1980/36. Tasmania - the gravity field and its interpretation

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Abstract

A Bouguer gravity map of Tasmania and environs has been compiled and interpreted. The onshore coverage has a maximum station spacing of 5-7 km, whereas that offshore has a line spacing of 7-12 km. A range of filters has been used to examine the data and the gross features of the region modelled using three dimensional methods. The treatment indicates a crust/Moho relief of up to 5 km and a maximum crustal thickness of 27 km. The triangular shape of Tasmania appears to reflect the disposition of batholithic masses.

INTRODUCTION

Gravity observations from the Tasmania region have been compiled from all sources and plotted as Bouguer anomalies. These are shown in Figure 1. Principal sources are indicated on the figure; the most important are the Bureau of Mineral Resources (BMR) and the Tasmania Department of Mines. BMR data made available for interpretation includes all offshore observations and most stations in western Tasmania. The latter were observed as part of a helicopter survey (Zadoroznyj, 1975). Department of Mines data cover the north of the state and a large part of the south, and all data included has been published previously (Longman and Leaman, 1971; Leaman, 1972; Leaman *et al.*, 1973; Leaman and Symonds, 1975). Not included in the compilation (1976 status) are more recent surveys along the east coast (Leaman and Richardson, 1980). Other surveys incorporated include thesis work from the University of Tasmania (McDougall and Stott, 1961; Jones *et al.*, 1966; Cameron, 1967; Leaman and Naqvi, 1968; Sheehan, 1969) and some exploration company surveys (*e.g.* Leckie, 1968; King Island). All data is held on master file by the BMR in Canberra. The only other compilation of this data currently available is on the 1:5 000 000 scale map of the gravity field in Australia (published by the BMR). This map presents the offshore data in the form of free-air anomalies. (A computer plot at 1:500 000 scale was made available to the authors - onshore data only).

All observations are based on ties to isogal network stations at Hobart, Launceston and St Helens. The station coverage is uneven. Offshore, lines are 7 to 12 km apart with a station spacing of 5 to 15 km. Onshore, the spacing is more variable, but in the range 0.75 to 2.5 km for University and Mines Department surveys and 5 to 7 km for the BMR helicopter coverage. Station accuracy is also variable, particularly in respect of elevation, and the claimed reliability of the Bouguer anomaly varies from 4 to 25 $\mu m/s^2$. A 50 $\mu m/s^2$ contour interval has therefore been used in Figure 1. All Bouguer anomalies have been calculated using densities of 2.67 and 1.03 t/m^3. Stations of Mines Department origin have been terrain corrected to a radius of 19 km.

BOUGUER ANOMALIES

Features

The observed Bouguer anomalies are presented in Figure 1. The total anomaly range is -500 to +2500 $\mu m/s^2$ (-50 to +250 mgal) of which -500 to +250 $\mu m/s^2$ represents onshore values. Negative values invariably correlate

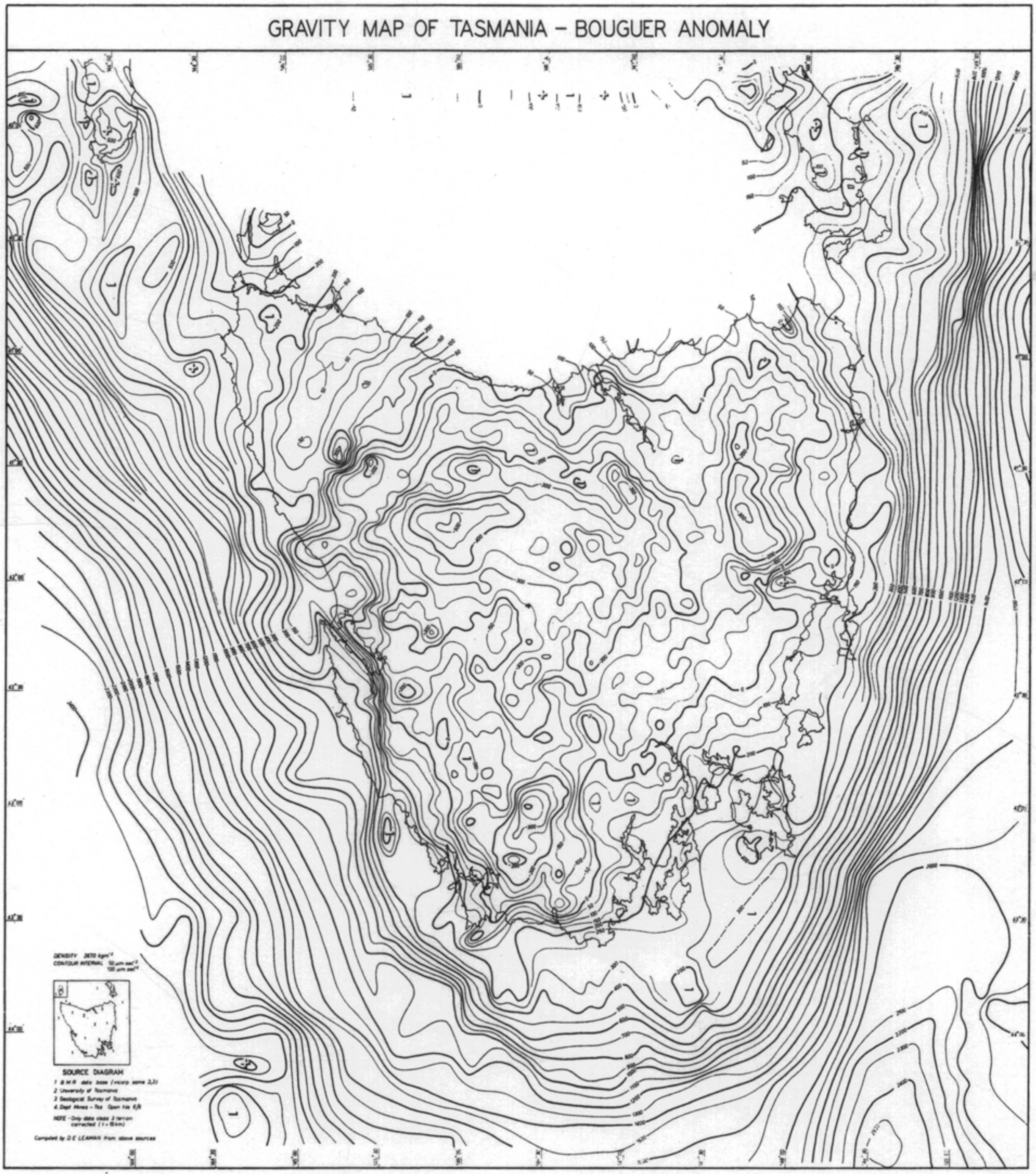


Figure 1.

5 cm

with Tasmania and positive values with deep ocean. Onshore gradients are generally much less than 10 $\mu m/s^2$ per kilometre, whereas offshore gradients - especially those related to the continental margin - are at least double this value and occasionally exceed 30 $\mu m/s^2/km$.

Several gross features may be noted and these are indicated in Figure 2. They are listed below and each is the subject of some examination in this report.

(1) The platform at about 400 $\mu m/s^2$ south of King Island.
(2) The trough and associated ridge, 50 $\mu m/s^2$ and 200 $\mu m/s^2$ respectively, trending SSW from Rocky Cape and Table Cape respectively.
(3) The juxtaposed 300 $\mu m/s^2$ and -200 $\mu m/s^2$ anomalies in the Heazlewood River region south of Waratah.
(4) The generally negative axis across north-west Tasmania from Moina to Deloraine.
(5) The closed -300 $\mu m/s^2$ negative anomaly at Cressy.
(6) The field distortion and positive trough trending south-eastward from Launceston to Campbell Town. The possible extensions of the Tamar structure as suggested in the figure are based on gradient trend variations in the Eastern Highlands.
(7) The substantial negative anomaly from Scottsdale to Royal George.
(8) The abrupt lesser negative anomalies at Ringarooma Bay (8A) and west of Bicheno (8B).
(9) The belt of negative trending anomalies parallel to the coast south of Maria Island.
(10) The positive embayment extending inland from Storm Bay, with an extension (11);
(11) north-west of New Norfolk to Westerway
(12) The sizeable negative anomaly in the upper Florentine River valley, north-west of Wylds Craig.
(13) The large negative anomaly north and east of Port Davey. A spine from this feature trends out to sea near South West Cape.
(14) The abrupt Macquarie Harbour anomaly and its southern extension.
(15) The erratic anomaly character around Trial Harbour and the northern end of Ocean Beach.
(16) The east-west trending positive anomaly in the Cranbrook-Lake Leake region.
(17) The general division of north and south Tasmania about an east/west axis from Trial Harbour to Swansea. Some general E-W trends and dislocations are evident.
(18) The augmented negative anomaly on the western side of the Central Plateau.

Previous evaluations

Several of these features have already been the subject of detailed analysis.

Feature 4. The negative trough, Moina to Deloraine. The regional survey of Sheehan (1969) covered this feature. It was concluded that a thick sedimentary pile including acid volcanic rocks produced the effects. The eastern end of the feature was also modelled by Longman and Leaman (1971). The correlation, in detail, with the lower Palaeozoic section in north-west Tasmania is inescapable. The sedimentary pile could be as much as six kilometres thick, given a contrast of -0.1 t/m^3 and the apparent anomaly of 100 to 250 $\mu m/s^2$. The maximum anomaly may be influenced by small (?)granite intrusives in the Moina region.

