feature has been attributed to Tertiary movements (Threader, 1968).

Numerous apparent faults and lineations have been identified on aerial photographs on the central part of the area (enclosure 5), but verification in the field has been hampered by the extensive dolerite and dolerite talus cover.

### 3. PREVIOUS EXPLORATION AND MINING

#### 3.1 Pre 1922

Hills and others in 1922 summarized exploration and mining activities in this area in their "Coal Resources of Tasmania" publication. The report deals in detail with the various exploration adits and mines as well as attempting some correlation of the coal seams.

Most of the early exploration and mining activities were concentrated around the Mount Christie and Bonneys Plains areas (enclosure 1). A few shallow shafts and adits as well as a couple of boreholes were sunk in an area around Mount Christie between Castle Carey Creek and Buffalo Creek and became known as the Buena Vista Mine although it never became productive.

An adit was also driven into a bed of coal (1.8 m thick) on the southern part of Greenstone Hill, and into a 2.7-3.6 m thick seam 80 m to the southwest. The latter seam was interrupted by a fault trending N 75°E and with a 18 m displacement downthrown to the south. A third inclined adit was driven on the eastern side of the fault and the seam eventually worked out to where it terminated against the Castle Carey Fault in the east. These workings were collectively known as the Mount Christie Mine.

During the Mount Christie exploration programme an adit was driven into an outcrop of coal in the Bonneys Plains area, but it was never worked.

In the Royal George area two adits were driven into seams in Rockhouse Creek. (AMG 577200 mE/5366200 mN St. Paul's 1:100000 sheet) and Stable Creek (AMG 573500 mE/5363800 mN St. Paul's 1:100000 sheet) both encountering 1.83 m thick seams. The only productive mine in this area was at Merrywood where a seam was worked at this time (Hills et al., 1922) (enclosure 1).

#### 3.2 1922 - 1978

Operating mines within the licence area during this period consisted of the Merrywood and Stanhope Mines.

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The Stanhope Colliery operated between 1931 and 1960 in two areas. The first or Old Stanhope Mine included some of the old workings of the Buena Vista Mine where a seam was worked but soon abandoned due to faulting. Mining of a second seam was attempted but it was also abandoned due to dolerite dykes and dolerite filled faults paralleling the Castle Carey Fault. In the New Stanhope Mine workings situated to the north of the old workings, mining activities were eventually terminated by faulting. During the operation of these mines two adits were driven in the Bonneys Plains area adjacent to the initial adit constructed during the Mount Christie exploration programme. Both adits proved unsuitable for production purposes (Hughes, 1954).

At the Merrywood Mine the coal seam was extracted initially by open cut techniques although some underground operations were conducted at a later stage. The seam was reported to have been 3.38 m thick (maximum) with a working thickness of less than 2.74 m. By the closure of the mine in 1961, 423 475 tonnes of coal had been removed (Investigator Coal Exploration, 1978).

Exploration work during the later part of this period included work done by Western Mining Corporation and Investigator Coal Exploration Pty. Ltd. In addition the Mines Department drilled two holes and commenced a regional gravity survey covering a portion of the licence area.

Western Mining Corporation's work consisted of mapping as well as drilling in the Bonneys Plains area in the northwestern part of the licence area during 1976-1977. In their mapping of the area Western Mining Corporation differentiated the 'Permian' and 'Triassic' and divided the 'Triassic' sequence into the following facies:

- (a) The coal and carbonaceous shale facies.
- (b) The mudstone facies commonly associated with the coal and carbonaceous shale facies as well as the lithic sandstone and siltstone facies.

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- (c) The lithic sandstone and siltstone facies which also occurs with the coal and carbonaceous shale facies at times and forms the roof of some of the seams in the area.
  - (d) The quartzose sandstone facies which occurs towards the base of the 'Triassic' sequence but also interbedded with all the other facies (enclosure 1).

Nine chip drill holes were completed with a total metreage of 587.3 m and a maximum depth of 85 m. All of these holes were situated on the Bonneys Plains and Buffalo Plains areas with the exception of TAR 8 situated on the eastern boundary of the lease and north of Avoca (enclosure 1). Western Mining Corporation was aiming at delineating shallow open cut coal but only two of the nine holes intersected reasonable seams (holes TAR 2 and TAR 8, enclosure 1). Holes TAR 1 and TAR 3 (enclosure 1) intersected the coal and carbonaceous shale facies, whereas the rest of the holes were all within the lithic sandstone and siltstone or lower quartzose sandstone facies of the 'Triassic' sequence. All the holes were logged with a portable logging unit producing gamma-ray, resistivity and S.P. logs. Correlation proved difficult between holes.

Parts of the present exploration licence 18/77 were held by Investigator Coal Exploration Pty. Ltd. (I.C.E.) for 12 months up to the 23rd of December 1978 as EL 16/77 totalling 545 km<sup>2</sup>. The area covered by this licence included the present northeastern and eastern parts of EL 18/77 both to the north and south of Royal George. Based on an initial mapping programme four potential target areas were delineated for drilling and four fully cored drillholes were completed (I.C.E. holes 1-4, enclosure 1). These holes intersected a total of 699 m of coal measures including 29 seam intersections ranging in thickness from 0.3 to 2.2 m. Correlation was attempted but proved difficult due to extensive lateral variation of interseam sediments. I.C.E. holes 3 and 4 situated in the Merrywood area (enclosure 1) intersected significant coal seams including a 2.2 m seam in hole 4 and a 1.24 m seam in hole 3. Hole 2 intersected an approximately 3 m section of coal with a dirt parting and a 6 m section with two partings and hole 1 intersected a 2.01 m seam.

I.C.E. concluded that igneous intrusions were more prevalent south of Royal George, and considered the areas around boreholes 1 and 3 worthy of further investigation (I.C.E., 1979).

The Tasmanian Mines Department drilled two holes (DOM 18 and DOM 29, enclosure 1) within the present licence area. Hole 18 situated north of Merrywood encountered 371.5 m of dolerite and 53.30 m of the Permo-Triassic sequence, the lower 6.13 m being regarded as Permian in age (marine sediments). Hole 29 situated in the north-eastern corner of the licence area encountered 346.0 m of dolerite and 85.43 m of Permo-Triassic with 6.83 m of marine siltstone at the base regarded as being Permian in age.

### 3.3 1978 - 1980 (Shell)

Initial exploration activities prior to the commencement of drilling consisted of a review of the area (Senini, 1978) as well as aerial photographic interpretation (Kind, 1978) and the construction of a geological map by consultants Layton and Associates from air photographs and Landsat-imagery. Layton and Associates also produced a fracture study of the area later in the year (Layton and Associates, 1978) (enclosure 5).

Drilling in the licence area commenced on the 2nd of May 1978 on a planned 18 hole drilling programme. This was a scout drilling programme and all the holes drilled in 1978 were situated south of Royal George and were concentrated predominantly in the Elizabeth River area. Constant problems with access aggravated by severe weather conditions hampered progress and resulted in the abandonment of hole AV 4. By the completion of the drilling programme in September 1978, 9 holes were drilled (AV 1-9) totalling 3294.40 m with holes AV 1 to AV 7 situated in the present licence area (enclosure 1) and holes AV 8 and AV 9 situated in a relinquished portion to the south of the current licence area (Ivett, 1979). Drilling statistics are presented in table 1.

All holes were sited on dolerite outcrop except AV 2 which encountered 97.70 m of coal measures before intersecting dolerite. This was the only occurrence of sediments overlying dolerite and must represent a rare uprafted section preserved from erosion.

Holes AV 1, 3 and 6 intersected the 'Triassic' coal measures while holes AV 4, 5, 7, and 8 and 9 were terminated in dolerite.

Hole AV 3, intersecting 269.57 m of dolerite and 269.13 m of the Permo-Triassic sequence and terminated in the quartzose sandstone of the section encountered a 1.12 m thick seam between 355.72 m and 356.84 m. Other seams encountered were thinner and contained thick dirt partings. In hole AV 6 the seam development was thin, deep and of poor quality despite intersecting 251 m of the Permo-Triassic sequence.

Hole AV 1 intersected one seam thicker than 1 m between 250.69 m and 251.55 m with a roof of shale and mudstone and a floor of lithic sandstone and was the only seam analysed (Taylor, 1979) (table 2 and 3).

At the end of this drilling programme it was still not clear to what extent the coal measures encountered by previous drilling and mapping work in the Mt. Christie and Royal George areas extended underneath the dolerite coverage. On the basis of the results from drillholes AV 8 and AV 9, parts of the original licence area were relinquished being regarded as having no exploratory potential (Ivett, 1979).

It was recommended at this stage to investigate the Northwest Avoca area to establish the extent of the coal measures there.

Exploration activities during 1979 consisted of mapping work predominantly in preparation for the next drilling programme. On the basis of the mapping and a review of the results from the 1978 drilling programme, two areas, namely the Northwest Avoca area and the area south of Royal George were selected as having prospective potential (Sansom, 1980). Four fully cored diamond drillholes were sited in these areas and completed between the 31st of March and the 15th of July 1980. The total metreage drilled during this programme was 1702.14 m and the drilling statistics are presented in table 1.

Borehole AV 10, sited south of Royal George (enclosure 1), intersected 340.87 m of dolerite before encountering marine mudstones of the Lower Parmeener Super-Group. The coal measure sequence has therefore obviously been removed by dolerite transgression and erosion at this location. Borehole AV 11, also sited south of Royal George (enclosure 1), was terminated in dolerite after 466.50 m. This indicates an extreme thickness of dolerite at this point as AV 11 is situated only 2.1 km southwest of I.C.E. hole no. 1 which contained a substantial coal measure sequence and no dolerite. In the area northwest of Avoca borehole AV 12 (enclosure 1) intersected 158.73 m of dolerite, 324.61 m of the Upper Parmeener Super-Group and 6.99 m of the Lower Parmeener Super-Group. Despite intersecting a complete coal measure sequence no significant coal seams were present indicating non-deposition or erosion of coal seams at this location. Borehole AV 13 situated west of Bonneys Plains (enclosure 1) intersected 307.46 m of dolerite and was terminated after passing through 52.24 m of the lower section of the Upper Parmeener Super-Group sequence.

Besides the drilling programme a field mapping review was undertaken to check mapping work completed by previous investigators, and to visit potentially prospective areas delineated by the gravity survey completed the Department of Mines in 1980 (Bornman and Murphy, 1981). It was recommended that these potentially prospective areas, and the northwest Avoca area be investigated in future exploration programmes.

A summary of all the technical reports on the licence area is presented in appendix 2 for reference purposes.

#### 3.4 Coal Quality and Utilization Potential

From within EL 18/77 coal quality data are available from I.C.E. holes 1-4, from Shell hole AV 1 and from the Merrywood and Stanhope Mines. Although these data are relatively sparse, the broad quality characteristics are supported by data from the nearby Duncan Colliery and from the more extensively explored region to the east of the EL.

In broad terms the coal within the EL and in the northeast Tasmania region in general, is relatively uniform in rank, type and quality except for ash content and ash content - related parameters. It is

classified as High Volatile Bituminous (A.S.T.M.), or as 501 (3-8) (A.S.A.), and is dull with a relatively high inherent ash content. Sulphur content is invariably low (less than 1%) and ash fusion temperatures are generally high.

The raw coal ash contents set out in tables 2 and 3 and in appendices 3 and 4 vary from 11.6% in the best quality coal, to in excess of 60% in samples which should be regarded as carbonaceous mudstone rather than coal. Ash is present as finely divided inherent ash and as extraneous ash in dirt bands. Results have indicated that washing at relative densities of less than 1.70 is unlikely to achieve significant ash reduction (table 2).

The raw ash contents of 20% or less quoted for the three mines (appendix 3) are quite acceptable for the domestic thermal coal market. Each of the five drill holes from which cores were analysed (I.C.E. 1-4 and AV 1) contain seams in excess of 1 metre thick which could produce an acceptable product either raw or with a minimal amount of beneficiation (table 3, appendix 4). Sparse as the data are they do confirm that coal seams with commercially attractive ash contents are developed in the EL.

The specific energy of the coal is inversely related to its ash content. The relationship can be approximated by the equation: specific energy (MJ/kg air dried) =  $35.0 - 0.4 \text{ ash \% (air dried)}$ . X  
Applying this equation, a coal with an air dried ash content of 20% will have an air dried specific energy of approximately 27.0 MJ/kg. In relation to the rank of the coal the specific energy is relatively high, enhancing its value as a thermal coal.

