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East Coast coal project gravity survey. Preliminary report.
Part 1. Survey details and qualitative interpretation.

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Abstract

A gravity survey of the region between Swansea, Rossarden and Falmouth in eastern Tasmania has shown that the cover of Permo-Triassic rocks containing limestone and coal is variable in thickness and disposition. Pre-Permian basement rocks providing a high relief surface to later deposition and Jurassic dolerite intrusions in the Triassic rocks have resulted in shortened sections. Several major dolerite sources have been recognised in the region west of Fingal and north of Cranbrook, but only two large sources have been confirmed on Fingal Tier. The sheet capping the southern part of Fingal Tier and the highlands forming the divides between the Swan, Apsley and Douglas Rivers is relatively thin compared with major cappings south and west of Fingal as well as north of Cranbrook.

Prime target areas for assessment of coal measures may be listed as Nicholas Range, St Marys-Dalmayne, Fingal Tier (north east-central), Apsley-Douglas and Lynes Sugarloaf-Llandaff. In all other areas, basement relief or dolerite intrusion have foreshortened or terminated the section.

No information of a confidential nature available to the author at the time of writing has been included, implicitly or otherwise, in this report.

INTRODUCTION

A reconnaissance exploration programme directed at coal resources has been underway in Eastern Tasmania for two decades. Drilling has been the only technique utilised for most of that period. In later years, as drilling and site selection problems mounted and as the demands to estimate reserves, or at least identify promising areas for further work, became more intensive, it became obvious that other methods must be used in addition. Budgetary and manpower considerations were limiting factors in any proposals to develop the exploration programme.

Gravity or seismic reflection methods, in association with detailed geological mapping, offered the only promise of an advance. In 1973, when these options were considered, only the first and last were available. The gravity survey was begun immediately and was completed late in 1978; problems of access, vegetation and restricted manpower produced this delay. Experiments with magnetic methods were also begun in an attempt to improve decisions about dolerite boundaries for mapping purposes and detailed mapping was begun in 1977. The presence of substantial talus deposits makes reliable mapping of dolerite-coal measures-talus boundaries difficult.

Reflection methods, which offer the greatest promise of structural resolution and even description of the coal measures themselves, are still under development. Research during 1978 offers hope that some short traverses will be available in selected areas to aid control of the quantitative interpretation of the survey discussed in this report. The method is not yet in productive use, due to a range of physical and geological problems related to the dolerite and the coal measures.

This report details the primary gravity survey undertaken over an area in central Eastern Tasmania which includes every major east-coast coalfield (refer Hills *et al.*, 1922) and the only currently operating coal mine. The survey was intended to provide information on;

a) basement structures

b) dolerite structures

c) sedimentary basin structures.

Perhaps the most important of the goals is the second, as dolerite sheets cap or transect the coal measures in every coalfield zone. Gravity surveys have proven valuable in describing dolerite structures (Leaman, 1972). If areas with concordance, transgressions or feeders could be located, the drilling programmes could be revised to yield results more economically and minimise drilling of dolerite. The whole area is known to have a high basement relief and in some extreme cases the coal measures may lie directly on pre-Permian basement rocks. Thus information on the entire sedimentary basin and the sedimentary sandwich contained between a variable basement and an unpredictable dolerite capping can be provided.

The area covered by this survey includes the Mount Nicholas-Fingal-Dalmayne coalfield, the Seymour-Douglas River-Denison Rivulet-Mt Paul coalfield and the Avoca coalfield (see Hills *et al.*, 1922 for subdivisions). The survey extends to exposed pre-Permian basement rocks in a region characterised by high relief, often dense vegetation and, until the advent of wood-chipping, poor access. Some previous surveys have included this area (Cameron, 1976; Johnson, 1972; Zadoroznyj, 1975) but in each case the coverage was very limited and directed at crustal features. No previous data is included in the current presentation. Locations cited in this report are shown on Figure 9.

GEOLOGY

A summary of the available geological mapping is presented in a simplified form in Figure 1. This information has been drawn from incomplete mapping by R.H. Castleden, N. Turner, C. Calver, D.E. Leaman, D.J. Jennings and the Launceston and Oatlands 1:250 000 map sheets. The compilation is rather uneven as a result.

Several materials of economic interest occur within the area covered by Figure 1. These include the Triassic coal, Permian limestone and Devonian tin-tungsten and gold deposits.

STRATIGRAPHY

Ordovician-Devonian

The Mathinna Beds, a series of sandstone, shale, quartzite and slate, possibly more than 10 km thick, range in age from Early Ordovician to Early Devonian. The major exposure is north and west of Fingal - St Marys, although significant exposures occur south of Bicheno. Metamorphic effects are generally slight unless within a kilometre of a major intrusive boundary.

Granitic rocks, of late Devonian age, occupy large tracts of the peripheral parts of the area near Avoca, Royal George, St Marys and Bicheno.

For the purposes of this report, all the Ordovician-Devonian rocks have been termed basement rocks, as they form the exceedingly irregular base for Permo-Triassic deposition, especially south of the Break O' Day valley.

Permian

Fossiliferous sandstone, shale, limestone and unfossiliferous siltstone, grit and conglomerate unconformably overlie the basement rocks. The best section available is at Elephant Pass (McNeil, 1965). Thickness of the Permian section varies from nil to about 250 m.

Triassic

Quartz and feldspathic sandstone and mudstone overlie, usually disconformably, the Permian succession. In some southern areas Triassic rocks rest unconformably on basement rocks. The Triassic sequence, which may contain much lithic arkose, also includes several coal seams which may rarely exceed 2 m in thickness. The succession may exceed 400 m in thickness.

Jurassic

Dolerite has intruded the Permo-Triassic section as large dykes and sheets. Some small dykes have also been mapped. Mapping by the author suggested, but could not confirm, the presence of feeders at St Marys-Gray, Fingal Rivulet, Seymour and Lochaber. Most intrusion has occurred in Triassic rocks.

Tertiary

Sand, clay and laterite deposits have been observed around Swansea. The thickness of the deposits probably exceeds 300 m. No basalt is known.

Quaternary

Alluvial deposits occur in all river valleys and in some cases coarse braided gravels may be found. Most slopes in those parts of the area where dolerite caps the highlands or forms complete valley walls are covered in a variable but often thick veneer of talus. Block sizes may locally exceed 10 m across. Marsh deposits are also common above the 500 m level.

STRUCTURE

The region is dominated by the igneous intrusions of Devonian and Jurassic age. The western margin of the surveyed area is provided by the Scottsdale Batholith and its extension to Royal George, whereas the coast is marked by a series of topographically dominant lesser intrusives. Inland, the dolerite disrupts and caps the coal-bearing sequence and dominates the entire area.

The Mathinna Beds are intensely folded but no consistent structural pattern can be provided due to granitic disruption and cover by later materials. A marked unconformity occurs at the base of the Permian rocks and, although it appears to occur at a consistent level north of Fingal, it is most irregular to the south. The importance of faulting cannot be appraised since faults are rarely positively recognised. Several have been inferred (*e.g.* Threader, 1968) but few have been confirmed. Three structural trends are evident; east-west, north-south and north-west - south-east (Williams, 1967, 1969).

Two faults are believed to define the area; the Castle Cary Fault to the west of Avoca and the coastal structure which extends north from

Freycinet Peninsula to Seymour. In each case granitic rocks are juxtaposed with coal measures. The exact nature of each of these major features has never been established.

GRAVITY FIELD

SURVEY DETAILS AND ACCURACY

The gravity survey presented in this report was intended to provide a semi-detailed coverage of central eastern Tasmania. It was important that a large area be covered in order to appraise the coal-bearing areas and the influence of basement rocks. However adequate detail was also necessary if dolerite structures were to be recognised and if areas were to be selected for further detailed work. A station spacing of 750 - 1000 m was chosen as a reasonable compromise between these objectives and also allow the work to be completed in a reasonable time. However access and manpower problems have meant a five year project.

Base station for the survey is at St Helens Airport (BMR reference station 6491.9136; 9.803 023 5 m/s^2). A tie station network consisting of sixteen points was established and corrected for loop errors by the methods of Gibson (1941) and Green (1961). All other observations have been tied to this network and corrected for drift. No specific tidal correction has been included. The accuracy of the tie station network is considered better than 0.2 $\mu m/s^2$ and of all other stations 0.3 - 0.5 $\mu m/s^2$. Details of the tie stations are provided in Appendix 1.

Stations have been sited, where possible on State Permanent Marks or Lands Department spot heights. About one half of the stations are based in this way. Elevations at other stations are based on high water mark or microbarometer ties to spot heights. Where loop times are short, spot control is available and check readings can be made during the traverse; an accuracy of 1.5 - 2 m is possible. Thus the elevation of stations is accurate, in many instances, to one metre or better than 2 m in nearly every case. The accuracy of the Bouguer anomaly is thus better than 3 - 4 $\mu m/s^2$ for more than 95% of the coverage.

All stations have been located within 50 - 100 m and several stations have been located to within 25 - 50 m. The maximum error in the Bouguer anomaly is about 0.5 $\mu m/s^2$.

All stations have been terrain corrected to a radius of 19 km using the method of Hammer (1939). The accuracy of the correction made is estimated at 5% for most stations, although an error of 10% is possible at some positions where the station was not installed by the author. The resultant error is 0.2 - 1.0 $\mu m/s^2$ at most stations.

The RMS accuracy of the observations is thus less than 4 $\mu m/s^2$ and the Bouguer anomaly may be plotted with a contour interval of 10 $\mu m/s^2$.

Due to the need to mimimise errors due to elevation uncertainties and the lack of access routes until late in the survey, most stations were established by cross country traverses on foot and associated with Lands Department survey points. The station numbering and distribution is provided in Figure 2.

Acknowledgement is due to G. Benn, D. Wyatt, T. Andrews, P. Lennox, G. Hodge, R. Munro, J. Knight, E. Johnson and J. Richardson for their contribution as observers and assistants during this survey.

BOUGUER ANOMALIES

Specification and presentation

The results of the survey have been expressed in terms of the extended Bouguer anomaly with an assumed density value of 2.67 t/m^3. Contoured reduced values are plotted in Figure 3 with a contour interval of 10 µm/s^2.

Regional separation

The Bouguer anomalies plotted in Figure 3 show a general increase in the gravity field from west to east, which reflects a general crustal thinning toward the continental shelf. The term regional may be applied to that component of the field derived from the core, mantle and lower crust. Alternatively, given the wide spectral range of the anomalies, it could be applied so as to include all but the uppermost part of the crust.

Previous gravity surveys (Leaman, 1972; Leaman *et al.* 1973; Leaman and Symonds, 1975) have examined residuals after extracting a coarse regional and this has proven quite adequate. However, in view of the considerable economic importance of this survey, two regionals have been calculated for this survey; these are presented in Figures 4 and 5. In each case, an averaging procedure has been adopted using a grid. The regional shown in Figure 4 is based on a maximum grid size of 4 km units whereas that in Figure 5 incorporates the 4 km average but moved four-fold yielding a 16 km grid unit. This process forms a crude but effective filter as a comparison of Figures 4 and 5 shows (see also St John, 1967; Leaman, 1977). A uniform distribution of points is desirable for the most effective filtering and two other problems may be noted; selection of grid size and edge effects. The BMR regional survey coverage (Zadoroznyj, 1975) offers some control of the latter and the regionals presented here cover most of the surveyed area as a result.

The two regional maps are presented pending final interpretation, although experience has shown that the 16 x 16 grid is adequate, provided the residual anomalies are interpreted to depths of the order of 5 km. In this case, due to extreme basement variations, interpretation using the 4 x 4 grid may prove more reliable, especially where interpretations relate to those features. However, it is considered that the 16 x 16 grid provides the best starting point for interpretation.

Description of residual anomalies

Figure 6 presents the residual Bouguer anomaly as obtained from the total field (fig. 3) by removal of the regional contribution (fig. 5). Several features may be described.

Positive anomalies;

a) Significant area anomalies of +40 to +60 µm/s^2 occur near Cranbrook [EP885487], King Bay [EP935420], Moulting Lagoon [EP970470], in the area bounded by Mt Henry [EP825675] - Lynes Sugarloaf [EP945597], Apsley River and south-west of Fingal Rivulet. In each case the anomaly covers an area of 60 - 100 km^2.

b) Point anomalies of +40 to +60 µm/s^2 occur south of St Marys [EP987960], north of Mt Puzzler [EP900780] and north-west of Seymour [FP060778].

c) Lesser anomalies match the dolerite cap on the divide between the Apsley and Douglas Rivers, smaller dolerite bodies occur near Bicheno and also occur randomly across the exposed and nearly exposed outcrops of the Mathinna Beds near St Marys and north-west of Fingal.