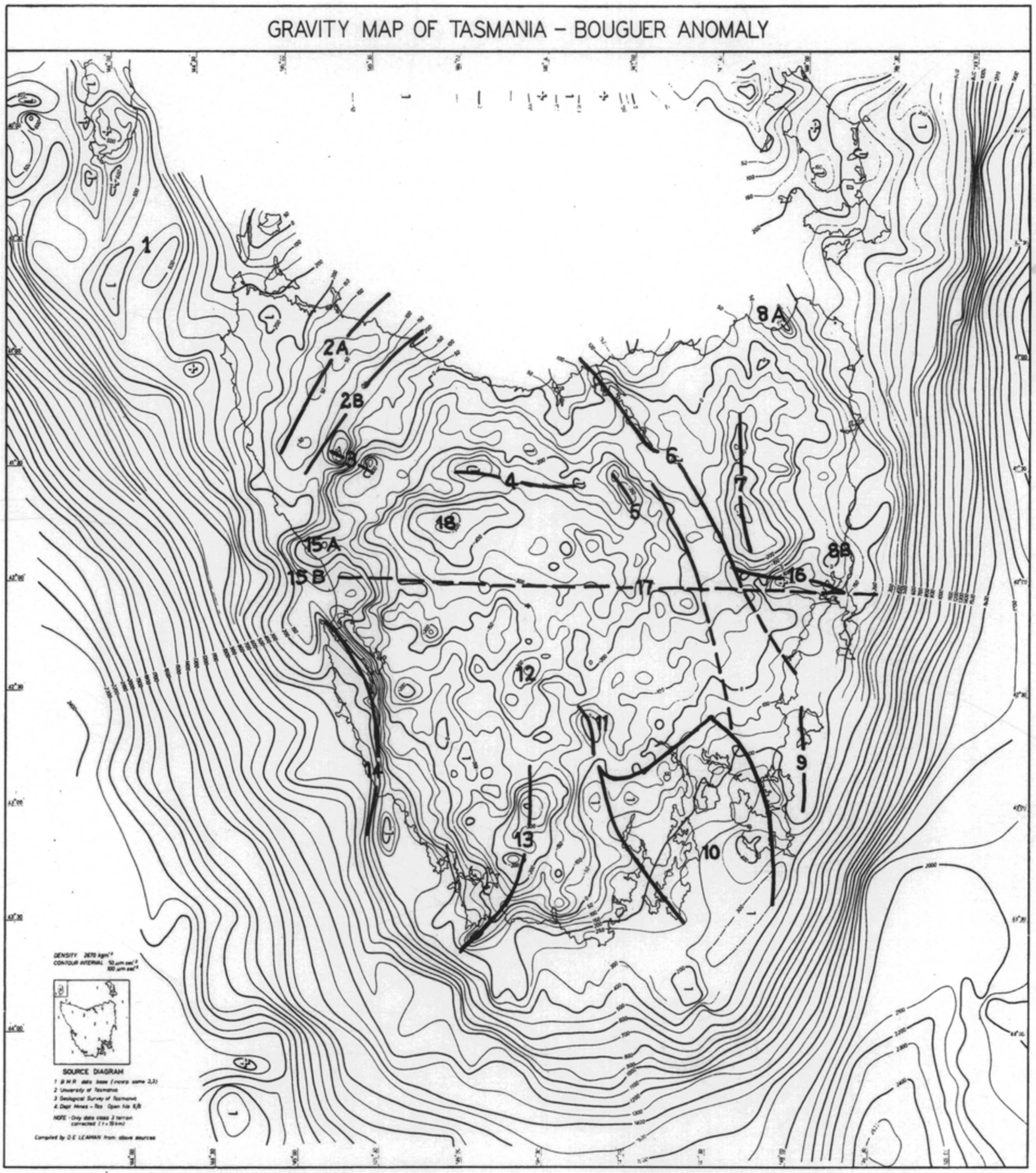
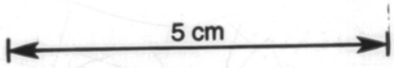


Figure 2. *Gross features of the Bouguer anomalies*



Feature 5. The Longford-Cressy anomaly has been examined by Hinch (1965) and Longman and Leaman (1971). It is due to a fault-controlled Tertiary basin with a remanent structural relief and sedimentary fill in excess of 500 m.

Feature 6. The Tamar Valley structures have been discussed by Leaman, Symonds and Shirley (1973). The anomalies noted have two source depth ranges, one very shallow and related to Tertiary structures and possibly a fossilized continental margin, and another in the lower half of the crust. The deeper source has a NNW-SSE trend and a diminishing magnitude to the south-east.

Feature 7. Major negative anomalies in north-east Tasmania. These have been discussed by Leaman and Symonds (1975) and Leaman and Richardson (1980). The regional survey (fig. 1) clearly indicates the Scottsdale batholith and its extension to Royal George, but gives little direct indication of the Blue Tier batholith which has the same scale (see Leaman and Symonds, 1975; Leaman, 1977*a*).

Feature 8A. The localised negative anomaly north of Gladstone around Ringarooma Bay has been examined by Leaman (1971, 1977*b*) and related to a deep small Tertiary(?)/Cretaceous(?) basin.

Feature 8B. The negative anomaly west of Bicheno has been re-surveyed and drilled. Red granite of the Coles Bay type was recovered from very shallow depth. A moderate-sized isolated stock has been interpreted (Leaman and Richardson, 1980).

Feature 16. The east coast survey (Leaman and Richardson, 1980) has covered much of the positive anomaly west of Cranbrook. The improved station density has restricted the feature and suggested that it has resulted from the superimposition of dolerite feeder effects and the relative positives of a region not intruded by deeply rooted granitic masses.

Data treatment

The basic compilation, as shown in Figure 1, contains numerous intricate features. Many of these clearly relate to local near-surface structures, but others may be spurious and result from uneven coverage or correction deficiencies. Where these features are adequately defined an interpretation will already be extant, such as given for the seven examples above. In other cases the coverage is generally inadequate to warrant detailed examination. Interpretation has therefore been restricted to the larger features listed above and to an overall crustal assessment based on the gravity data and any other independent information.

A previous crustal assessment has been made (Johnson, 1972, 1974) based on an improved coverage of the work of Cameron (1967). Johnson concluded that the best synthesis was given by data filtered by 20 km grid averages and subsequently analysed to include functions up to wave number 3. He interpreted a crustal thickness of around 35 km.

Such an assessment is clearly the principal objective from data of the scale and distribution offered in Figure 1. The present authors have used a similar first stage reduction technique and averaged the improved data using 10, 20, 30, 40, 50, 70, 100 and 150 km grid averages. Residuals have then been produced by subtracting the smoothed, filtered (or regional) versions from the observed field version (fig. 1). The regional versions are presented in Figures 3 and 4 and the residual versions are shown in Figures 5 and 6. This process (grid averaging) produces a smoothed version free of localised effects and with a frequency content consistent with sources at or below depths equivalent to about one quarter of the grid size. Conversely, the residuals contain information relevant to sources above this level. Discussions of the significance of the spectral content and equivalent continuation depths are given by St John (1967) and Leaman and Richardson (1980).

Thus a grid average of 100 km is roughly equivalent to a continuation from about 25 km. This simple, first stage processing allows the scale, penetration and overall significance of any feature to be assessed. Gross features of crustal significance are resolved and enhanced.

INTERPRETATION

Indicated source depths

It is possible, using the rule of thumb procedures outlined above, to infer maximum source depths for the anomalies listed in the previous section. This may be done by considering the variations in the relief and character of each anomalous feature through the range of averages and associated residuals. The critical point is reached where the form and magnitude of the original anomaly is translated to the residual. At the same time the feature will disappear from the smoothed field. Due to the complex spectral range associated with many features, some of which may be due to coverage problems, and the discontinuous selection of averages, the critical point may not be identified precisely. But an indication is possible.

Using such a treatment, each anomaly can be ascribed a maximum source depth. These are tabulated below.

1.	<2.5 km	10.	$\sim$10 km
2A.	<14 km	11.	<5 km
2B.	<5 km	12.	<10 km
3.	<5 km	13.	10-14 km
4.	$\leqslant$5 km	14.	<7.5 km
5.	$\leqslant$2.5 km	15A.	<7.5 km
6.	10-14 km	15B.	<7.5 km
7.	<14 km	16.	<5 km
8A.	$\leqslant$5 km	17.	$\sim$10 km
8B.	<10 km	18.	<14 km
9.	<10 km		

Estimates for 4, 5, 6, 7, 8A, 8B, and 16 are consistent with the more detailed evaluations. For example, 4, 7, and 16 are directly comparable, as are 5 and 8A if one presumes that the related faulting produces density contrasts involving upper Palaeozoic and Mesozoic materials juxtaposed with Lower Palaeozoic rocks. Seven and 8B are quite consistent with the nine kilometre roots interpreted for the major batholiths.

The values and sense of anomaly suggest that 9, 12, 13, and 18 are also related to deeply rooted intrusives. Given the distribution of these anomalies (and 7, 8B, possibly 15A) some of the 'positive' features may simply be relatively positive and reflect the absence of granitic plutons. Any whole crustal assessment must test this possibility.