The coking potential of coal in the EL is very poor. The absence of coking properties is primarily due to the low proportion of reactive macerals in the coal (appendix 3).

Hardgrove Grindability Indices are within the 50 to 65 range which is general to the region. This range is somewhat lower than most Australian coals of similar rank, but is not so low as to significantly increase grinding costs.

X it must be dry basis because air dried coal still contains moisture

My formula is  $SE = 32 - .32(\text{ash \% DB})$

022

Ash fusion temperature data are very sparse with only one determination from within the EL and one from the nearby Duncan Colliery. These few data indicate acceptably high fusion temperatures with hemispherical temperatures exceeding 1500°C in both cases.

Volatile matter varies between 28.7% and 34.6% on a dry ash-free basis. This is an ideal thermal coal range, suiting the coal for combustion in conventional furnaces.

Sulphur content is invariably below 1% for the whole region, and with one exception all the data from the EL indicate levels of less than 0.5%. These low sulphur contents add to the value of the coal as a fuel.

Overall the quality data indicate that the coal in the EL is well suited to utilization as a thermal coal. There are no detrimental characteristics apparent, and only coals with a high ash content are unlikely to be marketable.

### 3.5 Coal Reserves

In their 1978 report dealing with part of the Avoca EL, I.C.E. concluded that coal reserves can be calculated for a small area near the old Merrywood Mine. Indicated in situ raw coal reserves are 790,000 tonnes. These reserves could possibly be increased slightly by open-cut mining of some of the pillars in the old Merrywood mine. In other portions of the EL insufficient information and geological uncertainty precludes calculation of reserves.

The subsequent exploration by Shell on the larger area of the Avoca EL has been of a purely reconnaissance nature and has not aimed to delineate reserves. While the quantifiable reserves (measured and indicated) are not increased beyond those identified by I.C.E., the size of the EL and the wide distribution of coal occurrences within it suggest that in its totality the EL may contain inferred reserves in the large category (greater than 100 million tonnes). Adding a cautionary note however it should be said that these resources are likely to spread over a number of individual deposits not all of which may be readily exploitable.

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TABLE 1 DRILLING STATISTICS EL 18/77 AVOCA

Borehole No.	AV1	AV2	AV3	AV4	AV5	AV6	AV7	AV8	AV9	AV10	AV11	AV12	AV13
Surface elevation (m.a.s.l.)	640	560	510	580	575	600	540	300	180	300	825	480	500
Thickness of dolerite intersected (m)	221.24	344.80	269.57	155.60	350.00	201.00	299.00	300.00	298.60	340.87	466.50	158.73	307.46
Elevation base of dolerite (m.a.s.l.)	418.76	-	240.43	-	-	399.00	-	-	-	-40.87	-	321.27	192.54
Thickness of Upper Parmeener Super-Group intersected (m)	236.76	97.70	269.13	-	-	251.00	-	-	-	-	-	324.61	52.24
Elevation base of Upper Parmeener Super-Group (m.a.s.l.)	-	-	-	-	-	-	-	-	-	-	-	-3.34	-
Thickness of Lower Parmeener Super-Group intersected (m)	-	-	-	-	-	-	-	-	-	45.34	-	6.99	-
Total Depth (m)	458.00	442.50	538.70	155.60	350	452.00	299.00	300.00	298.60	386.21	466.50	490.33	359.70

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TABLE 2... EL 18 / 77 , AVOCA  
WASHABILITY RESULTS AV.1

Sample No	Depth (m)	Relative Density	CUMULATIVE %								Raw Ash %	
			FLOATS 1.50		FLOATS 1.60		FLOATS 1.70		FLOATS 1.80			
			Mass	Ash*	Mass	Ash	Mass	Ash	Mass	Ash		
AV 1/1	250.01 250.09	2.06										67.9
AV 1/2	250.09 250.62	1.54	49.4	18.5	65.4	20.8	75.9	22.9	81.5	24.3		30.8
AV 1/3	250.62 251.55	1.43	73.0	13.9	82.5	15.5	89.9	17.3	94.3	18.6		20.7
AV 1/4	251.55 251.64	1.79										53.2
AV 1/5	275.65 276.61	1.75	15.0	17.6			35.9	27.8				51.6
AV 1/6	281.12 281.62	1.35	94.6	9.8			98.1	10.4				11.6

957025



#### 4. REVIEW OF PROSPECTIVITY

It is apparent that the coal measure sequence of the Upper Parmeener Super-Group was deposited over most if not all of the E/L. It is also clear however that coal seams of economic thickness were not deposited over the entire area. Moreover a significant proportion of the coal measures originally deposited have been removed by erosion and dolerite transgression and have been in some instances adversely affected by faulting.

In a purely geological sense, prospective areas are those in which coal seams were originally deposited and have now been preserved from erosion, dolerite transgression and intense faulting. In an economic sense, prospectivity is also related to the proximity of any deposits to existing infrastructure.

##### 4.1 Coal Measure Sequence

###### 4.1.1 Extent

The extent of outcrops of the Upper Parmeener Super-Group as well as the estimated extent beneath the dolerite cover is presented on enclosure 1. It is apparent that sediments of this sequence exist over most of the licence area although they are covered almost entirely by dolerite. Most of the outcrops consist of the basal quartzose sandstone of the sequence although some of the upper mudstone and carbonaceous shale units as well as occasional coal seams do occur. Since the Upper Parmeener Super-Group in the licence area is 300 m thick on average and the lower quartzose sandstone varies in thickness between 60 to 100 m it is evident that the preservation of the upper 200 m of the sequence containing the coal seams is the most important factor in assessing the prospectivity of the area.

###### 4.1.2 Removal

The two main factors affecting the preservation of the coal measure sequence are erosion, and transgression by dolerite dykes and sills.

#### 4.1.2.1 Erosion and Structure

Upper Parmeener Super-Group sediments have been removed completely along the South Esk and St. Pauls river valleys by erosion. The orientations of these valleys along major fracture directions suggest structural influence on the erosional process (enclosure 5). Partial removal of the sequence has occurred along Bonneys Plains to the west of Avoca, and the orientation of the valley again suggests a structural influence. The affect of the Castle Carey Fault on the sequence is difficult to determine due to the extensive dolerite coverage. North of Avoca, where maximum movement occurred along the fault, the entire Parmeener Super-Group is absent to the east of the fault, whereas further to the south the sequence exists on both sides of the fault line (enclosure 1). From a consideration of the estimated elevation of the base of the Upper Parmeener Super-Group (enclosure 4) it is evident that the downthrow to the west along the fault line is significantly less to the south of the South Esk river valley. This may indicate either a gradual decrease to the south of the relative displacement, or faulting along the South Esk river valley with an upthrown component to the south.

#### 4.1.2.2 Dolerite Intrusion and Transgression

The removal by dilation and subsequent erosion of the coal measure sequence by transgressive dolerite intrusives is the most important factor to be taken into consideration in an assessment of the prospective potential of the licence area.

As discussed in the section on the regional geology of the licence area, dolerite in the form of sills and dykes was intruded into the Parmeener Super-Group sequence. The present extent of the dolerite cover in the licence area is, apart from the major

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river valleys, virtually complete thereby preserving from erosion the underlying Parmeener Super-Group over most of the area (enclosure 3). There is an apparent regional trend of the base elevation of the dolerite with dips to the southeast east of the Castle Carey fault, and to the southwest west of the fault (enclosure 3). From a consideration of the borehole information generated by the the various drilling programmes it is evident that the intrusive histories and the nature of the dolerite bodies are much more complex, with local extreme thicknesses of dolerite near feeder centres not conforming to the regional trend. The Upper Parmeener Super-Group has a regional dip trend to the southeast at a shallower angle relative to the dolerite (enclosure 4). From a comparison of the two trends it is clear that, in a regional sense, the Upper Parmeener Super-Group is progressively removed by transgressive dolerite bodies to the southeast and west within the licence area (enclosure 6B).

In order to get a detailed estimate of the Upper Parmeener Super-Group thickness, consideration must be given to the location of dolerite feeder centres and areas with a thin dolerite capping. Due to the sparsity of borehole and outcrop information on the licence area, most of this information has to be inferred from an interpretation of the results of a gravity survey completed by the Department of Mines in 1980. The survey did not cover the entire licence area and the extent of coverage plus the detailed residual Bouguer anomalies are presented in enclosure 2. The station spacing between observation points varied between 750-1,000 m, and the survey was therefore only regional and intended to provide an indication of the relative dolerite and coal measure thicknesses.

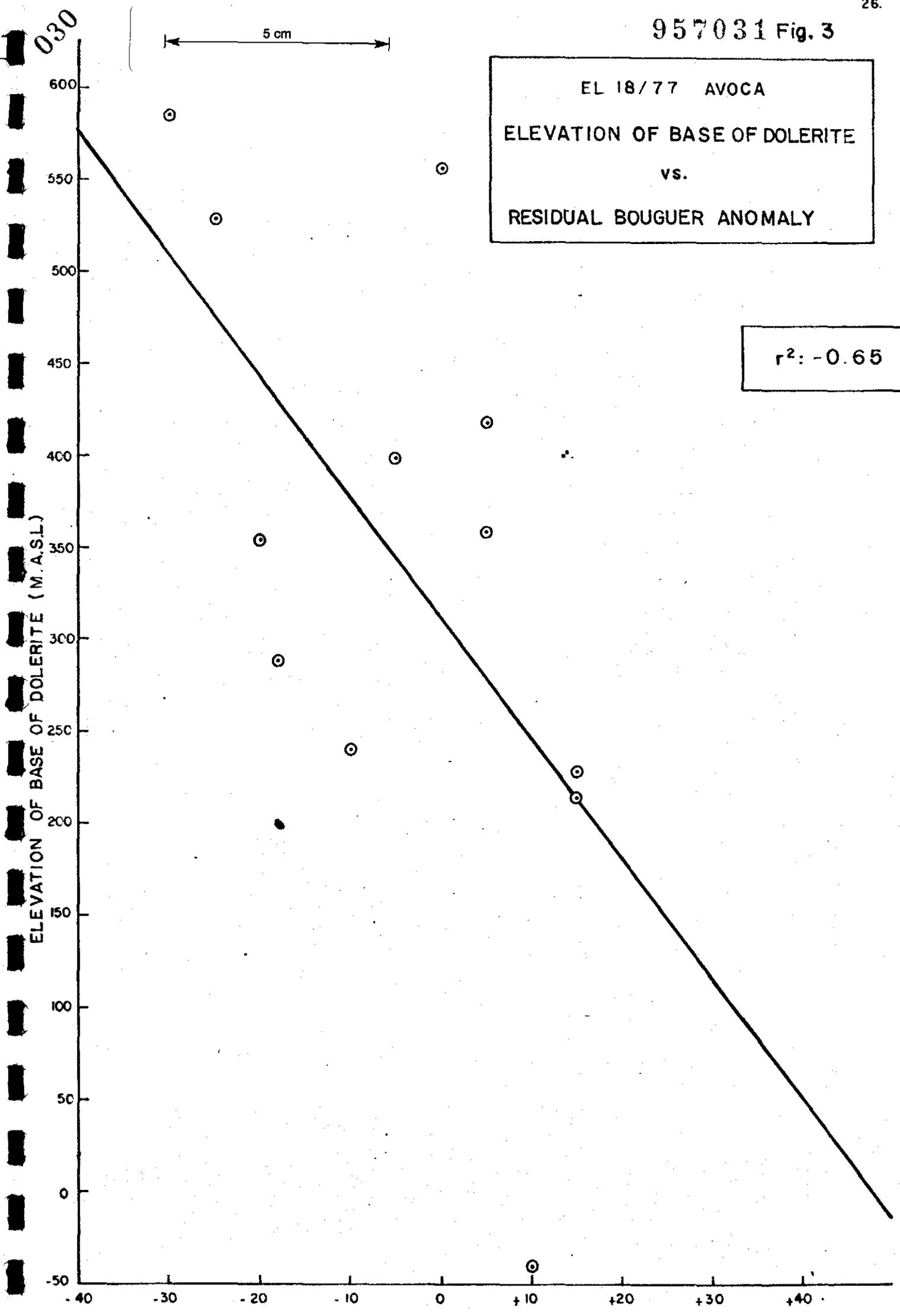
In order to obtain the information that can potentially be derived from the results of a gravity survey it is necessary to study the basic theoretical principles involved. A gravity survey essentially aims to measure the relative difference in the gravitational attraction between various points. The field of gravitational attraction exerted by a body is dependent on its mass and therefore density, as well as the distance between the body and the measured point. The observed values obtained for the gravitational force at any point is therefore a function of the density and thickness of the various lithological units at that point as well as their depth below surface. The observed values are further corrected for contributions made by differences between points of latitude, elevation, topography and the material between measuring stations. This produces a residual Bouguer anomaly that is a function of variations in density below a selected datum level.