Negative anomalies;

a) Several major troughs of negative anomaly have been noted in excess of -50 μm/s^2. Two transect the line of Nine Mile Beach [FP000390, EP380892], another correlates closely with Nicholas Range [EQ920005], one is near Gray [FP015912] and a final example occurs west of the Douglas River.

b) Two major areal anomalies with peak values in excess of -60 μm/s^2 have been observed; one around Rossarden [FP620865] and the other north of Apslawn [EP980537].

c) Moderate area anomalies of up to -40 μm/s^2 have been noted north of Mt Henry, on Fingal Tier and north-west of Merrywood [EP795740].

d) Lesser anomalies occur randomly across the Mathinna Beds, coastal granites and Fingal Tier.

INTERPRETATION

A qualitative interpretation is offered below which discusses the origin and nature of the features described in the previous section. As such, it is intended to provide immediate guidelines for drilling and exploration projects and to form the initial model for quantitative interpretation.

As quantitative interpretation of the complex interplay of structural features depends on a time-consuming three dimensional analysis and, if possible, additional control, it will be detailed in a separate report when available. It is likely that two or three quantitative iterations will be required before the interpretation becomes highly specific and reliable. Completion of a ten hole (complete section to basement) programme in addition to regular drilling targets and availability of usable, reliable reflection soundings will lead to improved iterations. Neither of the controlling methods can provide the rapid area wide assessment of the gravity method.

The present interpretation is general and the boundaries marked in Figure 7 are not intended to be precisely located. The necessary definition of the limits of feeders, sheet thickenings or other structures is wholly dependant on quantitative modelling and, in some cases, additional detailed surveys. The present interpretation is therefore provisional.

A collation of all deep drilling results is provided in Appendix 2.

REGIONAL INTERPRETATION

Two principal features are apparent in each regional separation (figs. 4, 5). A significant north-south gradient is apparent across the entire area with an abrupt sharpening in the region of Royal George [EP740694] - Rossarden. The bulk of this gradient must reflect lower crustal features and indicates a gradient of about 1 in 5 for the Moho. The increase in gradient noted above occurs near the surface exposure of the Scottsdale Batholith as extended into this area and presumably reflects an eastward dipping edge with a base level in excess of -8 km.

The second feature is the large closed negative anomaly west of Bicheno. Although offset from all known granite alignments, this anomaly indicates the presence of a discrete but relatively small and deeply rooted granitic mass. A very shallow depth is suggested for the roof of the body (compare figs 4, 5). Holes 1 and 3 at Llandaff (Hills *et al.*, 1922; see Appendix 2) confirm this interpretation, even though offset from the centre of the anomaly. No sedimentary feature could produce an equivalent anomaly and it is therefore likely that the entire anomaly has a granite source.

RESIDUAL INTERPRETATION

The following density values have been assumed in the discussion below: (Fresh, saturated material).

Tertiary sediments	: 1.92 t/m^3	
Jurassic dolerite	: 2.90 t/m^3	(av)
Triassic sequence	: 2.47 t/m^3	(av max)
Permian sequence	: 2.54 t/m^3	
Devonian granite/adamellite	: 2.62 t/m^3	
Ordovician-Devonian 'Mathinna Beds'	: 2.57 - 2.81 t/m^3	

The above values are based on the published results of Leaman (1972), Leaman *et al.* (1973) and Leaman and Symonds (1975) and no new determinations have been made. Examination of new cores of the Permian sequence suggests that the estimated value of 2.54 t/m^3 must be confirmed prior to quantitative interpretation. The estimates given for the Tertiary sediments, Jurassic dolerite and Devonian granitic suites have been discussed in the above references and are likely to be reliable. The estimate for the Triassic sequence is regarded as a maximum value as it excludes the effect of coal and quartzose rocks and presumes a 1:1 ratio of arenite:lutite. The estimate for the Permian sequence is based on a 1:1:1 ratio of siltstone/mudstone:limestone:grit/conglomerate and in view of DDH4 (Glen Albyn, fig. 9) also is likely to be a maximum value. The values quoted for the Mathinna Beds represent the limits for unmetamorphosed and metamorphosed materials, but there is a range of values depending on actual composition and grain-size.

Since the density value used for the Bouguer reduction was 2.67 t/m^3, the anomalies to be expected in areas of exposed basement rocks should be very nearly zero. In general, granites should be slightly negative and the Mathinna Beds either slightly negative or positive. The exact magnitude of the anomaly depends on the reliability of the regional separation and the contribution to the anomaly of mass discrepancies above sea level but excluded from the Bouguer reduction. The type of anomaly pattern expected is observed north of Coles Bay, south of Falmouth and in the Fingal-Mangana region. Larger (>20 $\mu m/s^2$) anomalies east and south of Rossarden in the belt of Mathinna Beds between granite exposures suggests denser metamorphosed materials near the surface. The substantial negative anomaly (-60 $\mu m/s^2$) associated with the Rossarden granite is considered to be due to exclusions in the Bouguer reduction, slight inadequacies in regional separation, local contrasts and the presence of a deeply rooted intrusive. Similar smaller scale effects may be noted for the adamellite east of Gray and the granite at Cape Lodi [FP093578] south of Bicheno.

In general, large negative anomalies should only be related to deeply-rooted granitic bodies or thick accumulations of Permo-Triassic rocks. A 300 m succession of coal measures overlying a 150 m succession of Permian rocks would contribute at least -40 $\mu m/s^2$ to the local Bouguer anomaly. 150 m of Tertiary sediments could produce a similar anomaly. Since Tertiary materials are relatively rare in the area under discussion most large negative anomalies are related to granite-coal measures combinations.

A typical dolerite sheet, thickness 300 - 350 m, can contribute about 35 $\mu m/s^2$ to the local anomaly. Thus sedimentary successions capped, or intruded by, a thick sheet yield a variable but near zero resultant anomaly. A substantial (>20 - 30 $\mu m/s^2$) positive anomaly in an area containing dolerite and coal measures implies a predominance of dolerite content. Very large positive anomalies (40 - 60 $\mu m/s^2$) imply that much dolerite is present, either in the form of multiple sheets, large dykes or feeders. The precise character of the anomalies will indicate which.

The area has been subdivided for ease of discussion (fig. 8). Each zone is discussed individually and all anomalies are identified by grid co-ordinates.

Mangana-St Marys

This zone (fig. 8) covers the low-lying country in the valleys of the South Esk and Break O' Day Rivers, includes the Nicholas Range, Mt Elephant [FP038916], St Patricks Head [FP968029] and the granitic coastal intrusives south of Falmouth [FQ060040] and east of Gray. Lower Palaeozoic Mathinna Beds or Devonian intrusives crop out over a large portion of the area and a relatively thin veneer (∿100 m) of Permian rocks is present along the Break O' Day valley. Only on the Nicholas Range, Mt Elephant and St Patricks Head are Triassic rocks and definitely *in situ* Jurassic dolerite to be found. Most dolerite exposures in the valley appear to be talus remnants.

The gravity field eastward from Mangana generally reflects this simple geological pattern. There are broad swells of anomaly ranging from -20 to +20 $\mu m/s^2$ and most lie in the range 0 to +20 $\mu m/s^2$. This suggests that the density used in the Bouguer correction (2.67 t/m^3) is lower than the average bulk density for the Mathinna Beds. A density of 2.8 t/m^3 overall might be more realistic if all the above geoid discrepancy is derived from inadequate correction. This is unlikely to be the case as some anomaly will be contributed by sub-geoid materials. The overall density of the Mathinna Beds is probably a little more than 2.7 t/m^3 and hence 2.8 t/m^3 would be a near maximum value. The presence of Permian rocks in the Fingal-St Marys area, which would include a negative Bouguer contribution, reinforces this conclusion. The discussion presumes no other positively contributing features (see below).

A broad negative anomaly may be correlated with the exposure of granitic rocks south of Falmouth and north of Chain of Lagoons [FP067862]. Some of the anomaly noted around Mt Elephant may reflect a contribution from the Permian and Triassic cover, although both are relatively thin. Some strong gradients have been observed in this region and it would appear that considerable variation of content exists within this granitic block. The pattern of anomalies is suggestive of a substantial sheet with localised sources [FP080920, FP030970] which thins eastward or dips abruptly westward. The small positive anomaly north-west of Wardlaws Point [FP058980] implies either little granite or a much denser rock, perhaps comparable to a diorite or granodiorite. Groves *et al.* (1977) have recognised no such distinction, but more recent mapping as published on the 1:500 000 and 1:250 000 series does indicate that granodiorite might underlie this region and a small inclusion is indicated at FP080910. Generally southerly dips have been observed for the margin of the body. The disposition of the positive values suggests an overall dip to the south-west (McNeil, 1965). If the contribution of Permian and Triassic rocks is removed from the broad anomaly in the region north of Mt Elephant [FP050940] (estimated at -10 $\mu m/s^2$), then a maximum sheet thickness of about 1100 m is implied (assuming a density of 2.62 t/m^3). No density determinations have been made and it is possible that the St Marys biotite-hypersthene-adamellite porphyry is slightly denser than the

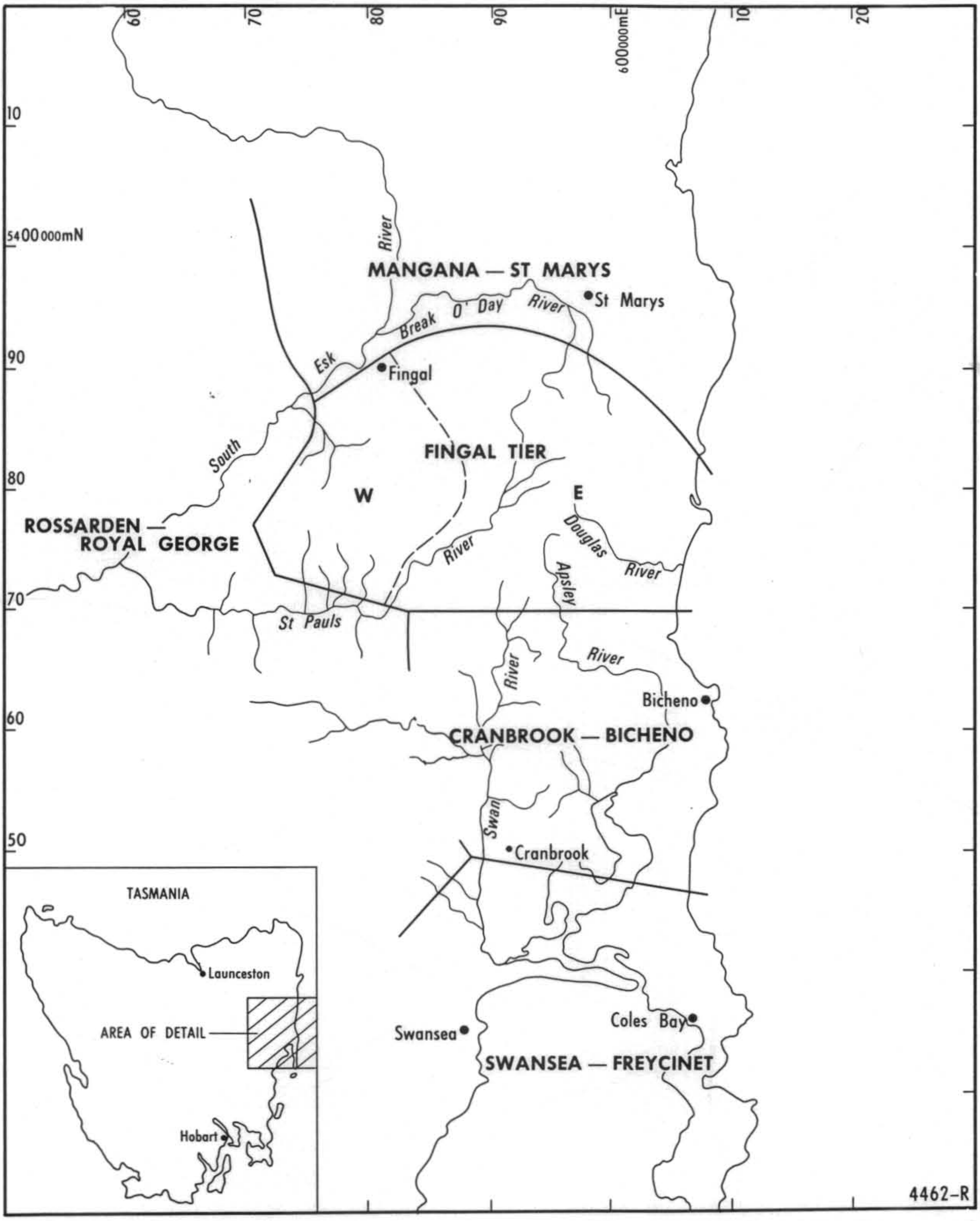

Figure 8. *Location of areas, residual anomaly interpretation.*

5 cm

normal adamellite. At 2.63 t/m^3 the thickness would be 1300 - 1400 m.

