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# GEOLOGICAL SURVEY BULLETIN No. 52

# GRAVITY SURVEY OF THE HOBART DISTRICT

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ISSUED UNDER THE AUTHORITY OF THE HONOURABLE
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MINISTER FOR MINES FOR TASMANIA

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## PREFACE

The work described in this Bulletin was undertaken as part of the author's doctoral thesis for the University of Tasmania during 1968 and 1969. The application of a gravity survey over an extensive area followed changes in the methods of approach to the problem of the determination of the form of dolerite intrusions.

The gravity survey of the Tertiary basins in northern Tasmania (Bulletin 51) demonstrated that, given an adequate coverage of gravity observations over an extensive area, it was possible to give an integrated indication of the form of the intrusions. Previous gravity surveys had not covered sufficiently large areas, nor had a sufficient coverage of gravity observations to be really successful. Following the survey in northern Tasmania a trial survey was undertaken in the Pitt Water - Campania area in order to determine whether a reliable structural interpretation could be achieved in an area containing a variety of rock types, and to estimate the measure of control needed by other geophysical methods, drilling and especially detailed geological mapping. The success of this pilot survey led to further gravity surveys over Hobart and adjacent areas, the results of which are incorporated in this Bulletin.

*J.G. SYMONS, Director of Mines*

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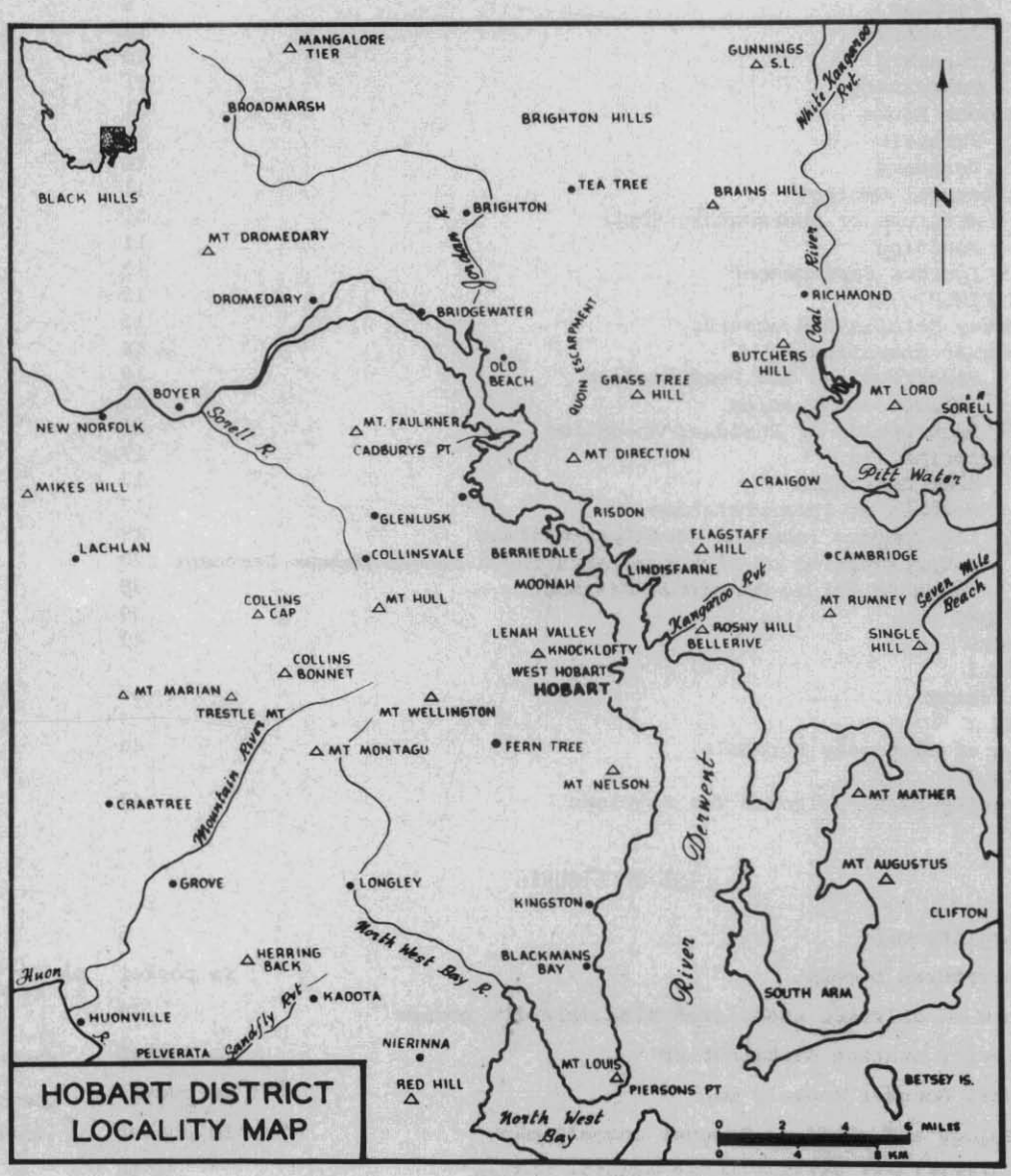

MANGALORE
TIER
BROADMARSH
BRIGHTON HILLS
GUNNINGS
S.L.
White Kangaroo Rvt.
BLACK HILLS
TEA TREE
BRAINS HILL
BRIGHTON
Jordan R.
MT DROMEDARY
DROMEDARY
BRIDGEWATER
QUOIN ESCARPMENT
Coal River
RICHMOND
BUTCHERS HILL
OLD BEACH
GRASS TREE HILL
MT LORD
SORELL
BOYER
NEW NORFOLK
Sorell R.
MT. FAULKNER
CADBURYS PT.
MT DIRECTION
MIKES HILL
CRAIGOW
Pitt Water
GLENLUSK
RISDON
LACHLAN
COLLINSVALE
BERRIEDALE
FLAGSTAFF HILL
CAMBRIDGE
MOONAH
LINDISFARNE
Kangaroo Rvt
Seven Mile Beach
COLLINS CAP
MT HULL
MT RUMNEY
ROSNY HILL
BELLERIVE
LENAH VALLEY
KNOCKLOFTY
SINGLE HILL
COLLINS BONNET
WEST HOBART
HOBART
MT MARIAN
TRESTLE MT.
MT WELLINGTON
Mountain River
MT MONTAGU
FERN TREE
MT NELSON
Derwent River
MT MATHER
CRABTREE
MT AUGUSTUS
GROVE
LONGLEY
KINGSTON
CLIFTON
North West Bay R.
HERRING BACK
BLACKMANS BAY
Huon
SOUTH ARM
KADOTA
HUONVILLE
Sandfly Rvt
PELVERATA
NIERINNA
MT LOUIS
RED HILL
PIERSONS PT
BETSEY IS.
North West Bay
0 2 4 6 MILES
0 4 8 KM
N
HOBART DISTRICT
LOCALITY MAP

Figure 1.

5 cm

## ABSTRACT

A gravity survey, employing an average station spacing of 0.8 km has provided considerable information on the structure of the dolerite intrusions and the major fault blocks.

About thirty dolerite centres have been revealed. Such centres usually take the form of pipes up to 1.6 km in diameter although some are dyke-like. The dolerite intrusions generally have an irregular, flattened, trumpet shape which results in a cross-wave pattern upon interconnection.

Many major fault blocks are deficient in intrusions. Tertiary faulting which commonly downthrows to the east is superimposed on Jurassic graben faulting. Tertiary structures near South Arm are deep, abrupt sediment-filled depressions.


## INTRODUCTION

The Hobart district, an area of 2,300 $km^2$ is centred on Hobart in south-eastern Tasmania (fig. 1).

Two topographic features dominate the Hobart district: the Mt Wellington-Mt Marian plateau and the Derwent lowlands. Relief is generally moderate to high. Without exception elevated country is dominated by dolerite bodies which give protection against erosion.

In detail, the topography is marked by fault-controlled features, such as escarpments and straight, narrow valleys. The Derwent lowlands are fault-controlled and represent, with the Coal River valley and Pitt Water, a graben some 32 km across. Step faulting within the graben has produced linear blocks at various elevations. The Mt Direction and South Arm blocks represent a central zone elevated with respect to the eastern escarpment and downthrown compared with the western escarpment.

The geology of the district is complicated by two superimposed systems of faulting: one Jurassic in age, and probably partly contemporaneous with the dolerite intrusion, and the other mainly Tertiary in age. Fault rejuvenation has made study of the intrusions difficult, due to uncertainties of age and structural relations. In addition, as also noted by Carey (1958*a*, p. 131), the detailed complexities of the intrusions have obscured first order examinations. Structural configurations typical of the Tasmanian dolerites are found: dykes, sills and sheets of various scales and attitudes. Previous workers have attempted to resolve the structural problems using only geological methods. Little of general value was derived. Failure was often due to the small area chosen, and the inability of geological methods to provide a unique solution. Gravity surveys have only recently been employed. Three surveys have been directed at these problems in Tasmania: McDougall and Stott (1961), Jones *et al.* (1966), Leaman and Naqvi (1968). All dealt with small areas. They indicated that with a detailed survey of large scale the form of the intrusions and related structures as a whole, could be resolved. A detailed geological study by the interpreter of the gravity survey was also shown to be essential. With application of both geological and geophysical methods a sense of uniqueness can be approached in interpretation, but without drilling control the parameters of intrusive bodies cannot be fully specified.

The basic approach during the present study has been to map and survey a significant, accessible, varied area in some detail. The range of structures present, both intrusive and epeirogenic, and the great topographic relief

were key factors in the choice of area. The district has one distinct disadvantage in that many structures related to, or concealed by, the Derwent estuary cannot be examined.

## Acknowledgments

I should like particularly to express my gratitude to Professor S.W. Carey for his guidance, discussion and criticism throughout all stages of the work. My gratitude is also extended to M.R. Banks, J.E. Shirley, Dr. R. Varne, Dr. E. Williams, Dr. W.D. Parkinson and I.B. Jennings for their general interest and help.

## Previous Literature

Although Hobart was first settled in 1803, it was not until 1865 that the first geological work was published (Harrison, 1865). Harrison referred briefly to the dolerites of the city site and classed them as basalts, which flowed down old valleys from which the divides have now been removed. In the first major work to appear, Johnston (1888) regarded most of the dolerite as 'greenstone' of pre-Carboniferous age and as flows antedating the rocks now known as Permo-Triassic. He was the first to recognise the significance of faulting in the area.

Hills *et al.* (1922) considered the intrusion to be a massive sheet with plugs and dykes pushing into overlying sedimentary rocks. Nye (1922, 1924) also developed this idea. It was not until Edwards (1942) and Lewis (1946) that a reasonable description of petrology and distribution became available. Some of Edwards' conclusions concerning mechanism of differentiation are based on Lewis' interpretations of the structure, and should be treated with caution. Lewis noted the particular importance of Tertiary faulting and the Wellington uplift. He considered the dolerite to be intruded in the form of thick and subsequently faulted sheets. He considered the dolerite intrusions to be the result of a hydrostatic and non-forcible process.

Subsequent workers have generally made detailed geological maps of small parts of the area. No great interest was shown, nor was it possible within the chosen areas, to deduce much of comprehensive value concerning the dolerite, *e.g.* Mather (1955), Rodger (1957), Woolley (1959), McDougall (1959*b*), Hastie (1961), Moore (1965, 1968) and Gatehouse (1968). However, Green (1961) mapped a sufficiently large area to suggest sill repetition by Tertiary faulting across South Arm. McDougall (1962), and Sutherland (1964) also mapped areas dominated by large dolerite bodies, which led both to significant comments on intrusion mechanism and form. The validity of their conclusions is discussed later (p. 32, 40 ).

Literature on the Tasmanian dolerites has been predominantly of a petrological character. However, the Dolerite Symposium (1958) contained some papers dealing with possible mechanisms of intrusion and descriptions of the intrusion form in this and other provinces (Carey, 1958*a*, 1958*b*; Walker, 1958). Carey (1958*a*) postulated that the dolerite was intruded as massive cone sheets emanating from many centres. This idea was followed by Spry (1958) and Sutherland (1964, 1966). Carey's postulate was based on use of contact-stratigraphic structure contours termed isostrats, which have since been criticised by Leaman and Naqvi (1968). Work in this district shows that while the isostrat principle is not invalid it gives only a partial solution.

Apart from the examination of the Red Hill intrusion by McDougall (1961, 1962) and McDougall and Stott (1961) no other detailed geological-geophysical work had been undertaken on the dolerites or associated structures of this district.

Some unpublished gravity work was in existence prior to the survey. It is presented by Cameron (1967) and included the small Sorell survey of Shalley (1964), and exercise surveys by geophysical students.

## GEOLOGY

Detailed geological fieldwork, extending over a period of more than three years, is summarised in the Hobart and Brighton 1:63,360 geological maps, and outlined in Figure 6. As much of the area had been mapped previously most of the present work took the form of revision and checking. About one quarter of the map is original work. No previous workers have had the advantage of an accurate area-wide topographic basemap.

Previous mapping by McDougall (1959*b*, 1962), Green (1961) and Moore (1965) was found to be reliable. Insofar as the map of Banks *et al.* (1965) includes such work, and some other unpublished Department of Mines work, it is also accurate. Considerable revision was undertaken of work by Mather (1955), Gatehouse (1968) and especially Woolley (1959), and the mapping of Sutherland (1964) has been simplified.

In a study of this kind, knowledge of all aspects of the geology is essential in order to sort out the structures involved. A brief summary of basic geological information follows. More detailed particulars are given on pages 20-37.

### Stratigraphy

#### *Permian*

The total thickness of exposed Permian rocks is about 600 m. The base of the system is not exposed within this district, although by analogy with the adjacent Woodbridge, Cygnet and Maydena regions there could be a further 150 m of glacigene rocks. All formations are conformable.

*Lower Permian*

The rocks designated Lower Permian consist of a monotonous mudstone-siltstone sequence, with occasional sandstone units, more than 120 m thick. The only exposures are in the Collinsvale-Glenlusk-Berriedale region (see also Sutherland, 1964). The group may be equivalent to the Quamby Group of northern Tasmania (see also Banks, 1962). It is possible that these rocks are in fact Carboniferous (Gulline, 1967; M.J. Clarke pers. comm).

*Bundella Mudstone*

A formation of fossiliferous and somewhat pebbly mudstone, containing calcareous mudstone and limestone units, about 75 m thick. Complete sections through this formation are rare because dolerite commonly intrudes these rocks.

*Faulkner Group*

Rocks of this group are variable in thickness, facies and lithology. They consist of sandstone, mudstone and conglomerate. With the exception of the Cygnet Coal Measures, the only non-marine Permian rocks occur in this group. The thickness of the group varies from 18-30 m (see also Banks and Hale, 1957).

*Cascades Group* (Banks and Hale, 1957)

This group consists of very fossiliferous mudstone, siltstone and limestone. The Berriedale Limestone has its greatest thickness on Mt Dromedary and thins to the south-west. The dominant unit over the southern half of the district is the Grange Mudstone. The group has a thickness of 90-100 m. Due to the common occurrences of sills in this horizon few estimates of total thickness are possible.

*Malbina Formation* (Banks and Read, 1962)

This formation is composed mainly of unfossiliferous siliceous siltstone, with a pebbly fossiliferous sandstone at the base and a very fossiliferous mudstone at the top. The formation varies in thickness from 65-90 m; the thickest development is near New Norfolk. It thins markedly to the south-west.

*Ferntree Group*

The base of the group is marked by a pebbly feldspathic sandstone about 6 m thick. The remainder consists of 170 m of fissile and non-fissile generally unfossiliferous siltstone with occasional sand and grit beds.

*Cygnet Coal Measures*

This formation is here defined as that non-marine sequence (coal, carbonaceous mudstone and shale and,or feldspathic sandstone containing carbonaceous fragments), which usually disconformably overlies the Ferntree Group. Its thickness varies from 0-30 m.

## *Triassic*

Triassic rocks may be divided into two lithological associations; a sequence of quartz sandstone, mudstone and shale of Lower and Middle? Triassic age overlain by a sequence of lithic feldspathic sandstone and mudstone of Upper Triassic-Rhaetic age (Hale, 1962; Townrow, 1962). All rocks are of freshwater origin.

The base of the Triassic rocks is marked by a topographic bench, the occurrence of pure siliceous rocks (compare Cygnet Coal Measures), and occasionally a quartz grit. The Lower Triassic rocks have a maximum thickness of 400-450 m, and show a change in composition and texture throughout the sequence. The basal rocks are nearly always dominated by a massive medium-coarse sandstone while the overlying rocks are more fine-grained, more feldspathic (c. 10-15%) and micaceous. The proportion of lutite increases upward, from minor dark shale occurrences near the base to units of thick massive mudstone near the top. A succession of massive mudstone units, often with red beds, normally underlies occurrences of Upper Triassic rocks. There is some interdigitation of the two associations.

The lithic sequence has a higher proportion of fine-grained rocks than the quartz sequence. Thin coal seams are also present. Its thickness is unknown but at least 150 m was proved by drilling at Richmond.

## *Tertiary*

Non-marine clay and sand has been deposited in fault-drainage-erosion troughs in the Coal and Derwent valleys. The maximum thickness known (drilling at 'Carrington', Richmond) exceeds 205 m. The deposits conform to the shape of the wedge-shaped fault troughs, although the influence of erosion

channels within these is very important. The basin north of Richmond contains much lignite.

### *Quaternary*

Alluvial deposits are associated with most streams, and are generally only 3-6 m thick. Thick deposits of windblown sand are found at Seven Mile Beach and South Arm. Gravels occur at up to 15 m above present river level in the Derwent valley west of Bridgewater. These deposits are probably related to greater river flows, or high sea levels of Pleistocene times.