Having made density determinations on the rock types comprising the lithological units of interest, the contributions by these units to the gravity field can be calculated, and using these calculated values models of various combinations of the lithological units with varying thicknesses can be made to fit the residual Bouguer anomaly at any point. Correlations between the residual Bouguer anomaly and the base elevation of the dolerite, dolerite thickness and coal measure to dolerite thickness ratio in Shell drill-holes is presented in figures 3, 4 and 5 respectively. It is obvious from these figures that in figure 3 and 4, with correlation coefficients of  $-0.65$  and  $-0.60$  respectively, the data can with some confidence be regarded as fitting a linear equation. Figure 5, with a correlation coefficient of  $-0.53$  represents a poorer approximation to a linear equation.

957031 Fig. 3

EL 18/77 AVOCA  
ELEVATION OF BASE OF DOLERITE  
vs.  
RESIDUAL BOUGUER ANOMALY

$r^2: -0.65$

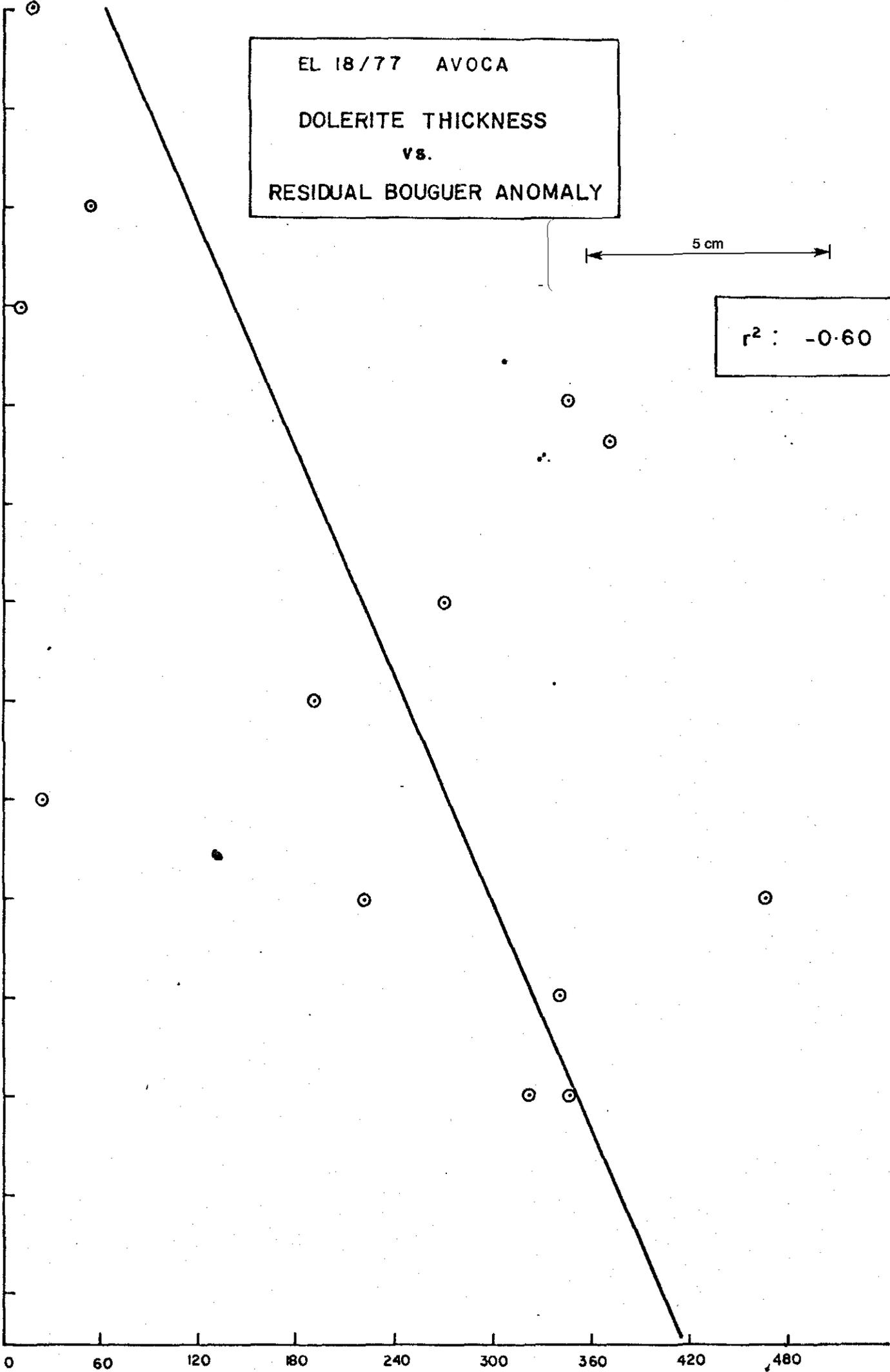
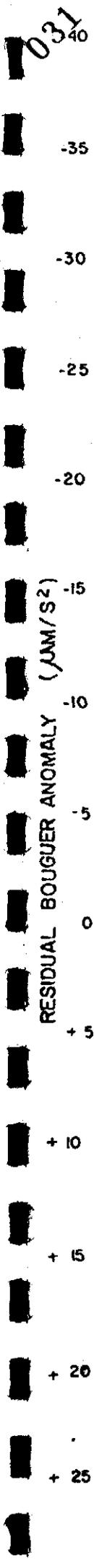


EL 18/77 AVOCA  
DOLERITE THICKNESS  
vs.  
RESIDUAL BOUGUER ANOMALY

$r^2 : -0.60$

5 cm

RESIDUAL BOUGUER ANOMALY ( $\mu\text{M}/\text{S}^2$ )



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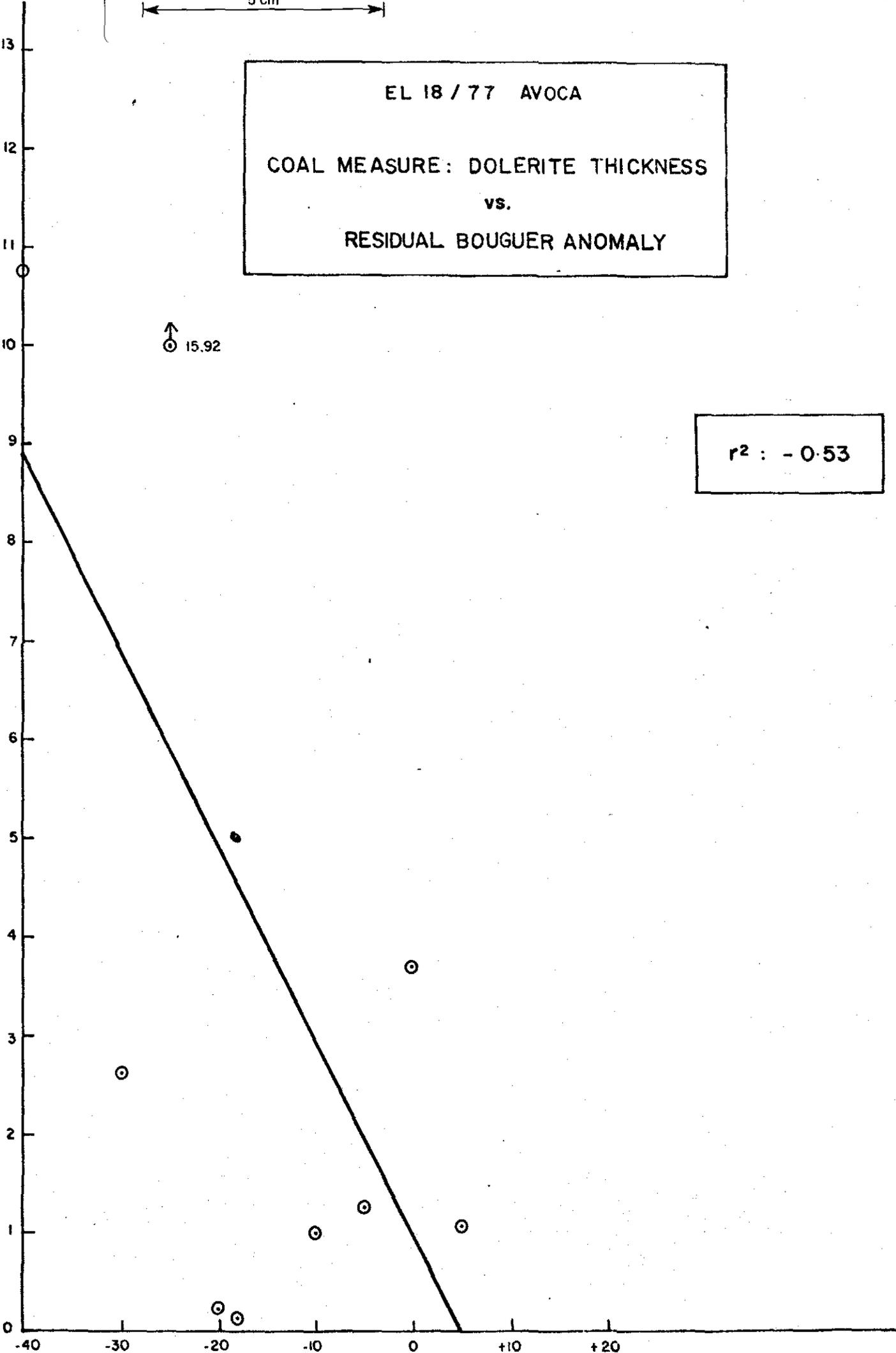
5 cm

EL 18 / 77 AVOCA  
COAL MEASURE: DOLERITE THICKNESS  
vs.  
RESIDUAL BOUGUER ANOMALY

$r^2 : -0.53$

COAL MEASURE: DOLERITE THICKNESS

↑ 15.92



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The calculated contributions from various lithologies to the residual Bouguer anomaly at any point are of such a nature as to exclude all areas with residual Bouguer anomalies in excess of + 10 micrometres/s<sup>2</sup> from consideration in terms of prospectivity due to excessive thicknesses of dolerite and therefore concomitant thin or absent coal measure sequences. The most prospective areas in terms of the relative coal measure and dolerite thicknesses and therefore the likelihood of the preservation of the coal measure sequence are those with residual Bouguer anomalies less than -20 micrometres/s<sup>2</sup>. Due to the nature of the contributions from the various lithologies, areas with residual Bouguer anomalies between +10 and -20 micrometres/s<sup>2</sup> may consist of various combinations of dolerite and coal measure thicknesses and should therefore not be discounted as being unprospective but nevertheless be regarded with caution. Positive anomalies greater than 40 represent areas with extreme thicknesses of dolerite and are probably feeder centres (Leaman and Richardson, 1980).

Enclosures 2, 3 and 4 have areas of thick dolerite accumulations and feeder centres indicated. Enclosure 2 presents, in addition, the areas with residual Bouguer anomalies less than -10 micrometers/s<sup>2</sup> and therefore the areas with the highest prospective potential. It is obvious from these enclosures that numerous feeder centres exist throughout the licence area and that parts of the licence area would not be prospective due to the removal of the coal measure sequence by dolerite transgression. Significant parts of the licence area are potentially prospective on the basis of the survey and warrant investigation bearing in mind that the negative residual Bouguer anomaly at any point may contain contributions from granites

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at depth or dolerite scree on the surface. The gravity anomaly values relate to the relative coal measure and dolerite thicknesses only and therefore areas indicated as being prospective in terms of the residual Bouguer anomalies may contain thick coal measure sequences as well as a thick dolerite capping.

The survey has in addition provided a basis for the analysis of the discouraging results from previous drilling programmes. Boreholes AV 2, 5, 10 and 11, all intersecting thick sequences of dolerite and no coal measures, are located within areas with anomalies greater than +10 micrometres/s<sup>2</sup> and within areas influenced by feeders (enclosure 2). Borehole AV 3 situated within a prospective zone, and boreholes AV 1 and 6 both situated within the -20 to +10 micrometres/s<sup>2</sup> zone, intersected thick coal measure sequences (enclosure 2). As discussed in the section on previous exploration, coal seams were intersected in boreholes AV 1 and 3 and the seam development was poor in AV 6. Boreholes AV 4 and AV 7 were located outside the coverage of the survey.