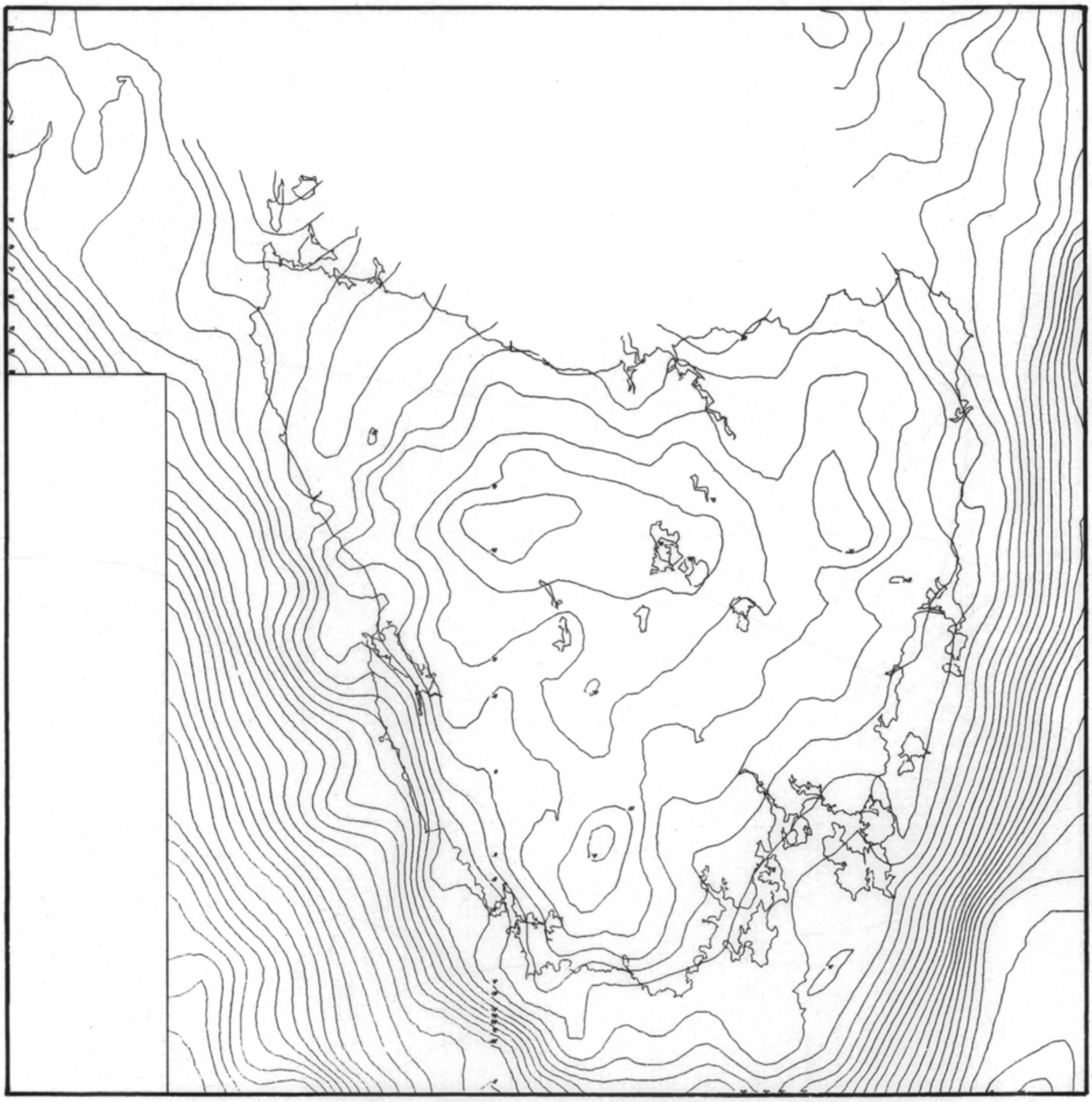
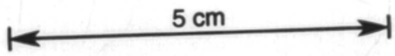


Figure 3a. *Regional gravity field: 10 km filter*



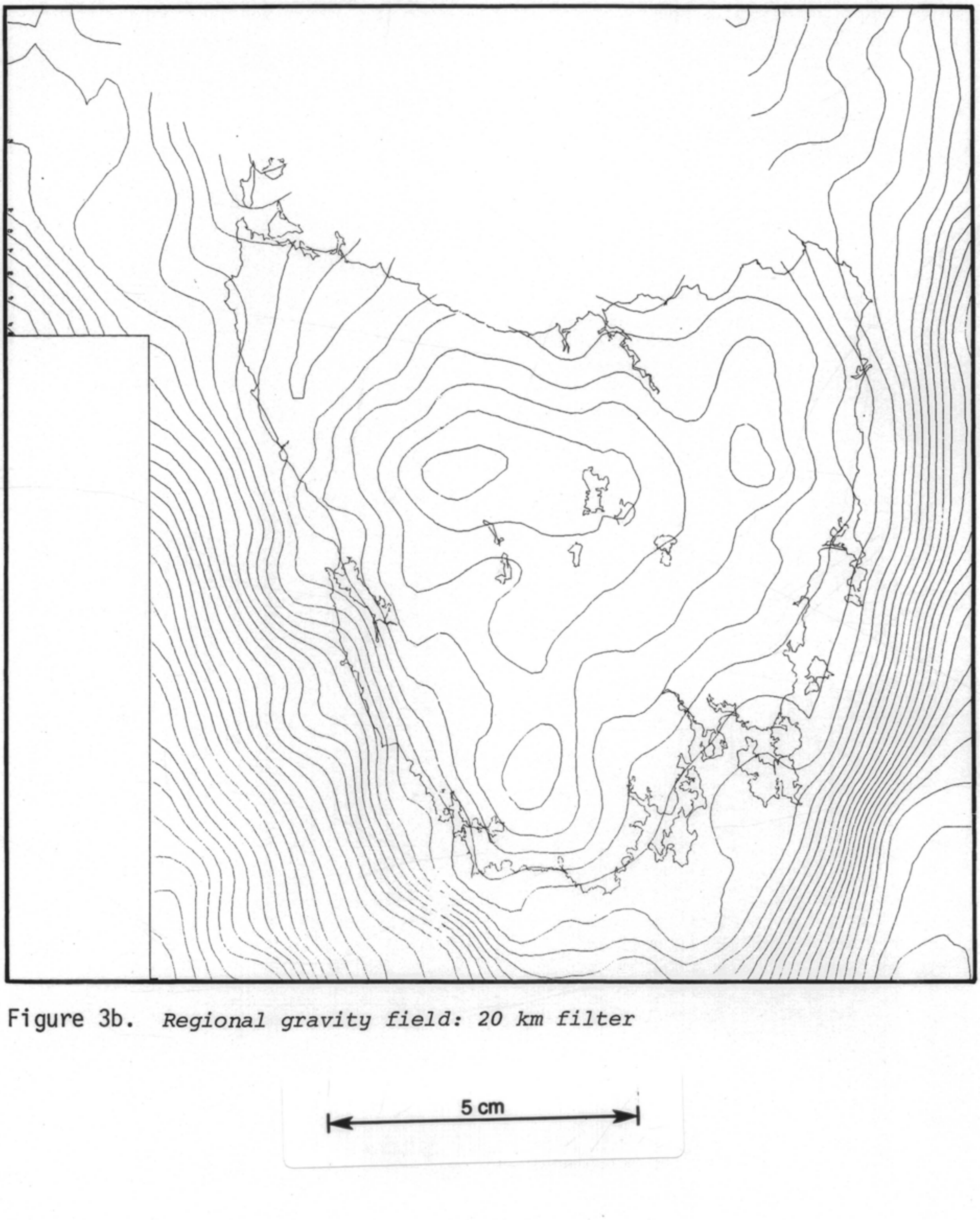


Figure 3b. *Regional gravity field: 20 km filter*

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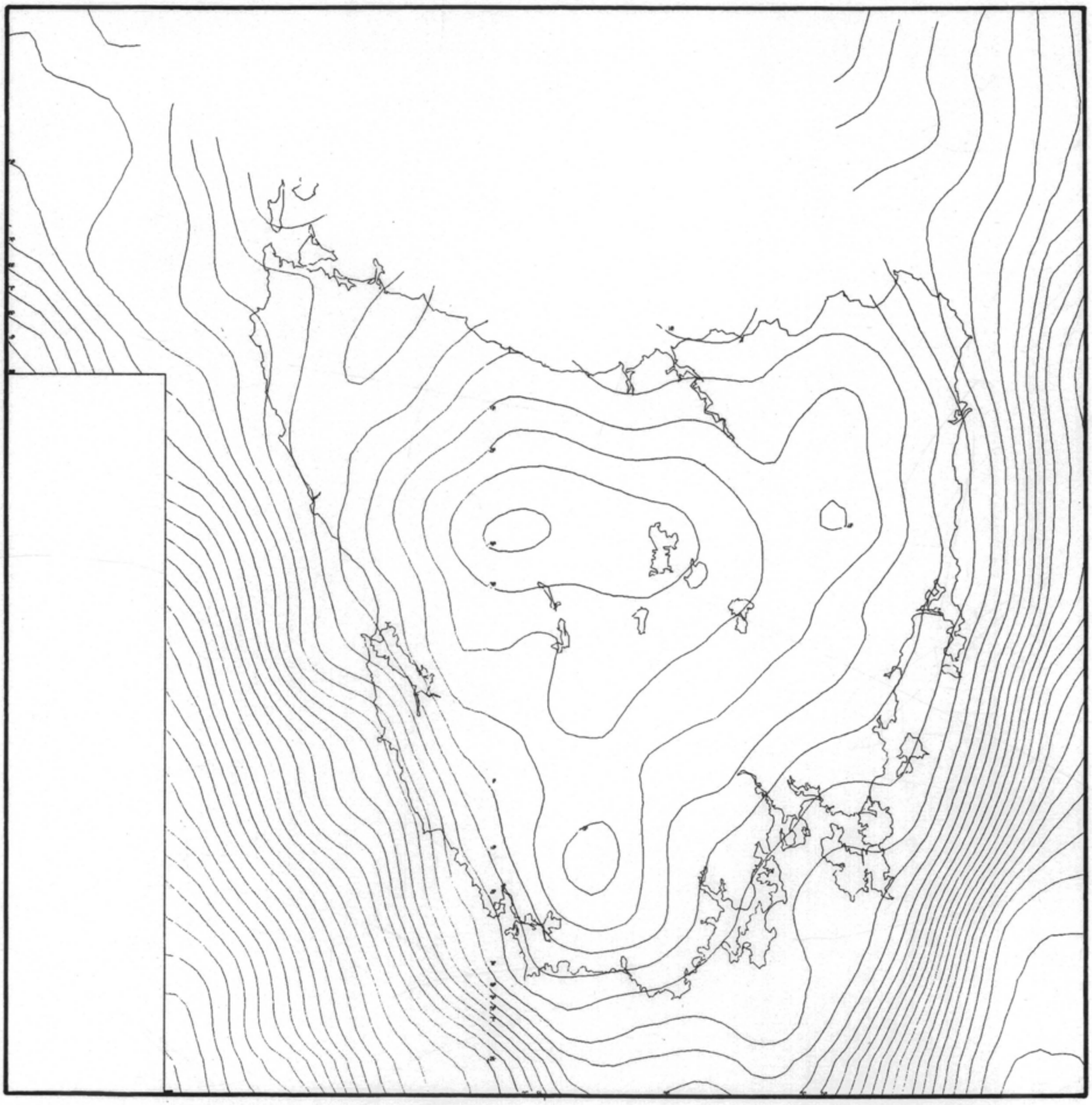
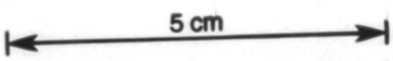