## Igneous Rocks

### *Jurassic*

Tholeiitic dolerite, dated at about 167 million years (McDougall, 1961) crops out over about half the district. Two major petrological studies have been made of bodies within this area; those of Edwards in 1942 (Mt Wellington, Mt Nelson, Gunnings Sugar Loaf) and McDougall in 1962 (Red Hill). Both studies were directed at differentiation sequences. No significant attempts have been made to relate type, or stage of differentiation to the form of the intrusion. The above-mentioned authors, Joplin (1957, 1964) and Spry (1962) have stated that the magma was very uniform in composition and intruded close to the liquidus temperature. This conclusion is based on chilled margin studies which may be open to some doubt. These authors have concluded that the intrusion took place in one major pulse but the general work done is hardly sufficient to be definitive. There is little petrological evidence available to suggest that the intrusion occurred in more than one pulse. Detailed work has not yet been undertaken on adjacent intrusions to examine such variations as may often be readily observed. A minor second pulse is definitely represented by small dykes *e.g.* Mt Nelson (Edwards, 1942) and Hickmans Hill (McDougall, 1962).

### *Tertiary*

Tholeiitic and alkali basalts occur in the valleys of the Coal, Jordan and Derwent rivers. The thickest flows are in the Jordan valley near Brighton, where the thickness exceeds 45 m. Petrological studies of the Brighton basalts have been undertaken by McDougall (1959*a*).

## Structural Geology

The location and general relationships of the major structural features are shown in Figure 2.

### *Attitude of Sedimentary Rocks*

With the exception of a narrow belt immediately east of the Mt Wellington-Mt Faulkner block, all rocks dip west. Dips are normally of the order of 5-10°, although dips of 15-25° are typical in the Coal River valley and estuary in association with Tertiary step faulting. Dips are east at about 10° in the crushed warp-monocline flanking Mt Wellington and extending southward to Kingston.

### *Faulting*

Normal faulting of Jurassic and Tertiary age has greatly contributed to the complexity of the district. Jurassic faulting includes all faulting directly associated with, or immediately preceding, the dolerite intrusions.

Such faults are indicated by many sharp intrusive boundaries, or by faults containing dykes and plugs in the slip surface. The younger faults are indicated by disruption of such intrusions. The age of the later movements may be impossible to date however, if there is more than one pulse of intrusion, as each pulse may activate or re-activate faults. There is commonly insufficient evidence to show that a fault disrupts one intrusion and not another. Jurassic faulting has produced N-S trending horst and graben structures. The Coal and Derwent Rivers occupy such grabens for part of their lower courses. The central trough widths are often less than 0.8 km, as at Richmond and Grasstree Hill and the structures have an overall wavelength of 65 km. The release of magma was probably indirectly caused by the stresses producing these structures. It is not known why the stress was developed in mid-Jurassic times, but forces related to the break-up of Gondwana would account for it, *e.g.* King (1953).

Tertiary step faulting is superimposed on the Jurassic structures and consistently downthrows to the east with a trend slightly west of north. A Tertiary age is ascribed to the later faulting on circumstantial evidence based on its relationships to basalts and sediments of known Tertiary age. Although there have been rejuvenations throughout the Cainozoic, the major post-dolerite movements appear to have been Eocene? (Solomon, 1962). Such faulting is pronounced only in the Coal River region, and adjacent to the Mt Nelson and Mt Wellington blocks. In many cases Tertiary movements have been deflected about major Jurassic structures, *e.g.* Mt Nelson, Mikes Hill. A shallow rotational origin is indicated by the fault-dip relationship in the Coal River region.

### *Igneous Emplacement*

The matter of dolerite emplacement forms the subject of a separate publication and will not therefore be discussed here. However, it may be noted that the most massive dolerite bodies occur in the Grasstree Hill-Cambridge and Black Hills-Collins Bonnet-Longley regions. Sills and sheets of dolerite are often prominent but are no more common than large dykes.

One particular aspect of value in structure reduction of dolerite intrusions is that of dilation (fig. 3). While dilation may be both horizontal and vertical, the vertical aspect is that usually noted, for example, where a dolerite sill terminates at a fault, and the intruded side is uplifted by the thickness of the sill. This simple estimate of intrusion thickness may be affected slightly by dip or transgressive angle reduction effects.

Small dykes of dolerite have been seen intruding major bodies in several places, *e.g.* Mt Nelson and Hickmans Hill. These are 1-6 m across and are always chilled.

Basalt centres are usually small dykes 2-15 m wide associated with Tertiary faults or fault junctions and large Jurassic structures, *e.g.* Craigow-Mt Rumney dyke intrusions.

## GRAVITY FIELD

The use of gravity surveys for assessing emplacement of basic intrusions is well known. Its effectiveness depends upon any non-gravimetric restrictions on interpretation available and the density contrast with the intruded rocks. A regional gravity survey of south-east Tasmania has been completed (Cameron, 1967), and some areas have been surveyed in detail. The work presented by Cameron (1967), comprising various small surveys, was limited in

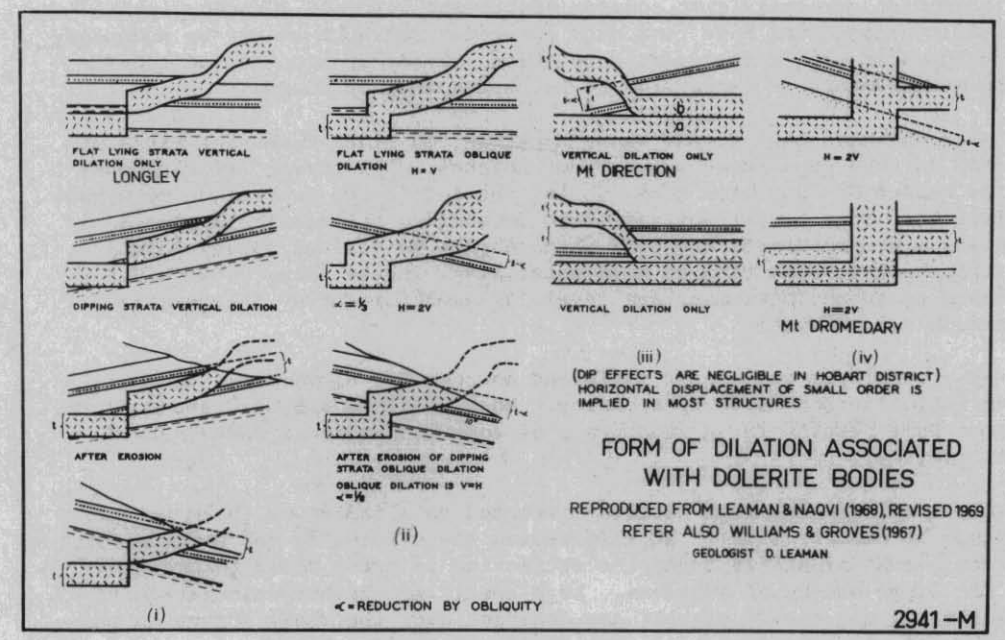
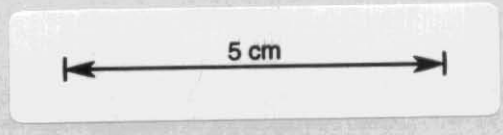



Figure 3.




scope. The entire area was resurveyed in order to obtain uniformity of results. Such surveys have either been directed at aspects of dolerite intrusion (McDougall and Stott, 1961; Jones *et al.* 1966; Leaman and Naqvi, 1968 or a combination of intrusion characteristics and Tertiary trough structure (Hinch, 1965; Longman and Leaman, 1971). Only the survey of Longman and Leaman covered a sufficient area to permit broad scale deduction. The limitations of earlier work in other areas precluded collection of useful general information.

## Survey Details and Accuracy

Approximately 2,000 stations have been installed with a station spacing of approximately 0.8 km. The base station for the survey, at Hobart Airport (reference 6491.0161), was originally installed by the Bureau of Mineral Resources, Canberra, as part of an Australian network. It has a datum value of 980448.91 mgal and a terrain-corrected Bouguer anomaly of 15.45 mgal. The station distribution is shown in Figure 4.

The meter used throughout the survey was Worden 273 with scale constant of 0.1008 mgal/division. Drift characteristics of the meter were excellent (c. ±0.02 (max) mgal/h).

Traverses on loop segments were made on a 2-3 hour base interval.

Although most loops contain more than 20 stations, loop errors were normally less than 0.05 mgal, and in many cases were nil. As a result many adjustments were made simply to tie stations in the loops. Where groups of adjacent loops had significant errors a least squares adjustment was made (Gibson, 1941). No specific corrections have been made for tides and such as may be necessary are incorporated within the drift correction. The precision of individual gravity measurements is considered to be better than ±0.02 mgal.

Stations have been sited, where possible, on State Permanent Marks or Lands and Surveys Department survey spot heights. The former are rare outside the Hobart Metropolitan Area, whilst the latter are scattered throughout the district. Most elevations have been determined barometrically, using a Mechanisms micro-barometer and tied with respect to various survey points. Many stations have been tied to high water level in the estuary, with 0.3 m subtracted to approximate mean sea level, as used for survey standard in Tasmania (m.s.l. Hobart).

As a result of the use of different sources for elevations, there is some variation in standards of accuracy. Most stations are accurate to only 1-1.5 m. This results in an inaccuracy of some 0.30 mgal in the observed Bouguer gravity.

All stations have been terrain-corrected to a radius of 19 km using the method of Hammer (1939). At this radius the effects of the earth's curvature become significant and the attraction in outer zones becomes constant for large blocks of stations. As a result no further calculation is worthwhile and any errors present are constant over the whole survey as the dimensions of the area covered become small compared with distances to significant features such as the continental shelf. The accuracy of the correction made is estimated at 5% or less resulting in an error of 0.05-0.10 mgal at most stations. This accuracy is consistent with the precision claimed by Hammer.

Availability of accurate survey maps has enabled station locations to be stated to within 30-75 m. This results in a maximum error of 0.05 mgal in the latitude correction.

The RMS accuracy of the observations is about 0.33 mgal, and values have been contoured with an interval of 1 mgal (fig. 5).

## Bouguer Anomalies

### *Specification and Presentation*

The results of the survey have been expressed in terms of the extended Bouguer anomaly, since this is the most direct and useful form of preliminary treatment, leading to an interpretation of near-surface crustal structures.

A density value of 2.67 g/cm$^3$ has been used throughout the reduction. Although no pre-Permian rocks are exposed in the Hobart district, and it is therefore not possible to state the density of such rocks, shallow crustal seismic surveys indicate a value of 2.65-2.67 g/cm$^3$ (Johnson, University of Tasmania Ph.D. thesis in preparation). In addition, examination of those rocks considered most likely to occur have a density range of about 2.60-2.70 g/cm$^3$. The upper and lower figures represent Cambrian rocks and Devonian granites respectively. Ordovician, Silurian and Precambrian rocks generally have average values close to 2.67 g/cm$^3$. The choice of a value of 2.67 g/cm$^3$ presumes that all anomalies would be related to density variations in the readily examinable post-Carboniferous rocks including the dolerite.

Contoured total Bouguer anomalies are presented in Figure 5, with a contour interval of 1 mgal. All data and observations from which this map was drawn are available at the Department of Geology, University of Tasmania.

*Regional Separation*

The total Bouguer anomalies (fig. 5) show that the gravity field decreases significantly to the north-west due to the effects of the Central Tasmanian plateau. The Hobart district is placed midway between the root of continental Tasmania and the continental shelf. It is thus situated close to the zone of steepest gradients.

The character of the regional gradient in Tasmania, and it should be noted here that regional is taken to mean that component of the field derived from the core, mantle and lower crust, has been examined (Johnson, Ph.D. thesis in preparation). On the limited information available the gradient was shown to be about 0.6 mgal/km to the north-west. The information provided by this previous work could have been considered adequate for the specification of the regional gradient. However, it was decided, in view of the increased data, to adopt an averaging procedure over this survey area and compare results. The initial averaging was based on squares with sides of 3.2 km. Each square included, with few exceptions, 8-16 stations. The averages obtained were then recalculated with squares of sixteen and twenty-five times the area. The separation is mathematically analogous to filtering in electrical circuitry - in this case a sinc($x$) function (St John, 1967). The filter has a section in the wave number domain of sinc($kx$), where $k$ represents the wave number as applied in two horizontal directions and $x$ is the width of the window used in the averaging process. A uniform distribution of points is desirable for the most effective filtering. The major problem is the selection of the length/scale factor ($x$) in view of the range and continuity of wave numbers.

Bulk filtering was found to produce a fairly consistent gradient across the northern, western and south-eastern parts of the area. It was however, distorted in the eastern portion due to the presence of a large positive anomaly with an area of approximately 260 $km^2$. The area of this anomaly is greater than the bulk area assumption used in the filter, and hence the breakdown. Bulk averaging on the scale required by this anomaly is impossible on an area as small as this district. The general gradient was shown to agree closely with that obtained by Johnson, although the contours are offset to the north as his data did not include terrain corrections. The final gradient as shown in Figure 5, was produced by eye-smoothing of contours, based on the averages obtained by the method described above and with the trend and absolute values indicated in the western half of the area carried through the positive anomaly which dominates part of the eastern half.

Edge effects were minimised, during averaging, by considering such information as is available outside the area (on the north, east and south only) and suitably weighted elsewhere. It should be noted that such data is in no way comparable in station density with the present survey and it is likely that some edge effects persist.

*Description of Residual Anomalies*

Figure 6 presents the residual Bouguer anomaly field as obtained from Figure 5 by removal of the gradient indicated. This map shows that most anomalies are nearly equidimensional, and have a range of +10 to -12 mgal.

One anomaly approaches the requirements of two dimensionality, *i.e.*

*Table 1. BULK WET DENSITIES*

| Rock Unit | Density Range $g/cm^3$ | Average Density $g/cm^3$ | Weighted Average $g/cm^3$ (b) |
|---|---|---|---|
| *Tertiary* | | | |
| clay, sandy clay | 1.82 - 2.00 | 1.92 | |
| volcanics (solid basalt) | 2.90 - 3.00 | | |
| *Jurassic* | | | |
| dolerite | 2.75 - 2.95 | 2.90c | |
| *Triassic* | | | |
| lithic sequence | | | 2.47 |
| sandstone | 2.36 - 2.48 | 2.43 | |
| mudstone | 2.49 - 2.52 | 2.51 | |
| quartz sequence | | | 2.45 |
| sandstone | 2.30a- 2.43 | 2.37 | |
| mudstone | 2.44 - 2.54 | 2.49 | |
| *Permian* | | | 2.57 |
| Ferntree Group | 2.37a- 2.58 | 2.50 - 2.52 | |
| Malbina Formation | 2.46 - 2.54 | | |
| Cascades Group | | | |
| weathered | 2.10 - 2.14 | | |
| unweathered | 2.49 - 2.54 | 2.53 | |
| metamorphosed | 2.64 - 2.68 | | |
| Faulkner Group, sandstone | 2.37 | | |
| Bundella Mudstone | | | |
| mudstone | 2.55 - 2.61 | 2.59 | |
| limestone | 2.63 | | |
| Lower Permian | | | |
| mudstone, siltstone | 2.58 - 2.60 | | |
| tillite matrix | 2.59 | | |
| tillite bulk | 2.66 | | |
| *Pre-Permian* | | 2.67 | |

*a* weathered; *b* weighted average based on the proportions of rock types in the sequence; *c* average for sill, Jaeger, 1964

has a length more than twenty times its width (Grant and West, 1965). It is that associated with the Tertiary basin faulting and the eastern margin of the Craigow-Rumney intrusion.

Significant positive anomalies are associated with the Mangalore Tier and Craigow-Lindisfarne blocks (+10 mgal), and lesser anomalies are related to the Huonville, Boyer, Lachlan, Dromedary and Mt Nelson blocks (+5 to +8 mgal). Large tracts of the district have anomalies between -2 and +2 mgal. Moderate negative anomalies are associated with the Lenah Valley-Berriedale, and Coal River graben faulting (-5 to -8 mgal). Large negative anomalies show a correlation with deep outlet? channels for Tertiary basins. Tertiary basins generally show a maximum negative anomaly of around -4 mgal.

## Interpretation

### *Rock Densities*

The results of density determinations upon rock formations occurring throughout the district are presented in Table 1. Each average is based on 10-20 samples. Determinations have been made on fresh samples, unless otherwise indicated, of 1-2 kg which had been water saturated. Densities stated are to British Density Standard Specifications. Most samples were taken from recent drill cores.

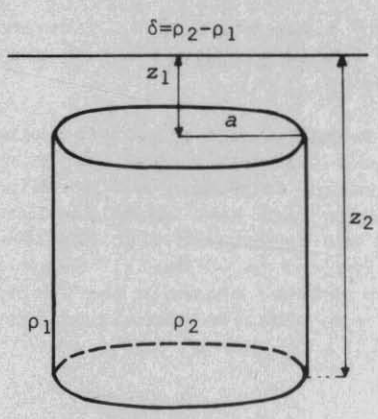
### *Methods of Interpretation*

Only indirect, comparative interpretation methods have been employed, as direct methods entail more complexity of calculation, precision and detail of specification of anomalies than was possible with this survey.

As most anomalies are nearly equidimensional, three dimensional interpretation methods should be employed if a reasonably precise interpretation is required. There are, however, considerable problems associated with such methods. For example, calculations are invariably lengthy and even with the facilities available for rapid computing (Elliott 503 automatic computer) corrective iterations are difficult to prescribe and time consuming to make. These difficulties notwithstanding it has been found fruitful to make such interpretation in parts of the area. In this way a greater understanding of aspects of the intrusion complex is gained although the general structural outline can be deduced from a qualitative study of the anomalies.

The attraction of slices of a vertical cylinder may be used to estimate values in many of the blocks. In addition calculations on the atraction of cylinders can give an indication of the scale of simple feeder systems. The attraction of a cylinder is shown in Figure 7.