In areas covered by the gravity survey it is possible to infer unprospective zones in terms of removal of the coal measure sequence by dolerite transgression, and to produce an estimate of the thickness of the upper Parmeener Super-Group based on the gravity and borehole information (enclosure 6A). Areas not covered by the survey have to be assessed purely on the basis of the available outcrop and borehole information. Due to the expected thinning of the Upper Parmeener Super-Group to the west as a result of the southwesterly dip of the dolerite cap, the western edge of the licence area can be considered as unprospective (enclosure 6B). Similarly, due to the steeply

dipping base of the dolerite in the northwestern part of the licence area (north of AMG 5380000 mN) (enclosure 3), these areas can be considered as being unprospective and the estimated thickness of the Upper Parmeener Super-Group minimal (enclosure 6B).

In the absence of geophysical information the area immediately to the northwest of Avoca between AMG 553000 mE and AMG 557000 mE, and AMG 5373000 mN and AMG 5380000 mN can be considered potentially prospective and the estimated Upper Parmeener Super-Group thickness 300 m (enclosure 6B). This estimate is based on information from outcrops and borehole AV 12 in this area, as well as a consideration of the relative regional trends of the base of the dolerite and the Upper Parmeener Super-Group. The possible presence of feeders or transgressive dolerite dykes in this area cannot be discounted, but further exploratory work needs to be done to ascertain the exact nature of the dolerite cover. Parts of the area south of the South Esk river and West of AMG 557000 mE (not covered by the gravity survey) may prove to be prospective on further investigation.

#### 4.1.3 Development of Coal Seams

The presence of coal seams within the Upper Parmeener Super-Group in prospective areas is, with the present information available, difficult to assess. Coal seams are present in outcrop, old mine workings and boreholes over a large portion of the licence and surrounding areas indicating possible existence throughout the extent of the coal measure sequence (enclosure 1). As discussed in the section on previous exploration, coal seams of significant thicknesses were worked in the Stanhope, Mount Christie and Merrywood Mines. One of the two coal mines operating in Tasmania at present is the Duncan Colliery near Fingal, 3 km north of the northeastern corner of the licence area and producing

188,000 t.p.a. (1976) (enclosure 1). Appendix 3 summarizes some of the available quality data on the Duncan, Stanhope and Merrywood Collieries. Further detailed information are available in Shell Company technical report CEPR 7/78 (Kind, 1978). Other smaller operations are the Blackwood Mine on Mount Nicholas near St. Marys operated by the same company, and a small privately operated mine in the Mount Christie area near the old Mount Christie Mine.

Despite the presence of coal seams throughout the licence area it is evident from borehole information that the seams are discontinuous or thin in some areas. Borehole AV 12 for example did not intersect any significant seams despite the existence of a complete or near complete Upper Parmeener Super-Group sequence (324.61 m) and the presence of coal seams in boreholes TAR 2 and TAR 8 5.5 and 1.5km to the east and west respectively. Correlation of the coal seams and interseam sediments throughout the area proved difficult due to the large interhole spacing, although in areas of closer hole spacing such as northwest Avoca problems still exist indicating rapid lateral facies changes.

The sequence of depositional environments for the area has been suggested by Bacon (1980) as an initial beach deposit producing the quartzose sandstones of the Upper Parmeener Super-Group during a phase of marine regression. As the shoreline receded to the east during regression, poorly sorted and rounded sandstones were deposited in lower energy environments such as coastal lagoons and this was followed by the formation of flood plains over the beach deposits. The flood plains were traversed by streams depositing lithic sandstones, and stagnant environments created by cut off meanders and channels produced interbedded mudstones, carbonaceous shales and coal seams with occasional siltstones from overbank floods. A study of the coal seams support the fluvial depositional environment as the predominant macerals in this area are fusinite and semi-fusinite indicating oxidation by exposure to air or flooding by oxygenated water.

In a flood plain environment stream channels change course and migrate across the plain, thereby producing a sequence characterised by rapid horizontal and vertical facies changes. Extensive coal seams interstratified with other facies can be expected to have formed throughout the plain and correlation problems can be attributed to this type of depositional environment.

#### 4.2 Role of Infrastructure

Due to the size of the licence area and the general absence of infrastructure, proximity to the railway line passing through Avoca (enclosure 1) is an important factor in an assessment of the prospective potential of selected areas. Of all the areas within the EL that may prove to be prospective in geological terms, the northwest Avoca area is the most suitably located at between 3 and 8 km from the railway line. The extreme northeastern parts of the licence area are also favourably located near the railway line and the township of Fingal, but are unprospective due to the presence of dolerite feeders (enclosure 2). The most prospective areas to the south of Royal George are located at a distance of between 35 to 45 km from Avoca (enclosure 6A), and are linked by means of a predominantly unsealed road surface except for a 16 km sealed section between Royal George and Avoca.

Potentially prospective areas located to the south of Avoca may be reached via the access road to Benham Estates at a distance of between 12 and 20 km from the railway line, although the southernmost areas are in closer proximity to the railway line at Campbell Town via the unsealed Loake Leake road (enclosure 6A, 6B).

#### 4.3 Discussion

Having delineated the most prospective areas in terms of the estimated thicknesses of the Upper Parmeener Super-Group sequence and discussed the existing infrastructure of the licence area it is clear that the northwest Avoca area is potentially the most prospective. As indicated previously, more work needs to be done in this area to obtain a better understanding of the nature of the dolerite. The possibility of the observed lineations being faults and affecting the preservation of the coal measure sequence needs to be clarified in

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addition. Potential reserves may be in the order of 70 million tonnes assuming a seam thickness of 2 m, a relative density of 1.4 and a surface area of 25 km<sup>2</sup>.

South of Royal George the prospective areas vary in size and proximity to Avoca, the closest and largest being in the vicinity of Lewis Hill (enclosure 2 and 6A). This area centered around AMG 579000 mE and AMG 5365000 mN has a maximum surface area of 16 km<sup>2</sup> indicating a 45 million tonnes potential reserve based on a 2 m thick seam and a density of 1.4. The prospective area centered around the headwaters of the West Swan river (AMG 579000 mE, 5361000 mN) has a surface area of 10 km<sup>2</sup> and possible reserves of 28 million tonnes based on the same density and thickness parameters as the previous estimates. Various smaller potentially prospective areas exist at a greater distance from Avoca and are, with the exception of the area centered around the Cygnet river, insignificant in size (3-5 km<sup>2</sup>). The Cygnet river area (AMG 581000 mE, 5356000 mN) has a surface area of 7.2 km<sup>2</sup> and therefore a potential reserve of 20 million tonnes on the basis of the previously used thickness and density parameters.

South of Avoca the potentially prospective areas west of Doctor Levers Head (AMG 559000 mE, 5363000 mN) and Gilbert Dick Hills (AMG 558000 mE, 5353000 mN) are larger than 5.8 km<sup>2</sup> and 2.2 km<sup>2</sup> respectively as the gravity survey coverage is incomplete over these areas (enclosure 2). North of Royal George the major area of interest is centered around the negative anomaly to the northwest of the old Merrywood open-cut mine (AMG 578000 mE, 5377000 mN) (enclosure 2). It has been suggested that due to the shape of the anomaly and the abundance of granites in outcrop in the area that this negative anomaly was due to a granitic cupola at depth and not due to a thick coal measure sequence (Leaman and Richardson, 1980). This hypothesis is supported by the fact that in borehole 18, drilled by the Department of Mines 250 m to the east of the edge of the anomaly, only 47 m of the Upper Parmeener Super-Group sequence was preserved below 371 m of dolerite. This area should therefore be regarded with caution.

The anomaly in the northeastern corner of the licence area around Rock Marsh (AMG 582000 mE, 5384000 mN) is small (4.8 km<sup>2</sup>) and borehole 29, drilled by the Department of Mines on the eastern edge of

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the anomaly, intersected only 78 m of the Upper Parmeener Super-Group sequence below 346 m of dolerite indicating that the coal measures would be absent over most or all of the area (enclosure 2).

It is recommended that future exploration activities be centered around the northwest Avoca area and the larger of the potentially prospective areas south of Royal George. The area to the south of Avoca requires investigation as the presently indicated potentially prospective areas may prove to be significant in size with an extension of the gravity survey to the west. The area north of Royal George appears to be unprospective due to the presence of numerous feeders.

## 5. APPROACHES TO FUTURE EXPLORATION

Due to the high cost of drilling in the licence area (appendix 1) as a result of the thick dolerite coverage and the lack of access, careful consideration has to be given in the planning of future exploration programmes to less expensive alternatives. In areas not covered by the gravity survey it is essential that geophysical work be carried out prior to drilling in order to delineate potentially prospective areas and avoid drilling in areas containing thick dolerite accumulations or feeders. On the basis of the gravity, magnetic and seismic surveys completed by the Department of Mines in northeastern Tasmania the gravity survey has been isolated as being the most effective in terms of meaningful results obtained and cost (Leaman, 1980). Mapping work may provide some information on the nature of the dolerite if careful attention is paid to the textural qualities of outcrops. A coarse texture for example usually indicates slow cooling and therefore a thick sequence and vice versa.

It is recommended that in the planning of a drilling programme over a negative anomaly, the initial holes be placed on the most negative part of the anomaly with subsequent holes, provided reasonable results are obtained, located towards the edge and possibly outside the anomaly. Contributions to the negative anomaly by granites and thick dolerite scree accumulations may therefore be determined early in the programme if the coal measure sequence proves to be thin over the most negative part of the anomaly, and unnecessary expenditure avoided.

Due to the thick dolerite sequences to be drilled through it is recommended that holes should not be cored or only cored once the coal measures are intersected. Powerful drilling rigs capable of hammering through the dolerite in reasonable time should be used to avoid the slow and therefore costly progress characteristic of previous programmes.

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6. CONCLUSIONS

- 6.1 The main productive coal measure sequence in Tasmania has widespread occurrence in the EL, and has in the past supported small scale open-cut and underground mining there.
- 6.2 The sparse analytical data from the old mines and from drill-hole cores indicate that, given acceptable ash contents, the coal in the EL has good steaming coal characteristics.
- 6.3 Limited reconnaissance exploration by three companies over the past five years has located a few seams of economic quality and thickness. None of the intersections have been sufficiently encouraging however to prompt the drilling of proven reserves.
- 6.4 The failure of exploration to locate large deposits is attributed primarily to the relatively small number of holes which have been drilled, to the apparent discontinuity of coal development, and to the widespread transgression of the coal measures by the overlying dolerite.
- 6.5 In view of the geological constraints it is concluded that the EL is prospective only for small to medium sized deposits, several of which could be distributed throughout the area. As a whole however the licence area may contain inferred reserves in the large category.
- 6.6 Specific exploration targets are indicated in the northwest Avoca area and in the area south of Royal George.
- 6.7 Cost effectiveness in future exploration is likely to be best achieved by making full use of gravity surveying to locate areas of minimal dolerite transgression and by drilling geophysically logged open-holes rather than cored holes.

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## APPENDIX 1

EL 18/77, AVOCA

Summary of expenditure 1978 - 1981.

Period	Expenditure (\$)
January - March 1978	14,229.00
April - June 1978	138,158.00
July - September 1978	176,497.00
October - December 1978	39,023.00
January - March 1979	15,192.00
April - June 1979	6,327.00
July - September 1979	3,803.00
October - December 1979	4,717.00
January - March 1980	12,361.00
April - June 1980	165,454.00
July - September 1980	26,161.00
October - December 1980	15,509.00
January - March 1981	27,599.00
Total	\$645,030.00

## APPENDIX 2

EL 18/77 AVOCATECHNICAL REPORTS : A SUMMARY

October 1977      CEPR 3/77 : Proposal for exploration and mining in Tasmania

This report deals briefly with the general Permo-Triassic geology of Tasmania, and in some detail with each of the various coalfields encompassing both Permian and Triassic coals. Available quality data are presented together with a summary of transportation and market availabilities and an assessment of the possible economic viability of a mine in the Fingal area. Based on the drawn conclusions, recommendations are made for an exploration programme in the northeastern coalfields of Tasmania.