The broad area of negative anomaly is terminated south-east of Gray by further gentle positive anomalies which may be correlated with rocks of the "Piccaninny Point Pluton" (Groves *et al.*, 1977). Rocks of this pluton are denser, including granodiorites and the pattern is similar to that observed elsewhere in north-east Tasmania (Leaman and Symonds, 1975). No great thickness of 'pluton' may be assumed from the anomaly values and the body is probably sheet-like. Similar anomaly values occur near Gray and west to Mangana as discussed previously. It is possible that a sheet of granodiorite is universal and that the positive anomalies reflect it. Detailed examination of the relationships between the St Marys porphyry to the north of Chain of Lagoons and the western contact of the granodiorite at Piccaninny Point may resolve the structure and distribution of this material.

The most significant anomaly in the zone (-60 to -80 $\mu m/s^2$) correlates closely with the coal bearing sequence, as mapped, around the Nicholas Range. The anomaly is always confined to areas of Permian or Triassic cover, but is much too large to be readily explained by direct relationships. Summation of the maximum possible thicknesses at Mt Nicholas (150 m for Permian, 400 m for Triassic) could only account for - 44 $\mu m/s^2$. An abnormal thickness of Permian rocks cannot explain the discrepancy since an additional 150 m would contribute less than 7 $\mu m/s^2$. Little of the anomaly is likely to be derived from structures or vaiations within the Mathinna Beds since the broad trends are slightly positive rather than negative. The substantial gradients related to this anomaly imply a source at shallow depth. A small acid pluton, possibly exposed at the Permian unconformity could explain this feature, either in total or in part as required, by the established discrepancy of 20 to 40 $\mu m/s^2$. No deep drilling to basement has ever been undertaken in the Nicholas region and this inference cannot be substantiated. The Killymoon borehole 1.5 km south-east of the edge of the anomaly and which lies on the 0 $\mu m/s^2$ contour encountered Mathinna Beds at 153 m. The demonstration of a small intrusive or cupola in this region may have economic and mineralogical ramifications and the structure should be proven.

Rossarden-Royal George

This zone (fig. 8) covers the western margin of the area. This area is dominated by major exposures of the southern extension of the Scottsdale Batholith, with granite cropping out around Avoca, Royal George and Rossarden. The boundaries of the zone are drawn so as to specifically exclude the western end of Fingal Tier at Mt Foster [EP737792].

Negative anomalies of up to -70 $\mu m/s^2$ occur south of Rossarden and north of Royal George. In each area, large portions of the anomaly exceed -50 $\mu m/s^2$ and each anomaly has strong marginal gradients. Deeply rooted plutons are implied in each case. The belt of positive anomaly extending from Avoca along the South Esk Valley to Ormley [EP690805] and then north of Ormley reflects a substantial screen of Mathinna Beds. The two bodies probably connect at a depth of more than 2 km. Gradients associated with the Rossarden intrusive can be closely correlated with the known geology, whereas those associated with Royal George and Avoca intrusions have more complex relationships.

Typical anomaly values near Royal George are -20 to -40 $\mu m/s^2$. Such values are recorded on granite exposures at low elevation in the valley of the St Pauls River. These values are increased and then terminated along a line from Mt Henry to Mt Foster. The actual termination is irregular with abrupt and irregular gradients, but there is good correlation with the dolerite-capped south-west face of Fingal Tier. Permian and Triassic rocks underlie the dolerite cap and contribute to the increased negative anomalies on the slopes around St Pauls Dome [EP692755] and overlooking Royal George. The strong gradients are related to the presence of a thick dolerite capping and comparable gradients are not observed north of St Pauls Dome, where a normal granite-Mathinna Beds contact is present without covering complication.

With the exception of an area south-west of Tower Hill [EQ700010], the anomaly pattern north-east of Ormley is very similar to that east of Mangana. However the cells of positive anomaly are slightly smaller and contain some stronger gradients. The sizeable negative anomaly south of Tower Hill (up to -50 $\mu m/s^2$) presumably reflects a sizeable cupola projection at moderate depth.

No part of the anomaly pattern recorded for the valley of the South Esk River from Avoca to Mathinna or for the valley of the Break O' Day River from Fingal to St Marys provides any firm support for concepts of structural control for these valleys. Only one tenuous possibility may be noted. Along a line from Avoca to Falmouth [EP600740 - FQ060040], two comparable anomaly offsets may be cited. Firstly, the eastern marginal gradient for the Rossarden and Royal George intrusions if offset about 7 km to the south and east and the Mt Nicholas anomaly and St Marys porphyry intrusion are offset about 10 km south and east. The margin of the latter intrusion is difficult to place due to faulting and the anomalies are not definitive, but the possibility of dextral displacement remains. No other features can be included in the correlation due to the substantial geology-anomaly differences north and south of the alignment indicated. In addition to the dextral notion suggested above, it is also possible that the southern side is downthrown, accounting for the more impressive expression of the granite around Rossarden, as contrasted with that at Royal George, and the sharpness of the Nicholas Range anomaly when contrasted with that of the coastal intrusives.

Fingal Tier

The Fingal Tier zone (fig. 8) is large and includes all the elevated plateau region south of Fingal and St Marys. Dolerite dominates it. For this discussion it has been divided into two parts, one north-east of the St Pauls River but west of Fingal Rivulet, the second east of Fingal Rivulet (fig. 8). The zone has been terminated on an east-west line approximately coinciding with grid line 5370000 mN due to the presence of significant east-west anomalies. Such a line also marks a geomorphic change from high plateau to a series of major valley dissections and lower elevations. The control strip at Seymour has been included to allow integration of discussion.

Western region. As mentioned in the previous section, severe gradients are associated with the south-west face of Fingal Tier above Royal George. The presence of a substantial capping (>200 m) of dolerite is largely responsible. Gradients on the north-west face from Mt Foster [EP737792] to Hogg Hill [EP787850] are less severe, due to the absence of contrasting granite, but a strong dolerite correlation persists. In both cases, the positive contribution due to a normal sheet thickness is exceeded. A normal sheet of 300 - 350 m thickness contributes a Bouguer anomaly of about 30 $\mu m/s^2$ whereas the average anomaly on the western part of Fingal Tier exceeds 40 $\mu m/s^2$. A peak of 65 $\mu m/s^2$ has been observed in three places [EP770810, EP795855, EP805840]. The first locality is not well defined due to irregular station coverage, but all anomalies fall on the dolerite cap. Feeders may be directly presumed as sources for such large, localised anomalies, since there is no evidence near the Tier escarpments for large multiple cross-cutting sheets, which could result in unusual dolerite thicknesses. The second and third localities listed above are associated with the highest portion of the western plateau, although there is no indication of an abnormal sheet thickness from surface mapping.

A broad area of anomaly, exceeding +40 μm/s^2, extends southward towards the southern face of Fingal Tier. Such values over a large area also suggest a massive capping sheet. Drilling north of Merrywood (Department of Mines hole 18) confirmed a substantial increase in sheet thickness under the Tier from predictions made at the escarpment. Much of the coal-bearing section has been removed by dilation. The belt of positive anomalies follow the exposure of a large dolerite dyke to the floor of the valley of the St Pauls River at EP860750. The correlation confirms the proposition made further north that the positive anomalies directly relate to the dolerite. In the latter case, the dyke observed would appear to be either a finger from a large feeder, a part of a feeder or an offshoot from a group of feeders. The broad anomalous zone thus represents the sum of effects of several feeding dykes and a very thick sheet. The whole area could not be recommended as worthy of coal investigation.

It might be argued that a large part, up to 30 μm/s^2, of the positive anomalies could be related to a metamorphosed screen of Mathinna Beds along the margin of the Royal George granite and under the western part of Fingal Tier. However, while some screens do yield such values, all produce small patchy anomalies which do not approach the area involved on Fingal Tier West. Further, the values north of the escarpment are less than 10 μm/s^2 and when the obvious overall anomaly-dolerite correlation is considered, any contribution by the underlying rocks must be minimal. The presence of any Permian or Triassic rocks beneath any part of the cap strongly reinforces this conclusion, since as little as 100 m of Permian and 50 m of Triassic rocks contribute -10 μm/s^2. Any extension of the granite pluton to the east would also disguise a much increased dolerite thickness.

Only one negative anomaly has been recorded on the western part of Fingal Tier [EP825840]. This anomaly was confirmed by additional surveys and then drilled (Department of Mines hole 29). On the basis of the then partially complete survey, it was believed that values of 60 μm/s^2 less than the surrounding region represented a section with negligible dolerite cap. This proved not to be the case with one important qualification. The hole was drilled within the anomaly but on the eastern margin where gradients are relatively gentle whereas the preferred site was central to the anomaly. It is quite possible that the hole encountered a transgressive sheet dipping eastward. Such a structure is wholly compatible with the massive column of dolerite dissected by Fingal Rivulet immediately to the east and the gently rising eastward gradient. Although the station coverage in the region of Fingal Rivulet is relatively poor, values in excess of +40 μm/s^2 have been observed and both geological observations and gravity results imply at least, the presence of a small feeder. Whether or not the above interpretation is correct, the implication of massive amounts of dolerite west of Fingal Rivulet is certainly justified if a hole drilled on the 0 μm/s^2 contour revealed more than 300 m of dolerite.

Another smaller anomaly relates to the most obvious land mark in the Fingal area, the Vertical Acre [EP823866], a massive dolerite exposure. An east-west anomaly trend extends from the centre at EP795855 toward The Vertical Acre, diminishing in intensity toward it. A dyke is clearly indicated for part of the distance, but the anomaly at the landmark is compatible with about 200 - 250 m of dolerite sheet. However, the anomaly rolls over in this region and if the results of hole 29 were to be directly accepted, a dyke would certainly be implied as well. However as there is still some doubt about the exact meaning of observations at hole 29 this cannot be assumed, as a similar roll-over of anomaly could be produced by sheet(s) transgressing upward from the north-west, east or south-west, where centres most certainly exist. Comparison of results from holes 28 and 29 drilled on either side of this anomaly indicates no significant displacement or dilation. Thus any dyke present must be a separate feature at this level of intrusion and embody no uplift component.

The marked gradients associated with all anomalies within a 4 km radius of Fingal Rivulet certainly suggest that features within 500 m of the surface have produced these anomalies. Yet, if one considers the anomaly at EP825840 which has a value of -12 $\mu m/s^2$ and assumes a 200 m cap of dolerite with 200 m of Triassic and 100 m of Permian rocks, the anomaly should be an absolute maximum of -3 $\mu m/s^2$ but more probably about +8 $\mu m/s^2$, allowing for three dimensionality of the structure. A discrepancy of -10 to -20 $\mu m/s^2$ is implied. If there is 100 m less capping the discrepancy reduces to about -5 to -10 $\mu m/s^2$. It was on this basis that the region was drilled and a surprising 346 m of dolerite revealed. The core log notes an inclined basal contact which is compatible with the conclusion quoted earlier. However it is possible that values in the Fingal area are depressed by a source of negatively attracting material in the basement, although there is little indication of this north of the escarpment.

Eastern region. A significant negative anomaly correlates with the region currently being worked at the Duncan mine (-60 $\mu m/s^2$). Such an anomaly is difficult to account for given the known materials. The anomaly correlates closely with the block of Triassic rocks enclosed by a feeder along Fingal Rivulet (previous section), a small dyke wall to the north, a major sheet transgression to the south and the main body of the capping sheet to the east. On the present coverage, the anomaly is centred at EP850890 within this block. Strong gradients to the west, north and north-east suggest that this block is largely confined by dolerite. A major problem relates to the magnitude of the anomaly. If a section comprising about 200 m of Triassic coal measures and 100 m of Permian rocks is assumed, the absolute value of the deficiency should be around -20 to -25 $\mu m/s^2$ allowing for problems of equidimensionality and coal removal. The problems of a lesser discrepancy to the south-west was discussed in the previous section and no firm solution can be offered at present. The maximum known thickness of coal measures is about 350 m and the maximum anomaly should therefore not exceed -35 to -4 $\mu m/s^2$ (see fig. 10).

The negative anomaly described above is closed abruptly to the west, north and east. To the west, a prong of positive anomaly extends along Fingal Rivulet where a significant mass of dolerite is exposed (see previous section). The sheet on the end of the eastern Tier around the drilled grid appears to have been derived from this source, since transgressions from the west may be observed near EP845860. Such an eastward transgression appears to dominate the entire central portion of the Tier and a general north-south gradient crosses the Tier south of this point. Anomaly values reduce eastward and a broad zone of negative anomaly occupies much of the Tier (*e.g.* between EP860820 and EP920880).