Minimum limits on the mass requirements of various anomalies can also be set by considering the anomaly produced by a two-dimensional structure composed of horizontal slabs. As dolerite is, for all practical purposes, the only positively attracting material present compared with the basic density assumption used in the Bouguer reductions, an anomaly of nil or greater greater implies dolerite in the column. The actual amount estimated is governed by the magnitude of the anomaly and the amount of negatively attracting materials present. Small negative anomalies are possible where the sedimentary sequence is thick even though several hundred metres of dolerite may be present. An example of this qualitative usage may be shown where basal Triassic rocks are exposed, and there is a positive anomaly of 1 mgal. This implies about 450 m of dolerite, *i.e*:




$$\Delta g = 2\pi G\delta\left[z_2 - z_1 + \sqrt{z_1^2+a^2} - \sqrt{z_2^2+a^2}\right]$$

(point on axis)

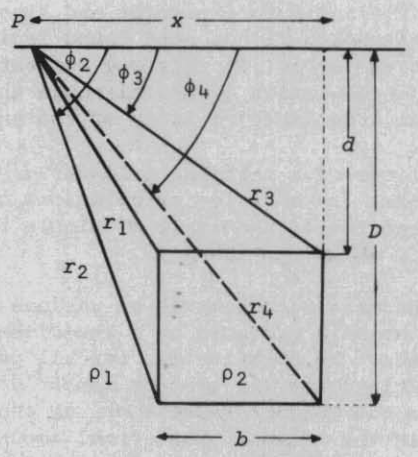
If $z_2 \to \infty$, $\Delta g = 2\pi G\delta\left[\sqrt{z_1^2+a^2} - z_1\right]$

If $z_1 \to 0$, $z_2 \to \infty$ $\Delta g = 2\pi G\delta a$

$$\Delta g = \frac{a}{4x}\left(2\pi G\delta\left[z_2 - z_1 + \sqrt{z_1^2+a^2} - \sqrt{z_1^2+a^2}\right]\right)$$

(point off axis, estimation valid if $x>a$) [Parasnis, 1961]

Cylinder

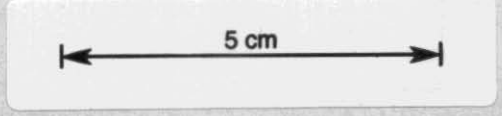



$$\Delta g\rho = 2G\delta\left[x\ln\frac{r_1 r_4}{r_2 r_3} + b\ln\frac{r_2}{r_1} + D(\phi_2-\phi_4) - (\phi_1-\phi_3)\right]$$ [Parasnis, 1962]

Two-dimensional rectangular prism

Figure 7. *Gravitational attraction of regular bodies.*





750 m of Permian rocks at -0.10 g/cm$^3$ = -3.14 mgal
450 m of dolerite at +0.23 g/cm$^3$ = +4.26 mgal

+1.12 mgal

This kind of usage is more accurate than is immediately obvious, provided the surface dimensions of the slab anomaly is much greater than the depth to anomaly base (basement). The relative reliability of this method is derived from the addition of positive and negative terms at variable depths in thin slices. This reduces the total mass two-dimensional end effects that would otherwise be incurred.

Such an approach may be regarded as preliminary to the use of more detailed methods. It provides much information about the structure, quickly revealing those blocks where much, little or no dolerite is present. It can give no indication of the magnitude of vertical bodies or feeders, and always understates the positively attracting material of a residual anomaly, and conversely, where anomalies are equidimensional. The degree of understatement has been found to be small.

The equation used for all such qualitative (and also complete where applicable) two-dimensional interpretation is stated in Figure 7.

All interpretation has been made from the ground surface and is thus a two-part process since the base level is sea level.

*Limitations Inherent in Interpretation*

As indicated above, many conclusions of direct value are possible, although interpretations of the gravity field are basically ambiguous. Care must be taken however, not to 'overinterpret' the field in this district on account of the following considerations.

*Basement Problems*

It is possible that the basement rocks are not uniform in density, and also that their bulk average is not 2.67 g/cm$^3$. The effect of the former property would be to produce, (1) anomaly patches of low amplitude and long wavelength, which would not be readily discernible in an area where anomalies correlate closely with obvious near-surface structures or (2) anomaly trends. The latter would cause total variations in the regional anomaly, making all parts of the residual gravity in error, although by a constant amount. The presence of feeder systems in the pre-Permian rocks may also add broad scale positive effects to residual anomalies. The mass requirements of most feeder systems can be estimated but the actual distribution of mass in detail is another matter. Deep carry-over effects may be present in many anomalies but are virtually impossible to recognise or estimate. Thus any interpretation made of the residual anomalies, neglecting the possibility of such side effects, is open to a margin of doubt.

A thickness of 750 m of Permian rocks has been assumed in all calculations, but only 600 m are proven in this district. Variations in thickness of tillitic rocks, if present, could produce variations of up to 0.3-0.5 mgal by altering the bulk Permian average which includes these rocks.

*Regional Assumptions*

It is assumed that the regional gradient indicated in Figure 5 is valid across the area. Since interpretation is undertaken upon the residual anomalies, any deficiencies in this gradient would invalidate any interpretation

in detail. The maximum variation considered likely is less than 1 mgal, but lacking a grid of deep bore holes by which to anchor fully some part of the interpretation, and the residual anomalies, the possible existence of this variation should be noted (see Appendix 2).

*Density Assumptions*

The validity of the density values given in Table 1, p. 16 is assumed. The variations noted may be significant. Dolerite densities are dependent on the form, size and position of (or in) the body. In all interpretation the density of dolerite has been taken at 2.90 $g/cm^3$, which in many cases would cause understatement of the anomalous body. Ferntree Group values are proportional to pyrite or siderite content. The averages given for the Triassic sequences are variable, depending on the actual proportions of rock members. The average value of the Permian rocks, as a group, increases with depth and thus a partial sequence is denser than a total sequence.

*Interpretation Difficulties*

Realism of structure and anomaly distribution may not be approached, particularly in regard to the difficulties inherent in specification and treatment of vertical bodies and feeder systems, where geologic control is minimal.

As a consequence of the above factors unambiguous interpretation is impossible, and indeed the magnitude of features included may be inexact. The station spacing used for the survey is adequate for a first order investigation such as this, although many small areas require a detailed coverage beyond the scope of this study.

Irrespective of the above deficiencies, this survey permits indications and size estimates of masses producing particular anomalies. The information it provides on the distribution of dolerite, and the order of its thickness, is sufficient to remove most of the uncertainties and ambiguities that have been unresolved by purely geological studies. Feeders may be unambiguously located by magnitude of anomaly, although their exact form is not necessarily deducible.

*Interpretation of Structure assuming a Non-Anomalous Basement*

Structure reduction has been basically geological, with application of gravimetric tests to check scale and sign of anomalies. The nature of the tests used have been outlined on pages 17-19. Some direct profile-model comparisons have been made and these are indicated where appropriate.

Each Section appearing in Figure 8 is discussed briefly below. Many structures appear across several sections; in order to avoid repetition, the sections are described from north to south and only at its first appearance is a particular structural feature discussed in detail. Sections are aligned approximately W-E along the lines of the metric grid at 2.5 km intervals. Further comments may be given in subsequent sections, but these are subsidiary and specialised to the particular section. For ease of reference letter or number symbols have been used to refer to blocks of each section. The key aspects of each profile only, are outlined as a comparative review of the residual Bouguer anomalies and the geology make more detailed comments unnecessary.

*Section 800*

This section is typical of those areas where dolerite has intruded

Triassic rocks and in which much information on the intrusion is not available due to lack of definite marker horizons.

Lower Triassic sandstone outcrops in block *A1*. The anomaly here of about 0 mgal shows that 400-450 m of dolerite is present. This figure often recurs in anomaly estimates and dilation studies and has thus been used throughout the interpretation. There is no real proof that such a thickness could not be composed of two smaller bodies but for simplicity a single body has been indicated. Also, in many cases significant exposures of sheet bodies show thicknesses approaching this figure (*e.g.* Mt Dromedary). The presence of small plugs and dykes in *A1* implies that the sheet is not at any great depth. The hills to the north and south of this section show the base of a further higher body and this is indicated in the section.

*B1* shows a decreasing anomaly to the east. Its absolute magnitude indicates the presence of a sheet, and the dilated block supports this conclusion. No exact figure can be given to this dilation. The eastern boundary of *B1* is a fault-igneous margin feature. It is likely that the dolerite in block *C* is related to the body falling transgressively east in *B1*, since it is a sheet base, and the anomaly shows conclusively that there is no deeper intrusion. A centre is implied, and the presence of a series of anomaly swells to the south along this line, supports this implication. A source (*S1*) has been indicated. The magnitude of the anomaly, and its shape, suggests that in this section it is the northern end of a narrow dyke wedge.

The major anomaly in the section falls in *D*. The margins of +5 mgal imply a very thick intrusion (c. 800 m if concordant) and the peak value of +10 mgal suggests a very substantial dyke or pipe extending well into the crust. Even a pipe 1.5 km in diameter extending through the crust with effective contrast for 11-12 km would not produce this anomaly! This centre (*S2*) appears to have a basic 'Y' shape but further details are unobtainable. The great thickness of dolerite, indicated in the section, is based on the above estimates. It is likely that there are several closely associated bodies present.

Fault *f3*, known as the Bagdad Fault, passes along the eastern margin of the Mangalore Tier mass. The steep gradient and negative anomaly to the east, suggests that the feeder system (and associated sheets ?) dips westward and that little dolerite is present to the east. One sheet, at least, is suggested in *E* by the presence of bosses and the moderate residual anomaly. The value of the anomaly and the known thickness of sedimentary rocks show that this sheet is about 400 m thick. Since the increasing negative anomaly reflects less dolerite and more sedimentary rocks this sheet must also transgress steeply eastward. A fault at the point of transgression is also suggested, both gravimetrically and dilationally, as lack of such a feature would imply too little Triassic in *F*, and the sheet would then expose Permian rocks, which it does not.

Block *F* is typified generally by an irregularly roofed series of intrusions. Immediately south of this section is a substantial positive anomaly and the structure shown is regarded as a sheet arm rising away from that feature (*S5*, Section 775).

Blocks *G1*, *G2* are essentially devoid of dolerite except for the surface exposures of sill bases. The sharp, elongate positive anomaly, on the western side of Gunnings Sugarloaf, shows that the dyke boundary is in fact the edge of a feeder and not part of a transgressing sheet since no dolerite can be present at depth in *G1*.

*G3* is a little understood graben block which contains 100-200 m ? of

Upper Triassic rocks. For the most part it is probably devoid of dolerite bodies. The narrowness of *G3* makes definitive interpretation difficult even though it is an easily calculable two-dimensional feature. The bounding faults were in existence prior to the intrusion. Field evidence suggests that they have been moved subsequently. The scale of later movement on the western fault is inferred to be small on the basis of comparative elevations of a fragment of a sheet base east of Gunnings Sugarloaf which is thought to be part of the same body. The eastern boundary fault has many plug and dyke intrusions along its length. All are reflected by a series of positive anomalies. The amount of subsequent movement on this fault is unknown.

*H1* may contain one or two major sheets, or alternatively the anomaly could be affected by the feeder system (*S25*) to the south. This cannot be directly resolved in this section, but a lower sheet is inferred in Sections 725, 750, 775. This sheet may account for the transgression apparent near [395800]*. Alternatively the transgression could represent the base of the sheet from *S25* passing northward. Another possibility is that the two bodies link at the line of White Kangaroo Rivulet; the lower sheet in rising to the north between Sections 775, 800 has been cut off by a sheet from *S25*. The occurrence of dolerite north of the section (continuation of the lower sheet) supports this possibility, and also accounts for the tendency of the anomaly pattern to trend along the line of the rivulet. Extensive, abnormal thermal metamorphism is apparent in *H1*.

The anomalies drop sharply in *H2*, *I* and show that the dolerite of the hills and escarpment in *I* is only a capping, and that no intrusions of consequence occur at depth.

*Section 775*

Many comments made in regard to Section 800 apply here. Block *A1* shows the high level capping of the Black Hills range. The anomaly over this part of Black Hills suggests the presence of a further major sheet, probably in Lower Triassic rocks. This is also demonstrated by the outcrop pattern near Black Hills. The sheet present in *A2* is part of the inclined western arm of *S1*. The eastern side of this body has intruded along a fault which is indicated by drag phenomena. The western side has been faulted subsequently to the intrusion, and there is a similar possibility on the eastern side as well. A dilational block, *B1*, is also apparent. The anomaly due to *S1* in this section is about +4 mgal, and suggests quite a substantial feeder. Rocks within *B1* and east of the fault above the feeder *S1* are intensely metamorphosed. *C* must be generally devoid of dolerite in depth, since the anomaly is so strongly negative. The dolerite at the surface can be shown to be a sheet base which dips steeply west to *S1*. A dyke in *C* may in depth be part of the Mangalore Tier feeder system (*S1*), as it certainly appears to be connected to it north of the section. It cannot be related to other dolerites since *C* is deficient in dolerite.

The section cuts obliquely across the northern tip of the uplifted block of Permian rocks at Mangalore. These are completely surrounded by dolerite, probably one sheet 400-500 m thick, with the displacement about the southern and western portions of block *D* essentially dilational, being roughly equal to the calculated excess mass of dolerite. However, on the slope of Mangalore Tier there is a suggestion of an overlying body which is reflected by topography and included blocks. Interpretation is impossible here due to the unknown depth effects of *S2*. One arm of the feeder system extends south-east along the Bagdad Fault. Many intrusions are present in

* 100 metre grid reference

this zone, and two (*c* and *d*) are indicated in the section. The sheet *d* is transgressive through both sedimentary rocks and sheet *c* and the relationships are clearly visible in the western part of the uplifted Mangalore block. The great variety of boundary phenomena led to this conclusion, and only detailed petrological work could separate them thus either proving or disproving this hypothesis.

Block *E*, as exposed in this section, is the western part of *F* in Section 800 and is composed of Permian and Lower Triassic rocks with minor occurrences of the Upper Triassic lithic sequence. The gravity anomaly is about -1 to -3 mgal in this section, but is wedged between two large positive anomalies. The separation and gradients do suggest that this is close to the true attraction, and that a moderate sized sheet is probably present and rising northward. The small plugs present suggest dolerite below. The presence of steep dips near the line of upward transgression of this body to the east is another significant feature. The roof boundary is very irregular, *e.g.* at [240760], but is partly concordant. It is believed to be a remnant of another intrusion which has been sliced through (see also comments, Sections 700, 725). *S5* must be a substantial pipe. The anomaly of +4 mgal is localised in an area where the exposed Triassic rocks are estimated to be more than 300 m thick. The presence of roof pendants and disruptions in *F*, with the general gentle anomaly reduction, shows a transgressing eastern limb. More than one intrusion may be present here, judging by the number and distribution of sedimentary fragments.

Blocks *G1*, *G2*, and *G3* are essentially as in Section 800, with one notable exception. *G1* contains a large basalt centre and the anomalies are considerably distorted about it. While not a great volume of basalt remains, either as a flow or pipe (which is relatively small), there is considerable thermal metamorphism. The problem of *G3* was described in the previous section.

*H* is shown to contain the northern part of feeder *S25* and a sheet transgressing from the west. The size of the positive anomaly (+3- 4 mgal) implies a minimum mass requirement equivalent to two large sheets. The shape and termination of the anomaly does not support such a conclusion. There is also extensive thermal metamorphism in this region. The anomalies west of *S25* suggest only one intrusion is possible, although more than 200 m of Triassic rocks may be present. All igneous boundaries in this locality are irregular, commonly discordant and very suggestive of disrupted roof effects.

Block *I* is as described for Section 800.

*Section 750*

The western half of this section is structurally similar to Sections 775 and 800, while the eastern half is characteristic of the step-faulted Derwent and Coal River grabens. *A1* is basically similar to Section 775 and the transgression of the Black Hills capping sheet from the west is clearly seen. The presence of a deeper body is indicated by the dykes and plugs emanating just south of the western end of the section and by the general gravity anomaly.

On the eastern side of the Black Hills massif is a block (*B*) of Lower Triassic sandstone completely surrounded by dolerite. It lies over the southern end of *S1* at a point where dolerite rising from the south joins material from *S1* (Section 725) and is intruded again by part of the higher cap dolerites. The gravity pattern is not a great help at this point, but the conclusion based on study of all outcrop phenomena as shown in the section is compatible with the anomalies. The dolerite from *S6* (Section 725) trans-

gresses steeply north-west in the large dyke at [085745] and meets that from *S1*. It then passes over the enclosed block. The structure of *S1* also appears a little different here, a vertical western margin being indicated. The dilational effect of the *S1* intrusion has elevated this block, since without dilation Upper Triassic rocks would be expected to crop out.

*C1*, *C2* and *C3* are blocks showing a sheet base only and the anomaly of -4 mgal shows that deeper dolerites are unlikely. The section across *D* appears a little odd due to obliquity. The dolerite is rising consistently southward although showing crenulation. A concealed fault of some magnitude is shown to pass beneath the western arm of the Mangalore structure and a feature not unlike a cauldron subsidence is produced. North of the section a wedge of Ferntree Group has been caught between the dolerite and a pre-intrusion fault.

Block *E* shows the presence of three sheets. The upper sheet is clearly exposed as a fragment at [230755] and across the hills to the south, where it can be shown to be relatively thin (200-250 m). A sheet from the west rises steeply through the upper body to form the steep (dip slope?) slopes of the Brighton Hills. The general level of the gravity anomalies, and the presence of dykes suggest a deeper dolerite about 400-500 m thick. Correlation with other sections suggests that it is probably equivalent to the dolerite from feeder *S5*, although some cross faulting is suspected to account for absolute differences in altitude. There is evidence for subsidiary feeders at Brains Hill (*S7*) and *S8*, both south of the section. The faulting east of *f3* is consistently down to the east and throws are generally small.