Figure 3c. *Regional gravity field: 30 km filter*



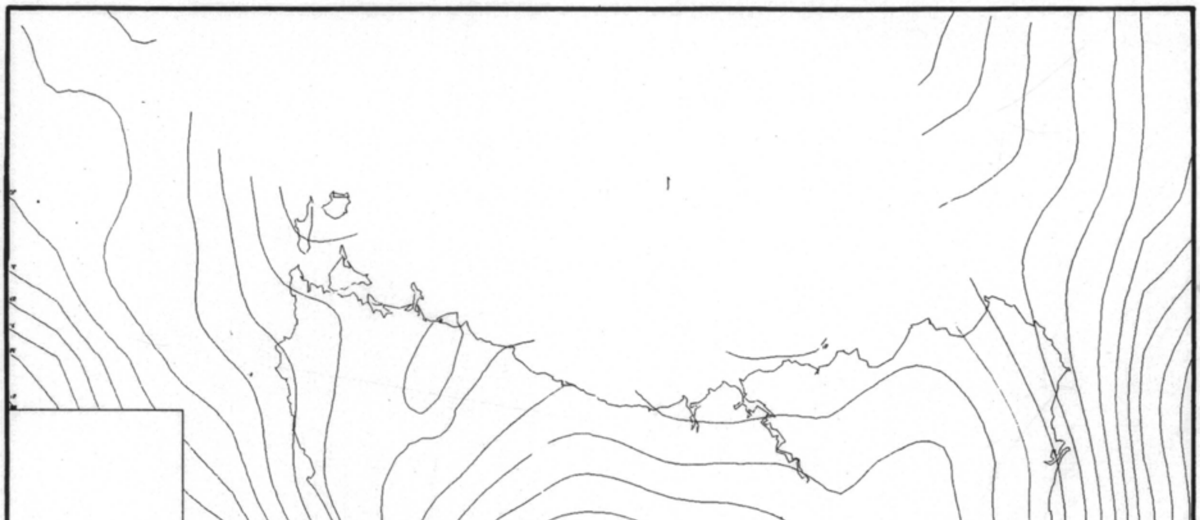


Figure 3d. *Regional gravity field: 40 km filter*

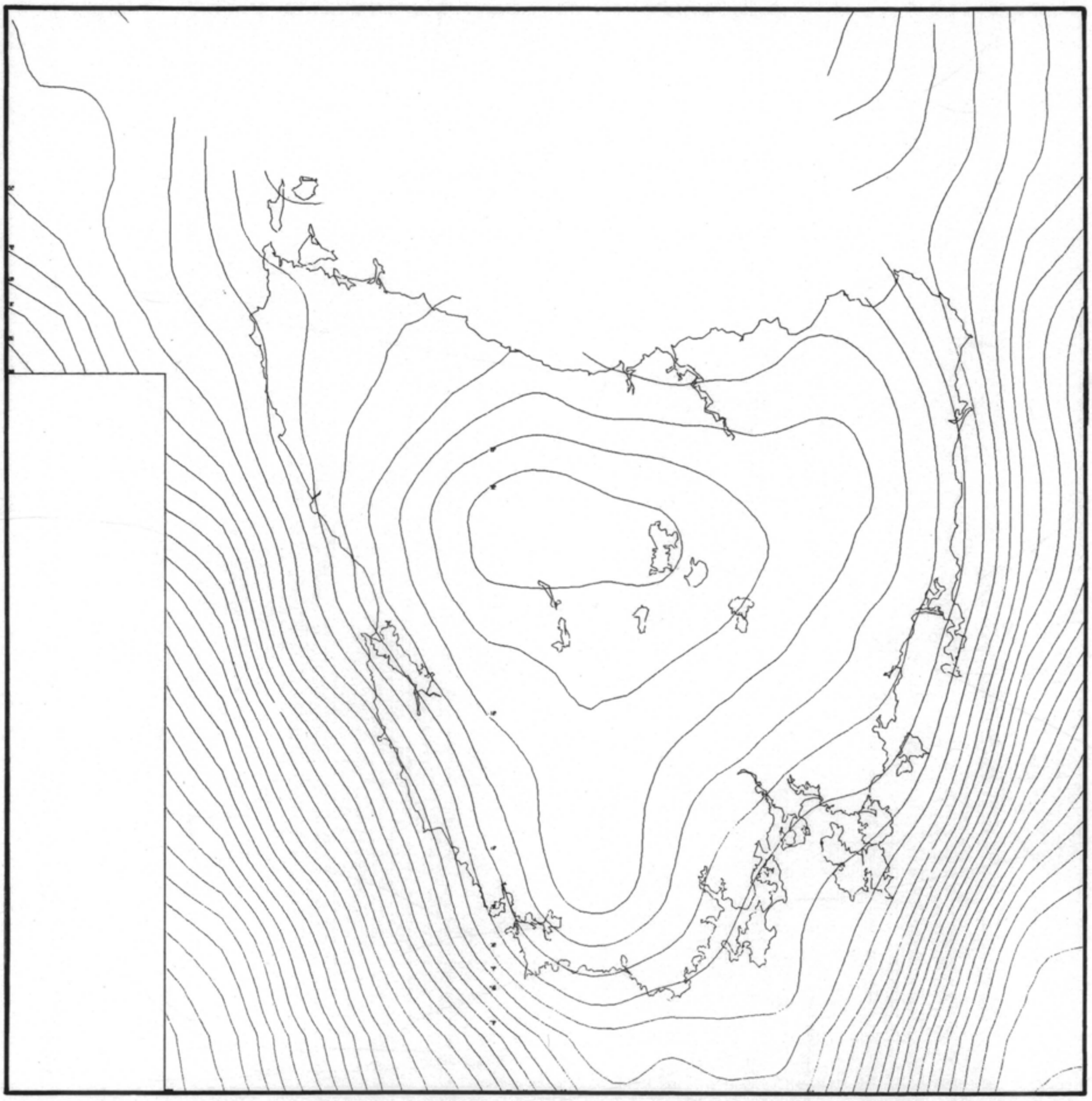
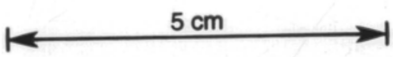


Figure 4a. *Regional gravity field: 50 km filter*



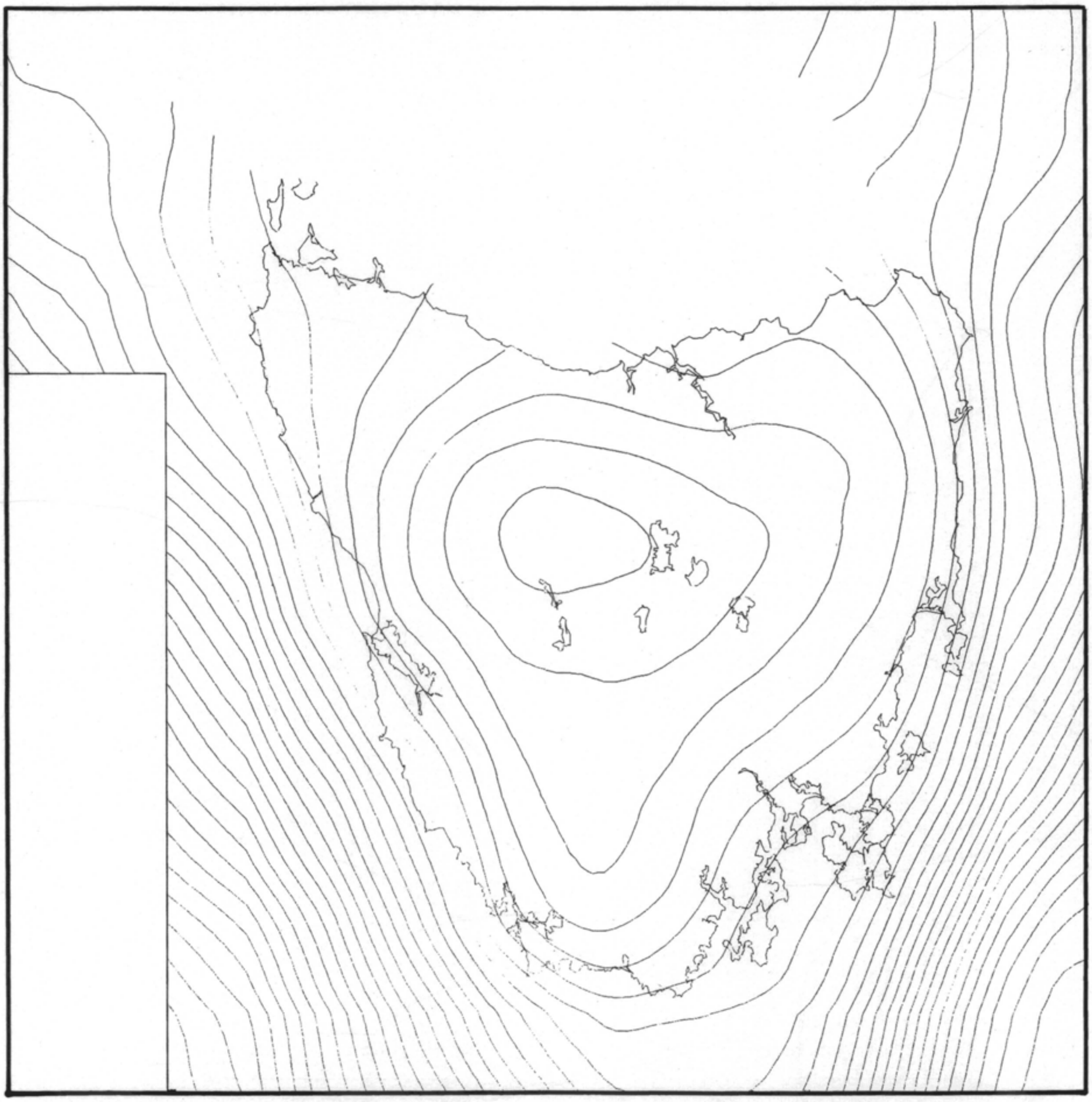
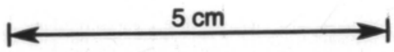