To the north, a thin dyke, probably occupying a fault, terminates the coal measures, uplifts the Permian rocks and forms the boundary to the anomaly. To the east, the dyke ends in a large boss-like intrusion [EP860900]. A 25 $\mu m/s^2$ anomaly is assocaited with this feature but is poorly defined due to limited station coverage. Faulting does not appear to account for the relationships observed in this area and the dolerite body gives the impression of being a moderate sized pipe. A much reduced positive anomaly may be observed on the Tier proper and there is probably no connection between the two features. On the Tier, values of -5 to +5 $\mu m/s^2$ are associated with a substantial thickening in the capping sheet; holes 23, 24, 17 and 31 lie within this zone and on its axis. The cap, as observed in these holes, is 60 to 140 m thicker than noted in surrounding holes. This is clearly shown in Figure 10 where more detail is presented. It has not been positively established that only a substantial sheet thickening is present in this part of Fingal Tier. Preliminary calculation indicates that the anomalies noted are also consistent with a model containing a thickened sheet, as specified by existing drilling, and a dyke up to 150 m wide. Such a model has severe mining ramifications (see fig. 10).

The anomalies noted in the region of holes 23/24 are about 0 to -5 $\mu m/s^2$. The section, as noted in these holes, could be expected to produce about -5 $\mu m/s^2$. This is an acceptable agreement for hole 23. The section at hole 24 should yield about +5 $\mu m/s^2$. The anomaly seems slightly displaced but this is probably due to problems of scale. The large areas of negative anomaly to the north, east and south clearly reflect areas in which the dolerite cap is thinner. Estimates of thickness of cap for each zone are listed below and are for the central point in each area. The estimates apply, with the proviso that levels relate to the higher elevations in the region and sheet thickness will be reduced appropriately in depressions and incisions (main discussion refer fig. 6; for detail see fig. 10).

AMG reference	*Anomaly* ($\mu m/s^2$)	*Thickness* (m)
EP900890	-40	∿150
EP915860	-35	∿220
EP875840	-30	∿250
EP895815	-41	∿150
EP955830	-25	∿150

The above estimates assume some multiple source interference and no basement contributions to the residual anomalies. The estimates are variable and the areas may need improved definition, but the cap thickness for much of these areas is likely to be as much as 100 m thinner than the average drilled around the present grid at about EP875870.

Two large areas of significant positive anomaly are included in this generally negative area, which should be contrasted with the substantial positive area west of Fingal Rivulet at the same elevation. The two parts of Fingal Tier are structurally distinctive. The two positive anomalies are at EP960880 and EP925820. Both are closed and both can be related to a major dolerite column. The anomaly centred at EP960880 coincides with a large dolerite body which is coarse-grained (exceptional in this area) and which is associated with a number of faces plunging to a low elevation. A plug is suggested by its appearance at the escarpment south of St Marys. The substantial anomaly of +45 $\mu m/s^2$ confirms this inference. A feeder and associated thick sheet is implied in this area. Drilling inside the 0 $\mu m/s^2$ contour is likely to prove a cap thickness in excess of 300 m. Drilling inside the +25 to +30 $\mu m/s^2$ contour is not recommended. Similar comments apply to the anomaly centred at EP925820. In this case the anomaly follows a spine of dolerite which plunges into the gorge of the St Pauls River. A further feeder, dyke and thick sheet are implied. The substantial gradients associated with each anomaly suggest that the basal surface of the sheets about each centre and any associated dykes has a significant dip.

A smaller centre may be reflected in the increased anomaly at EP980845, although a localised sheet thickening may account for the +10 $\mu m/s^2$ increment. Many anomalies on the Fingal Tier region suggest a relatively irregular pattern of sheet intrusion with minimal concordance. Many sheet troughs appear to be present, spanning upward and outward from the centres with the result that the basal surface of the sheet is quite wavy. Amplitude variations of 150 m are to be anticipated.

With the exception of some relatively small areas, the residual anomalies are negative east of the two principal centres. Around Mount St John [EP890710; EP900765], Gray [EP990890] and the Douglas River [EP980720] values exceed -50 $\mu m/s^2$. The major anomaly near Gray may be correlated with exposed coal measures sequences and the anomaly is reduced southward due to the influence of capping dolerite and thinner successions resulting from faulting and dilation differences. The anomalies of around -5 to -20 $\mu m/s^2$ in the headwaters of the Douglas River south of Thompsons Marshes suggest little more than 150 m of cap. At the local base level in the marsh areas this estimate can be reduced by the average relief (60 - 120 m). The local positive anomaly (+5 $\mu m/s^2$) at FP000815 suggests a localised thickening of the sheet by up to 100 m.

The negative anomaly at Gray is very similar to that observed south-east of Fingal near the Duncan Mine. A thick Triassic sequence may be presumed, although some of the anomaly may be the result of a general local negative trend extending to the north-west.

The substantial anomalies occurring in an arc about Mount St John [EP910737] may be correlated with exposed coal measures successions to the north and thick talus deposits, presumably concealing coal measures to the south. The belt of negative anomaly extends east-west from Lochaber [EP837706] to near the coast and the mouth of the Denison Rivulet. Positive anomalies of less than +30 $\mu m/s^2$ are associated with the divide between the Douglas-Apsley and St Pauls Rivers. The average anomaly is about +10 $\mu m/s^2$ which is consistent with a general cap thickness of little more than 200 m. Local variations are indicated (*e.g.* at EP930730, EP945965, EP970795) and the first two examples may be the expression of small centres. Alternatively, a sheet 300 - 350 m thick covering the headwaters of the Apsley River is suggested. However marked transgressions to the east and west would also be implied and a feeder would be a natural corollary to such a structure in any event. The base of such a sheet appears to be exposed near EP955728.

Negative anomalies around the valley of the Douglas River indicate that the sheet exposed to the west at EP970770 is thin, but thickens markedly westward. The sheet around FP010780 is generally a patchy capping, but which thickens to the north and north-east where small and large sources are respectively located. The values of +22 $\mu m/s^2$ at FP010760 related to the southern end of the capping sheet north of the Douglas River probably reflect,in view of surrounding negative values associated with Triassic rocks, a small feeder. The dolerite spines of Nichols Cap to the immediate south are at a lower elevation and the presence of dykes exposed in the river bed nearby support this suggestion. The sheet to the south at EP990730 is generally less than 150 - 200 m thick, until south of grid line 5 370 000 mN where substantial thickening occurs.

Positive anomalies at FP045820, FP040800 and FP035720 in the coastal hills probably represent a string of feeders. The coverage around the first two sites is insufficient to determine whether there is any continuity. In each case, massive dolerite bodies are to be found near sea level with marked discordant margins to the west.

Anomalies along the coastal plain near Seymour are small (+10 to +20 $\mu m/s^2$) and positive. They are consistent with general background basement anomalies when Mathinna Beds or granodiorite are predominant.

The anomalies across Fingal Tier, while providing little indication of major structural alignment compatible with currently known geology, do indicate three main trends. All features show trends or margins aligned north-west, north-east or east-west.

Cranbrook-Bicheno

The anomalies in this zone can be divided into three types. The first is a broad belt of positive anomaly extending from EP955680 to EP860560 and FP000480 and which encloses the second, a large negative anomaly centred on Lynes Sugarloaf [EP960590]. The third type consists of small, paired anomalies peripheral to the second along the coast.

Dolerite is the ubiquitously exposed material in the belt of positive anomaly. It occurs at all elevations and few windows in which other rocks are exposed are known. The average anomaly value over this entire region is about +35 $\mu m/s^2$, with many local peaks of +55 $\mu m/s^2$. There is little correlation between magnitude of anomaly and elevation and it is likely that a number of feeders are represented. For example, some increases in anomaly are associated with valley floors at EP955680 and EP895605, when a reduction in elevation should produce reductions in the Bouguer anomaly with the density used (2.67 t/m^3 *cf* 2.90 t/m^3 necessary) if the intrusions were slab like. Feeders are definitely indicated at the example sites. Elsewhere, a very thick sheet (or sheets) is implied with other probable feeder sites at EP875680, EP860560, EP885520, FP000480 and EP860490.

The large negative anomaly which peaks at -100 $\mu m/s^2$ averages -50 $\mu m/s^2$ in the residual Bouguer anomaly. This anomaly zone is clearly visible in both regional maps (figs. 4, 5) and hence the source is a major basement feature not wholly compensated in the residual separation. A sizeable granite stock is the only likely source for such an anomaly. The strong gradients associated with the western and southern margins are partly due to the contrast of granite-dolerite columns in depth and partly to structures which are near surface. The pinnacles of negative anomaly about the western margin imply local cupolas. The dolerite capping on Lynes Sugarloaf does not modify the pattern in any significant way and it is possible that the wafer of intruded Triassic and Permian materials is very thin west of grid line 597000 mE, This is revealed in the 1888 drilling at Llandaff (see Appendix 2). In holes L1 and L3 no Permian rocks can be deduced in the log and the roof of the granite rises to -100 m. On the northern side of Lynes Sugarloaf hole 992/637 encountered granite at -43 m. The Permian succession in this area is extremely variable in content and thickness but a thick limestone unit is normally present.

Two groups of small anomalies may be noted along the coast, one at Bicheno and one along the Denison Rivulet valley. At Bicheno, a small discrete negative anomaly (-40 $\mu m/s^2$) may be correlated with the ridge of outcropping granite. Adjacent, to the west, is a small positive anomaly (+20 $\mu m/s^2$) which may be correlated with exposed dolerite. The correlation is limited, however, since to the north and south, positive contributions due to the presence of dolerite are overwhelmed by the large negative background. A small feeder is thus implied at FP060615.

The positive anomalies along the southern side of the Denison valley are a continuation of the major features described above. They enclose a small pocket of coal measures and produce an anomaly differential of about 70 $\mu m/s^2$. Sizeable dykes are considered to be present in this region.

It appears that the granite stock centred beneath Lynes Sugarloaf has dominated sites for dolerite emplacement and is ringed by feeders.

Swansea-Freycinet

This zone contains some extensions of the positive anomalies described in the previous zone and includes two large anomalies at EP930435 and EP840400. The first, of +72 $\mu m/s^2$, clearly represents a massive feeder in The Grange Hills north-east of Swansea and the second either a small centre or thick sheet west of Swansea.

Two major negative anomalies run out to the coast along Nine Mile Beach. The largest, of some -110 $\mu m/s^2$, is rather box like and situated toward the eastern end of the beach. The gradients east of this feature are smoothed by the presence of negatively attracting granitic materials. The anomaly at this site and of this scale can only be due to a Tertiary sequence and some Tertiary materials are present around Pelican Island and north of Swansea. Block faulting is suggested. The sediment thickness is likely to be at least 350 - 400 m. A similar but smaller structure is present at the western end of the beach and correlates with the large plain north of Swansea. The peak anomaly in this region is about -65 $\mu m/s^2$ and about 200 m of sediment is implied. Surface expression of Tertiary materials is terminated near the -5 $\mu m/s^2$ contour and the small offset negative anomaly along the Swan River from The Grange to Cranbrook is presumably due to a section of Triassic rocks with minimal dolerite intrusions. The maximum anomaly in this region is about -12 $\mu m/s^2$ but is rapidly closed to the north.

Relatively low amplitude anomalies may be observed on Freycinet Peninsula associated with the granite, Mathinna Beds and basal Permian rocks. The pattern is comparable with that observed on granitic basement elsewhere, *e.g.* Zone 1. The scale and form of the structures north of Coles Bay cannot be estimated qualitatively. There is no obvious expression of any anomaly contribution from the major structure which juxtaposes dolerite and granite along the western side of the peninsula.

CONCLUSIONS

A gravity survey of central Eastern Tasmania has clearly revealed the location of more than a score of dolerite feeders, thick dolerite sheets, several granite plugs and identified several sectional problems worthy of further work. Combination of observations on dolerite feeders and sheets with granite highs severely limits the areas liable to contain thick sections of coal bearing rocks. In general, the prime target areas lie in the eastern parts of Fingal Tier and Lynes Sugarloaf and the southern part of Fingal Tier. No other parts of the area covered by this survey, with the sole exception of the Nicholas Range, can be expected to contain significant reserves of coal. The prime target areas may be specified as

i) South-east of the Duncan mine, Fingal
ii) South of St Marys, west of Dalmayne
iii) Lochaber to the Douglas River
iv) East Lynes Sugarloaf to Llandaff.

Most of the first area lies within State Reserve 1964/167, which also includes two major feeder systems, while the second, fourth and most of the third are presently held under exploration licence 5/61 (Gray) by Industrial and Mining Investigations Pty Ltd and the Shell Company of Australia.