*G3*, comprising the central Coal River graben, is virtually impossible to interpret because of the cover of Tertiary basalt and sediments of unknown thickness. South of this section these rocks are known to be in excess of 200 m thick. Precise estimates of structure or dolerite content are impossible especially as the whole Triassic sequence, of unknown thickness, is probably present as well. A possible solution satisfying the gravity requirements is indicated in Figure 9.

Block *H* is as described in Sections 775, 800, except that this section passes over the anomaly peak related to *S25*. The gradients to the east and south indicate a marked transgression of the related sheet, and its base is clearly seen in the small escarpment along the valley to the immediate south.

The structure in *I* is quite confused and the two intrusive bodies seen in *H* interfere. Thus there are a large number of included blocks and contacts of all types. In addition, the gravity anomalies show that interference occurs wholly in Triassic rocks near the surface and that there is no deeper intrusion.

*Section 725*

In *A1* the upper capping dolerite is thicker and this is reflected in higher anomaly values. Fault *f1*, which is one of a pair of faults concealed beneath the dolerite of Black Hills, clearly shows pre-intrusion movement. Both faults appear to have suffered minor subsequent movement. *A2* is marked by a substantial N-S anomaly (*S6*) suggesting that it has been produced by a dyke at depth. The anomaly trend carries northward toward Mangalore Tier (*S2*), and the two features may be inter-connected. The reduction in anomaly northward may reflect a depth effect since the Dromedary Fault (*f2*) is crossed between them. Around the entire eastern flank of Mt Dromedary dolerite appears at about the Bundella Mudstone horizon. Thus the feeder and sheet must form a 'T' junction. This sheet passes to *f1* at about the same level.

Its thickness is estimated at 400-500 m since the entire column, including the thickness of the capping dolerite, is well known.

The composition of *B* is difficult to assess due to the shadowing effect of the nearby *S6* anomaly. A thin sill crops out and it is considered unlikely that there is dolerite at a lower level. There is evidence that *f2* is in part Jurassic in age, and that the sheet from *S6* was terminated upon it. There has been 500-600 m of subsequent movement. *C* is probably devoid of dolerite; the value of -3 mgal is not as low as might be anticipated but then there are many additive effects about *C*. Certainly no thick intrusion can be present.

*D* and *E* are simple step-faulted blocks with one complete sheet in Lower Triassic rocks and the base of a further sheet some 100-200 m higher (compare *E*, *F*, Section 750). South-east of Brighton, at *f2A*, there is a rise in the anomaly of about 2 mgal which cannot be accounted for in any other way than a further deeper intrusion. This conclusion is reinforced by the occurrence of stratigraphically higher rocks to the south, which would increase the negative component of the anomaly, and a cross fault approximating the axis of the basalt-filled Jordan valley is implied. Examination of Sections 625-700 also shows the consistency of this, and that *f2A* represents the source limit to the west of any such lower body. Such a source is indicated in the axis of the Derwent trough.

In *F* a dyke shows the contact relations and dilation of the previously mentioned upper dolerite. This reflects the transgression of a sheet rising from the west. Two concealed sheets are present to the west and only one to the east (note grade in anomaly). The simplest coherent explanation is indicated in the section.

Block *G* shows the asymmetrical lower sheet and source *S7*. The symmetry of this intrusion increases northward (Section 750). The eastern limb is exposed as the lower sheet on the east side of Brains Hill. The western limb is inferred to be in the Permian rocks, as seismic work and drilling has shown the Triassic rocks to be devoid of dolerite. The presence of a dolerite body here is not obvious from a study of the anomalies south of the section, but these are complicated by the presence of Tertiary sediments. The sheet limb is proved in Figure 9.

The structure of the Coal River Graben is uncertain and the comments on Section 750 apply here also. Block *H* in this section shows part of a very irregularly roofed intrusion. The anomalies show that these intrusions are roof effects and that a thick sheet is present below. The anomalies here reflect a single sheet only, being between the effects of *S25*, *S26* (Section 700). In *I*, a sheet rising southward from *S25* is considered to cut the previously mentioned sheet. This conclusion is based on depth and thickness requirements.

*Section 700*

Blocks *A1*, *A2* show that the dolerite sheet derived from *S6* (Section 725) is rising westward. The arch, at about [020700] is based on intrusion levels and suggests a merger with another body rising from the west. Fault *f1* is associated with the major upstep, and some rejuvenation is also indicated resulting in a present-day escarpment. There is a possibility of a small Jurassic fault under the Dromedary plateau. Comments on *B*, *f2* are as for Section 725.

Centred south of *C* in the section is a further centre (*S9*). The transgressing sheet arms are indicated in *BB1, BB2*. Their character, at least on the eastern side, is seen north of Bridgewater, which is about a kilometre from the centre of the intrusion. The sheet in *BB1* is inferred from the gravity anomaly. *C* is as in Section 725, but due to the irregular nature of pre-intrusion? faulting the symmetry of *S9* is disrupted. Such faults have also been reactivated. The intrusion *c* in *D, E* and *F* in the Lower Triassic rocks of Sections 700 and 725 arises from this source.

The requirement of a further deeper sheet east of *f2A* and its subsequent transgression was discussed in Section 725. The slope of the transgressive step in *F* must be steep, since there is a marked gravity gradient at this point. The Brains Hill structure has been partially outlined in Section 725 (see also Section 675). The structure in *G, H* and *I* is similar to previous sections, except that in the far east of *I* a further centre is inferred. The anomaly in this region is too high for simple sheet structures, and only one such body is suggested. The irregular pattern of the intrusion, the dilation associated with cross faults at [400705] and eastwards, and the very substantial positive anomaly in an area where the sedimentary sequence is thick, supports this contention.

*Section 675*

A sheet outcrops in Cascades Group rocks at *A1* and *A2*. The minor variations in residual anomalies north of New Norfolk are due to variations in the amounts of Triassic rocks present in the various fault blocks. This section passes directly through the plug intrusion (*S6'*) on the southern slope of Mt Dromedary. At this point an offshoot from the sheet rises vertically and terminates with this plug in a pipe type of structure.

*C1* and *C2* are essentially lacking in dolerite as indicated by moderate negative anomalies. The N-S anomaly trend (*S9*) passing through *C1* appears to be related to a plug on Mt Faulkner, and probably represents the continuation in depth of a feeding dyke between the two major features.

*C3, D, E, F,* and *G* are as for Section 700 except that blocks *D* to *F* are upfaulted by 500-600 m. The northern part of the Quoin escarpment represents most of the movement. Fault *f2A* corresponds with an anomaly gradient and probable source *S8* continued. Two interpretations are possible for *C3*. The area is basalt covered and the gravity data do not provide an unambiguous solution. In E the inflection of the upper sheet represents the scoop base of a sheet radiating north and west from *S10* (Section 650).

The structure in *F* to *G* is crucial to several sections. The need of the sheet in Permian rocks is clearly shown in Figure 9. Drilling and seismic work shows that it is not in Triassic rocks. *S7* is also fixed in form.

Blocks *H* and *I* are as in Sections 700, 725 with a feeder *S27* suggested on the east margin of the Coal River structure. Some plug-like intrusions are present at the surface. The single sheet emphasised in previous sections is demonstrable by the large areas of 0 mgal anomalies in the Triassic rocks. The sheet tongues of *S26* are discordant and rise through the hills in this region giving an irregular outcrop pattern.

*Section 650*

The anomalies in *A1* and *A2* indicate a sheet of about 450 m thickness which is known to occur in Cascades Group rocks. Faulting in these blocks is the southern extension of the Middle Derwent trough. There is evidence

for an included block east of *f1* in *A3* where the dolerite is much thinner. The enclosing faults subsequently occupied by dolerite and plug *S6'* are difficult to represent in section. The dolerite passes under and round *A3* if only as a thinner, more irregular body.

The Faulkner block (*B*) is essentially devoid of dolerite. A thin body (<200 m) may occur. The limitations inherent in the interpretation should be noted, as its occurrence is doubtful and possibly within the interpretive errors. Small dolerite bodies have been located on the north face of Mt Faulkner suggesting the occurrence of a small sill. The plug north-east of Mt Faulkner and its associated anomaly is distinctive and it probably dips south-east. The apparent plug at [130640] is deduced to be a basal step in a sheet rising south from *S6* as no anomaly is associated with it.

In Sections 600-675 the Cascades Fault (*f2*) has a throw of about 600 m. Block *C* is lacking in dolerite (anomaly -4 to -5 mgal) except for the irregular sheet base exposed. This block is more faulted than the map or section shows, but the positions of the faults are difficult to specify. There are zones of steeper dips as well, and these structures combined probably account for the obviously 'irregular' base of the sheet.

*S8*, *D* and *E* are as for Section 675, although the end of feeder dyke *S10* is clearly developed (+7 mgal). The lower sheet is dilationally lifted to the east and is now not generally exposed although apparent chilled margins and fine-jointing are present over much of this area. The ribbon wedge of sediments between the sheets is round Mt Direction on all sides.

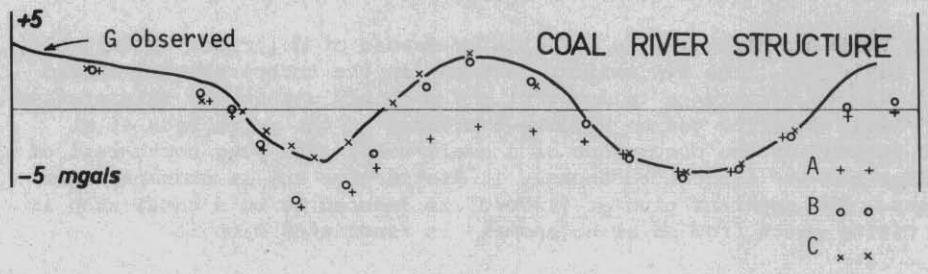
Block *F* is characterised by a very large anomaly (+9 mgal) which has a sharp eastern margin. The broad swell of anomaly west of *f3* can be accounted for by *S10*, which could imply a consistent forked sheet structure. The dolerite which crops out in *F* has an intrusive, but subsequently faulted eastern margin (*f3*), and a moderately dipping western boundary. The termination of this body shows that the roof is present and that it is hinged southward. The anomaly is not compatible with a single sheet arm (as clearly seen in Sections 575-625 where two anomalies separate). The sheet arm present conceals what must be a large dyke-plug which dips steeply? westward, as implied by gravity gradients and total anomaly values west of *f3*. A single body is most unlikely in any event. The particular problem of excess mass exists throughout the Rumney ridge to the south and a dyke of this trend is seen at Cambridge. The mass requirements there are less and the dyke seen is related to a sheet offset from the main plug system.

The sheet in blocks *G1*, *G2* and *G3* and its southward extension is clearly necessary as shown in Figure 9. In this region the thickness of Tertiary rocks, and the nature and composition of basin base are well known from drilling and seismic studies.

East of the Brains Hill feature (*S7*) is a narrow channel about 150 m deep filled with Tertiary sediment. The gravity shows only a slight dip here, due to the presence of two sizeable positive anomalies nearby, but drilling has proved the structure and the channel is eroded along the line of the western graben fault.

*H* and *I* are as described in previous sections; there is an additional high level sheet on Mt Lord. *S7* is shown to be unrelated to that sheet, although the plug and outcrop indications of Section 675 could suggest a relationship. *S27* is considered to be associated with the disrupted general sheet at shallow depth in this region.

# RICHMOND TERTIARY BASINS



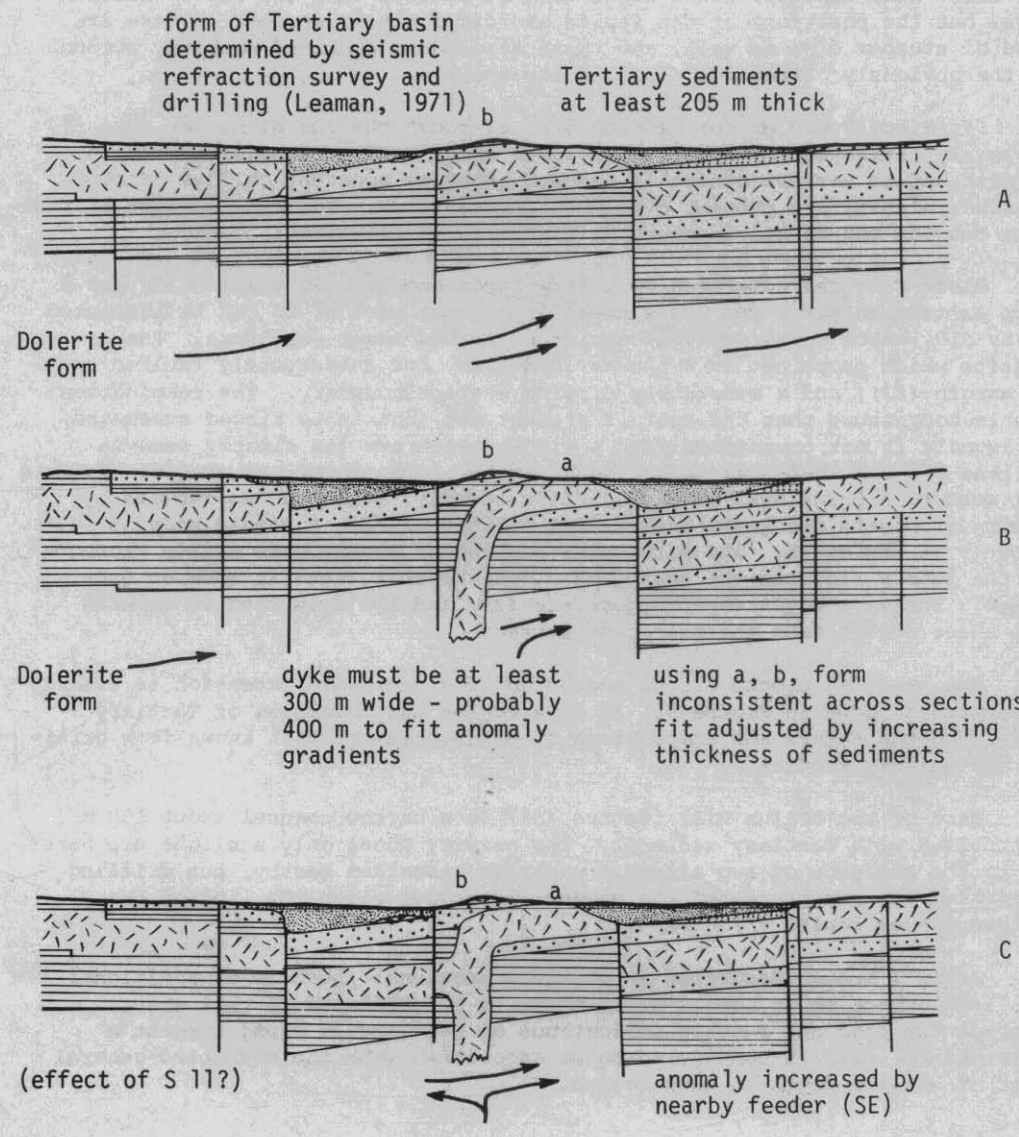
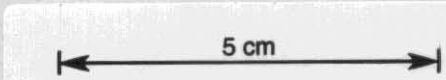




Figure 9.





*Section 625*

The anomaly at *A0*, which is related to the uplifted fault block of Lower Permian rocks (dilation 300-400 m), is clearly due to a feeder. Any sheet producing such an amount of dilation could not provide more than about +2 - 3 mgal. The structure is difficult to indicate in section. The dolerite appears to rise southward onto Mikes Hill, and be terminated by, or be a very thin dyke in *f1* which extends north-west into the Derwent valley (Anandalwar, 1960). This fault was probably pre-intrusion. The Lachlan intrusion is also bounded by it although this is by no means clear in the section. In *A1* there is an unusual effect of a sheet from the south arching over. The effect is merely a contraction of that structure in *A1-A2*, Section 600. Dolerite from *S13*, *S14* (Section 600, 575) join near [404620] as a closed structure, and in a definite arch (see *A2*, Section 600). The sheet from *S13* persists for some miles to *A3*, and then transgresses steeply eastward upon the same trend as dolerite rising from *S6*. The eastern part of *A3* is devoid of any major intrusions as indicated by the -4 mgal anomaly.

The Faulkner block (*B*) with capping sheet was described on page 27. *C1*, *C2* and *C3* are monoclinal drag blocks west of the Cascades Fault (*f2*). They are lacking in dolerite and persist to Mt Nelson in the south. There are some plug intrusions present which produce the small closed irregularities in the anomaly pattern.

*S8* is clearly seen as the Cadburys Point dyke. It is the definite termination, or source of the lower Direction sheet, which is observed to plunge westward. The dyke in this locality is probably aligned along a major fault in this part of the valley. The fault is possibly of Jurassic age and the east side of the graben structure which dominates the valley. The present line of the river appears to occupy the trend of such an implied fault and the anomalies are consistent with such a structure.

*D*, *E*, *F1*, *F2*, *G1*, *G2* and *G3* are as for Section 650. A separation of anomaly sources is clearly seen in *F1-2*. The peak of the anomaly lies close to *f3*, whereas the known dipping body is well away and completely exposed. The need for more mass near *f3* is apparent and the sheets, as drawn leading to *S10*, cannot produce the +5 mgal which is the base value in the whole Lindisfarne block. Much of the broad swell of internal anomaly (2 mgal?) must be contributed by the feeder system *S10* which has a N-S axis. The axis of the centres comprising *S10* is the narrow graben extending from Grasstree Hill to Bellerive and offset at Risdon. Fault *f2A* forms the eastern boundary of this graben.

*H1* is as described in previous sections. However, *H2* and *I* show a sheet rising from the south and which upsteps onto Mt Lord enclosing the Permian block at its southern end. The amount of dilation indicated is more than 200 m. That it is an intrusion separate from *S27*, is implied by the fact that material from *S27* is not faulted into juxtaposition, since one body could not produce the sheet in both *H1*, *H2* and *I*.