October 1977      Coal in Tasmania : A Study for Shell Development Australia Pty. Ltd. by Layton & Associates

This study by Layton & Associates covers the regional geology of the coalfields, the Permian and Triassic coalfields, information on coal quality and mining legislation. Statistics on power stations in Tasmania are presented and an assessment of the possible future market requirements is made.

March 1978      CEPR 7/78 : Washability, quality and rank of coal mine samples from northeastern Tasmania

In this report coal quality data and washability characteristics of eleven samples from four Tasmanian mines were assessed and compared with other Australian steaming coal.

May 1978      CEPR 16/78 : A preliminary review of exploration licences 5/61 Gray and 18/77 Avoca

The section on the Avoca area deals with general information such as location, access, climate etc as well as presenting a review of available literature on the area and previous exploration programmes. In addition, the geology and coal resources of the area is dealt with in detail.

May 1978                    CEPR 13/78 : Photo-geological/structural interpretation of Shell coal leases in northeastern Tasmania

Photo-geological maps of the licence area are presented as well as maps of faults and fractures, coal measure sub-outcrops and base elevations of the dolerite. In addition, the geology of the area is treated together with a discussion of the results of the photo-interpretation with reference to applications during future exploration programmes.

July 1978                    CEPR 20/78 : Exploration licence 18/77, Avoca. Six monthly progress report for period ending 26 July 1978

This report deals with the results of exploration activities during the six month period as indicated. Statistics and borehole lithological logs are presented for the boreholes completed (AV 1 - AV 5) and in progress (AV 6). Results of a field mapping programme and the laboratory testing of coal samples are presented and discussed.

October 1978                Fracture Study, N.E. Tasmania for Shell Development (Australia) Pty. Ltd. by Layton and Associates

This study complements the photo-geological interpretation completed by Layton & Associates earlier in 1978 and presents diagrams and maps of fracture frequencies and directions over the licence area.

December 1978              CEPR 29/78 : Exploration licence 18/77, Avoca. Report on the geology and coal resources of E.L. 18/77, Avoca

This report details the results of exploration activities over a 12 month period ending 26.1.1979 in the licence area. Drilling statistics and borehole lithological logs are presented for the boreholes completed in this period (boreholes AV 1 - AV 9). The laboratory results from the one seam analysed are discussed as well as results of the field mapping programme during this period.

January 1979                CEPR 2/79 : Relinquishment report on exploration in the southern part of E.L. 18/77 Avoca

This report deals with the results of exploration activities conducted in the relinquished part of E.L. 18/77 during the 12 month period ending 26.1.1979, and includes photo-geological office studies, field mapping and drilling results. On the basis of these results, relinquishment of the area was recommended.

048

January 1979      CEPR 4/79 : Exploration licence 18/77, Avoca. Six monthly progress report for period ending 26 January 1979

This report is effectively the equivalent of CEPR 29/78 as it presents the results of exploration activities over a 12 month period ending 26.1.1979 in Avoca. On the basis of field mapping work and the boreholes completed, prospective areas for future exploration work are delineated.

January 1980      CEPR 6/80 : Exploration licence 18/77, Avoca. Six monthly progress report for period ending 26 January 1980

This report deals with exploration activities during the six monthly period indicated. On the basis of field mapping work several borehole locations are recommended and prospective areas outlined.

January 1981      CEPR 3/81 : Exploration licence 18/77, Avoca, Tasmania. Progress report 1980

This report presents the exploration results for 1980 and include drilling statistics and borehole lithological logs (holes AV 10 - AV 13) as well as the results from a field mapping programme. Conclusions are drawn and prospective areas delineated on the basis of all available information at the time.

APPENDIX 3

Coal quality data from Stanhope Colliery,  
Duncan Colliery and Merrywood Open-cut Mine

	Duncan Colliery, Fingal	Stanhope Colliery	Merrywood Open-cut Mine
	Raw	Raw	Raw
Ash d.b.	20.2	14.7	18.36
Inherent Moisture a.d.	6.0	3-6	
Volatiles d.b.	25.3	29.5	25.10
Volatiles d.a.f.	31.7	37.6	30.7
Fixed Carbon d.b.	54.5		53.88
Swelling Index	½		
Gray King Coke Type	B		
Austral, Standard Class	501(5)		
Vitrinite Reflectance % (mean max.)	0.67		
Vitrinite %	13		
Extinite %	6		
Micrinite %	11		
Semifusinite %	59		
Fusinite %	1		
Minerals %	10		
Carbon % d.a.f.	83.3		57.76
Hydrogen % d.a.f.	4.79		4.59
Nitrogen % d.a.f.	1.5		1.16
Oxygen % d.a.f.	10.0		17.69
Sulphur, total % d.a.f.	0.36	0.47	0.44
Sulphur, organic % d.a.f.	0.26		
Phosphorus % d.b.	0.033		
Chlorine % d.b.	trace		
Hardgrove Grindability	56		
Gross Calorific values			
air dried, Btu/lb	10,680		10,893
dry, Btu/lb	11,363		
dry, ash free Btu/lb	14,240		
at 8% moisture Btu/lb	10,395	11,500	
at 8% moisture MJ/kg	24.178	26.7	

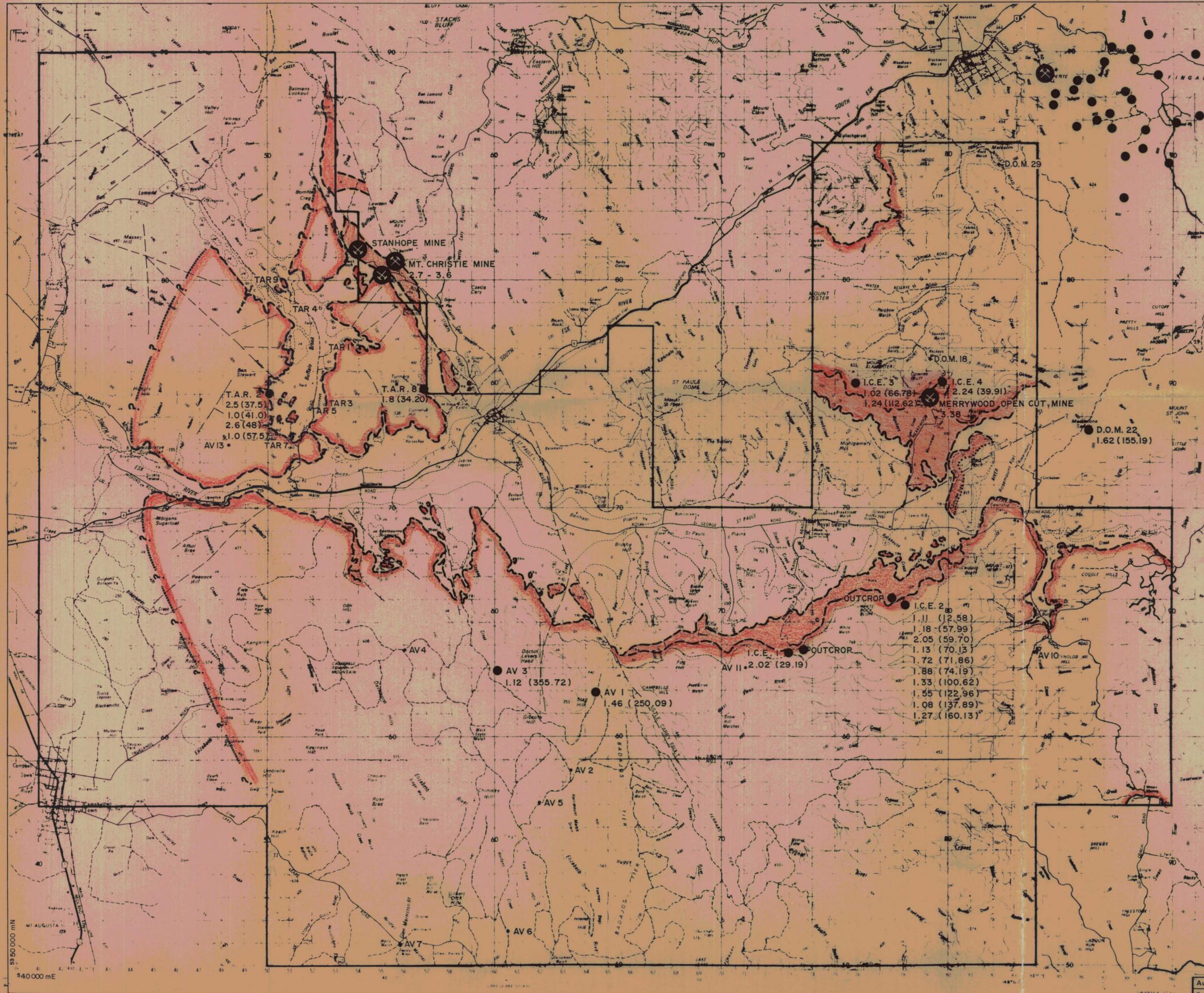
050

	Duncan Colliery, Fingal	Stanhope Colliery	Merrywood Open-cut Mine
	Raw	Raw	Raw
AFT °C Reducing Softening	+1,520		
Hemispheric Flow	+1,560 +1,566		
Mineral Matter %	22.2		
Ash Analysis %			
SiO <sub>2</sub>	62.9		
Al <sub>2</sub> O <sub>3</sub>	28.2		
Fe <sub>2</sub> O <sub>3</sub>	5.48		
TiO <sub>2</sub>	0.78		
Ca <sub>2</sub> O	0.17		
MgO	1.02		
Na <sub>2</sub> O	0.60		
K <sub>2</sub> O	0.67		
P <sub>2</sub> O <sub>5</sub>	0.02		
Mn <sub>3</sub> O <sub>4</sub>	0.08		
SO <sub>3</sub>	0.10		
Fischer Assay			
Coke %	86.9		
Tar %	5.7		
Water %	3.0		
Gas %	4.4		

APPENDIX 4

COAL QUALITY DATA FROM INVESTIGATOR COAL EXPLORATION PTY. LTD. BOREHOLES

DEPTH FROM (m)	DEPTH TO (m)	THICKNESS (m)	AS RECEIVED MOISTURE %	ASH % (d.b)	VOLATILE MATTER % (d.b.)	FIXED CARBON % (d.b.)	% S (d.b.)	S.E. MJ/kg (d.b.)	RELATIVE DENSITY	F.C./VOL.	SEAM
					<u>I.C.E. 1</u>						
22.515	23.3	0.785	4.0	28.5	21.1	50.4	0.36	24.73	1.47	2.39	1
29.155	30.12	0.935	8.0	23.2	23.5	53.2	0.47	26.26	1.45	2.26	2
30.12	30.63	0.51	6.4	37.4							2
30.63	31.2	0.57	5.6	33.4							2
95.78	96.485	0.705	5.4	39.7							8
					<u>I.C.E. 2.</u>						
12.58	13.5	0.92	12.2	58.7	5.0	36.4	0.81	12.50	1.65	7.28	1
57.99	58.51	0.52	3.8	36.6							2
58.51	59.165	0.655	5.5	40.9							2
60.205	60.585	0.38	3.4	38.4	18.3	43.2	0.41	21.98	1.55	2.36	3
60.825	61.71	0.885	13.2	82.6					2.23		3
70.125	71.255	1.13	6.6	75.5					2.02		4
71.86	73.58	1.72	4.9	79.4					2.12		5
74.185	76.06	1.875	4.4	73.8					2.03		6
100.62	101.935	1.315	4.6	51.9					1.70		7
122.96	124.185	1.225	5.5	24.9					1.48		8
137.89	138.97	1.08	4.0	66.6					1.93		9
160.325	161.295	0.97	4.2	63.8					1.90		10
					<u>I.C.E. 3.</u>						
66.78	67.795	1.015	5.3	27.2					1.50		
102.43	103.535	0.605	5.2	65.9					1.88		
112.62	113.86	1.24	3.9	80.7					2.26		
113.04	118.61	0.57	4.3	43.9					1.71		
					<u>I.C.E. 4</u>						
34.98	35.885	0.905	7.4	36.3					1.56		
36.945	37.575	0.63	7.1	31.6					1.52		
37.575	38.105	0.53	6.4	23.4	23.6	53.0	0.44	25.86	1.45	2.25	
38.105	39.145	1.04	7.1	28.8					1.49		
107.39	108.16	0.77	8.3	35.6					1.55		



**LEGEND**

- Coal seams thicker than 1 metre in boreholes, outcrop and old mine workings.
- AV3  
1-12 (355-72)  
● Borehole number  
Thickness of coal seam, (m)  
Depth to roof of coal (m).
- Outcrop and estimated extent of coal measure sequence (Upper Permian Super-Group) beneath the dolerite.
- ⊗ Operating coal mine.
- ⊘ Disused coal mine.