The survey has confirmed the sheet like character of the St Marys porphyry and the stock character of the granites at Rossarden and Royal George. The nature and extent of the granodiorite north of Piccaninny Point remains uncertain without model calculation. An additional large stock west of Bicheno, below Lynes Sugarloaf, has been located and limits placed on its extent. The present interpretation does not offer any solutions for the nature of the bounding structures which juxtapose dolerite and granite, although at least one feeder occurs in such a zone. Many small feeder systems are likely to be concealed in the broad areas of positive anomaly south of Lochaber and south-west of Fingal.

A major negative anomaly centred on the Nicholas Range is thought to be related to an additional small pluton. A pre-Permian structural control has been suggested for the siting of the South Esk and Break O' Day Rivers and which may have persisted to the present. The evidence is currently very weak. The common north-west, north-east and east-west trends are reflected by the gravity anomalies.

Revision of the qualitative interpretation offered in this report will depend on three dimensional modelling and adequate controls. This report establishes the first model. However one major problem is indicated; what is the contribution to each anomaly of basement influences? In general, the complete section is rarely known, is variable in thickness and content, and rests on a varied basement which contains a substantial pre-Permian relief. Consider how this problem manifests itself on the eastern part of Fingal Tier where a number of estimates of the section are about 20 $\mu m/s^2$ too high and others of the section are about 20 $\mu m/s^2$ too low. In many cases, it is not certain if this is due to incorrect density assumptions or basement effects. The latter problem can only be assessed where the section exposes basement or where drilling has proceeded to basement. A paucity of exposure and drilling in the key hub of the region means that this factor is currently not assessed. The density values are considered to be reasonable. However, if the coal measures were locally variable between 2.42 and 2.51 t/m^3 and the dolerite was denser than normal, at 2.95 - 3.00 t/m^3, then most of the discrepancies could be explained. Use of the increased value for the dolerite portion of the section implies a reduction in interpreted thickness of dolerite by 20 - 40%. A decreased value for coal measures in the region south-east of Fingal could account for the larger anomalies observed there. A broad scale drilling coverage of the section to the top of the Permian succession, at least, is needed to improve the estimates offered in this interpretation which are based on limited drilling results at Fingal, Llandaff, Seymour and Nicholas Range. The usefulness of these results is limited by the restriction on coverage (relate to about 3% of the area concerned) and a common lack of base level reference (*e.g.* top of Permian succession or basement).

RECOMMENDATIONS

1) Density determinations of the coal measures sequence and local dolerites to confirm whether the values to be used in modelling should be varied as suspected from limited calculation.

2) Increased coverage around the Duncan mine to confirm the anomaly values.

3) Increased coverage at those places on Fingal Tier where gentle gradients bound anomalies of <-10 to >+10 $\mu m/s^2$, since these appear to reflect substantial thickening of the dolerite sheet to the positive side. Some faulting may be disguised in this way. Definition of the actual boundaries and hence parts of possible transection of the coal measures will greatly aid reserve estimation. The nominal 1 km station spacing of this survey is too coarse to undertake such estimates reliably.

4) Increased coverage around Piccaninny Point is essential to determination of the form of the granodiorite pluton.

5) The anomalies related to a possible granitic pipe at St Patricks Head and a small dolerite plug immediately east of the Duncan mine should be checked and better specified.

6) About 10 further deep drill holes to basement are required. These should be widely spaced and be sited to avoid thick accumulations of dolerite. One hole should be sited on Frodsley Estate to evaluate the Nicholas Range anomaly. Suggested sites are shown in Figure 9.

7) About 40 - 50 reflection soundings should be attempted to complement the drilling programme. Some sites are indicated in Figure 9. Such soundings serve two purposes; additional control for the gravity survey and fuller description of the section including recognition of coal content. Unfortunately the use of the method over much of this area will require extensive and demanding processing but sites accessible to analogue processing may be examined pending resolution of the complex problems at the other sites.

8) Quantitative processing of the results of this survey should proceed as soon as possible in order to provide improved definition and resolve many of the structural ambiguities discussed above.

9) The area must be mapped geologically and in detail sufficient for a reliable 1:25 000 map. Care must be taken to ensure location of as many of the small windows and roof remnants, which occur in such dolerite areas, as possible. They are important structural indicators. Textural variations in the dolerite should be noted and any evidence for multiple intrusion recorded.

   Reliable mapping of many slopes incorporating dolerite, dolerite-talus and boundaries which are some combination of dolerite-coal measures-talus will not be possible without use of magnetic surveys undertaken as part of the mapping process. In some situations refraction surveys may also be needed.

10) The Mathinna Beds around Mt Nicholas should be examined for metamorphic effects which might indicate the presence of a significant intrusion in the area.

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[13 December 1978]

APPENDIX 1

Gravity survey tie stations.

Place & number	*Description*	*Observed gravity* (m/s^2)	*Elevation* (m)
FALMOUTH 7551-9401	Foot signpost, Tasman Highway. Falmouth 3, junction.	9.8031916	61.0
ST MARYS 7551-9402	Esk Highway, St Marys 1 mile peg adjacent HEC 524.	9.8028160	255.0
ESK HIGHWAY 7551-9403	Concrete slab, foot of Sign, Mt Nicholas Road.	9.8028097	238.4
FINGAL 7551-9404	Foot HEC 335, 400 m east of Duncan Colliery road.	9.8027822	250.3
AVOCA 7551-9405	Foot eastern leg, overpass sign between Esk Highway and rail bridges.	9.8027417	197.0
ROYAL GEORGE 7551-9406	Foot of HEC 65	9.8027788	223.0
LOCHABER 7551-9407	Foot of Lochaber sign post, Old Coaching Road.	9.8029221	252.0
CRANBROOK 7551-9408	Foot HEC pole, fence corner beside Old Coaching Road at Tasman Highway junction.	9.8036502	20.0
SWANSEA 7551-9409	Entrance gate "Belmont"	9.8037094	11.0
BICHENO 7551-9410	Foot signpost, Coles Bay, Freycinet, Tasman Highway (west side road)	9.8035173	20.0
7551-9411	Foot 60/70 kph post north side Bicheno	9.8035056	11.0
DOUGLAS RIVER 7551-9412	Upper Gate, road termination, DMR camp Douglas River.	9.8034738	17.0
CHAIN OF LAGOONS 7551-9413	Centre traffic island, road junction Tasman Highway.	9.8034635	14.0
MATHINNA 7551-9414	HEC pole, bus shelter corner Beauty Flats & Mathinna Main Roads.	9.8026704	260.2
ROSSARDEN 7551-9415	Station/grid 04, SPM, slab, Rossarden/Storys Creek Road junction.	9.8018495	626.6
COLES BAY 7551-9416	End concrete path, launch ramp, Coles Bay.	9.8038758	0.0

APPENDIX 2

Drilling records summary

The listing below is not exhaustive and only the most basic of logs is quoted. Further details, about coal seams especially, can be obtained from Hills *et al* (1922), Threader (1968) and Departmental files. All sites are indicated in Figure 9.

Mines Department programme

Hole 1	0 - 218 m	Coal Measures. Hole completed near presumed base of Triassic succession.
Hole 2	0 - 184 m	Coal Measures.
Hole 3	0 - 88 m	Dolerite scree.
	88 - 217 m	Coal Measures.
Hole 4	0 - 12 m	Weathered dolerite.
	12 - 254 m	Coal Measures.
	254 - 330 m	Permian mudstone, sandstone, limestone. Glauconite at 315 m.
Hole 5	0 - 6 m	Dolerite scree.
	6 - 270 m	Coal Measures.
Hole 6	0 - 129 m	Dolerite
	129 - 451 m	Coal Measures.
	451 - 458 m	Permian mudstone with grit.
Hole 7	0 - 9 m	No core.
	9 - 52 m	Coal Measures - hole abandoned.
Hole 7B	30 - 341 m	Coal Measures.
	341 - 352 m	Permian siltstone.
Hole 8	0 - 6 m	No core.
	6 - 227 m	Coal Measures.
	227 - 251 m	Permian mudstone, grit, limestone.
Hole 9	0 - 81 m	Coal Measures.
	81 - 140 m	Permian mudstone, siltstone.
	140 - 180 m	Calcareous siltstone, limestone.
	180 - 232 m	Mudstone, siltstone, grit.
	232 - 234 m	Mathinna Beds.
Hole 10		Dolerite scree - abandoned.
Hole 11	0 - 42 m	Dolerite scree.
	42 - 139 m	Coal Measures.
Hole 12	0 - 44 m	Dolerite scree.
	44 - 224	Coal Measures.
Hole 13	0 - 228 m	Coal Measures.
Hole 14		Abandoned.
Hole 15		Abandoned.

Hole 16	0 - 263 m	Dolerite.
	263 - 364 m	Coal Measures.
Hole 17	0 - 323 m	Dolerite.
	323 - 505 m	Coal Measures.
Hole 18	0 - 371 m	Dolerite.
	371 - 425 m	Coal Measures.
Hole 19	0 - 247 m	Dolerite.
	247 - 455 m	Coal Measures.
Hole 20	0 - 247 m	Dolerite.
	247 - 465 m	Coal Measures.
Hole 21	0 - 282 m	Dolerite
	282 - 492 m	Coal Measures
	492 - 502 m	Permian mudstone, grit.
Hole 22	0 - 229 m	Coal Measures.
Hole 23	0 - 341 m	Dolerite.
	341 - 546 m	Coal Measures.
	546 - 554 m	Permian siltstone, grit.
Hole 24	0 - 386 m	Dolerite.
	386 - 523 m	Coal Measures.
Hole 25	0 - 194 m	Dolerite.
	194 - 511 m	Coal Measures.
	511 - 526 m	Permian siltstone.
Hole 26	0 - 241 m	Dolerite
	241 - 459 m	Coal Measures.
Hole 27	0 - 260 m	Dolerite.
	260 - 488 m	Coal Measures.
Hole 28	0 - 151 m	Coal Measures.
	151 - 160 m	Permian siltstone, grit.
Hole 29	0 - 346 m	Dolerite. Dip base 60°.
	346 - 424 m	Coal Measures.
	424 - 431 m	Permian siltstone, grit.
Hole 30	0 - 27 m	Dolerite talus.
	27 - 242 m	Coal Measures.
	242 - 255 m	Permian siltstone, grit.
Hole 31	0 - 302 m	Dolerite.
	302 - 566 m	Coal Measures.
	566 - 576 m	Permian siltstone, grit.
Hole 992/637	0 - 3 m	Coal Measures.
	3 - 118 m	Permian shale, limestone, grit.
	118 - 128 m	Granite.
Hole 040/675	0 - 217 m	Coal Measures.
	217 - 441 m	Permian siltstone, limestone, grit, conglomerate.

	441 - 450 m	Metamorphosed Mathinna Beds.
Killymoon	0 - 153 m	Permian siltstone, limestone, grit.
	153 - 154 m	Mathinna Beds.
Harefield	0 - 110 m	Coal Measures.
	110 - 216 m	Permian succession.
	216 - 221 m	Mathinna Beds.
Llandaff 1	0 - 142 m	Coal Measures.
	142 - 145 m	Granite.
Llandaff 2	0 - 171 m	Coal Measures.
	171 - 218 m	Permian siltstone, limestone, grit, conglomerate.
Llandaff 3	0 - 17 m	Dolerite talus.
	17 - 221 m	Coal Measures.
	221 - 228 m	Granite.
Seymour 1	0 - 52 m	Coal Measures.
Seymour 2	0 - 94 m	Coal Measures.
Seymour 3	0 - 73 m	Coal Measures.
	73 - 75 m	Dolerite.
Seymour 4	0 - 103 m	Coal Measures.
	103 - 271 m	Permian shale, limestone, conglomerate.
Seymour 5	0 - 197 m	Coal Measures.

Note: Coal Measures term includes lithic, quartz sandstone, shale, mudstone, coal, carbonaceous beds, some limestone, grit.