*Section 600*

In *A1* the dolerite capping Mikes Hill rises from the north-west whereas the Lachlan body is rising northward. On the north and east sides of Mikes Hill it appears as though the upper body has cut through the lower. This is the only structure compatible with dilation and anomaly distribution. The dilation could be explained with a vertical body comprising the bulk of the hill but this would not account for the low and high level dolerites, nor

their dip and concordance. *A2* shows coalescence of two dolerites and in this zone of arching and consequently thinner dolerite exposure there is a decrease in anomaly. *A3* shows the uplifted, inner zone above a sheet from *S13* (+5 mgal). The dilation, and hence sheet thickness, is about 450 m. *A4* is lacking in intrusions (-4 mgal).

*B1* and *B2* contain a sheet, low in Permian rocks, which is transgressing northward from the Collinsvale structure. In *B1* there is an apparent excess in dolerite thickness, but this is due to the angle of the section and the twisted northward transgression. The thickness of the Collinsvale body is a minimum of 300 m, as shown by the dilation across the dyke limb on the east side of Mt Faulkner [170610]. However, as there is known to be 150-200 m of dolerite present in the Faulkner block, this thickness is increased to about 500 m. The general anomaly values are consistent with this figure. There is a smaller abrupt positive anomaly high on Mt Faulkner which may represent a feeder to the Collinsvale body or the upper Faulkner sheet (*S28a*).

Apart from small plugs, *C* is lacking in intrusions. An anomaly of -7 mgal can only be produced when the complete thickness of the Permian and Lower Triassic rocks is present. No sheet is possible. There is the suggestion that *f2* is in part concomitant or pre-intrusion and that the Collinsvale body terminated upon it or rose up to it.

*D, E, F, S10* and *S11* are described in Sections 625-650. Transgression of the sheet from *S8* is clearly seen on the face of Mt Direction and the dilational effects of the sheets above *S10* are most marked. The continuous dyke from Grasstree Hill to Risdon represents the margin of the sheets from *S10*. The extra mass of the Craigow body (*S11*: +10 mgal) is also noted. The anomaly is far too great over the whole area to have been produced by inclined sheets alone as that would require an impossible one kilometre thick sheet. A feeder must be postulated to explain the anomaly. Fault *f3* causes some offset of the anomalies to the west and shows that the eastern dyke boundary dips west.

*FF* is sandwiched between *S11* and *S12*. *S12* is a localised anomaly, the magnitude of which upon a small dolerite body in a thick sedimentary sequence, implies a feeder structure. The anomaly spread from the two features blankets *FF* and the anomaly of 0 mgal suggests no dolerite between the two bodies. This is supported by the sharpness of the *S11* anomaly implying a mass deficient zone.

East of *S12* lies Pitt Water with a faulted Triassic sandstone platform covered by Tertiary sediments. The precise structure is indeterminate. A study of the anomalies about the water-covered areas suggests that the Lower Triassic rocks which crop out in the area, or more likely in the Permian rocks below, are intruded by a single large sheet as at Single Hill (Section 525).

*Section 575*

*S14*, a centre for the Lachlan body, is indicated by a +6 mgal NW-trending anomaly in *A1*. The sheet of more than 400 m thickness transgresses east and west. *A2* shows windows of dilationally lower rocks as sheets from *S13* and *S14* pass over them. *B1* and *B2* show the thick Collinsvale sheet. There is a further complication in *B2*, where the higher level sill caps the Mt Hull ridge and is clearly observed at its eastern end. *C1* and *C2* are as in previous sections (see also p. 38 and Appendix 2).

Block *D* covers the main Derwent lowlands which lack dolerite sheets of any significance at depth. There are some small plugs and sills near the Cascades Fault margin and material intruded along it may have squeezed into

this block. The course of the old Derwent River and the sediment fill and lava capping is indicated west of the present course. Drilling has shown that basalts are intercalated with the sediments. The thickness of the deposits probably exceeds 100 m.

*S10* and associated structures are detailed under Section 550. The graben block inferred to lack dolerite further north may contain dolerite here. *F1* needs comment. The inclined sheet from *S10* crops out as a dyke arm which is terminated on *f2A*. At about the same point the anomaly is increased. In addition a dolerite sheet of considerable thickness must persist under *F1-2*. The *S10* sheet is observed to rise and flatten into the Lower Triassic rocks and cap Craigow. The lower intrusion rises steeply east via the Cambridge dyke. The point anomaly at [310560] and much of the anomaly increase in *F1-2* is probably due to an extension of *S11* and that the second sheet derived from it closes round and reconnects via the dyke limb in the east. There is also a pronounced step in the intrusion at depth indicated by the anomaly upstep at the E-W faults which bound the southern edge of *F1-2*. Two sheets are conclusively necessary, as a study of the dilation requirements will reveal. A vertical dyke and horizontal limb cannot produce this pattern, nor account for the upper Craigow concordancy.

Comments on *FF* apply as in Section 600. The structure of *G* is adequately discussed in Section 525 where exposure permits full evaluation. In this section all structure is obscured by Tertiary sediments. Further east towards Pitt Water the anomalies do indicate a lower sheet (cf. Section 600), which by analogy with Single Hill ( Section 525) upsteps about the line of splay faulting from *f3*, and is considered to pass through the region of *S12*.

*Section 550*

In *A1* and *A2* dolerite rises transgressively from *S14*. The fault between *A1* and *A2* has been indicated as post intrusion. This may not be so, and in view of the size of the anomaly over the Lachlan block, the sheet may be thicker than indicated with a change in thickness at this point. The structure at [024545] shows some post-intrusion movement whereas that at [025533] does not. The ages may be purely relative. The roof form of the Lachlan intrusion to the south is quite complex and irregular although showing an overall transgression southward. The larger anomaly over this intrusion (compare Boyer structure, *S13*) may be explained in three ways. The feeder could be larger and more trumpet shaped; the sheet could be thicker although dilation estimates do not support this; or a further dolerite intrusion could be present deeper in the section. The first possibility is the most likely.

The feeder *S14*, a transgressive limb and small fault (*f1*), probably pre-intrusion, meet in this section. A structure of the form suggested is necessary to preserve the approximate dilationary balance between intrusions from east and west. Blocks *A3* and *A4* which contain thick successions must also contain a large sheet to balance anomaly requirements. Study of the windows to the north shows that it rises steeply around *A3*. Feeder *S15* is indicated by the marked increase in anomaly, which occurs over the small dolerite tongue exposed at [095560]. Metamorphism is more intense than usual here. These blocks also contain a higher level dolerite south of the section at Collins Cap.

Block *B* shows the structure proposed for the Collinsvale structure. It is not dissimilar to that of Sutherland (1964) which was based partly on petrological evidence. The anomalies suggest a sheet 500-550 m thick. The Mt Hull rise is exceptional and stands as a dyke projecting from the sheet roof. A small source is inferred beneath this zone on the small increase in

anomaly (*S16*). Dolerite transgresses westward and rises to meet material from *S15*. This relationship and the necessity of two separate bodies meeting is seen from comparison of the requirements of adjacent sections (especially Sections 500 and 525), and also from structure dips. The occurrence of Lower Triassic rocks at [130545] is a result of the transgression of the sheet being steeper than the topography at this point. (cf. *B1*, Section 575). There is also the possibility of a small fault, the only demonstrable outcrop of which is at [140510]. To the east the Collinsvale sheet rises steeply and the blocks *C* are devoid of any major dolerite (see also p. 38 and Appendix 2). Similarly *D* contains only a sheet base (also Sections 575, 600), and here *f2* has a throw of 800 m. The anomaly pattern in *D* shows that the sheet base is repeated by faulting, although some arching and cross transgression is indicated from both east and west.

The structure beneath the river cannot be outlined, but it is likely that it is comparable to the structure of the Coal River valley at Richmond. Available drilling information supports this conclusion. The circular anomaly (+7 mgal) at Lindisfarne on *f2AA* is a finger? from the *S10* feeder system. The dolerite bodies around this area show dips radial to *S10*.

Dolerite crops out in *E* as a coarse-grained, irregularly-roofed sheet; probably the sheet derived from *S10*. While faults *f2AA* and *f2A* can be shown further north to be Jurassic in age, at this point post-dolerite movements are indicated. It is not clear whether this graben block contains dolerite north of Kangaroo Rivulet. The thickness of this body is estimated from the anomaly requirements of this block further south, and away from the effects of *S10* and *S11*. Weighing all considerations and remembering the position and termination of the Flagstaff Hill intrusion, which has been deduced to be related to *S10* also, only one conclusion is possible. It appears likely that the sheet in *E* passes southward, but is terminated at about the line of the valley of Kangaroo Rivulet by a cross fault, with the same alignment as the Flagstaff intrusion. Thus the entire *S10* structure is a large ovate funnel with a sheet centred on it. Its southern end has been broken by reactivation of the graben faulting, thereby depressing the associated sheet which had risen into Triassic rocks at this point. The inconsistency of throws on the graben faults in this region, allied to the known presence of sheets is compatible with the assumed presence of cross faulting and/or upstepping of the sheet.

Throughout *F1*, *F2* and *F3* a thick body of dolerite intrudes the Permian rocks. It is either an E-W dyke limb upstepping to the north from *S11*, a change in thickness structure, or most probably a combination of the two. The dyke limb is indicated by the arc of higher anomaly around blocks *F1* to *F3* from the Flagstaff intrusion which it underlies structurally but overrides gravitationally.

In *F4* there is no evidence for dolerite in the Permian rocks, but a body does intrude Triassic rocks. There is much evidence of metamorphism. The patch of Triassic sandstone on Mt Rumney is considered to be on the roof of this sheet. It is difficult to specify all forms of the movement on the faults in *F1* to *F4*. Many of the faults appear to be rejuvenated concomitant or pre-intrusion structures. *F4* in this section also shows the special mass requirements for the Rumney ridge as were necessary for Craigow (Sections 600-650). The residual anomaly produced by a 500 m sheet at the base of the Triassic system would be about +1.5 mgal. Both sides of the intrusion are discordant, and comparisons with Sections 500, 525 show that the sheet alone cannot produce the boundary phenomena or the +4 - 5 mgal anomalies. A partly concealed? dyke mass (*S17*), is added to compensate and provide the extra mass. As there can be no dolerite in depth in *FF*, *S17* is indicated as a vertical intrusion with a plug-dyke character.

The structure in *G* is implied from Section 525, as there is total concealment in this section.

*Section 525*

*A1* is dilationally lower than *A1* and *A2* of Section 550 by at least 300 m. It is comparable with *A2* in this section, however. As the anomaly on *A1* suggests the absence of any major bodies, while that on *A2* shows one dolerite cap (clearly seen) and one body (from *S15*) at depth; the sheets from sources *S14* and *S15* must rise and meet at *f1*. Consistent with comments in Section 550, *f1* must also have a pre-intrusion throw of about 250-300 m. The mass, dip and dilation requirements can be explained in no other way. The sheet from *S15* is transgressive to east, south and west.

*B1* consists of a dolerite cap from *S16* (Collinsvale). The anomaly distribution over the whole Mt Wellington block shows only one body can be present and that it is on the top. Dolerite from *S16* and *S15* meet in the Collins Bonnet ridge. The sheet-dyke separation is clearly seen south of the section. *B2* is similar to *B1*, but contains a plug intrusion which is aligned with *S18*, as the anomaly trend clearly shows.

*C1* and *C2* are monoclinal or warp blocks intruded by a thin irregular sheet from *S18*. The intrusions are more discordant than concordant. Many of the faults contain dolerite dykes. The faults are thus dated, in part at least, although some have been rejuvenated. The anomalies suggest the presence of *S18* as a partly injected plug. There are probably many small offshoots, *e.g.* [214506], and also that drilled at depth in South Hobart (Johnston, 1888).

*D1* and *D2* are difficult to interpret. North of the section they are clearly devoid of dolerite at depth, whereas south of it there is an implied sheet. It is possible that a deep carry-over effect from the Nelson mass is complicating the anomaly pattern. The problem of whether there is a deeper sheet, or whether the feeder anomaly carries over cannot be solved at present. The need to terminate abruptly any such lower body of sheet form makes that possibility unlikely. The dolerite of Knocklofty appears more than a simple sheet base although its form can be explained by a sheet rising from the south-west and, as indicated, this would provide the discordant eastern margin.

*E* is as described in Section 550 except that here the anomalies are sufficiently separated for one to be sure that the sheet is present. The intrusions in *F1*, *F2* and *F3* are as in Section 550, but in *F3* the separation of the two bodies clearly shows the need for a major accessory plug system. The small patch of Triassic rocks forms a window to the sheet rising steeply from the west. *FF* is as for previous sections.

The structure of Single Hill has been referred to earlier. The outcrop and gravity pattern show it to be an elbow in a sheet rising from the east. Some of the associated faulting appears concomitant. On the coast a sill in Cascades Group rocks is disrupted by later faulting. The deficiency of mass to the west confirms the field observations.

*Section 500*

*A1* and *A2* are as for Section 525. The fault in *f1* is again implied marginal to the intrusion. Its throw cannot be determined precisely due to lack of outcrop of any specific horizons. The anomalies in the region immediately south of the section imply a further massive intrusion concealed by the capping dolerite. In *A3* the Collins Bonnet dyke is seen at a much lower level. It is likely that the sheet from *S15*, indicated in Permian rocks, is not as thick in this part of the region. Examination of the anomalies in

the Grove-Mountain River region suggests a sheet with marked thickness variations. Dolerite occurs below this region, as indicated by numerous small plugs and other irregular intrusions. As described in Section 425, a thin sheet rises to the south-west from this region. It is possible that the faulting is simply in the roof, above the intrusion, and thereby reflects variable sheet thicknesses.

All the anomalies south of this section in the region of Mountain River appear more negative than might be expected. The anomalies in *A3* show that no major sheet can be present to the west. The range of dolerite hills form no part of a dyke complex here. The anomalies over the Mt Wellington-Mountain River blocks are about 2-3 mgal more negative than can be accounted for with the known rocks. This precludes the possibility of deeper intrusions.

In *B*, the Mt Wellington block, the maximum anomaly that can be obtained with the observed geology is -4.5 to -5.5 mgal. The deficient area is too large and the topography too varied for this to be a result of short radius terrain corrections.

*C1* and *C2* are the severely faulted monoclinal blocks of South Hobart. The anomaly indicates a general lack of dolerite although plug feeders such as *S18* are present. Blocks *D1* and *D2* expose dolerite but its exact relationship to the Nelson intrusion is unclear due to faulting and discordancy, although it may represent an offshoot sill with a discordant north-west arm. The thickness of Tertiary sediments in *D2* exceeds 200 m. No other details are known and no alternative interpretation can be postulated until the thickness of these sediments is known. The thicker the overlying cover, the thicker the dolerite body required beneath it.

*F1*, *F2*, *F3* and *FF* are as for Section 525. A large pipe in *F3* is implied by the anomaly of +6 mgal. The sheet in *F1*, *F2* cannot provide this anomaly, although it is transgressing eastwards at an angle of about 30° in this region.

*Section 475*

*A1*, *A2*, *A3*, *B* and *f1* are as described in Section 500 with the exceptions that a pipe is present in *f1* and that the western transgression from the lower intrusion in *A2* and *A3* is probably to the west of the included Triassic block at Crabtree [055475]. The anomaly over this block is too high for it to be deficient in dolerite although a feeder zone is nearby (*S19*).

The limitations on the reconstruction in *A2* and *B* are as for Section 500, although south of the core of the Mt Wellington block it does become possible to explain the anomaly with known materials.

Blocks *C* comprise the faulted South Hobart monocline, which is intruded by an irregular transgressive sheet with many discordant basal upstep edges. The anomaly distribution shows that little intrusive material is present in these blocks away from the Nelson feeder zone in *D*. All outcrops in *D* show that sill initiation has taken place in the Cascades Group.

Blocks *F2*, *F3*, *FF* and *G* are as for Sections 500, 525. In *F1* the increasing anomaly towards the river, the outcrop of Permian rocks and the transgressive character of the dolerite thereby implied suggests a source equivalent to *S11?* (Section 525). The eastern coastline of the South Arm peninsula (*G*) is intruded by a sill in Cascades Group rocks.

*Section 450*

The Permian rocks in *A1* contain a thick sheet emanating from centres

*S20a* and *S20b*. It transgresses east and north but only in the narrow dyke to the east is the transgression observed, as dolerite from *S19* conceals it to the north. The relationship of intrusions from east and and west in *A2* is clearly seen further south (Section 425). *A2* and *A3* appear to contain dolerite in a patchy? intrusion which also transgresses east into, through or under a steep pipe intrusion which is partly dyke-like to the north-east. This is shown by the dyke in the North West Bay River at Wellington Falls and Mt Montagu.

In *B2* dolerite rises as a transgressive wall (hence the apparent thickness) from the Nierinna intrusion to the south. This body is about 500 m thick based on the general +4 mgal anomaly over the large region where the sheet is concordant in Cascades Group rocks.

*C* and *D* are as in Section 475. A series of fault blocks tangential to the Nelson intrusion form the western side of the Derwent trough and comprise *DD*. Tertiary sediments fill the basin so produced.

*F3*, *FF* and *G* are as in Sections 475, 500. The diminishing positive anomaly in *F3* for which a plug-dyke feeder system is proposed along strike suggests a size reduction or greater depth. No surface dolerite features can be correlated.

*Section 425*

*A1* is composed basically of a feeder-sheet system for which few details can be adduced due to the magnitude and breadth of the anomaly. It does appear to be a two part system which upsteps gently to the east and steeply to the west along the line of pre-intrusion structures. The upstep at the west end of the section is in fact a complex wedge-shaped intrusion which has lifted a large triangular piece of roof from the sheet arm to the west (Mather, 1955).

At *A2* the major sheet from *S20a* and *S20b* rises steeply east and south. In the narrow dyke trending north-west from Grove there is sufficient exposure to show that two bodies are in fact involved. The small wedges of sedimentary rock at [085415] are below both. The eastern intrusion, which in Sections 450, 500 has been regarded as patchy and variable in thickness, is about 100-150 m thick. Exposures further east are consistent with this conclusion and such a value of thickness is also compatible with the general spread of anomaly values in the Grove-Mountain River block.