5 cm

SCALE 1:100 000

0 1 2 3 4 5 Kilometres

40°40'S

100000 SHEET INDEX

0 1 2 3 4 5 Kilometres

**LEGEND**

C	QUATERNARY	Alluvium
DT	TERTIARY	Dolerite flows
Ts	TERTIARY	BASALT
Ju	JURASSIC	DOLERITE
TR	UPPER PERMIAN SUPER-GROUP (TRIASSIC)	Undifferentiated
TRa		Coal & carbonaceous shale facies
TRb		Mudstone facies
TRc		Lithic sandstone & siltstone facies
TRd		Quartzose sandstone facies
TRe		Quartzose sandstone facies (very coarse grained)
LP	LOWER PERMIAN SUPER-GROUP (PERMIAN)	Undifferentiated sandstone, grits, conglomerate, mudstone, siltstone
Dg	DEVONIAN	Ben Lomond Granite
MO	EARLY ORDOVICIAN / EARLY DEVONIAN	Mothina Group quartzite, slate, siltstone, schist

Geological boundary

Fault, showing direction of downthrow

○ Coal Outcrop

⊗ Mine Adit, Shaft

— Aero: Photo Lineation

● AV13 Drillhole Shell Company

○ T.A.R.7 Western Mining Corp

● I.C.E.2 Investigator Coal

● D.O.M.22 Department of Mines

— Lease Boundary

⊗ ESK Main Road

— Railway line

Topography, infrastructure from Lands Department 1:100 000 sheets

Geology based on Western Mining Corporation (1977) with amendments

and Investigator Coal Exploration Pty. Ltd. (1978)

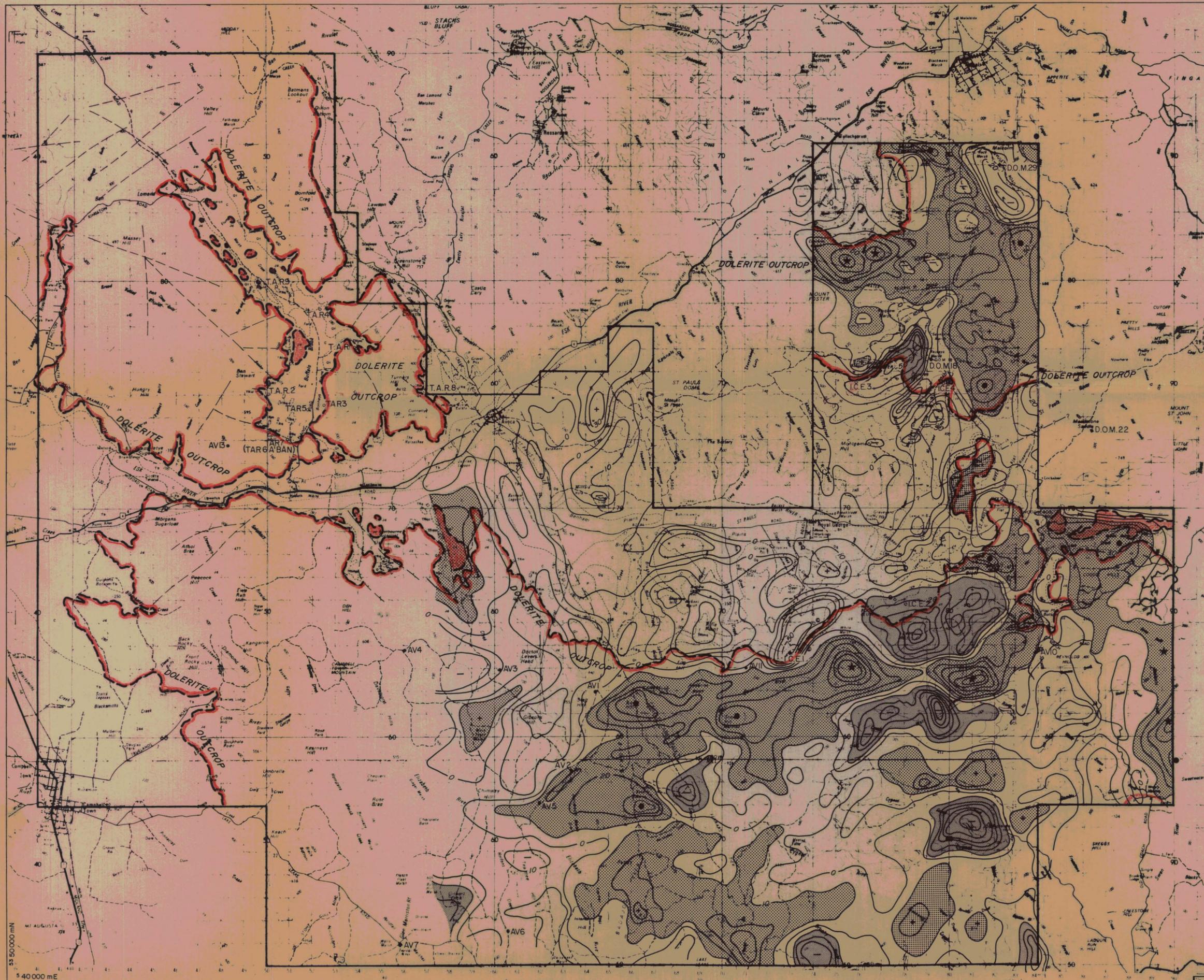
EL 18/77 AVOCA

**KNOWN COAL OCCURRENCES & EXTENT OF THE UPPER PERMIAN SUPER-GROUP SEQUENCE 2491**

Author: J. BORNMAN Date: APRIL 1981

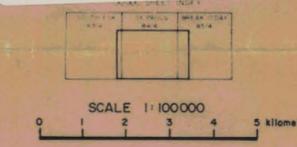
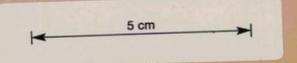
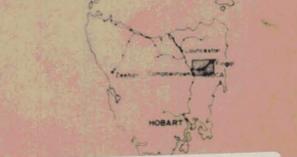
Report No: CEPR 8/81 Drawing No: 1992 Encl. 1

81-1570 957053



- Areas with residual Bouguer anomalies less than  $-10 \mu\text{m}/\text{s}^2$  on dolerite (Leaman and Richardson, 1980)
- Major areas with residual Bouguer anomalies greater than  $+10 \mu\text{m}/\text{s}^2$  on dolerite
- Inferred feeder locations
- Location of thick accumulations of Dolerite - possibly feeders
- Dolerite Outcrop
- Residual Bouguer anomaly contour  $\mu\text{m}/\text{s}^2$

SOURCE:  
D.E. Leaman, Department of Mines, Tasmania.  
Gravity Survey of the Eastern Highlands, Central Eastern Tasmania.



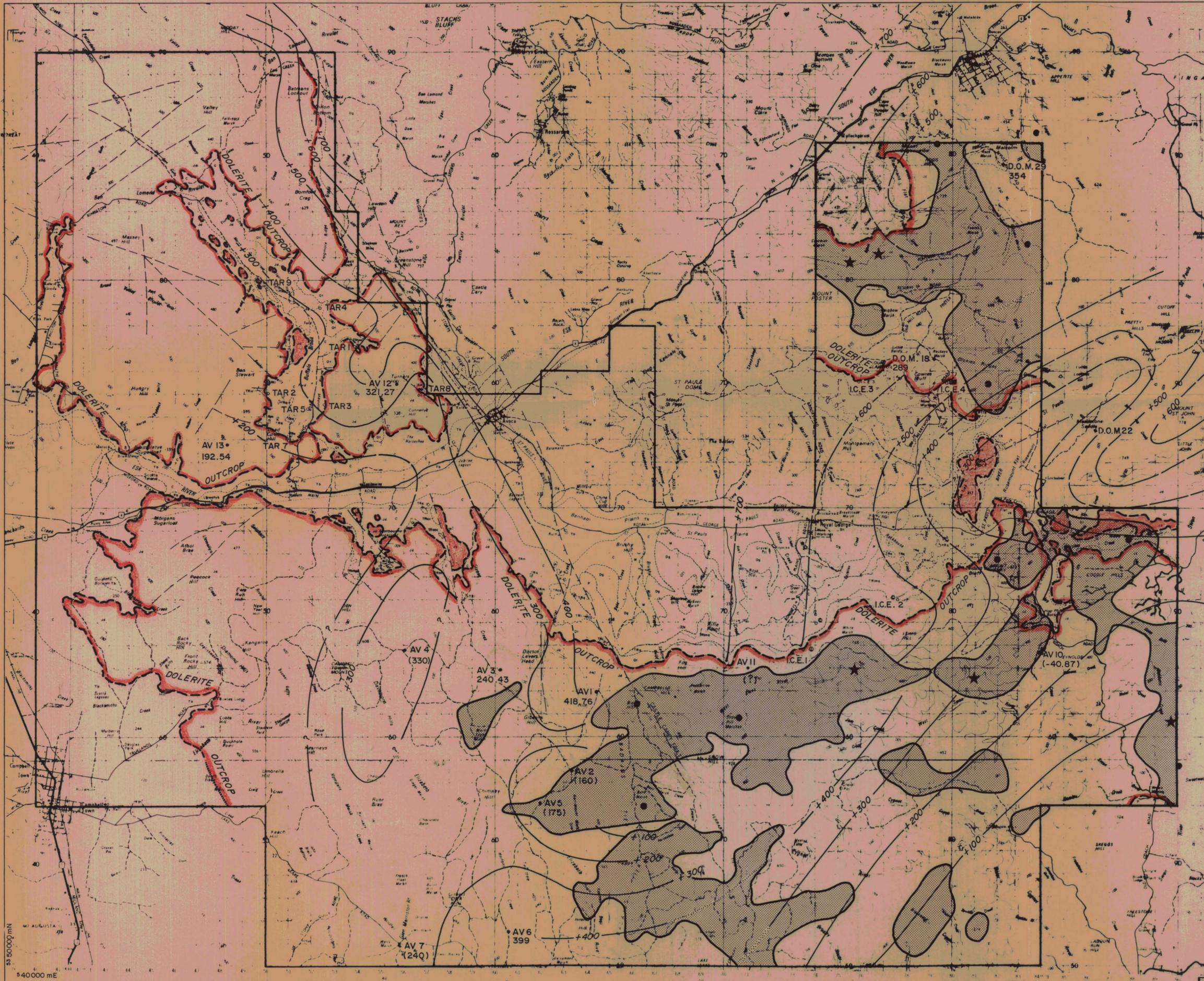
LEGEND

- |  |                                      |  |
|--|--------------------------------------|--|
|  | QUATERNARY                           | Alluvium   |
|  |                                      | Dolerite talus   |
|  | TERTIARY                             | BASALT   |
|  | JURASSIC                             | DOLERITE   |
|  |                                      | Undifferentiated   |
|  |                                      | Coal & carbonaceous shale facies                                     |
|  | UPPER PARMEER SUPER-GROUP (TRIASSIC) | Mudstone facies  |
|  |                                      | Litic sandstone & siltstone facies                                   |
|  |                                      | Quartzite sandstone facies   |
|  |                                      | Quartzite sandstone facies (very coarse grain)                       |
|  | LOWER PARMEER SUPER-GROUP (PERMIAN)  | Undifferentiated sandstone, grits, conglomerate, mudstone, siltstone |
|  | DEVONIAN                             | Ben Lomond Granite   |
|  | EARLY ORDOVICIAN / EARLY DEVONIAN    | Melting Group quartzite, slate, siltstone, schist                    |
|  |                                      | Geological boundary  |
|  |                                      | Fault, showing direction of downthrow                                |
|  |                                      | Coal Outcrop   |
|  |                                      | Mine Adit, Shaft   |
|  |                                      | Aerial Photo Location  |
|  | AV13 Drillhole                       | Shell Company  |
|  | TAR7                                 | Western Mining Corp.   |
|  | ICE.2                                | Investigator Coal  |
|  | D.O.M.22                             | Department of Mines  |
|  |                                      | Lease Boundary   |
|  |                                      | ESK Main Road  |

Topography, infrastructure from Lands Department 1:100,000 sheets  
Geology based on Western Mining Corporation (1977) with amendments  
and Investigator Coal Exploration Pty. Ltd. (1978)

957054  
EL 18/77 AVOCA 2492  
**RESIDUAL BOUGUER ANOMALY**  
Based on a 4 x 4 km regional.  
Density = 2.67 t/m<sup>3</sup>  
Terrain correction applied, r = 19km

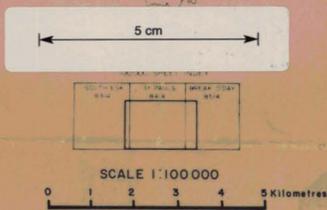
Author: J. Bornman	Date: April 1981	Encl. 2
Report No: CEPR 8/81	Drawing No: 1993	



**LEGEND**

- +600 Elevation contour (m.a.s.l.) of base of Dolerite.
- AV13 192.54 (160) Base elevation of Dolerite (m.a.s.l.) Estimated base elevation of Dolerite (m.a.s.l.)
- Location of thick Dolerite accumulations - possibly feeders
- Inferred feeder locations.
- Dolerite outcrop.