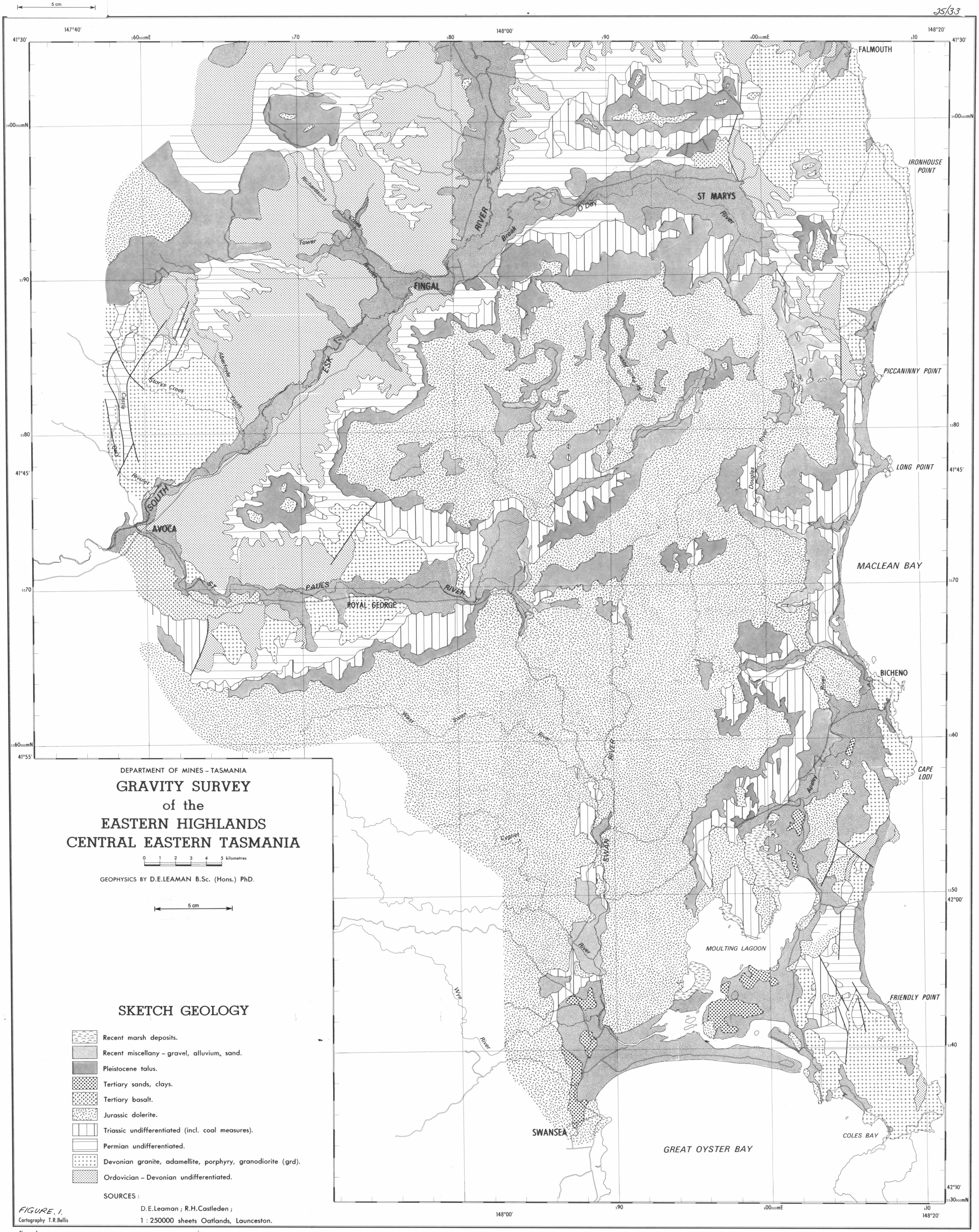


FIGURE. 1.

Figure 1

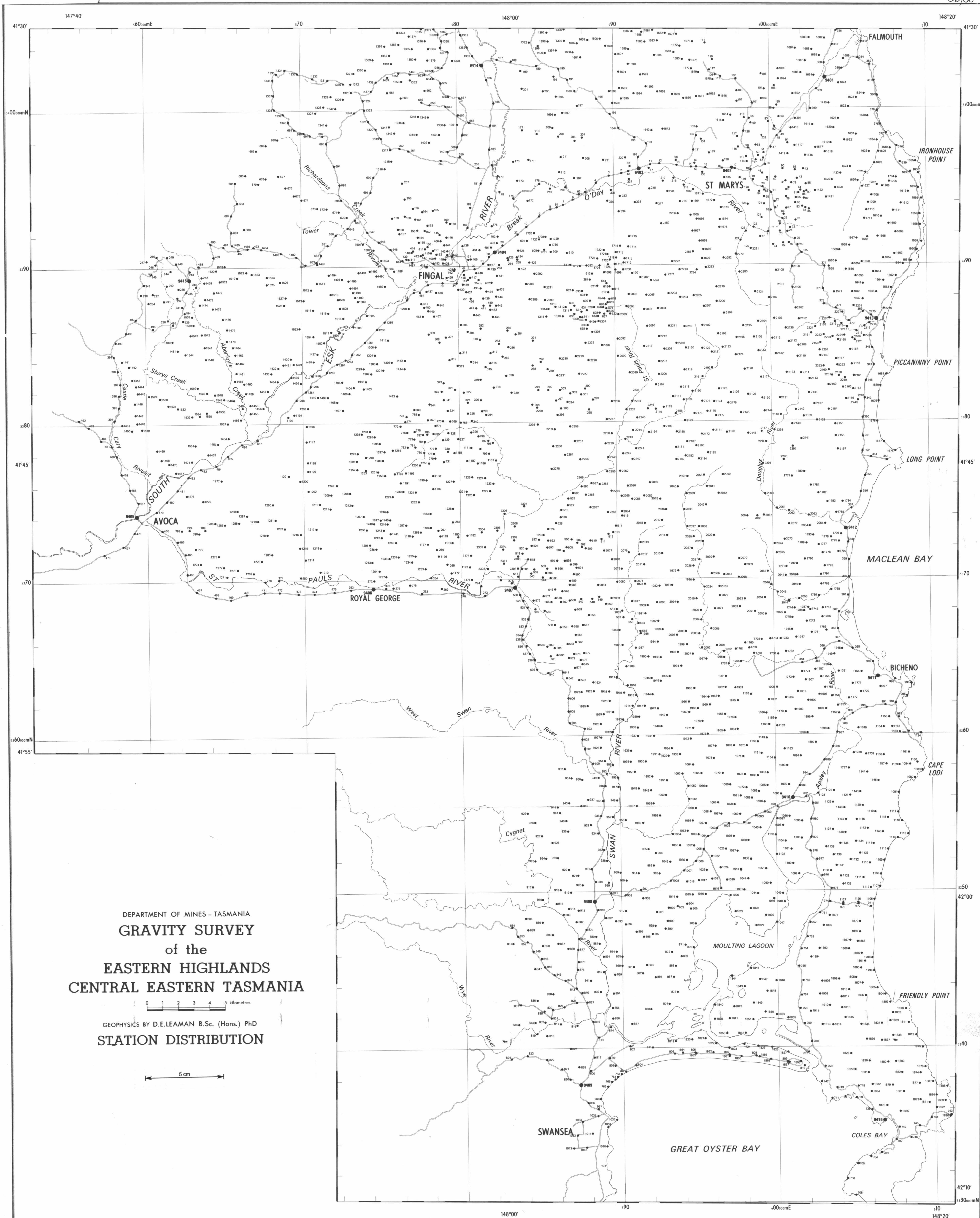

DEPARTMENT OF MINES – TASMANIA
GRAVITY SURVEY
of the
EASTERN HIGHLANDS
CENTRAL EASTERN TASMANIA
0 1 2 3 4 5 kilometres
GEOPHYSICS BY D.E.LEAMAN B.Sc. (Hons.) PhD
STATION DISTRIBUTION
5 cm
FALMOUTH
IRONHOUSE POINT
ST MARYS
FINGAL
AVOCA
ROYAL GEORGE
PICCANINNY POINT
LONG POINT
MACLEAN BAY
BICHENO
CAPE LODI
MOULTING LAGOON
FRIENDLY POINT
SWANSEA
GREAT OYSTER BAY
COLES BAY
SOUTH ESK RIVER
ST PAULS RIVER
O'Day Break
St Pauls River
Douglas River
Apsley River
SWAN RIVER
West Swan River
Cygnet River
Wye River
Richardsons Creek
Tower Rivulet
Storys Creek
Aberfoyle Creek
Castle Cary Rivulet
147°40'
148°00'
148°20'
41°30'
41°45'
41°55'
42°00'
42°10'
560000mE
570
580
590
600000mE
610
5400000mN
5390
5380
5370
5360000mN
5350
5340
5330000mN

Figure 2

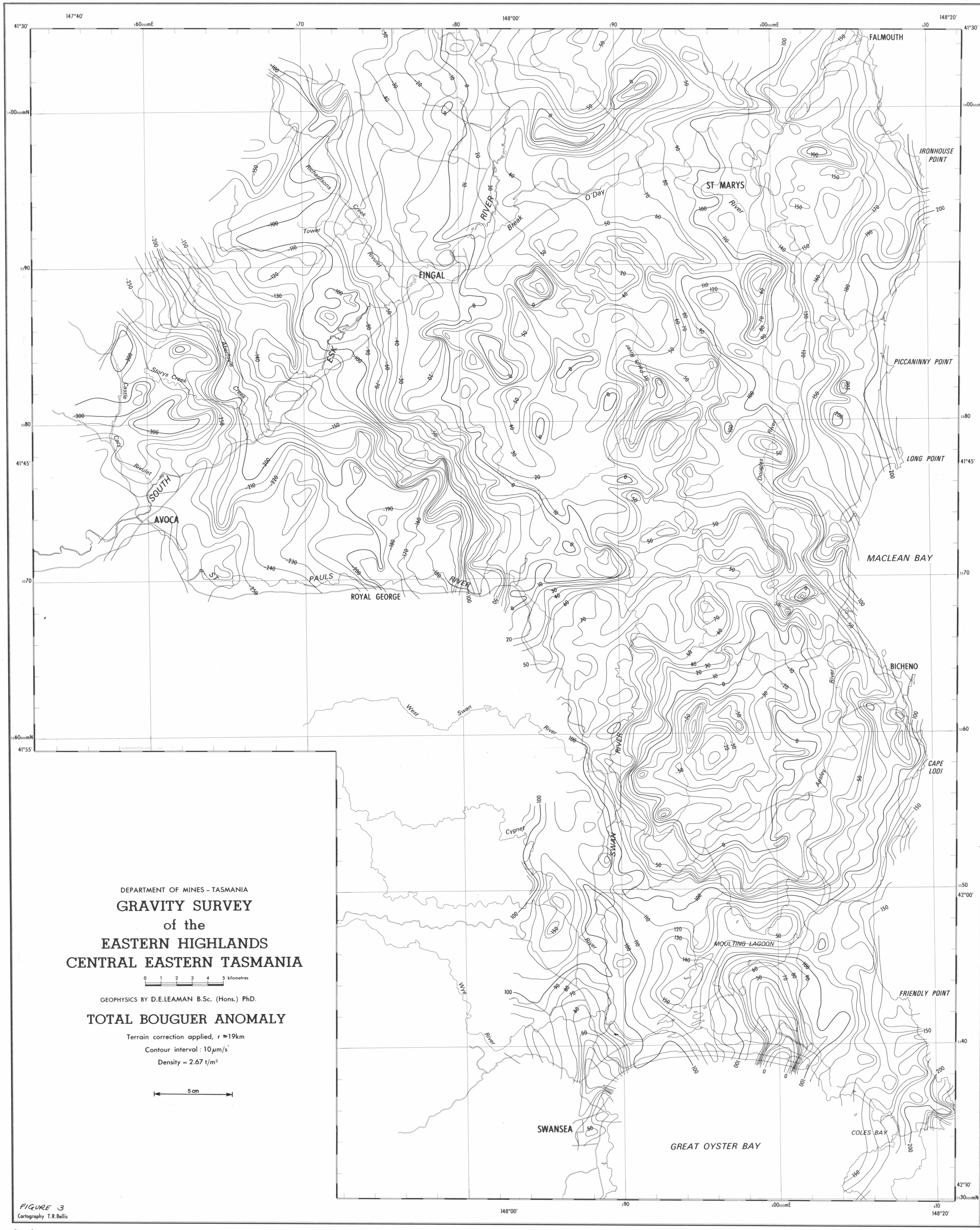
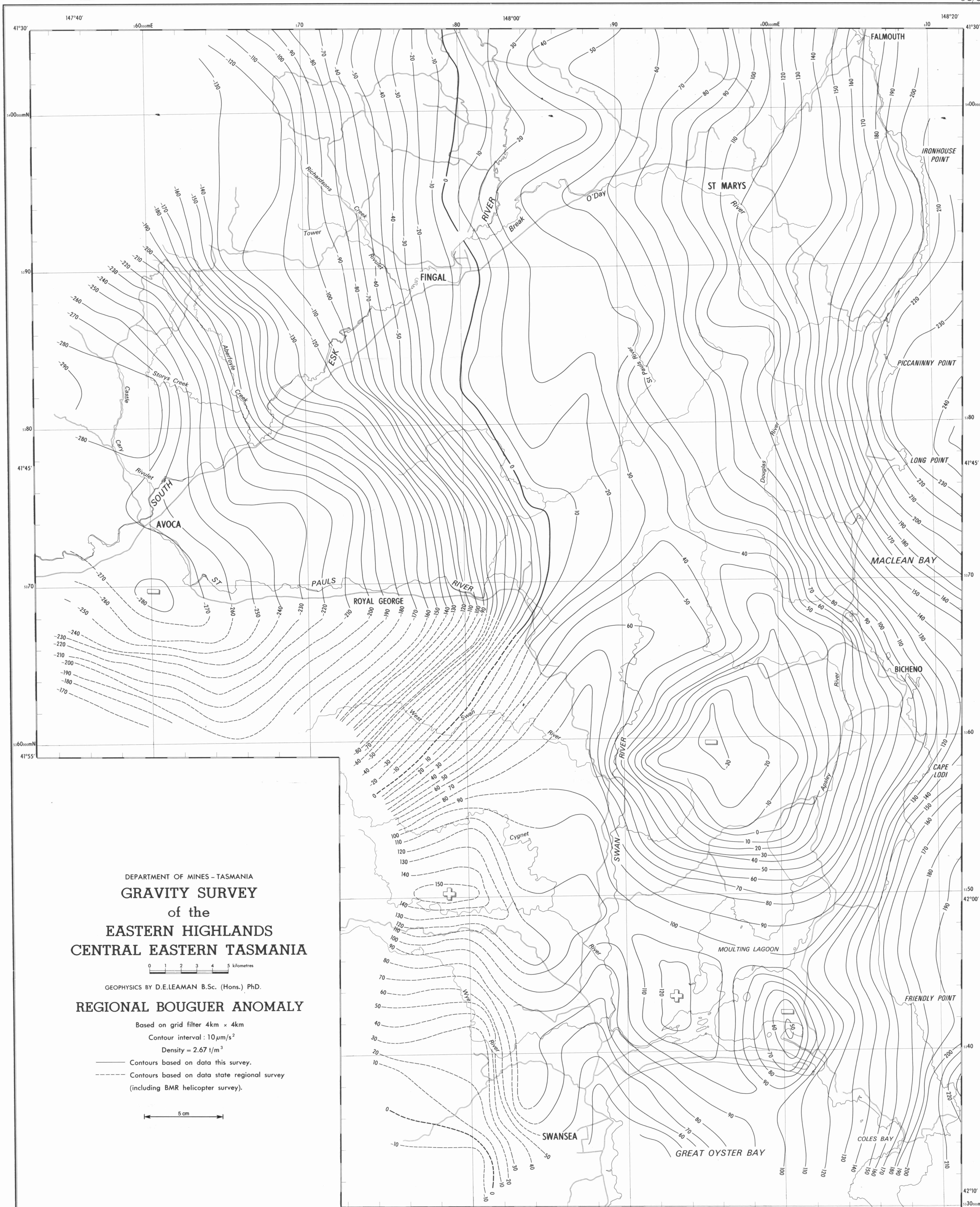