The Triassic sedimentary block at Longley (*B1*) must be devoid of dolerite as indicated by the low anomalies of -4 to -6 mgal. A dilationary step can be seen at the NNE-trending fault-boundary structure at Longley [160420]. *B2* contains the thick Nierinna sheet. Only the top of this body with various roof pendants is visible. It is seen to rise gently northward over the whole area with an anomaly of +4 mgal. The implied thickness, accepting this anomaly value, is 550-600 m which seems very thick. The dilation indicated at Longley is 400-500 m, and this figure may represent either the true thickness of the sheet and a 100 m pre-intrusion fault at Longley or overall residual value elevation.

West of *f2*, which is the Tertiary component of the Cascades Fault zone movement offset around the Nelson block, the Nierinna sheet is faulted and generally concealed. At the time of intrusion *f2* also shows itself to have been a basic fault since no major sheet intrusion can be ascribed to the Triassic-capped block east of it. There is some confusion here in interpretation since the Nelson anomaly trend appears to continue into the Kingston-

Blackmans Bay region and cause a slight elevation in values.

The line of the Jurassic movement of the Cascades fault is represented by *f2A*. The shape of the intrusions in its vicinity show its importance. In addition it shows more than one age of movement. Small dykes of younger dolerite are intruded into the fault zone at [255434] and contact phenomena with the major body are visible. Some basalt necks of Tertiary age also occur adjacent to this structure.

*D* contains the squared transgressive southern end of the Nelson block rising to the south.

*F1* and *F3* are as in Sections 450, 475. In *F4* the Rumney dyke-plug system indicated in other sections is offset about 2 km to the east. Although little dolerite is obvious here, comparison with the features of the Rumney dyke and the relative sharpness of the anomaly generally would indicate that this is a dolerite structure and not a pre-Permian basement influence. It is possibly a small feeding dyke, or just the plug in *F3* offset. The nature of any connection of the plug-dyke system and the sheet in unknown. The sheet passing beneath this area is shown to rise to the east in *F5*. The structure in *F6* cannot be detailed as there are too many unknowns, the most critical of which is the thickness of less dense sedimentary cover. *G* is as in Section 450.

*Section 400*

Block *A1* is as described in Section 425 except that a fault (*f10* west of Mountain River is crossed. The anomaly associated with this fault implies a thickness variation in the sill rather than just a change in depth on the east side. This sheet transgresses east and south and its base is repeated at the deep gully in *A2* [105405]. The structure in *A3* reflects dolerite rising from the Nierinna intrusion to the south-east and does not represent dolerite from either east or west. The Triassic rocks on the surface are clearly a roof as examination of the neighbouring areas shows.

*B1*, *B2*, *f2*, *C1* and *C2* are as in Section 425. Block *D* is probably not dissimilar to the western margin of the Mt Nelson intrusion. Part of a dyke, which has the same trend as *f2A*, can be seen along the coast south of Kingston. Comparisons with Section 375, 350 suggest that this is merely the west wall of a transgressive upstep from the east.

Blocks *F1* - *F5* and *G* are essentially as for Section 425 except that the anomalies present can be adequately accounted for by the simple sheet in mid-Permian rocks. Little evidence of the plug trends of previous sections persists. It is not possible to correlate structures in *F5* or *G* due to the deep Tertiary basin at Clifton, which is believed to be a filled fault wedge at least 200-300 m deep (anomaly maximum -12 mgal!).

*Section 375*

Blocks *A1* and *A2* are basically as in Section 400 except that the structures of *A1*, *A2*, *A3* and *B1* of that section are compressed here. The nature of the contacts on the Herring Back are indicated and the small patches of Upper and Lower Triassic rocks are either small roof capping remnants or windows to one or other of the intrusions. Dolerite rises into the Herring Back from the south-east, south and west; any northern contribution being negligible. Between *A1* and *A2* the situation is more complex. The gravity field indicates the necessity of a second dyke and subsidiary feeder system north-west of the main transgressive boundary [060380] but cannot resolve the structure completely. Mather (1955) suggested a structure not unlike

that proposed, and which is based on the occurrence of a trapped wedge block being of such stratigraphic elevation as to indicate dilation. This is consistent with the boundary phenomena and the requirements of the sheet from *S20* to north and south. A detailed petrological study would be necessary to sort out the entire story at this point since all the bodies merge to one great mass of dolerite over much of the ridge and it is only where included blocks are present that any separation can be made. Gravity anomalies are generally 0 to-4 mgal and indicate the amount of capping dolerite. The anomaly range would be -1 to 3 mgal if a deeper sheet was present.

Blocks *B1* and *B2* are dominated by the massive Nierinna body which is essentially a large dyke with uplifted roof over the central feeding zone (*S21*) (especially in the Red Hill region). Fault *f2* appears to have little Tertiary movement in this section, although further south such movement is indicated at the dyke boundary (Section 300). Further north the younger movements are offset into many small fault blocks. Most of the surface displacement of 500+ m is thus dilational since the gravity field on *C2* indicates little or no dolerite. Indeed, with a slightly thinner Permian succession the anomalies would be totally accounted for. The illusion of a very thick Nierinna sheet can also be reduced slightly in this way.

*D, F1, F3, F4, F5, F6* and *G* are as in previous sections, although a junction between the eastern and western sheets of South Arm exists at *F5* where a number of discordant boundaries occur. It is not possible to determine whether this is a true merger or whether one body cuts another.

*Section 350*

Block *AA* cannot be completely defined due to lack of gravity coverage. The hilltops south-west of Huonville are capped by a sill. It is not clear whether the dyke to the river is connected as the one body, or whether it has been cut through by a later intrusive sheet. The anomalies of 1-2 mgal at Huonville and north in *AA* suggest that the dolerite from *S20a* rises southward in this dyke. This is clearly indicated in *A1* east of the Huon River. The structure suggested for *A2* is only one of two possible. There must be dolerite rising south from *S20a* and dolerite rising north from the region of Grey Mountain (outside the present area; see Leaman and Naqvi, 1968). This second structure is shown by the upstep in Sandfly Rivulet and the gravity anomalies over the Pelverata-Kaoota block (*A2*). Where the two bodies merge, the section would imply Upper Triassic rocks at shallow depth. In fact the outcrops adjacent to this section are of Lower Triassic age. It is likely that a concealed dilation of the type suggested in Section 375 would provide the solution. Faulting is an unsupported possibility.

Dolerites from the Nierinna and Grey Mountain sources merge in *A3*. Contact phenomena and petrographic variations are present. Block *B* with *S21* and *C2* are as in previous sections but with *f2* showing little displacement other than can be accounted for by dilationary effects.

The structure of *D* is clearly shown in coastal exposures to be a sheet transgressing steeply westward by a narrow dyke limb to cap the hills of Piersons Peninsula. A dilation of about 350 m is indicated across this dyke and the anomaly of more than -3 mgal on the Triassic rocks of North West Bay preclude much dolerite continuing under the peninsula. As mentioned in Section 375 a slight thinning of the Permian succession would account completely for the anomaly and no dolerite would be necessary. The structure of Piersons Peninsula is shown in Figure 10. *F1* and *F2* are as for previous sections. The Tertiary trough is fairly symmetrical (a graben?) and of unknown depth, but probably more than 200 m assuming a structure as indicated in the section.

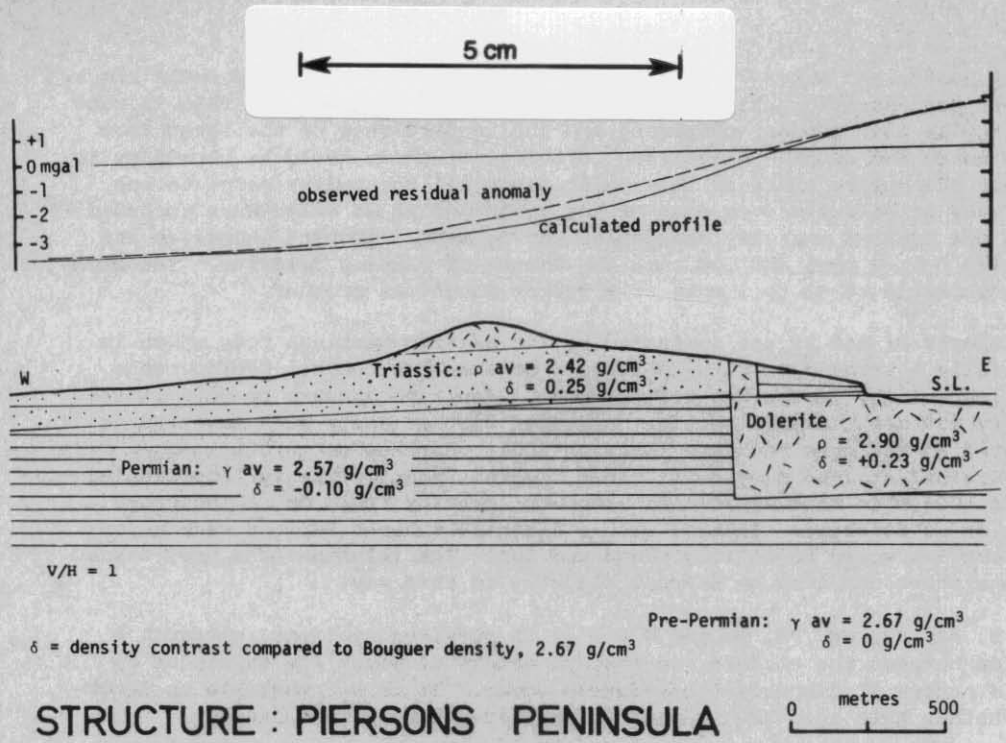



Figure 10.

*Evidence for an Anomalous Basement*

Drilling, in block *C*, at Glenorchy has revealed a major dolerite body not predicted in interpretation based on a non-anomalous basement (see Appendix 2). The inadequacy of interpretation has been stressed earlier, but a major revision of the structural interpretation such as is required by the results of the Glenorchy borehole was not anticipated.

The survey over blocks *C* shows an anomaly of -2.5 mgal. This anomaly was more negative than could be accounted for with the known rocks assuming a basement density of 2.67 g/cm$^3$. On this basis no dolerite could be expected. The presence of 309 m of dolerite in this column means that the real anomaly should be -6 to -7 mgal. It is clear that the regional adjustment, which is merely an averaging process of observed values, could not be so greatly in error unless the basement density assumption was also in error.

A further basement anomaly was noted by Leaman (1970*b*) following a seismic survey at South Arm, 25 km SSE of Glenorchy. The most reasonable solution to the structure in this area also leaves a residual -4.6 to -5.6 mgal deficiency.

There are two main possibilities for anomalous basement materials, which must be widespread.

(1) A series of granitic cupolas in basement rocks with a density approximating 2.67 g/cm$^3$. A single, massive, district-wide intrusive body would produce an excessive deficiency. A cupola was suspected by Leaman (1970*a*, p.103) in the Mt Wellington region to account for lack of feeders and the concentric nature of faulting. Granitic, or quasi-granitic

material could be of similar form to the bodies in north-east Tasmania or be related to the base of acid-intermediate volcanic piles as in western Tasmania.

(2) Upper crustal rocks with an overall density of less than 2.67 $g/cm^3$. For example, if there were 6 km of rocks with a density of 2.65 $g/cm^3$ the deficiency would be -5 mgal. The Precambrian, or upper crustal rocks as a whole, have been shown on seismic grounds to be in the range 2.65-2.67 $g/cm^3$ (see p. 14). Denser units within a light series are not precluded but would imply a greater thickness of light units.

Since highly-sheared and dense (2.7-3.1 $g/cm^3$) Cambrian, or possibly Precambrian, metamorphic rocks of acid(?)-intermediate composition were observed in the Glenorchy borehole the possibility of a Lower Palaeozoic succession of less dense rocks appears to be excluded. The metamorphic rocks could, however, be very local, a thin part of a lighter sequence, or be related to a granitic cupola (compare the Murchison area of western Tasmania). Further drilling would be needed to determine which possibility was correct.

A general deficiency of -5 mgal has been presumed on the basis of observation of an extra dolerite at Glenorchy and the assumption of the most reasonable structure at South Arm (Leaman, 1970*b*). In each case a dolerite sill/sheet is assumed. If this assumption were not valid then the known rocks could account almost completely for most anomalies, provided of course that denser basement rocks were generally an insignificant proportion of the whole. Some minor deficiencies would still exist (*e.g.* Section 500, blocks *A*, *B*). However this would imply that the major dolerite body drilled at Glenorchy was a small dyke. The implication of this would be that 300 m of Lower Permian rocks were missed. Such a thickness of Lower Permian rocks seems unlikely, although no tillite was found. The evidence for the body being a sill may be stated as follows:

(1) The contacts appear concordant.

(2) Petrological and textural variations appear to be sub-horizontal although it should be noted that the differentiation series normally found in sills of this size is absent.

(3) Appropriate dilation is observed.

A dyke is unlikely since:

(1) There is no trace at the surface.

(2) The contacts are apparently concordant.

If a dyke is present it must dip to the SW, since the borehole was inclined at 5° to the NE at 400 m. Angular contacts would thus be expected since horizontal step edges are nowhere observed in angled dykes. The lack of a surface trace would imply a termination and while not impossible this is unlikely. The petrological variations could be compatible with those found in dykes, but insufficient is known about dykes to confirm this. Alternatively such variations could reflect multiple intrusion in a sill.

## CONCLUSIONS

The Derwent, Mt Faulkner and Mt Wellington blocks contain no dolerite sheets below the level of 200-300 m above the Permo-Triassic boundary (assuming a non anomalous basement). Dolerite feeders are fairly regularly spread

over the district (fig. 11). Elsewhere the dolerite intrusions occur as trough or basin shaped structures.

Examination of the geological map and structural sections shows that the intrusions within this area have the form of sub-circular inclined sheets, each sheet being related to a source at its deepest point in the intruded rocks. The actual shape of each intrusion is quite variable and ranges from Y to T shape at its heart. The sheets are composed predominantly of concordant or sub-concordant limbs with abrupt transgressions between such limbs. In the Permian rocks concordant bodies are restricted to Bundella Mudstone and Cascades Group horizons and in the Triassic rocks to those parts where much mudstone is present. The condition of the roof is much more irregular and disrupted at, or above, the boundary with Upper Triassic rocks.

In the third dimension each intrusion ranges from a crude circular outline to a sheet trough. In extreme cases, such as the inferred Craigow and Rumney-Augustus plug-dyke systems, the trough reduces to a dyke. The general shape of some of these intrusions was predicted by Carey (1958a) although none of the examples described by him were in this area. The form predicted, based on a mechanistic 'punch' process, is valid and the *S1*, *S10* and *S15* intrusions may be cited.

Apart from the descriptive aspects of the form of each individual intrusion (chonolith), the most important single observation is the recognition of up to three large intrusive sheets in one column over substantial areas. This leads to the corollary that at least three pulses of intrusion are represented.

A further general observation is possible regarding the source localities. Many are related to graben faulting which was at least concomitant with the intrusion (*e.g. S10* and *S11*). Others are related to single faults of the same age (*e.g. S1, S13, S19, S20*). The implication is that these faults were (and still are?) major fractures in the crust, since the anomalies suggest bodies extending to great depth. There is nothing to imply that the dolerite fortuitously occupies them at shallow depth only. Since the magma was probably derived from a depth of at least 35 km any association of centres with faults implies use of a major fracture from that depth. Normal faults pass to shallow angles at depth (65-70° or less, De Sitter, 1956, p. 147) and in most cases would not reach that depth. This suggests that many of the occupie faults, as observed now, are normal rejuvenations of major crustal fractures which at one time may have had some transcurrent movement. Many other faults act as terminators to the intrusion or as initiators of transgression. This clearly implies either concomitancy or pre-intrusion.

The effects of Tertiary, or certainly any post-dolerite, faulting have been basic to the structural confusion experienced by earlier workers and may be fully appreciated, particularly when the results show many localities in which different dolerite bodies can be placed adjacent to one another. Tertiary faulting is most pronounced east of *f2*, (Dromedary-Cascades Fault). Fault *f2* extended as the North West Bay fault shows surprisingly little Tertiary movement over much of its length. These three faults were key structures at the time of the intrusion as many intrusions terminate or upstep near them. Whether they then formed one fault system is not clear. It is likely that Tertiary reactivation and block cross-breaking, as near Dromedary and Mt Nelson, combined to produce one crush zone. The monoclinal or warp blocks about the Mt Wellington block are probably related to this activation.

The Bagdad Fault (*f3*) and its southern extension have a similar history although the later movements show a hinging southward. Tertiary faulting

dominates the present strcture of the Derwent lowlands, the Coal River lowlands, the Brighton-Tea Tree region and South Arm. The southern part of the Middle Derwent faulting is observed near New Norfolk but much of the movement is terminated on one or two cross faults. Few features between New Norfolk, Huonville and Mt Wellington are of this age (see also Figure 2).

Some structural conclusions made by previous workers may also be discussed here. The structure proposed for South Arm by Green (1961) has been proved basically correct. The 'cone' structure proposed for the Collinsvale region by Sutherland (1964) has also been verified. There is a problem in providing a feeder for this structure, and the only conclusion is that several small sources are involved, *e.g. S28a, S28b*. The two sheet structure of Mt Dromedary (McDougall, 1959*b*), and the dyke-sheet structure of Red Hill (McDougall and Stott, 1961; McDougall, 1962) have been verified. The present results on Red Hill are minimum estimates because a uniform density value has been used whereas McDougall and Stott allowed different values across the dyke but did not terrain-correct their observations. They also had difficulty in accounting for the amount of granophyre present, but their survey did not extend far enough north to locate the Nierinna feeder. The concept of a massive feeder system of upturned V shape for the Craigow-Rumney dyke (Hastie, 1960) is partly supported geophysically, but modified to the extent of demonstrating that more than one body is present.