Figure 4b. *Regional gravity field: 70 km filter*



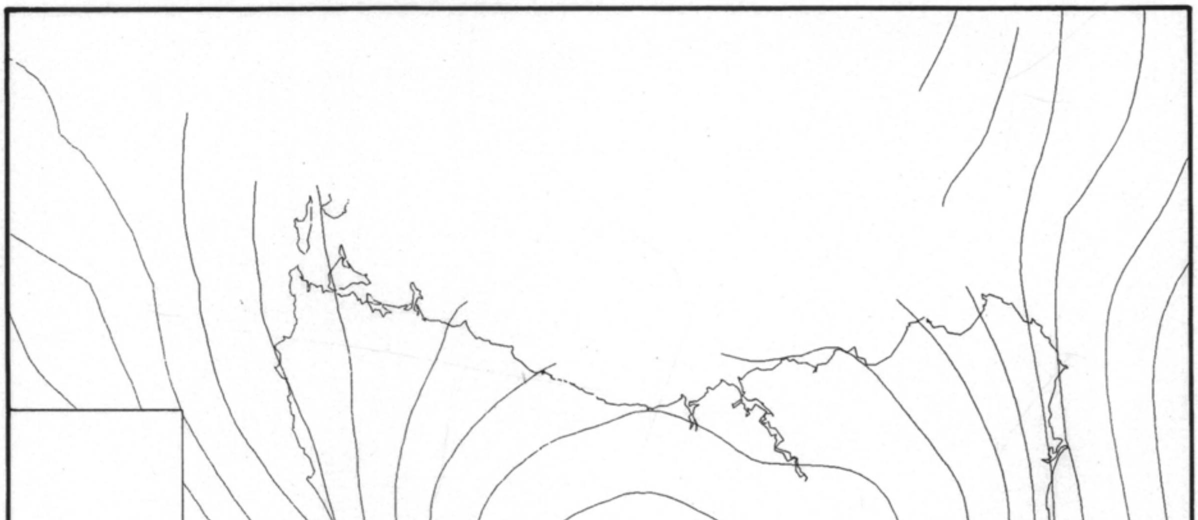


Figure 4c. *Regional gravity field: 100 km filter*

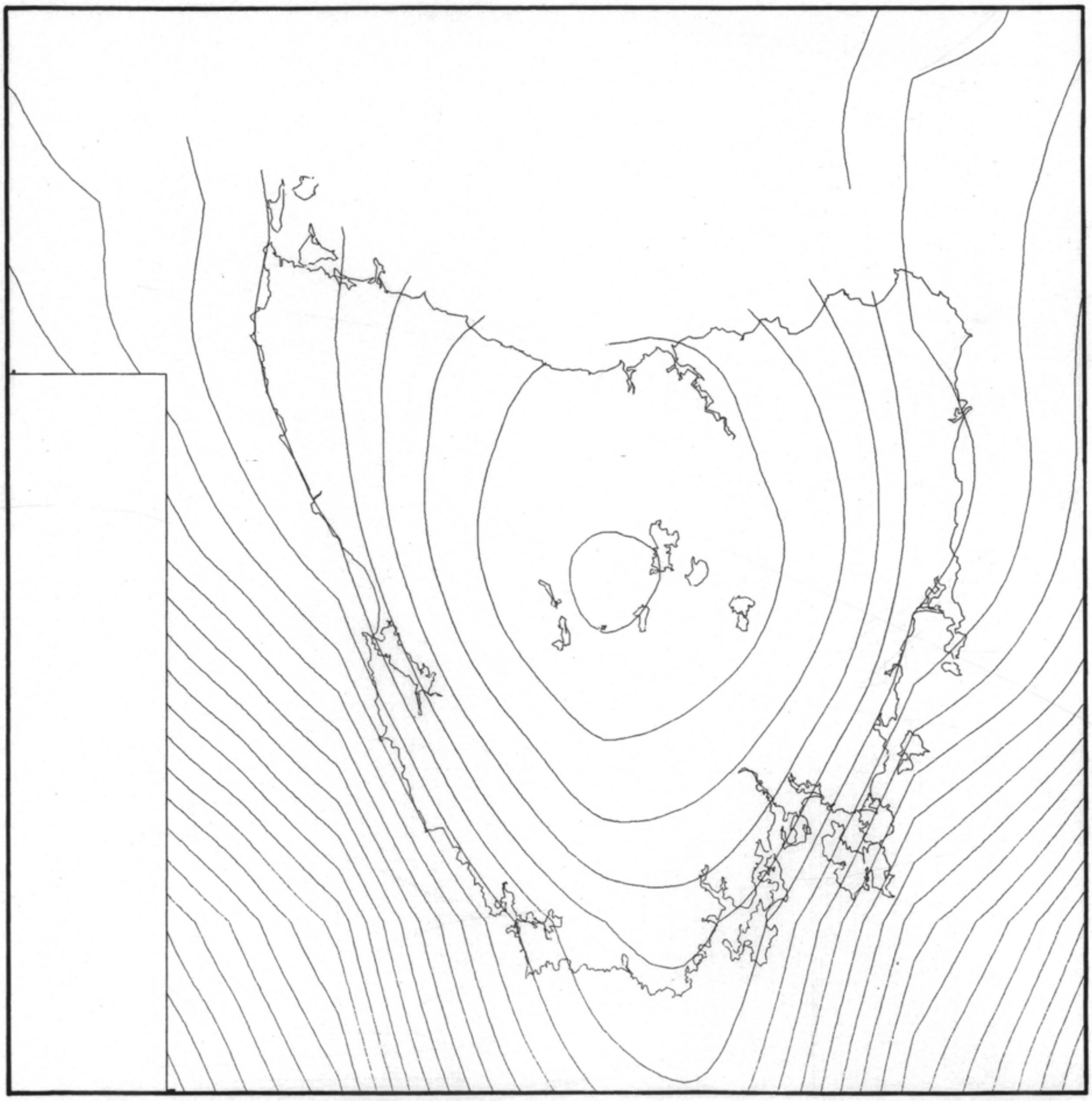
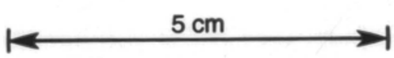