DEPARTMENT OF MINES – TASMANIA
GRAVITY SURVEY
of the
EASTERN HIGHLANDS
CENTRAL EASTERN TASMANIA
0 1 2 3 4 5 kilometres
GEOPHYSICS BY D.E.LEAMAN B.Sc. (Hons.) PhD.
TOTAL BOUGUER ANOMALY
Terrain correction applied, r ≈ 19km
Contour interval : 10μm/s²
Density = 2.67 t/m³
5 cm
147°40′
148°00′
148°20′
41°30′
41°45′
41°55′
42°00′
42°10′
FALMOUTH
IRONHOUSE POINT
ST MARYS
FINGAL
PICCANINNY POINT
LONG POINT
AVOCA
MACLEAN BAY
ROYAL GEORGE
BICHENO
CAPE LODI
MOULTING LAGOON
FRIENDLY POINT
SWANSEA
GREAT OYSTER BAY
COLES BAY
FIGURE 3
Cartography T.R.Bellis

Figure 3

5 cm



DEPARTMENT OF MINES – TASMANIA

GRAVITY SURVEY of the EASTERN HIGHLANDS CENTRAL EASTERN TASMANIA

0 1 2 3 4 5 kilometres

GEOPHYSICS BY D.E.LEAMAN B.Sc. (Hons.) PhD.

REGIONAL BOUGUER ANOMALY

Based on grid filter 4km × 4km

Contour interval : 10 $\mu m/s^2$

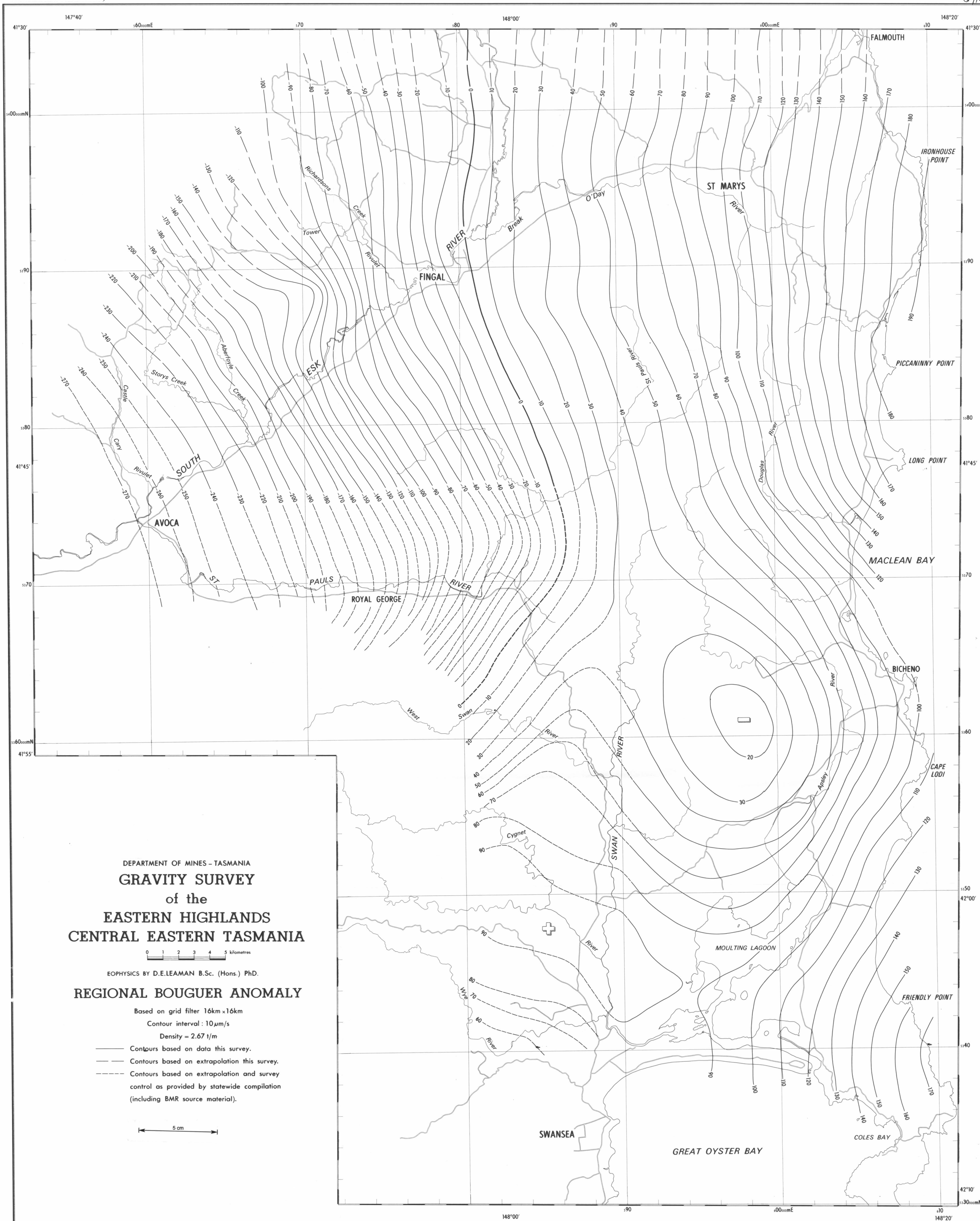
Density = 2.67 t/m^3

Contours based on data this survey.

Contours based on data state regional survey (including BMR helicopter survey).

5 cm

FIGURE 4.



DEPARTMENT OF MINES – TASMANIA

GRAVITY SURVEY of the EASTERN HIGHLANDS CENTRAL EASTERN TASMANIA

0 1 2 3 4 5 kilometres

EOPHYSICS BY D.E.LEAMAN B.Sc. (Hons.) PhD.

REGIONAL BOUGUER ANOMALY

Based on grid filter 16km x 16km

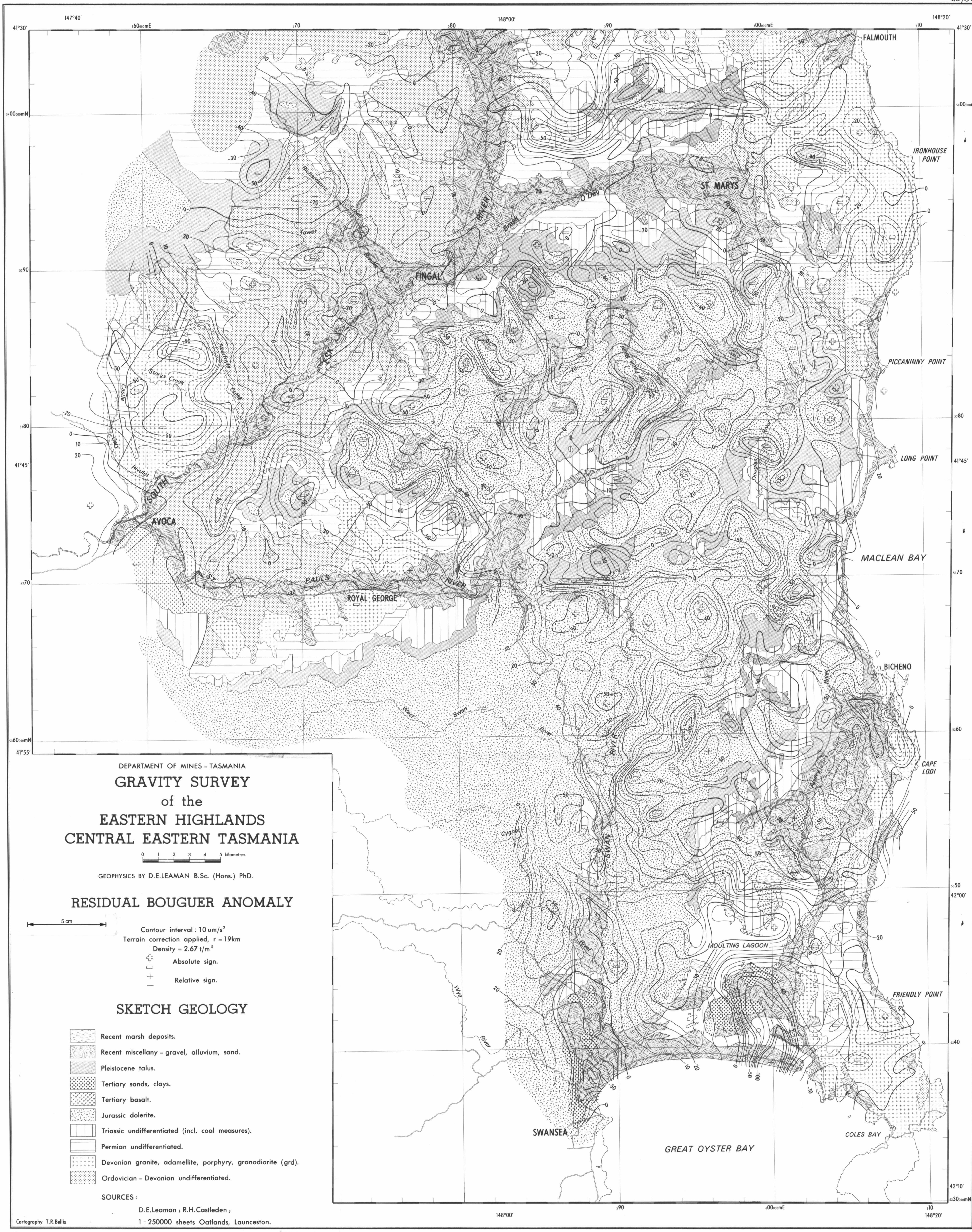
Contour interval : 10 µm/s

Density = 2.67 t/m

- Contours based on data this survey.
- Contours based on extrapolation this survey.
- Contours based on extrapolation and survey control as provided by statewide compilation (including BMR source material).