Areas affected by Dolerite feeders with local extreme thickness of Dolerite cross-cutting the regional base elevation trend. (Source: Department of Mines, Tasmania) - gravity survey



**LEGEND**

C	QUATERNARY	Alluvium
Q1		Dolerite talus
T3	TERTIARY	BASALT
J4	JURASSIC	DOLERITE
T4		Undifferentiated
T3c		Coal & carbonaceous shale facies
T3m	UPPER PERMIAN SUPER-GROUP (TRIASSIC)	Mudstone facies
T3l		Lithic sandstone & siltstone facies
T3k		Quartzose sandstone facies
T3x		Quartzose sandstone facies (very coarse grain)
P2	LOWER PERMIAN SUPER-GROUP (PERMIAN)	Undifferentiated sandstone, grits, conglomerate, mudstone, siltstone
D4	DEVONIAN	Ben Lomond Granite
E4	EARLY ORDOVICIAN / Maitland Group	quartzite, slate, siltstone, schist

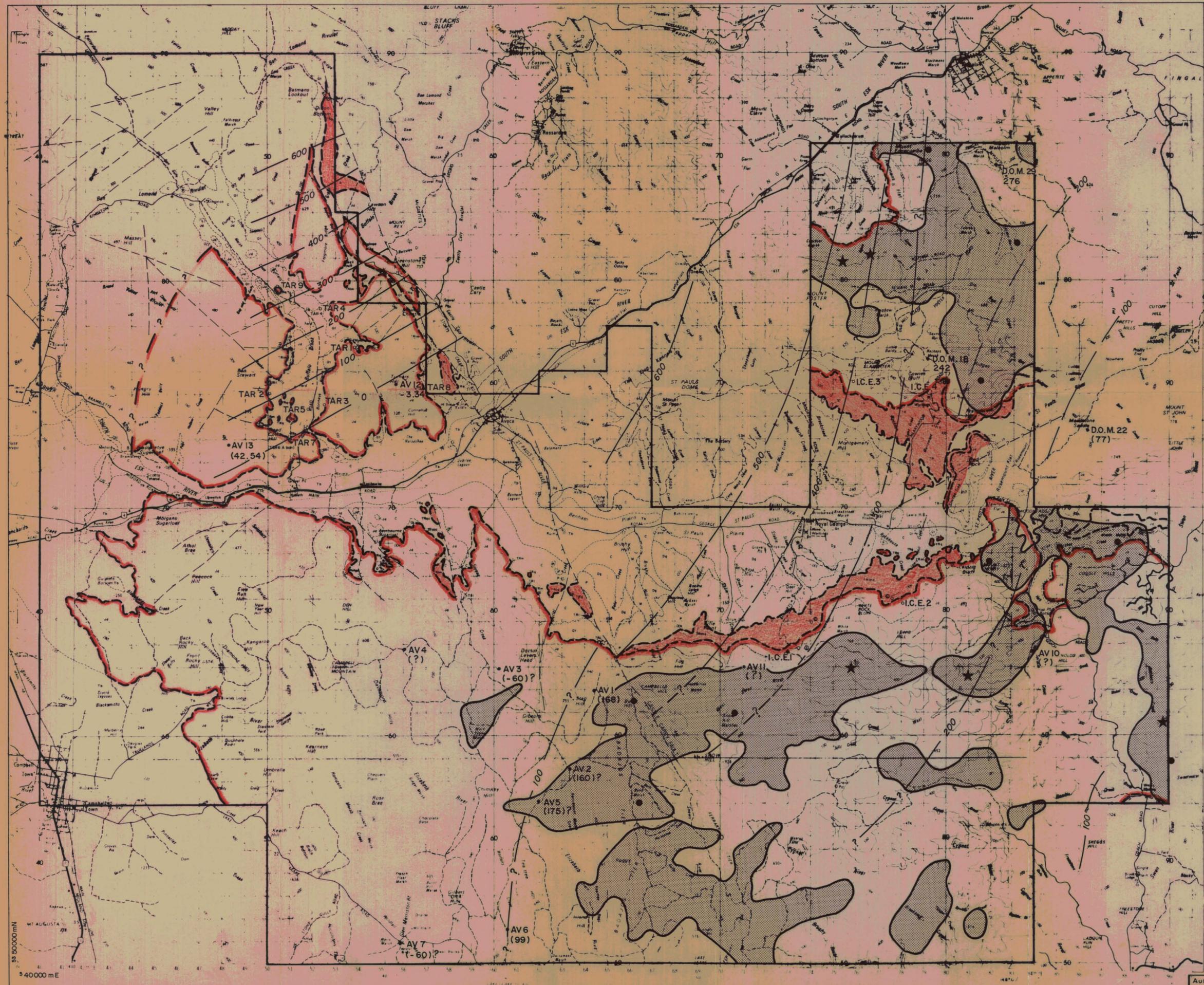
- Geological boundary
- Fault, showing direction of downthrow
- Coal Outcrop
- Mine Adit, Shaft
- Aerial Photo Lineation
- AV13 Drillhole Shell Company
- TAR 7 Western Mining Corp
- I.C.E.2 Investigator Coal
- D.O.M.22 Department of Mines
- Lease Boundary
- ESK Man Road

Topography, infrastructure from Lands Department 1:50 000 sheets  
 Geology based on Western Mining Corporation (1977) with amendments  
 and Investigator Coal Exploration Pty. Ltd. (1978)

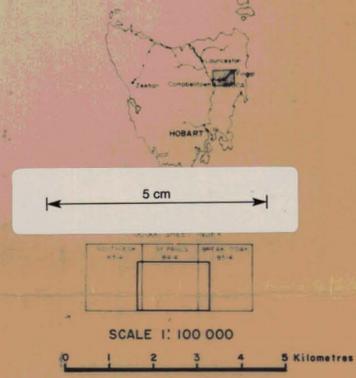
957055

EL 18/77AVOCA 2493  
 ESTIMATED  
 BASE ELEVATION OF DOLERITE  
 & EXTENT OF DOLERITE OUTCROP

81-1570



- LEGEND**
- ★ Inferred feeder locations
  - Location of thick accumulations of Dolerite - possibly feeders.
  - ~300~ Base structure contour (m.a.s.l.)
  - [Hatched Box] Area affected by Dolerite feeders and dykes which do not conform to the regional base structure trend of the Upper Parmeener Super-Group (Source: Department of Mines, Tasmania - gravity survey)
  - [Red Outline] Outcrop and estimated extent of Upper Parmeener Super-Group beneath the dolerite.
  - AV1 (168) Estimated base elevation of Upper Parmeener Super-Group (m.a.s.l.)
  - 10-33 Base elevation of Upper Parmeener Super-Group (m.a.s.l.)



- LEGEND**
- [C] QUATERNARY Alluvium
  - [D] QUATERNARY Dolerite talus
  - [T] TERTIARY BASALT
  - [J] JURASSIC DOLERITE
  - [U] Undifferentiated
  - [U1] Coal & carbonaceous shale facies
  - [U2] Mudstone facies
  - [U3] Litic sandstone & siltstone facies
  - [U4] Quartzose sandstone facies
  - [U5] Quartzose sandstone facies (very coarse grain)
  - [L] LOWER PARMEENER SUPER-GROUP (PERMIAN) Undifferentiated sandstone, grits, conglomerate, mudstone, siltstone
  - [D] DEVONIAN Ben Lomond Granite
  - [E] EARLY ORDOVICIAN/EARLY DEVONIAN Maitland Group quartzite, slate, siltstone, schist
  - [F] Geological boundary
  - [F1] Fault, showing direction of downthrow
  - [O] Coal Outcrop
  - [M] Mine Adn. Shaft
  - [A] Aerial Photo Lineation
  - [AV13] AV13 Drillhole Shell Company
  - [TAR7] T.A.R.7 Western Mining Corp
  - [I.C.E.2] I.C.E.2 Investigator Coal
  - [DOM.22] D.O.M.22 Department of Mines
  - [L] Lease Boundary
  - [R] ESK Main Road

EL 18/77 AVOCA

**ESTIMATED STRUCTURE OF  
BASE OF UPPER PARMEENER  
SUPER - GROUP & EXTENT**

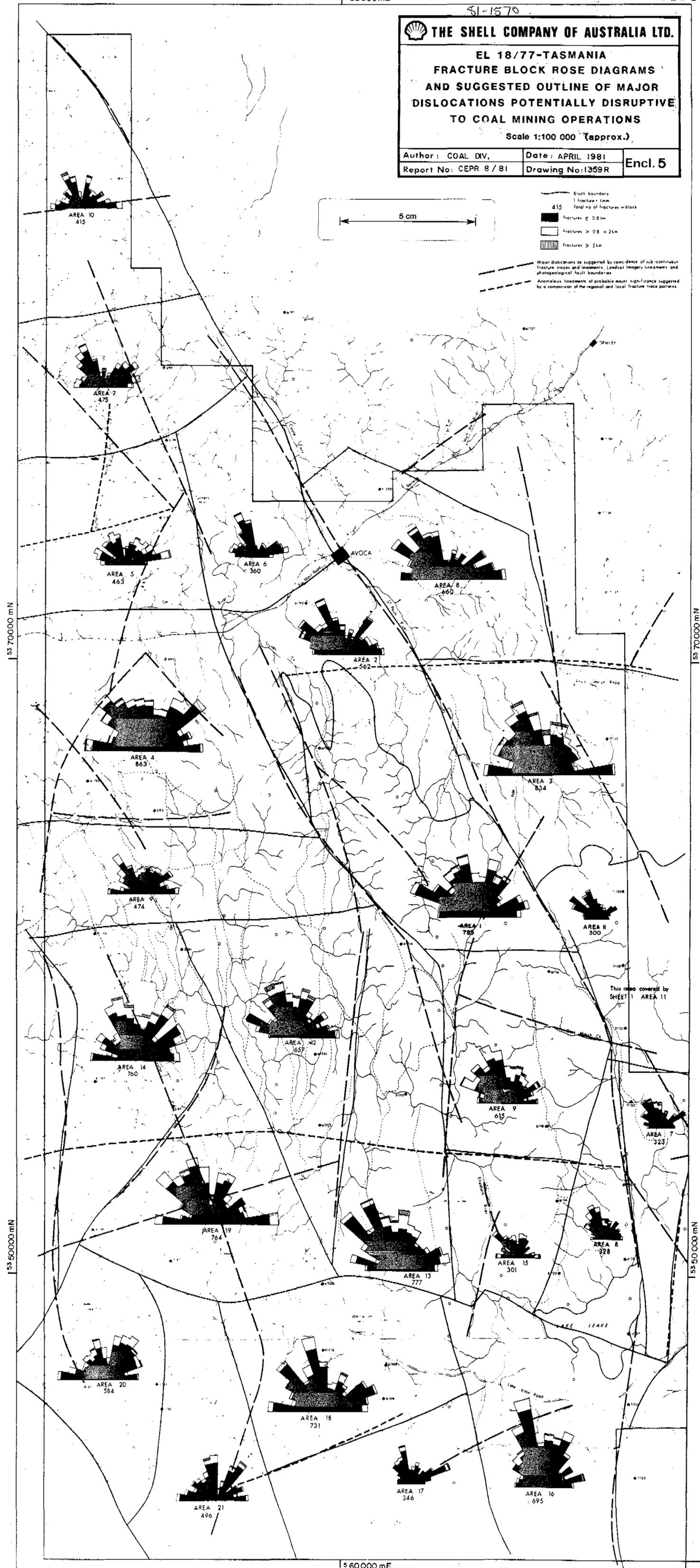
957056 2494

**THE SHELL COMPANY OF AUSTRALIA LTD.**

**EL 18/77-TASMANIA**  
**FRACTURE BLOCK ROSE DIAGRAMS**  
**AND SUGGESTED OUTLINE OF MAJOR**  
**DISLOCATIONS POTENTIALLY DISRUPTIVE**  
**TO COAL MINING OPERATIONS**

Scale 1:100 000 (approx.)