Figure 4d. *Regional gravity field: 150 km filter*



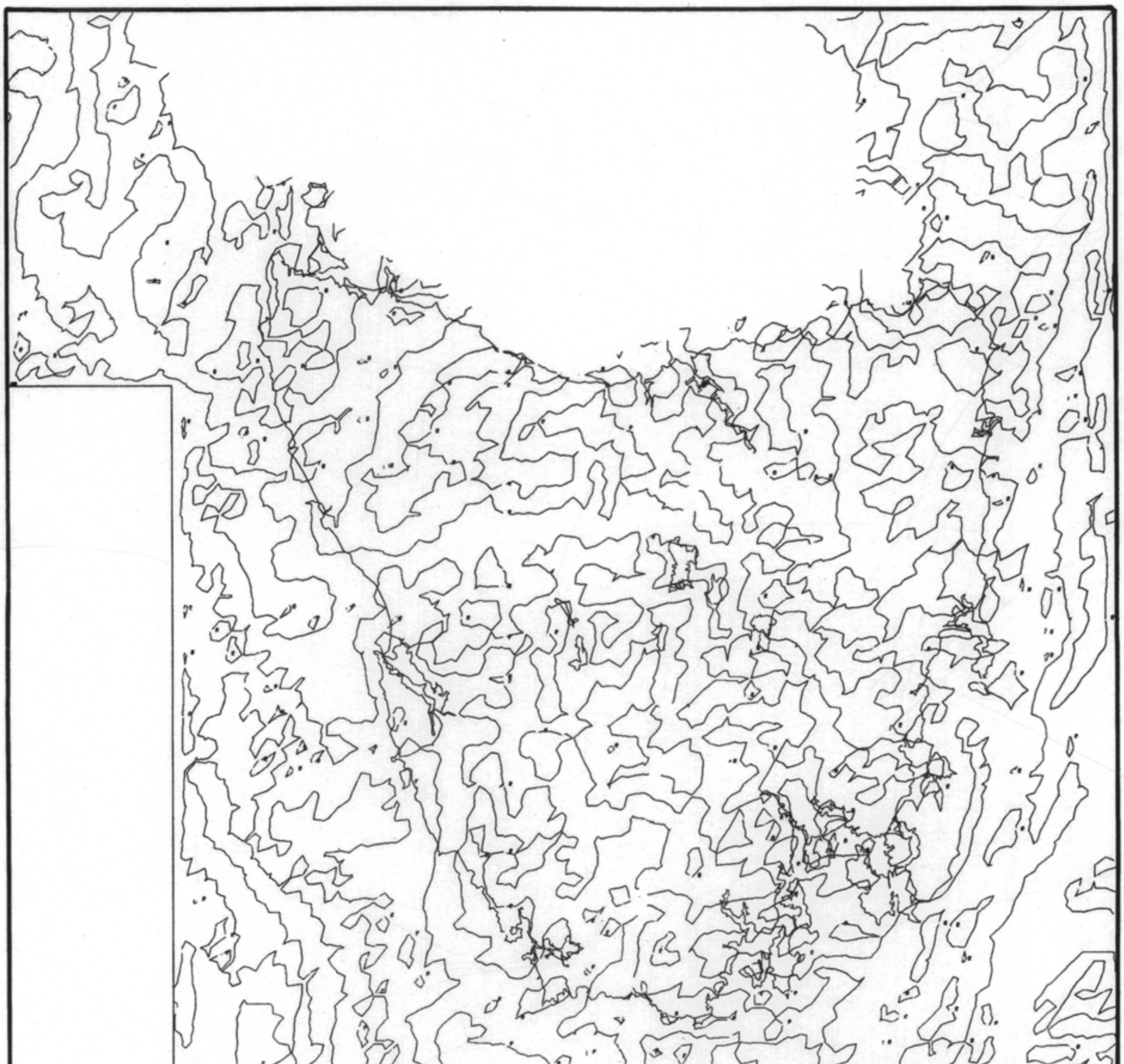


Figure 5a. *Residual gravity field: 10 km filter*

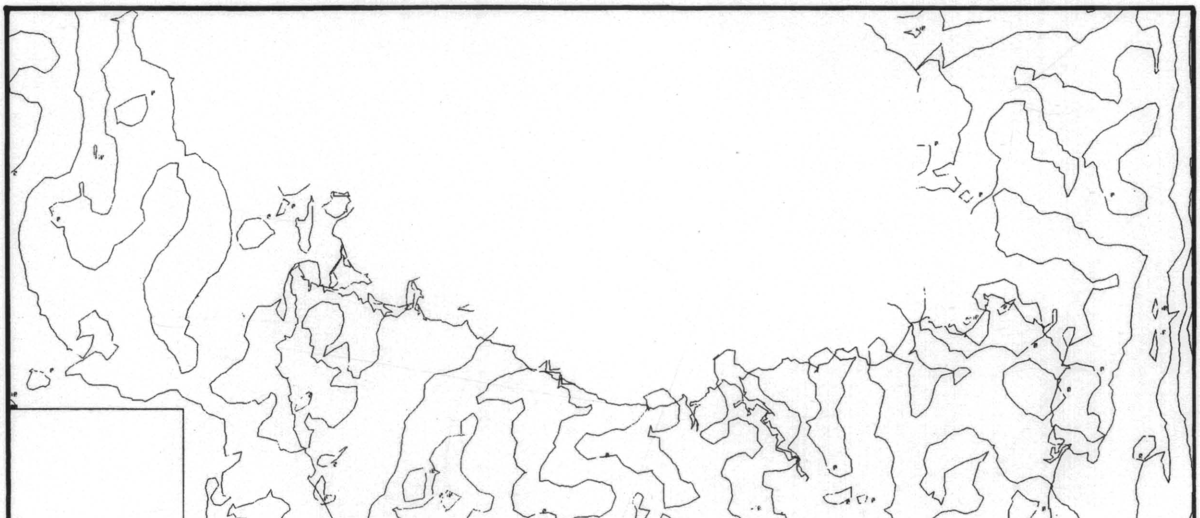


Figure 5b. *Residual gravity field: 20 km filter*

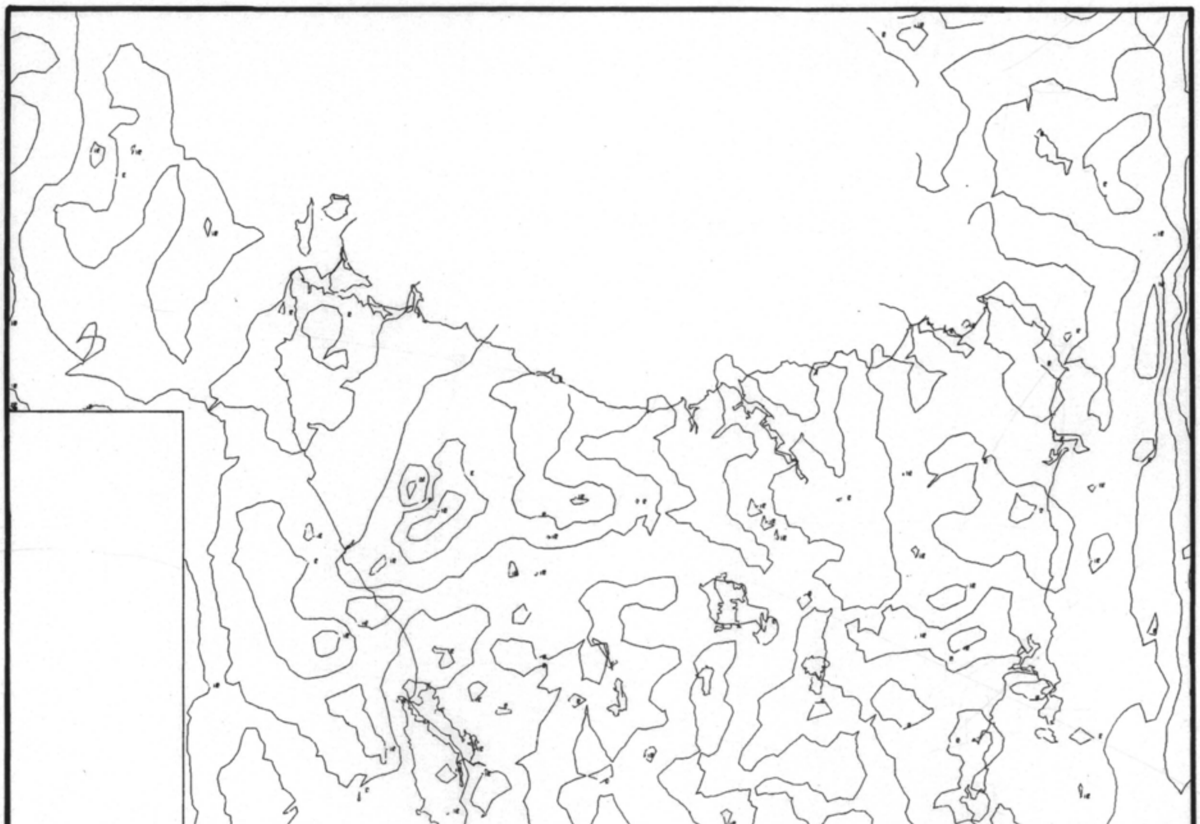


Figure 5c. *Residual gravity field: 30 km filter*

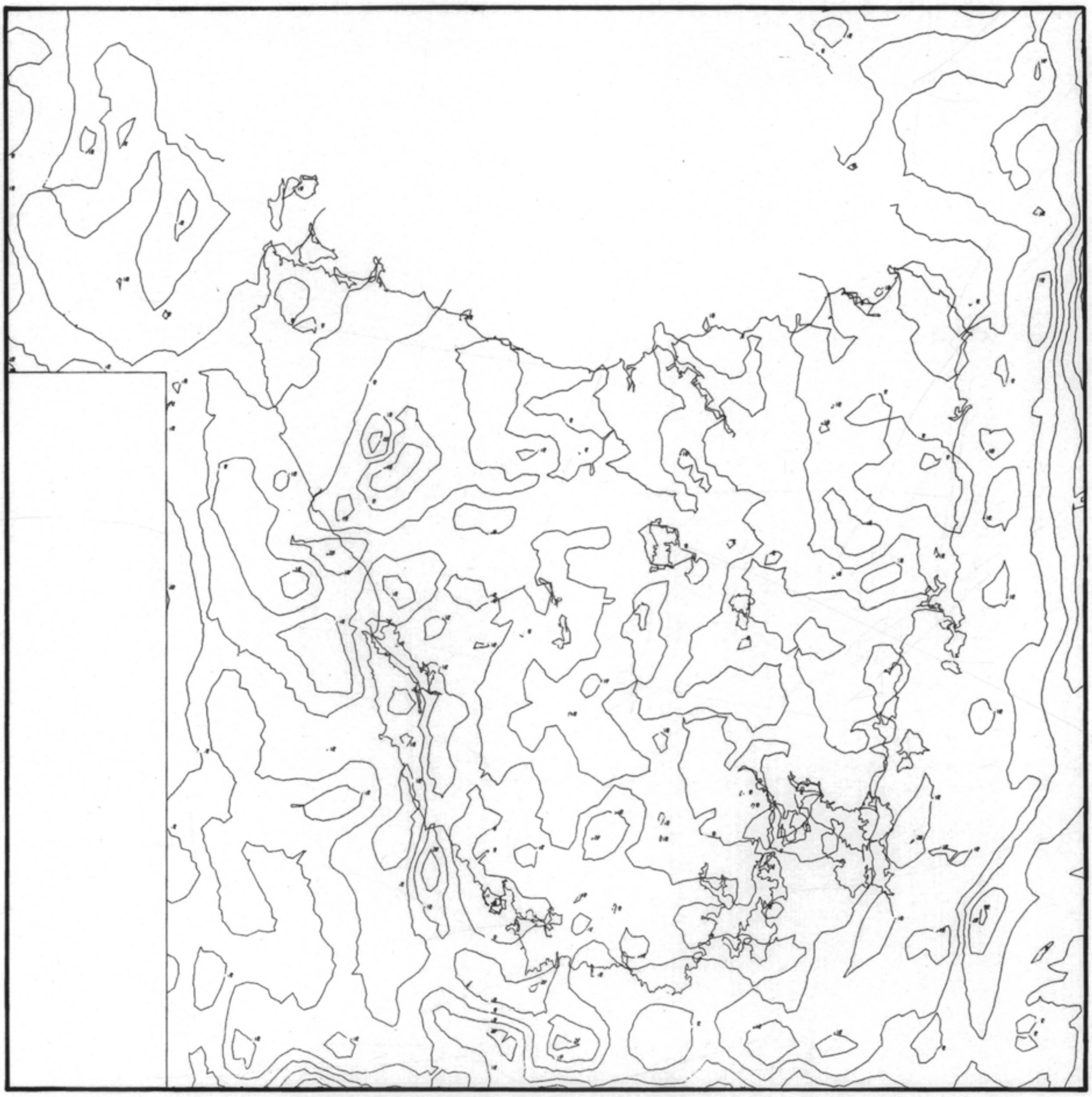
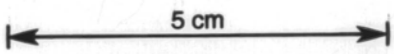