The sections described represent the simplest solution to the structure of this area. The addition of another dolerite body is a further problem which cannot be resolved without further drilling control although such additional intrusions would strengthen the conclusions of Leaman (1970*a*). The implications of a further sill for the ordinal scheme, a-e, of the intrusions can only mean a more involved solution at lower levels.

However, the basic assumption of the interpretation given is in some doubt. This does not affect the interpretation as a whole, which is basically sound to the effective geological base level of the area - the Bundella Mudstone, since interpretation of potential fields is not unique and some variation in position of anomalous bodies is admitted. Below this level, there was, and with the exception of the one borehole, there still is, no control. The further sheet verified suggest the possibility of a universal, but not necessarily single or contemporaneous body near the unconformity. There is little suggestion of edge anomalies and it is doubtful that they would be detected in view of the presence of many large near-surface effects.

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# APPENDIX 1

## Glossary

The following definitions of terms are used throughout the text and unless otherwise stated are based on the Dictionary of Geological Terms (American Geological Institute, 1962).

*Boss:* A steep-sided protrusion from a major body (sill or sheet) into overlying intruded rocks (the writer's definition). A plug in local terminology.

*Dyke:* A tabular body which cuts across the structure of the intruded rocks.

*Feeder:* The pipe or dyke-like body, in the crust, by which the magma was intruded (the writer's definition).

*Sheet:* A tabular mass of igneous rock, either a flow, sill or dyke. In the context of this Bulletin it will be taken to be a generally sub-horizontal body on the broad scale. The term *sheet* will also be taken to include combinations of sills, transgressions and dykes, where the whole system is substantially wide-angle and predominantly sub-concordant in broad scale.

*Sill:* An intrusive body of igneous rock of approximately uniform thickness and relatively thin compared with its lateral extent, which has been emplaced parallel to the bedding of the intruded rocks. (Note use of adjective 'transgressive' where the angle between the plane of the intrusion and the bedding is small, and the noun 'transgression' which is a departure from concordancy or sub-concordancy).

## APPENDIX 2

*LOG OF BOREHOLE, UPPER CHAPEL STREET, GLENORCHY*

| Description of strata | Depth (*m*) |
|---|---|
| Fossilferous sandy siltstone with subordinate limestone | 0 - 17.5 |
| Calcareous sandstone | 17.5 - 24.4 |
| Sandy siltstone | 24.4 - 28.9 |
| Calcareous sandstone, limestone | 28.9 - 69.5 |
| Pyritic fine siltstone | 69.5 - 71.0 |
| Calcareous sandstone | 71.0 - 74.3 |
| Pyritic siltstone | 74.3 - 198.0 |
| Dolerite sill | 198.0 - 492.0 |
| Pyritic siltstone | 492.0 - 564.0 |
| Dolerite sill | 564.0 - 579.0 |
| Siltstone | 579.0 - 582.0 |
| Siltstone with occasional pebbles | 582.0 - 591.0 |
| *Unconformity* | |
| Albite-epidote schist (probably Cambrian) | 591.0 - 616.0 |

A fuller description and profile will be given by the author in the Explanatory Report to accompany the Hobart geological map (1:63,360).

## APPENDIX 3

*GRAVITY DATA: SELECTED TIE STATIONS*

| Station | Location | Observed Gravity (*gal*) | Altitude (*m*) |
|---|---|---|---|
| BELLERIVE 6851.9309 | At foot of HEC pole 23, SE side of roundabout | 980.44795 | 22.9 |
| BLACK HILLS 6851.9315 | Road junction, Gretna/Magra/ Black Hills, centre of road | 980.31698 | 487.7 |
| BRIDGEWATER 6851.9304 | Junction Dromedary Rd, Midland Highway. Give way sign, corner of footpath N side | 980.42002 | 9.4 |
| BRIGHTON 6851.9305 | Road junction, Broadmarsh-Elderslie/Midland Highway. Foot of signpost | 980.40932 | 53.9 |
| BROADMARSH 6851.9322 | Road junction, Upper Dromedary/ Brighton/Elderslie, centre of road | 980.40257 | 61.0 |
| CAMPANIA 6851.0202 | BM 2387 | 980.41481 | 49.4 |
| COLLINSVALE 6851.9319 | Road junction, Collins Cap/ Myrtle Gully/Collinsvale. Signpost | 980.37821 | 299.6 |
| FERNTREE 6851.9340 | Ridgeway Road. Quarry entrance near Huon Highway | 980.37593 | 366.4 |
| GLENORCHY 6851.9328 | HEC pole 33, corner of Jackson St and Chapel St. Substation sign | 980.42262 | 71.3 |
| GRASSTREE HILL 6751.0275 | Milepost, East Risdon 6 | 980.40875 | 178.3 |
| GROVE 6851.9345 | Road junction, Grove/Mountain River/Crabtree. Transformer CGI/30/1 | 980.43539 | 88.1 |
| HOBART AIRPORT 6400.0000 | BMR mark, TAA entrance | 980.44891 | 4.9 |
| HOWRAH 6851.9310 | Junction of Rokeby Rd and Howrah Beach Rd. Signpost | 980.45258 | 20.1 |
| HUONVILLE 6851.9348 | HEC 1 transformer pole, Main Street | 980.45924 | 4.6 |
| KINGSTON 6851.9335 | Adjacent to stop sign, BM marker, junction of Proctors Rd and Channel Highway | 980.45584 | 47.55 |
| LACHLAN 6851.9312 | Track junction, SW end of concrete bridge | 980.41230 | 107.3 |
| LAUDERDALE 6851.9329 | Junction of Acton Rd and South Arm Rd. Stop sign, school entrance | 980.45576 | 20.7 |

| Station | Location | Observed Gravity (*gal*) | Altitude (*m*) |
|---|---|---|---|
| LONGLEY 6851.9341 | Junction of Huon Highway and Leslie Vale Rd. Stop sign S side of road | 980.40124 | 279.8 |
| MARGATE 6851.9352 | Bridge sign, E end of bridge North West Bay River | 980.46602 | 5.8 |
| NEW NORFOLK 6851.9311 | Highway sign, west of Junction of Lyell Highway and Upper Plenty Rd. PMG MS57 | 980.42282 | 18.3 |
| NEW TOWN 6851.9325 | North-east corner of junction of Culloden Av. and Risdon Rd, on footpath | 980.44008 | 1.8 |
| OLD BEACH 6851.9330 | Entrance to 'Ravensbourne' | 980.42430 | 35.1 |
| ORIELTON 6751.0183 | Municipality sign, Tasman Highway and Richmond Rd | 980.41910 | 77.7 |
| RICHMOND 6751.0013 | SPM. Road junction, Cambridge/ Campania/Sorell | 980.43134 | 20.12 |
| RISDON 6851.9317 | Road junction, Richmond/Old Beach/Lindisfarne. Signpost | 980.44327 | 11.9 |
| SANDY BAY 6091.0160 | University of Tasmania, outside Faculty of Engineering lecture theatre. BMR mark | 980.44427 | - |
| SNUG 6851.9354 | North-east corner of junction of Snug Beach Rd and Channel Highway. HEC pole 19 | 980.46747 | 15.5 |
| SORELL 6751.0194 | Junction of Arthur and Tasman Highways. Foot of signpost | 980.44467 | 14.0 |
| SORELL CREEK 6851.9302 | Road junction, Lyell Highway/ Collinsvale. HEC pole C 5190 3 m W of signpost | 980.42822 | 1.8 |
| SOUTH ARM 6851.9356 | North-west corner of road junction, Opossum Bay/Clifton/ Cape Direction. HEC pole 410 | 980.46959 | 14.9 |
| TEA TREE 6751.0267 | Junction of Campania Rd and Middle Tea Tree Rd. Centre of road | 980.40825 | 96.6 |
| TUNNEL HILL 6751.0157 | Road junction, Mt Rumney/Tasman Highway. Foot of sign on Highway 3, E side of road | 980.42455 | 149.7 |

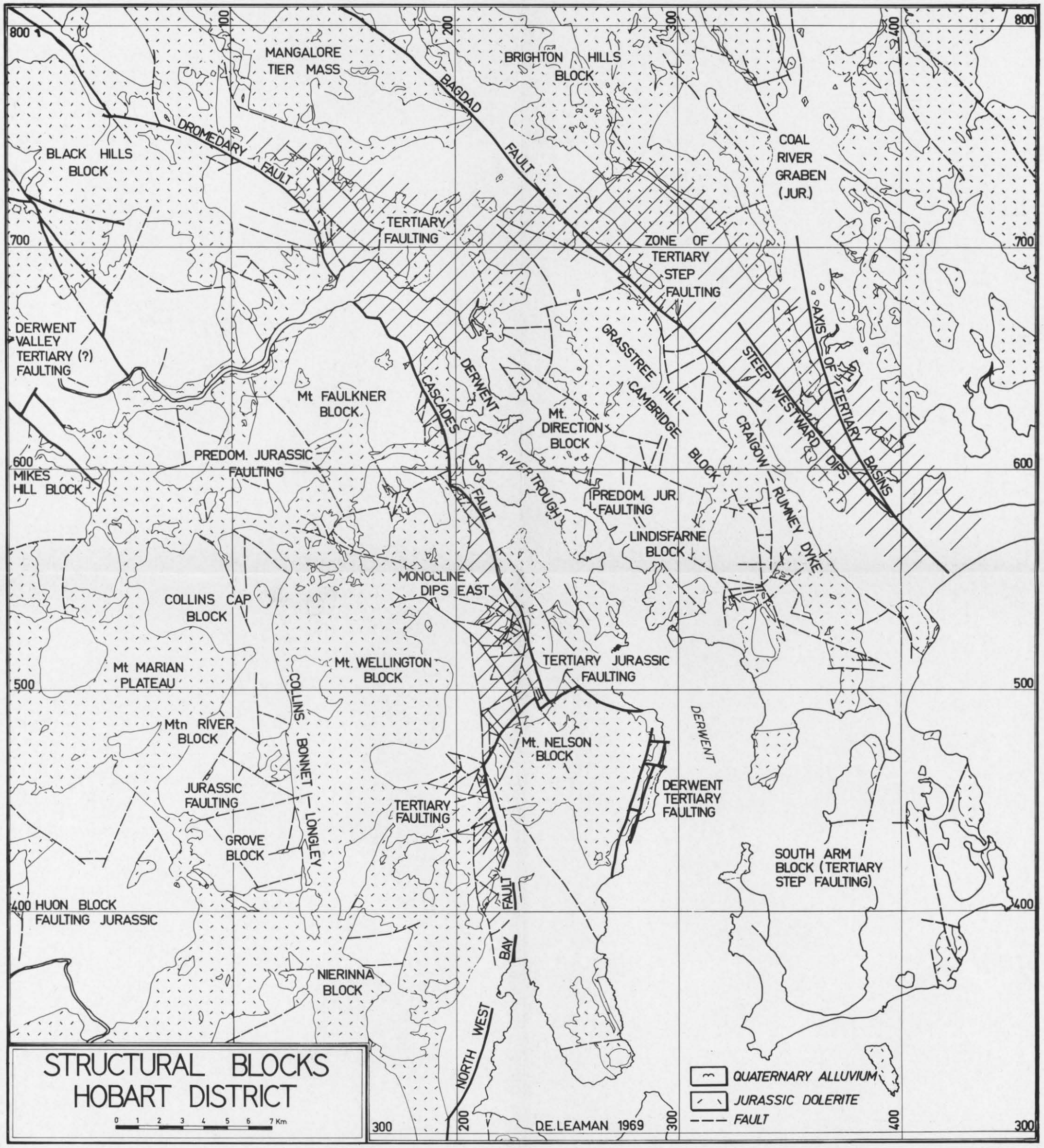
MANGALORE TIER MASS
BRIGHTON HILLS BLOCK
BAGDAD FAULT
DROMEDARY FAULT
BLACK HILLS BLOCK
COAL RIVER GRABEN (JUR.)
TERTIARY FAULTING
ZONE OF TERTIARY STEP FAULTING
AXIS OF TERTIARY BASINS
STEEP WESTWARD DIPS
GRASSTREE HILL
CAMBRIDGE BLOCK
CRAIGOW
RUNNEY DYKE
DERWENT VALLEY TERTIARY (?) FAULTING
Mt FAULKNER BLOCK
CASCADES FAULT
DERWENT
Mt. DIRECTION BLOCK
PREDOM. JURASSIC FAULTING
MIKES HILL BLOCK
RIVER TROUGH
PREDOM. JUR. FAULTING
LINDISFARNE BLOCK
MONOCLINE DIPS EAST
COLLINS CAP BLOCK
Mt MARIAN PLATEAU
Mt. WELLINGTON BLOCK
TERTIARY JURASSIC FAULTING
COLLINS BONNET — LONGLEY
Mtn RIVER BLOCK
Mt. NELSON BLOCK
DERWENT
JURASSIC FAULTING
TERTIARY FAULTING
DERWENT TERTIARY FAULTING
GROVE BLOCK
SOUTH ARM BLOCK (TERTIARY STEP FAULTING)
HUON BLOCK
FAULTING JURASSIC
NIERINNA BLOCK
BAY FAULT
NORTH WEST
STRUCTURAL BLOCKS
HOBART DISTRICT
0 1 2 3 4 5 6 7 Km
D.E.LEAMAN 1969
QUATERNARY ALLUVIUM
JURASSIC DOLERITE
FAULT
800
700
600
500
400
300
200
100

Figure 2.



5 cm

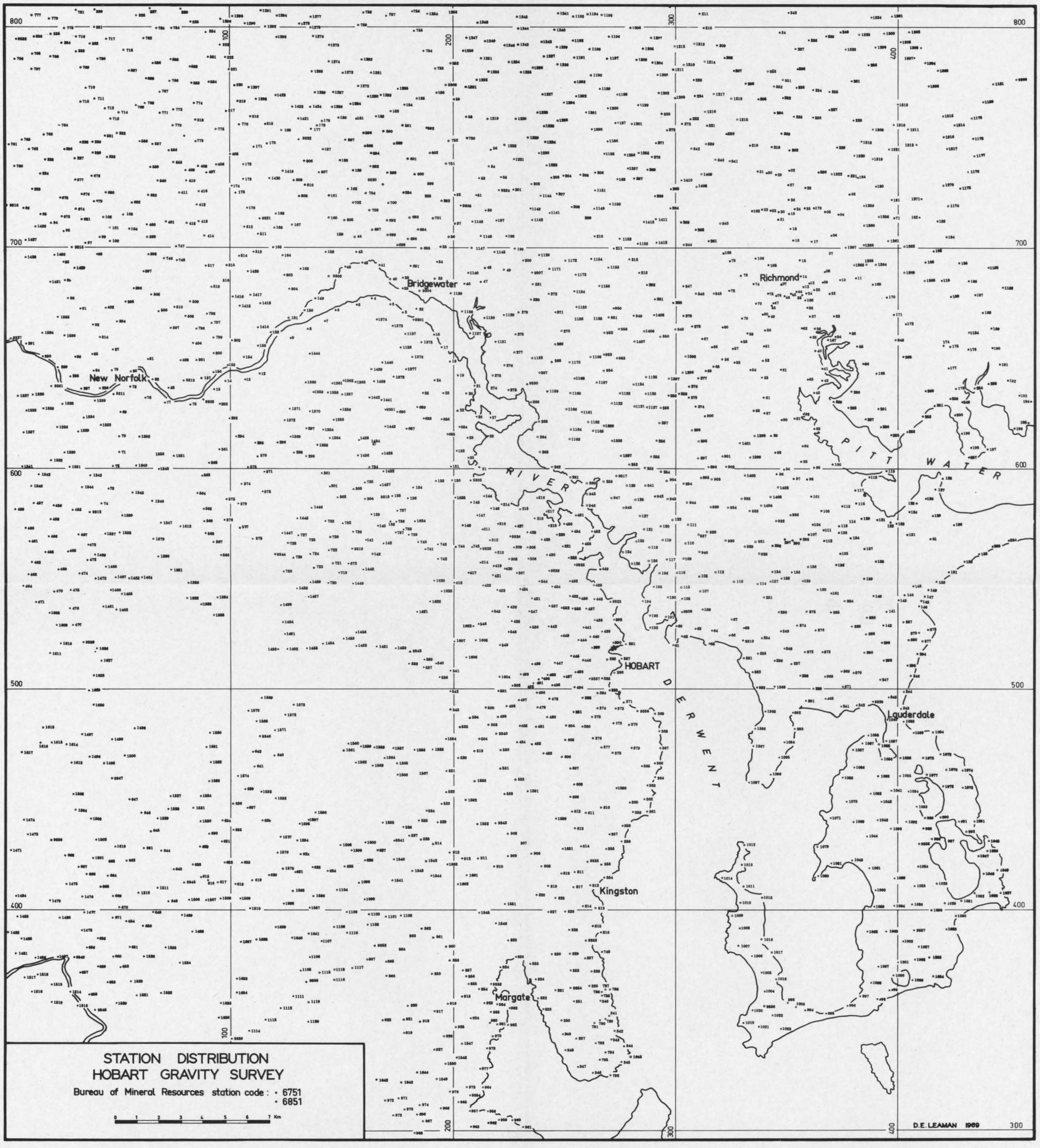


Figure 4.

*Bull.geol.Surv.Tasm.* 52.