Author: COAL DIV.	Date: APRIL 1981	Encl. 5
Report No: CEPR 8/81	Drawing No: 1359R	

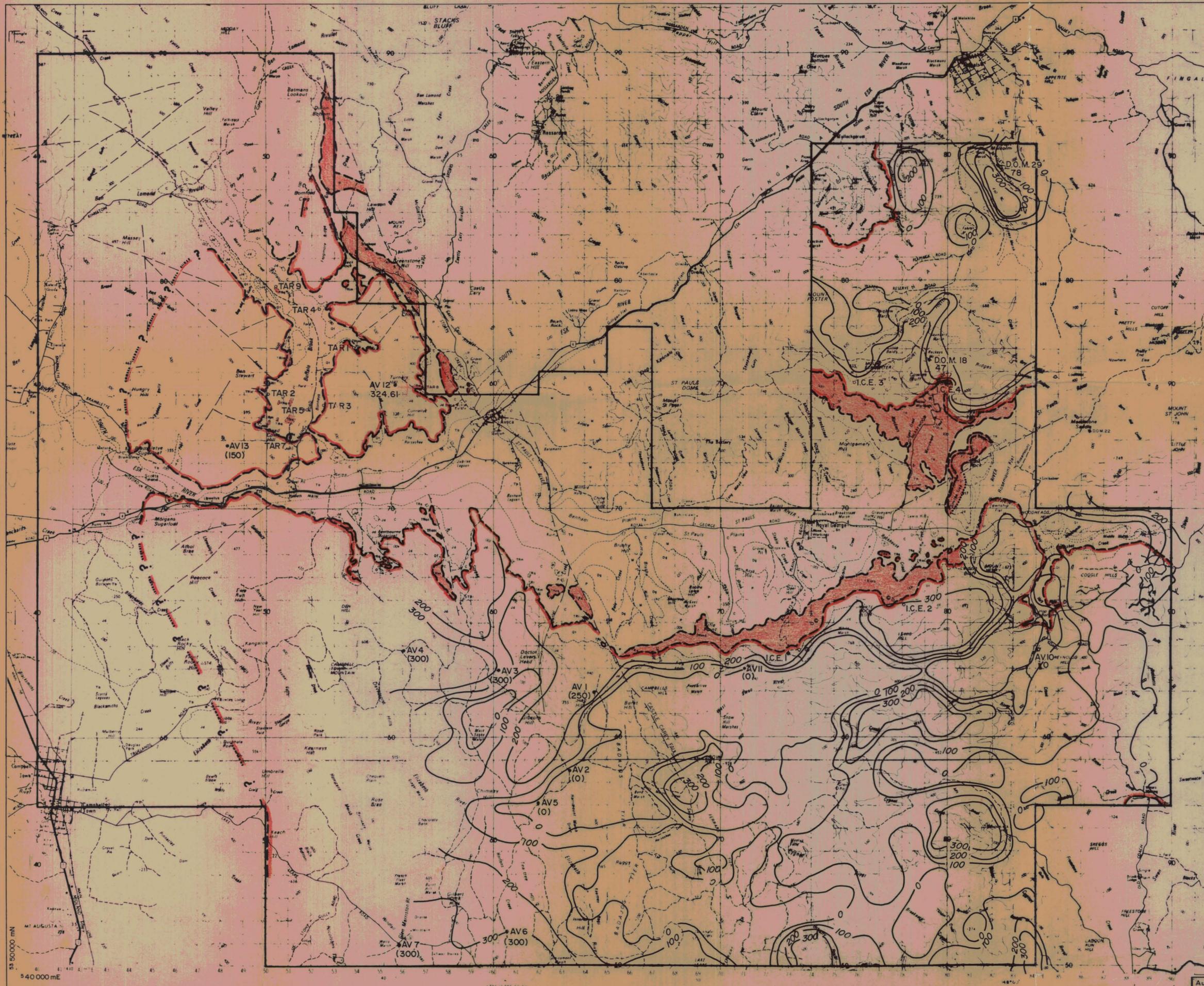


53 70000 mN

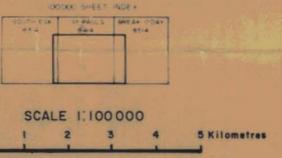
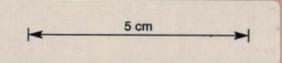
53 70000 mN

53 50000 mN

53 50000 mN



- 300 Estimated thickness of the Upper Parmeener Super - Group (m) (Based on Gravity Survey information)
- AV 10 (300) Estimated thickness of the Upper Parmeener Super - Group (m)
- 331.60 Thickness of the Upper Parmeener Super - Group (m)
- Outcrop and estimated extent of the Upper Parmeener Super - Group sequence beneath the dolerite



**LEGEND**

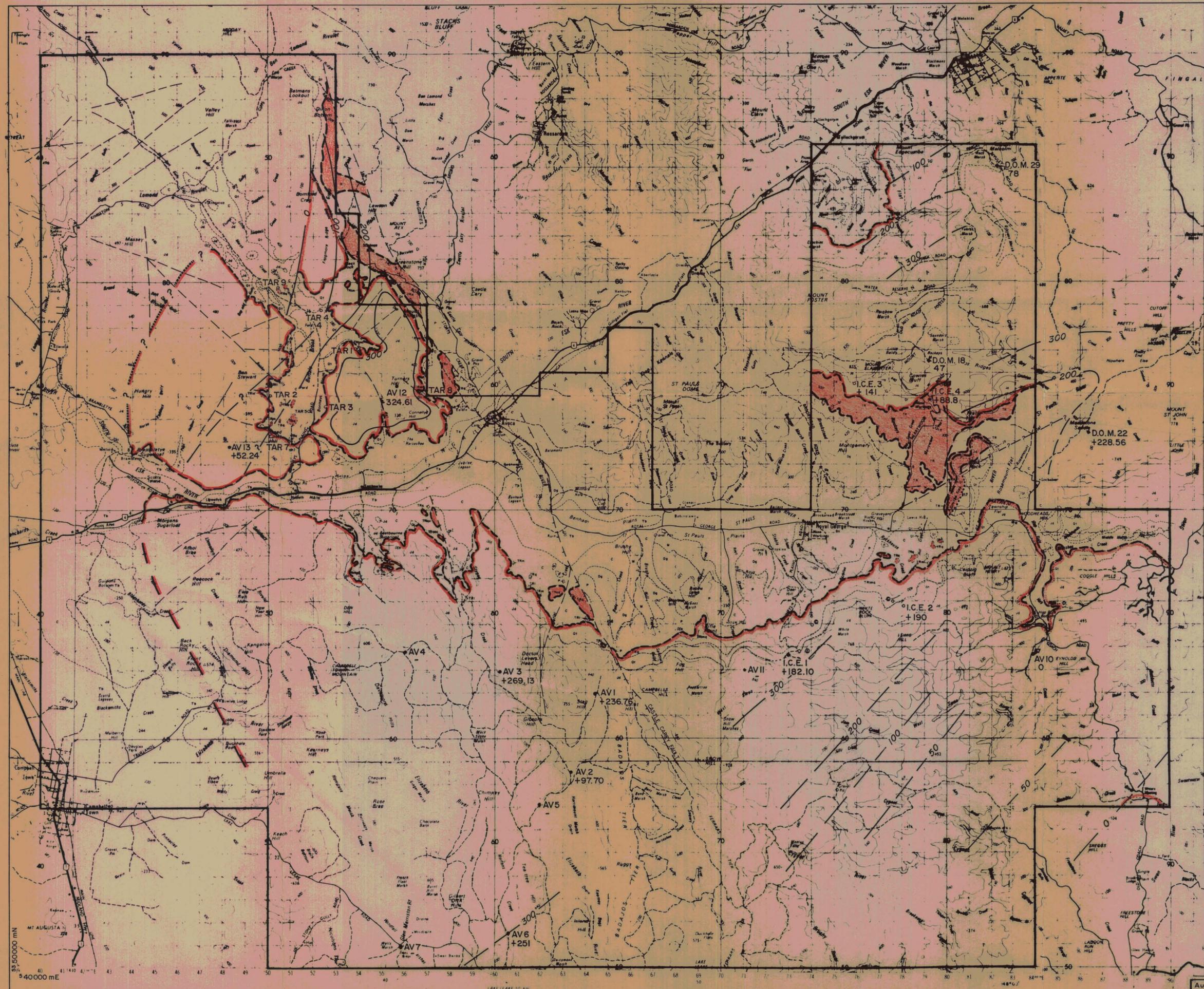
- QUATERNARY Alluvium
- Dolerite flows
- TERTIARY BASALT
- JURASSIC DOLOERITE
- Undifferentiated
- Coal & carbonaceous shale facies
- Mudsstone facies
- Litic sandstone & siltstone facies
- Quartzose sandstone facies
- Quartzose sandstone facies (very coarse grain)
- LOWER PARMEENER SUPER-GROUP (PERMIAN) Undifferentiated sandstone, grits, conglomerate, mudstone, siltstone
- DEVONIAN Ben Lomond Granite
- EARLY ORDOVICIAN/ Mething Group quartzite, slate, siltstone, schist
- Geological boundary
- Fault, showing direction of downthrow
- Coal Outcrop
- Mine Adit, Shaft
- Aerial Photo Lineation
- AV13 Drillhole Shell Company
- TAR.7 Western Mining Corp.
- I.C.E.2 Investigator Coal
- D.O.M.22 Department of Mines
- Lease Boundary
- ESK Main Road
- Railway Line

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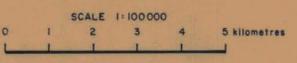
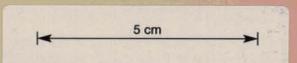
EL 18/77 AVOCA

**ESTIMATED THICKNESS AND EXTENT OF THE UPPER PARMEENER SUPER - GROUP BASED ON GRAVITY INFORMATION**

2496



- 300 — Estimated thickness of the Upper Parmeener Super-Group (m) (Based on the regional trends of the dolerite and Upper Parmeener Super-Group base elevations)
- AV10 331.60 Thickness of the Upper Parmeener Super-Group (m)
- Outcrop and estimated extent of the Upper Parmeener Super-Group sequence beneath the dolerite



**LEGEND**

- QUATERNARY
  - C Alluvium
  - Q1 Dolerite talus
- TERTIARY
  - Ta BASALT
- JURASSIC
  - J4 DOLERITE
- UPPER PARMEENER SUPER-GROUP (TRIASSIC)
  - TR Undifferentiated
  - TR1 Coal & Carbonaceous shale facies
  - TR2 Mudstone facies
  - TR3 Lithic sandstone & siltstone facies
  - TR4 Quartzose sandstone facies
  - TR5 Quartzose sandstone facies (very coarse grain)
- LOWER PARMEENER SUPER-GROUP (PERMIAN)
  - P Undifferentiated sandstone, grits, conglomerate, mudstone, siltstone
- DEVONIAN
  - D4 Ben Lomond Granite
- EARLY ORDOVICIAN / EARLY DEVONIAN
  - M Mothian Group quartzite, slate, siltstone, schist
- Geological boundary
- Fault, showing direction of downthrow
- Coal Outcrop
- Mine Adit, Shaft
- Aerial Photo Lineation
- AV13 Drillhole Shell Company
- T.A.R.7 Western Mining Corp
- I.C.E.2 Investigator Coal
- D.O.M.22 Department of Mines
- Lease Boundary
- ESK Main Road

957059

EL 18/77 AVOCA  
**ESTIMATED THICKNESS AND EXTENT OF THE UPPER PARMEENER SUPER-GROUP**  
**BASED ON THE REGIONAL TRENDS OF THE DOLERITE AND UPPER PARMEENER SUPER-GROUP BASE ELEVATIONS**

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