Figure 5d. *Residual gravity field: 40 km filter*



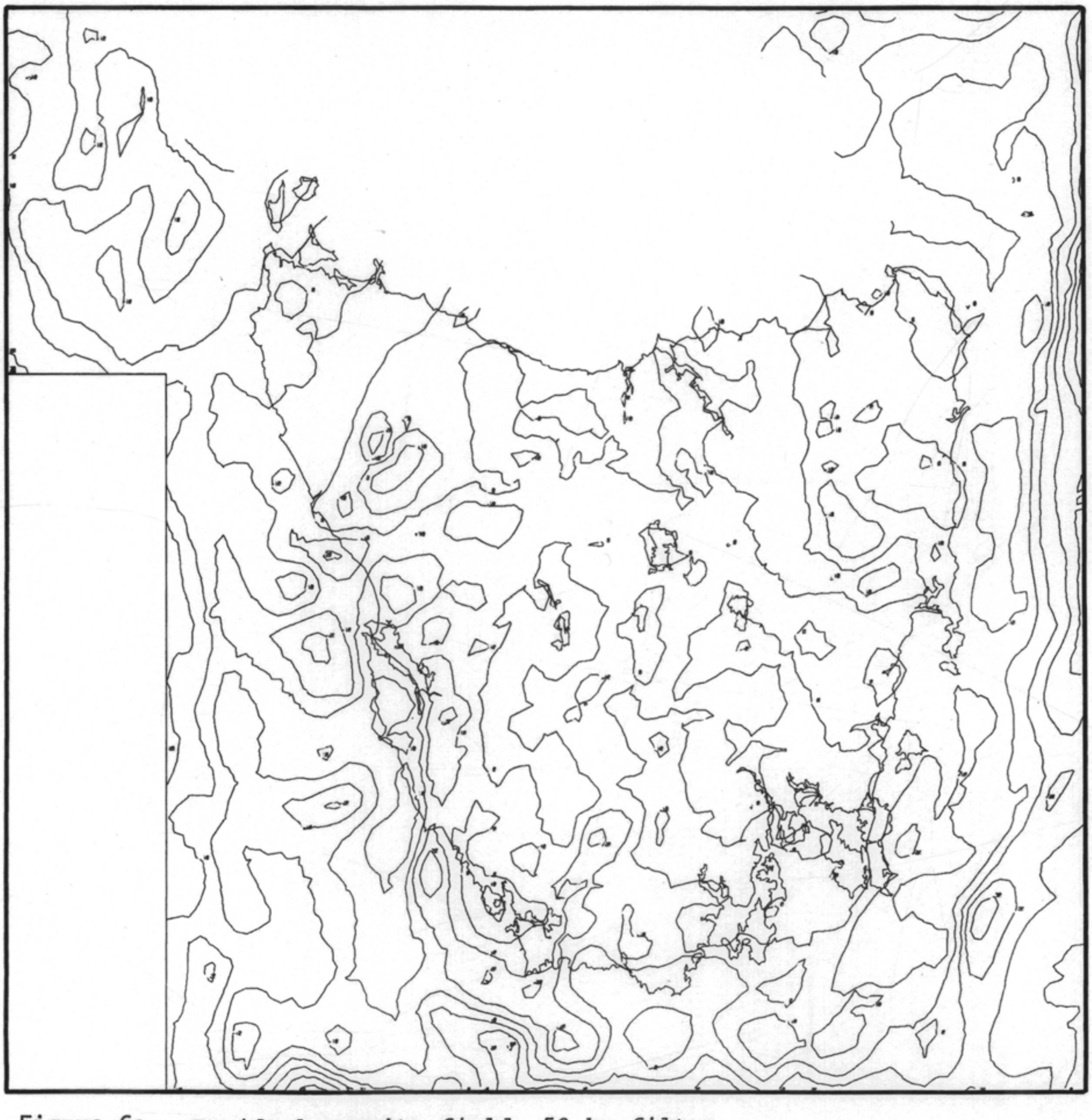


Figure 6a. *Residual gravity field: 50 km filter*

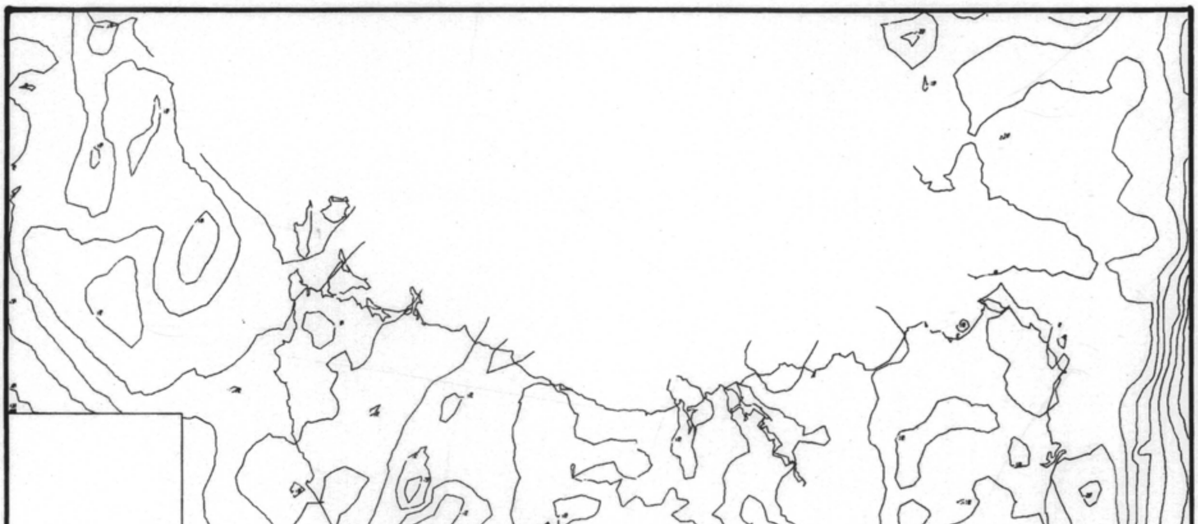
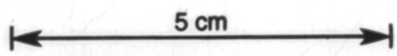


Figure 6b. *Residual gravity field: 70 km filter*



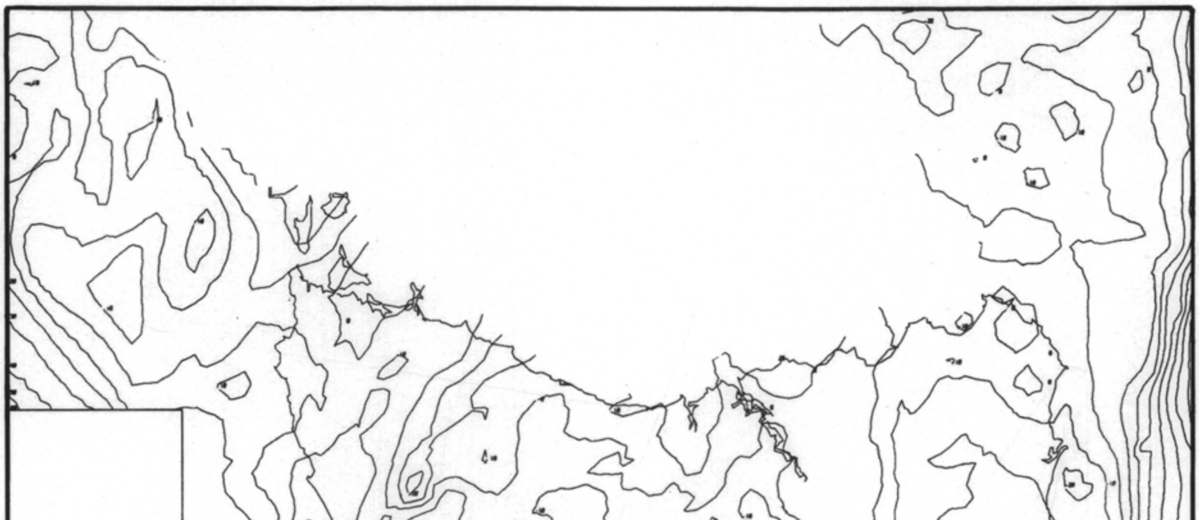


Figure 6c. *Residual gravity field: 100 km filter*

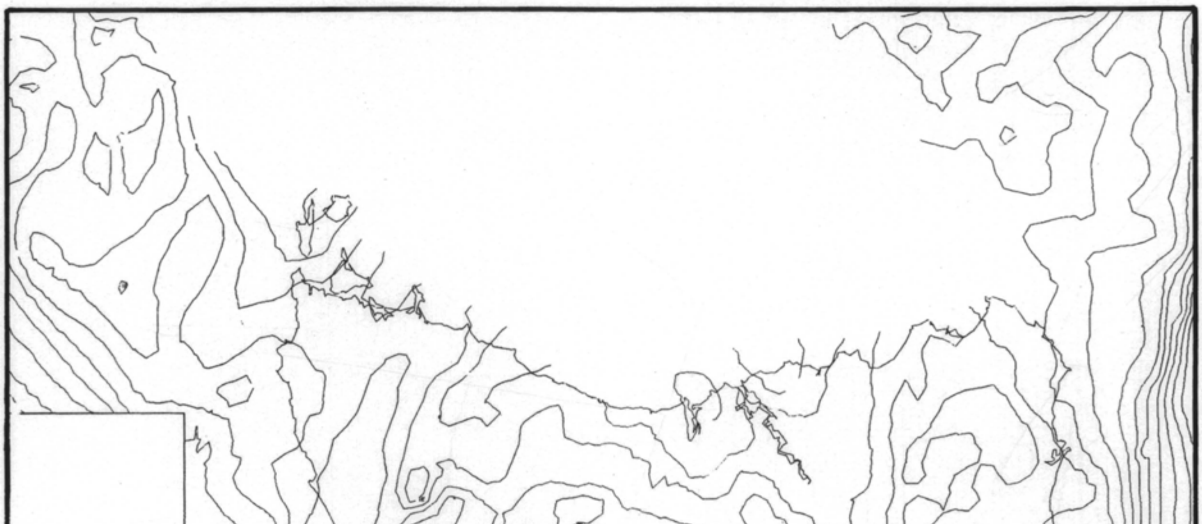


Figure 6d. *Residual gravity field: 150 km filter*

Structures 2A, 2B, 3, 14, and 17 are clearly different. 2B and 3 are relatively shallow and readily correlated to the belt of Whyte Schist (2B) and Heazlewood ultrabasic complexes (3). The couplet anomaly (3) is produced by juxtaposition of the Meredith Granite. Structure 14 relates to the predominantly Cambrian block juxtaposed against the pre-Cambrian southwest Tasmania block. Unfortunately the contact zone is not well exposed and the covering Tertiary materials enhance the gradients observed. Structure 17, although not well defined, is apparent in many averages. It may reflect a major intracrustal fault or the effect of topography. Examination of topographic maps of Tasmania on the same scale and with contour intervals of 100-200 m show a strong E-W trend in this position.

The foregoing discussion implies that a large part of the character of the smoothed gravity field, as represented by regionals larger than the 30 km averages, is granite-pluton induced, either by presence or absence. The body of the interpretation examines this possibility.

Model interpretation

The interpretation of the gross features of the Tasmania region is based on a three part model.

(i) the ocean basins
(ii) the crust/mantle profile
(iii) major anomalous crustal masses

The attraction of each part of the model has been calculated using three dimensional procedures based on the slice method of Talwani and Ewing (1960). The effects of each slice in the model, which may be any shape, are summed at a regular grid of calculation points and the resultant sum contoured. The contoured calculated field has then been compared with the 30 km average field.