5 cm

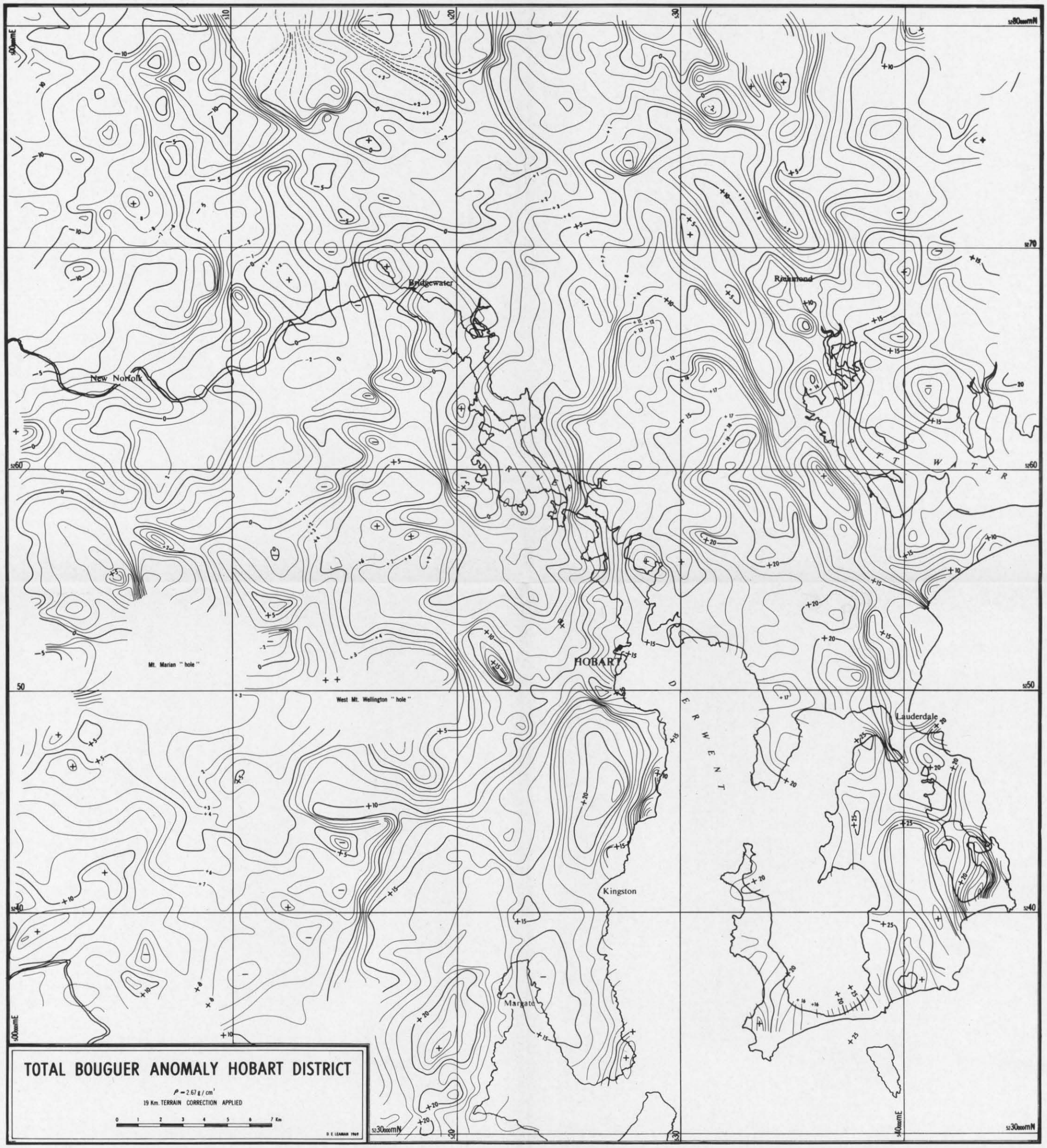
New Norfolk
Bridgewater
Richmond
HOBART
Kingston
Margate
Lauderdale
Mt. Marian " hole "
West Mt. Wellington " hole "
R I V E R
D E W E N T
X P I T W T E R
TOTAL BOUGUER ANOMALY HOBART DISTRICT
ρ = 2.67 g / cm³
19 Km. TERRAIN CORRECTION APPLIED
0 1 2 3 4 5 6 7 Km
D. E. LEAMAN 1969

Figure 5.



5 cm

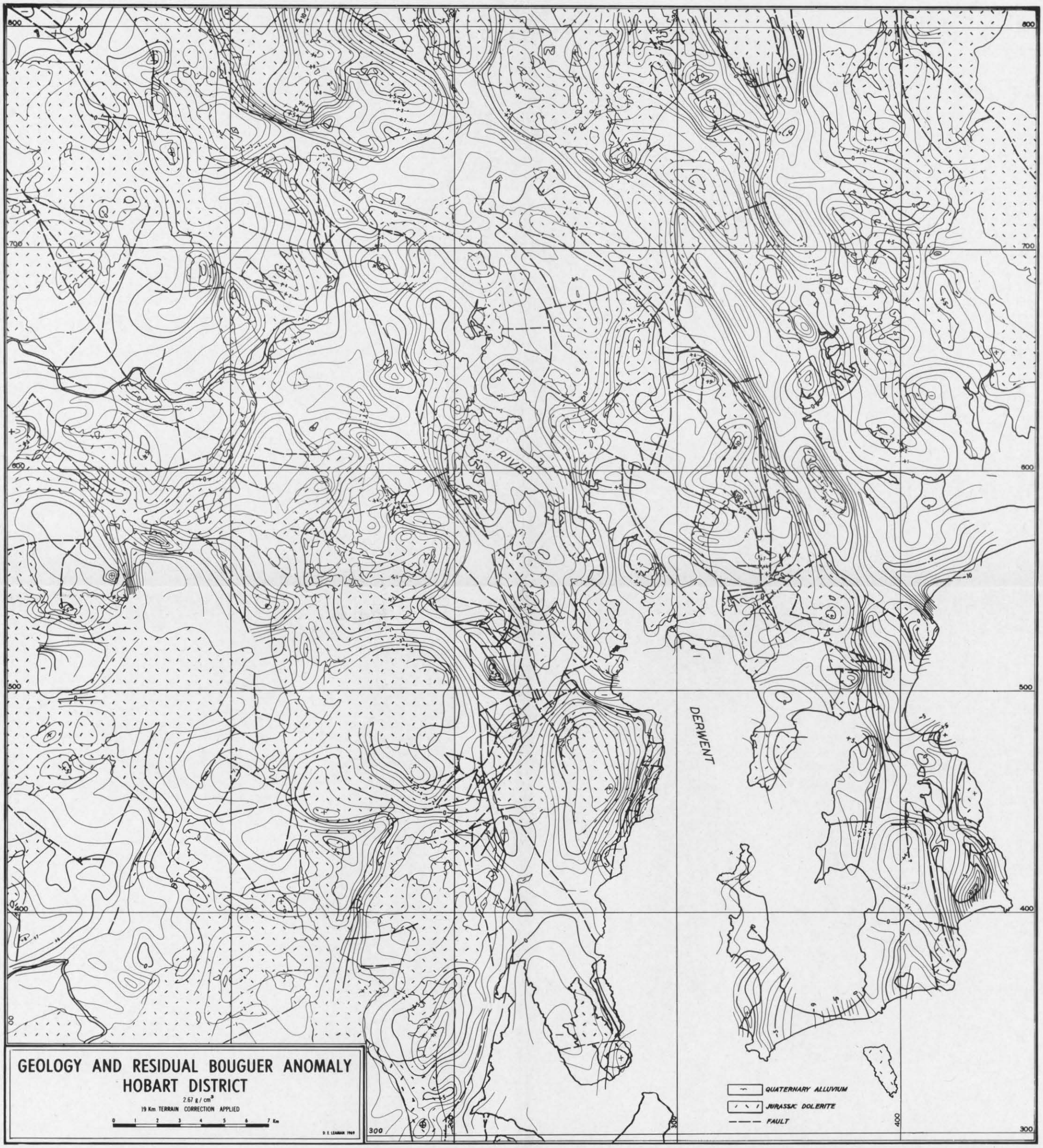
RIVER
DERWENT
GEOLOGY AND RESIDUAL BOUGUER ANOMALY
HOBART DISTRICT
2.67 g / cm³
19 Km TERRAIN CORRECTION APPLIED
0 1 2 3 4 5 6 7 Km
D. E. LEAMAN 1969
QUATERNARY ALLUVIUM
JURASSIC DOLERITE
FAULT

Figure 6.



5 cm

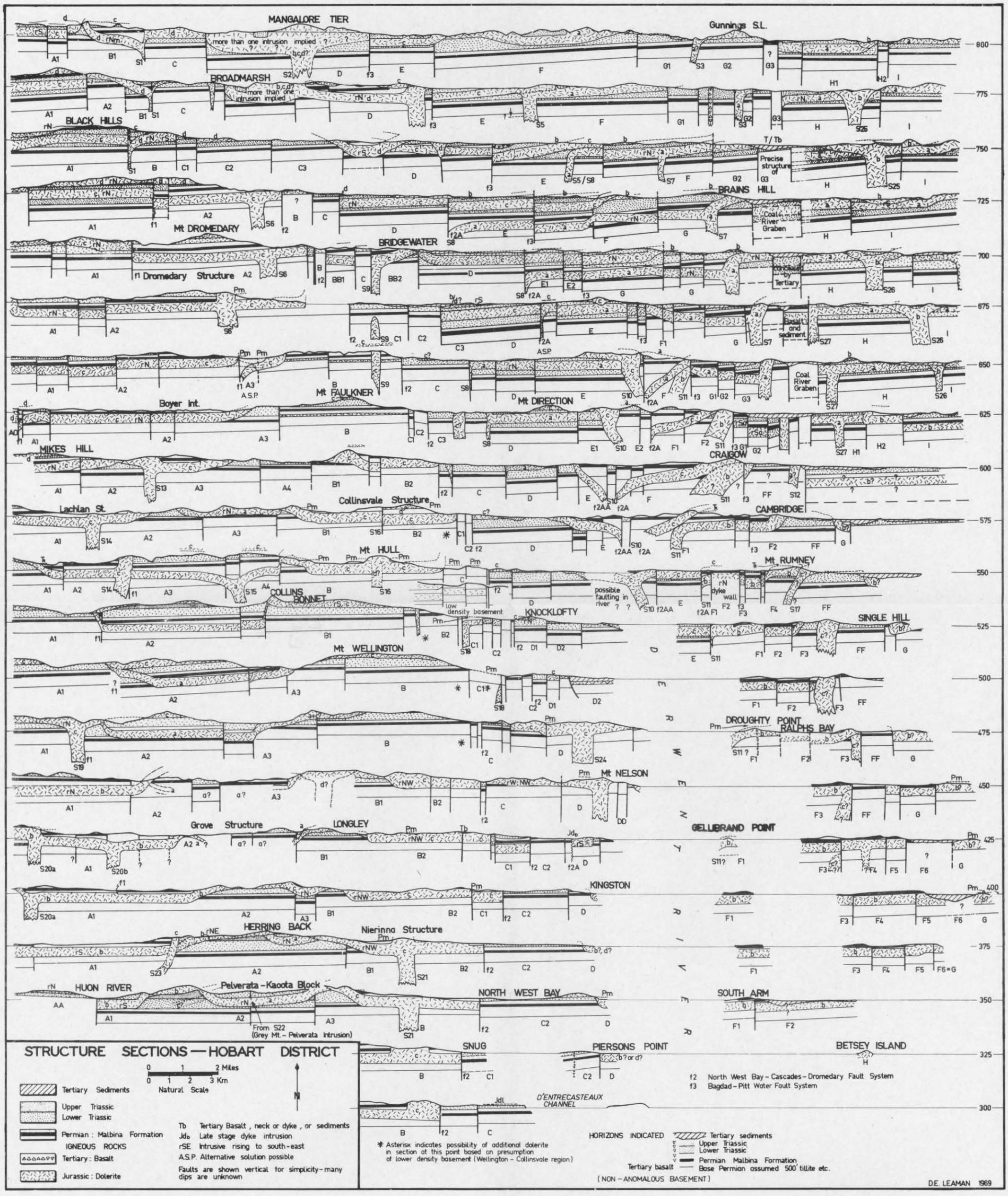
MANGALORE TIER
Gunning's S.L.
BROADMARSH
BLACK HILLS
Mt DROMEDARY
BRAINS HILL
BRIDGEWATER
Dromedary Structure
Coal River Graben
Mt FAULKNER
Mt DIRECTION
Boyer Int.
MIKES HILL
CRAIGOW
Collinsvale Structure
Lachlan St.
CAMBRIDGE
Mt HULL
Mt RUMNEY
COLLINS BONNET
KNOCKLOFTY
SINGLE HILL
Mt WELLINGTON
DROUGHTY POINT
RALPHS BAY
Mt NELSON
Grove Structure
LONGLEY
GELLIBRAND POINT
KINGSTON
HERRING BACK
Nierinna Structure
HUON RIVER
Pelverata-Kaoota Block
NORTH WEST BAY
SOUTH ARM
SNUG
PIERSONS POINT
BETSEY ISLAND
D'ENTRECASTEAUX CHANNEL
more than one intrusion implied
Precise structure of
Basalt and sediment
possible faulting in river ? ?
low density basement
rN dyke wall
From S22 (Grey Mt.- Pelverata Intrusion)
800
775
750
725
700
675
650
625
600
575
550
525
500
475
450
425
400
375
350
325
300
STRUCTURE SECTIONS — HOBART DISTRICT
0 1 2 Miles
0 1 2 3 Km
Natural Scale
N
Tertiary Sediments
Upper Triassic
Lower Triassic
Permian : Malbina Formation
IGNEOUS ROCKS
Tertiary : Basalt
Jurassic : Dolerite
Tb Tertiary Basalt , neck or dyke , or sediments
Jdo Late stage dyke intrusion
rSE Intrusive rising to south-east
A.S.P. Alternative solution possible
Faults are shown vertical for simplicity - many dips are unknown
* Asterisk indicates possibility of additional dolerite in section at this point based on presumption of lower density basement (Wellington - Collinsvale region)
f2 North West Bay - Cascades - Dromedary Fault System
f3 Bagdad - Pitt Water Fault System
HORIZONS INDICATED
Tertiary sediments
Upper Triassic
Lower Triassic
Permian Malbina Formation
Tertiary basalt
Base Permian assumed 500' tillite etc.
(NON - ANOMALOUS BASEMENT)
D.E. LEAMAN 1969

Figure 8.



5 cm

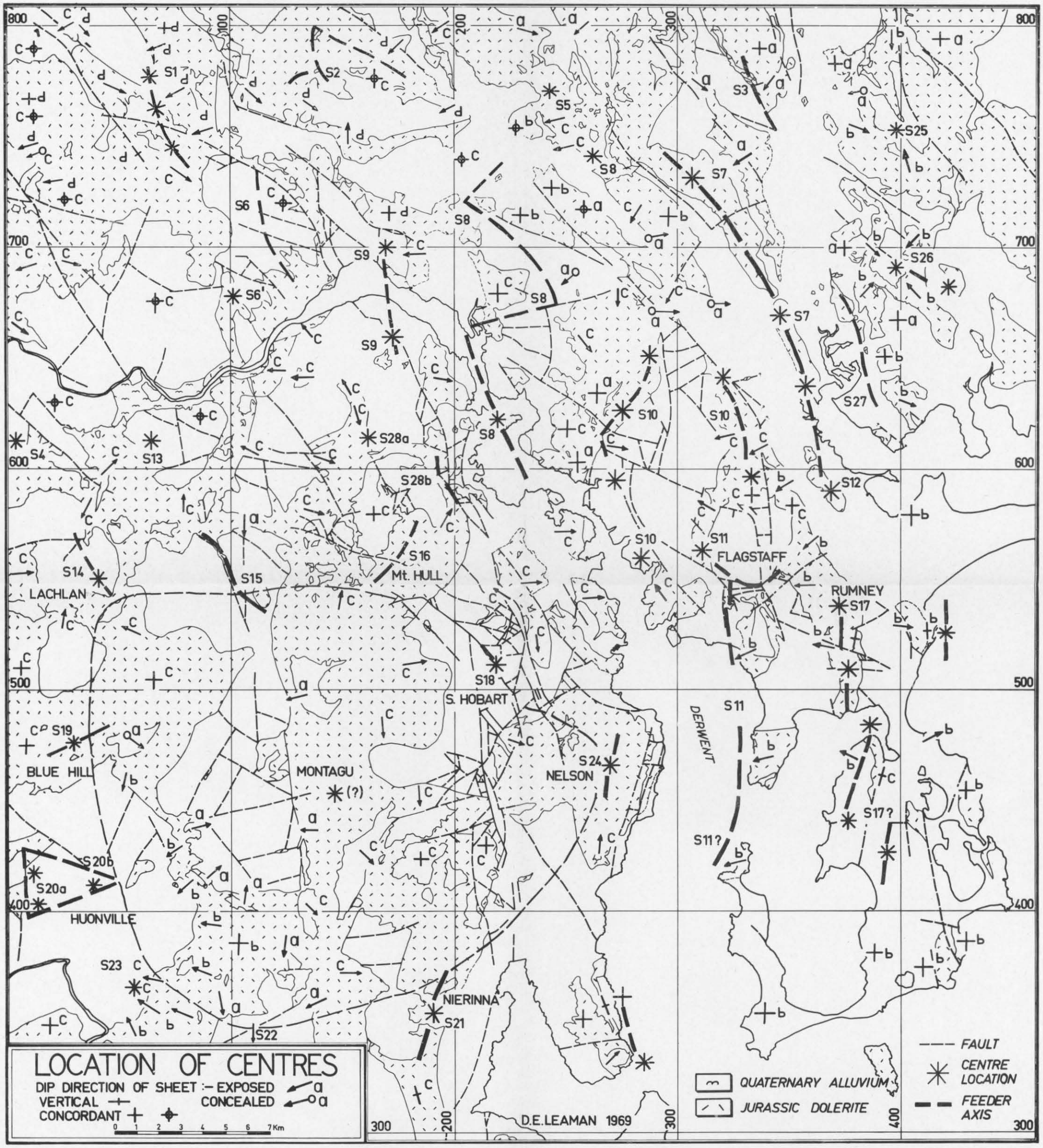


Figure 11.

*Bull.geol.Surv.Tasm.* 52.

5 cm