5 cm

Figure 5


DEPARTMENT OF MINES – TASMANIA
GRAVITY SURVEY
of the
EASTERN HIGHLANDS
CENTRAL EASTERN TASMANIA
0 1 2 3 4 5 kilometres
GEOPHYSICS BY D.E.LEAMAN B.Sc. (Hons.) PhD.
RESIDUAL BOUGUER ANOMALY
5 cm
Contour interval : 10 um/s²
Terrain correction applied, r = 19km
Density = 2.67 t/m³
Absolute sign.
Relative sign.
SKETCH GEOLOGY
Recent marsh deposits.
Recent miscellany – gravel, alluvium, sand.
Pleistocene talus.
Tertiary sands, clays.
Tertiary basalt.
Jurassic dolerite.
Triassic undifferentiated (incl. coal measures).
Permian undifferentiated.
Devonian granite, adamellite, porphyry, granodiorite (grd).
Ordovician – Devonian undifferentiated.
SOURCES :
D.E.Leaman ; R.H.Castleden ;
1 : 250000 sheets Oatlands, Launceston.
Cartography T.R.Bellis
FALMOUTH
IRONHOUSE POINT
ST MARYS
FINGAL
PICCANINNY POINT
LONG POINT
AVOCA
MACLEAN BAY
ROYAL GEORGE
BICHENO
CAPE LODI
MOULTING LAGOON
FRIENDLY POINT
SWANSEA
GREAT OYSTER BAY
COLES BAY
147°40'
148°00'
148°20'
41°30'
41°45'
41°55'
42°00'
42°10'

4

5 cm

31/33

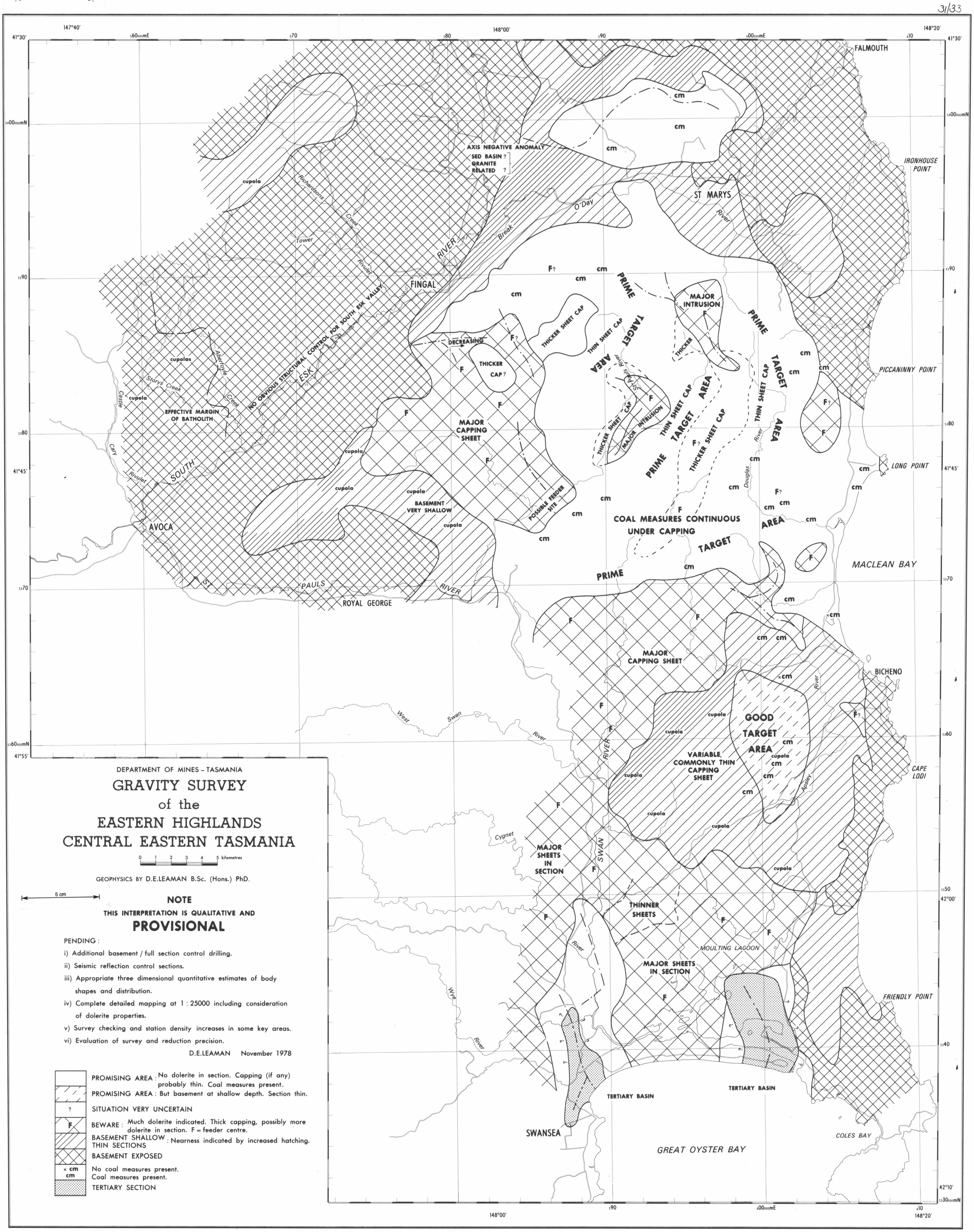


Figure 7

32/33

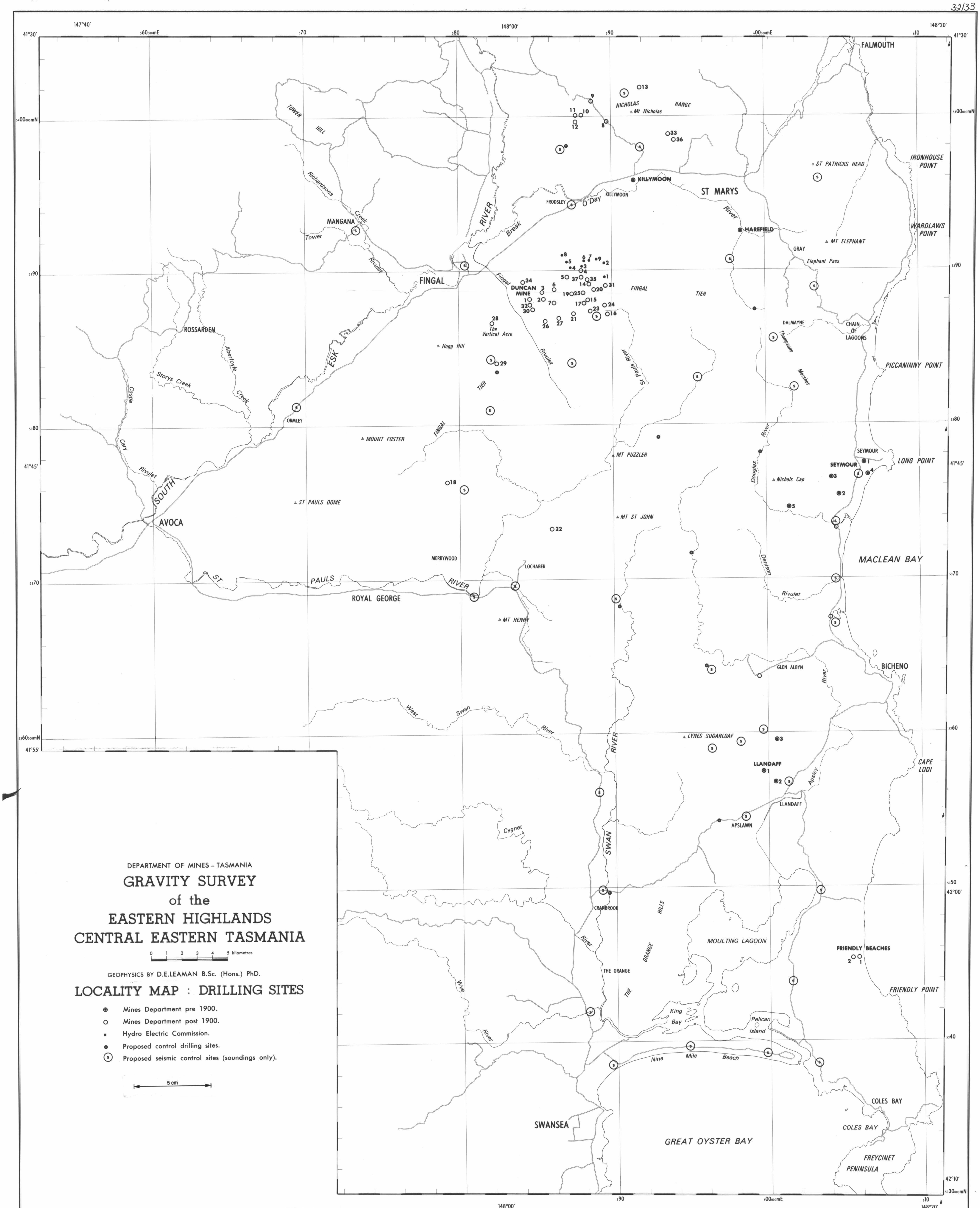
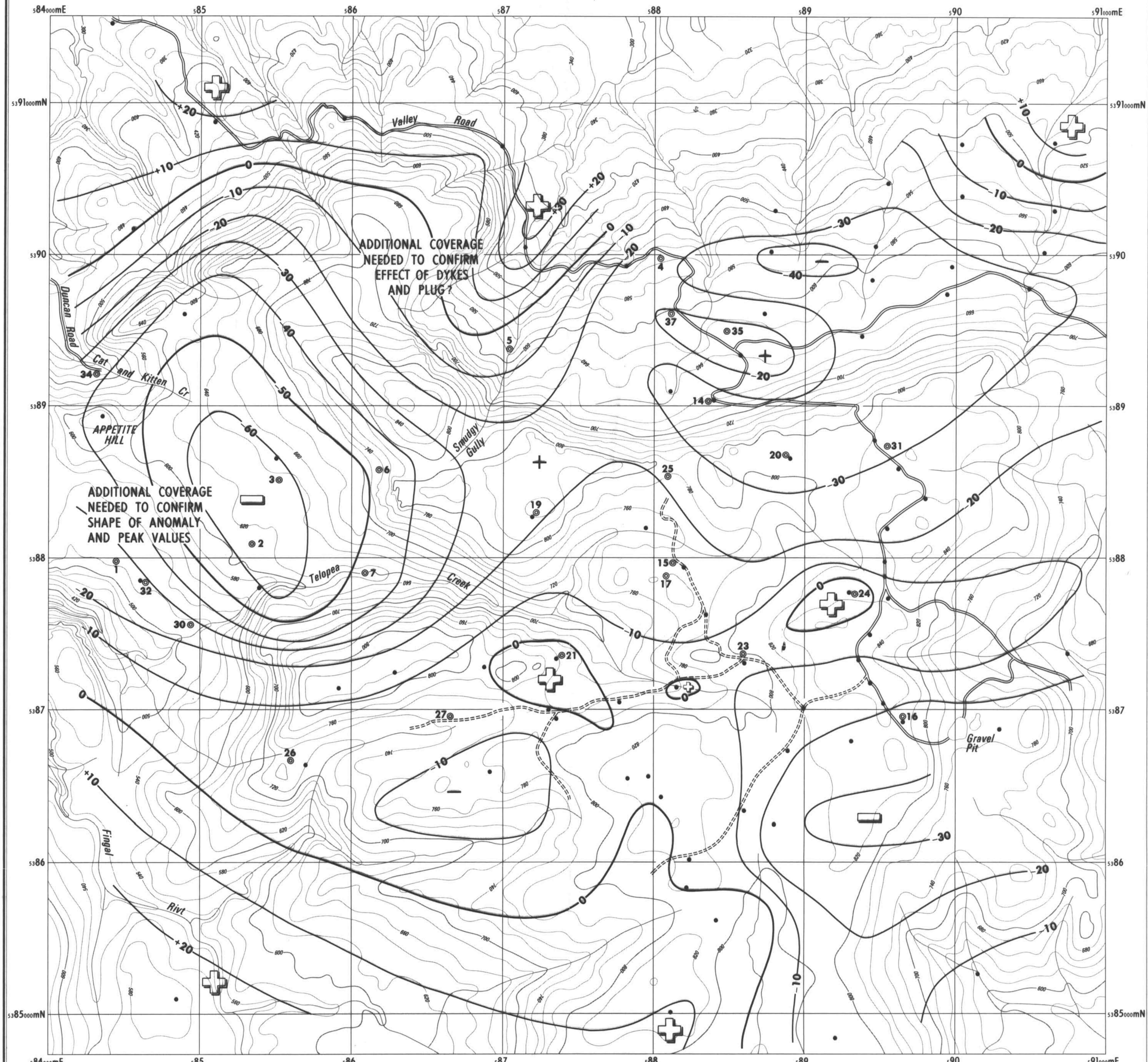


Figure 9

5 cm



DETAIL OF RESIDUAL BOUGUER ANOMALIES SOUTH EAST OF THE DUNCAN MINE AND AROUND THE VALLEY GRID

Contour interval 10 $\mu m/s^2$
Station position •
Bore Hole ◎6

0 500 1000
metres

4516 /49

Fig. 10

5 cm