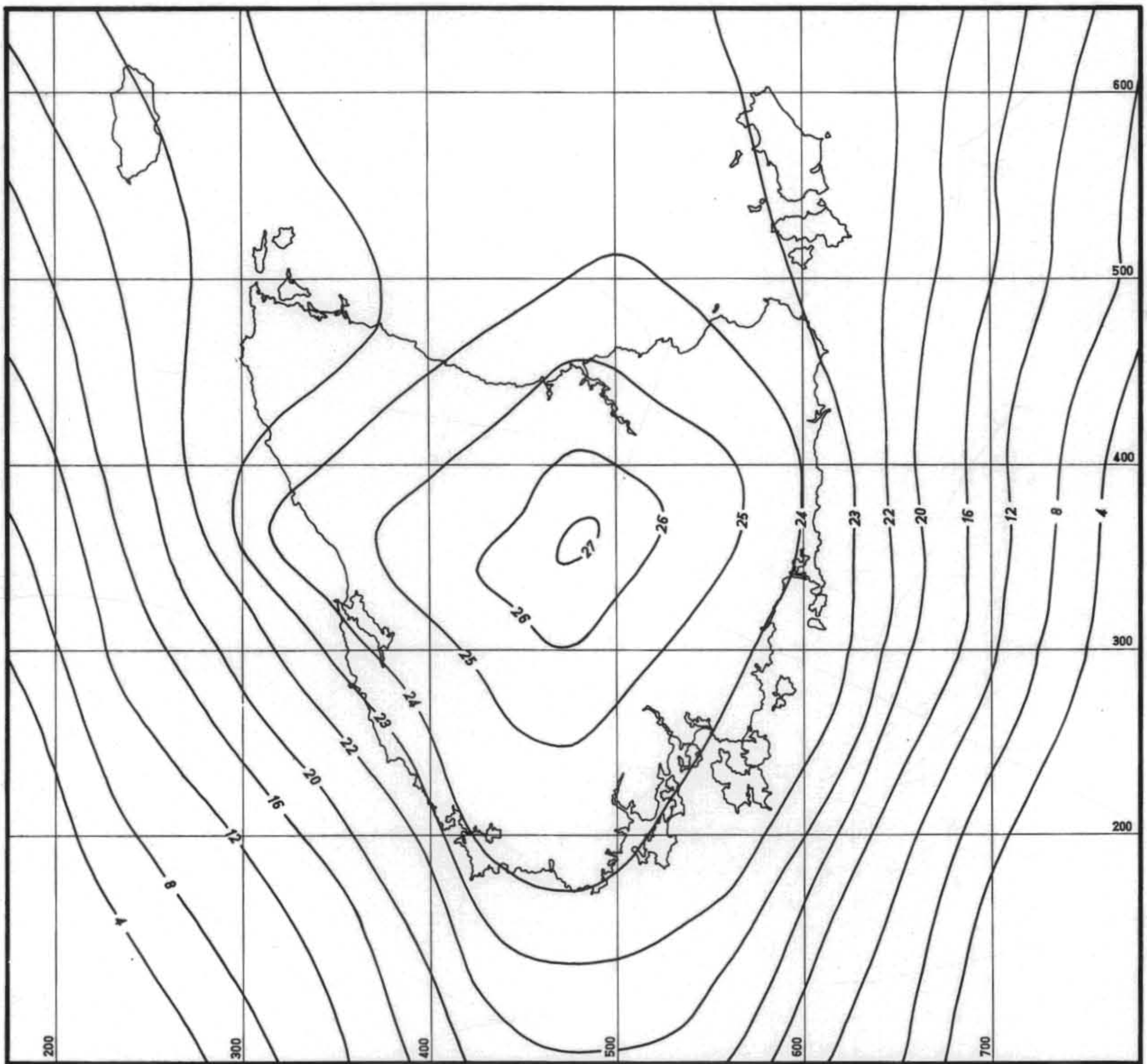
Initial models were unrestricted in terms of densities used, or layer depths estimated, even though the observed field data had been reduced using a density of 2.67 t/m^3 which is probably appropriate only for the near surface materials. It is not a valid density to use for the crust as a whole or even the upper half of the crust. Values between 2.72 and 2.85 t/m^3 have been used instead. Granitic masses of crustal scale have been modelled using densities of 2.62 t/m^3.

The entire interpretation has been based on Bouguer anomalies. Consequently the shape and water content of the ocean basins has also been included. Two problems have been introduced as a result.

(1) The Bouguer reductions originally made presume two dimensional conditions at the depth incorporated in the correction. Since no terrain correction has been applied, a variable error occurs for those observations over the continental slope due to a combination of the presumption and the omission.

(2) Bathymetry control is essentially limited to the survey lines and substantial interpolations are often needed. Since the slope profile contributes a considerable anomaly, any errors tend to be magnified.

As a consequence good anomaly correlations were not expected in the region of the continental slope, nor regarded as essential to a sound interpretation, provided a good match was achieved over Tasmania and the overall anomaly relief was appropriate. In fact, good gradient matching over the

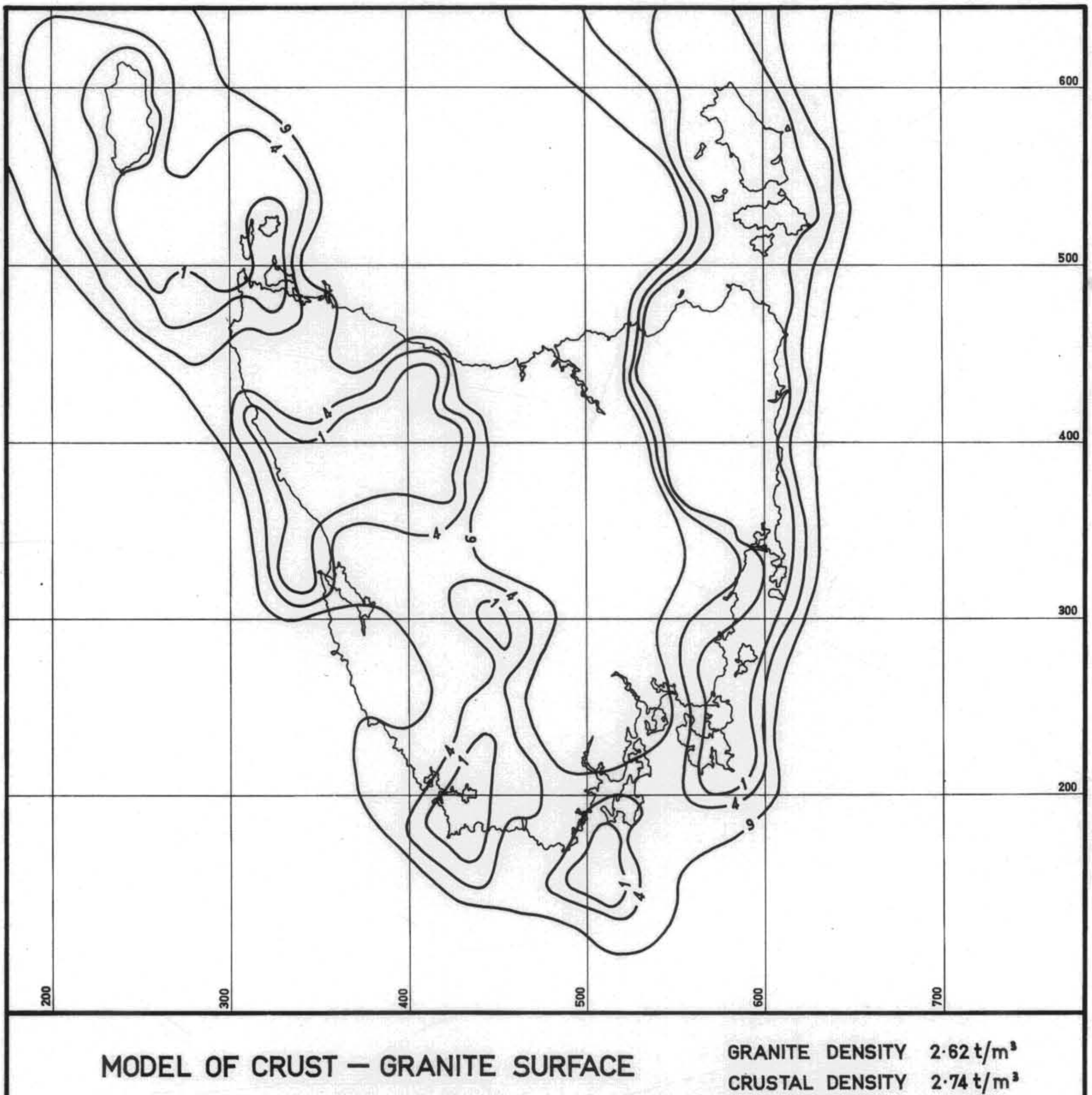


MODEL OF CRUST-MOHO SURFACE

CRUST DENSITY 2·74 t/m³
MANTLE DENSITY 3·34 t/m³

Figure 7.

5 cm


600
500
400
300
200
200
300
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500
600
700
1
4
9
MODEL OF CRUST — GRANITE SURFACE
GRANITE DENSITY 2·62 t/m³
CRUSTAL DENSITY 2·74 t/m³

Figure 8.

5 cm

slope was never approximated even though several attempts were made to improve the bathymetry model.

The key tests, therefore, of any interpretation were

(1) Matching overall anomaly contrast from ocean basin to central Tasmania.
(2) Restriction of appropriate anomaly contrasts to two ranges -
  (*a*) within the 100 m contour sea depth,
  (*b*) over the continental slope and ocean basin.
(3) Achievement of general anomaly form for continental Tasmania, including the gross effects of the primary features.
(4) Checks that the densities and depths implied are consistent with available seismic data.

Only the final interpretation is presented here (figs. 7 and 8). It is not claimed that the model presented is definitive or that similar results might not be obtained with slight variations in depth range, shape or density contrast. However, two specific criteria, apart from the gross aspects listed above, have been used to judge the acceptibility of any model. These are

(1) that gradients be of the right magnitude and orientation, and
(2) that the resultant field distribution should agree within 50-100 $\mu m/s^2$ of the 20/30 km regional smoothed field.

No fine detail has been included in the models since a gross structural interpretation was desired. It could not be justified in any event since the effects of topography, terrain corrections and shallow sources cannot be readily assessed on this scale, and the station coverage is inadequate to define them.

Little published seismic data is available for Tasmania (Dooley, 1976; Dooley, 1977; Ripper, 1963; Underwood, 1969; Johnson, 1972). General conclusions may be summarised: Crustal thickness, 27.6 km maximum; mantle density, 3.28 t/m^3; mantle velocity, 7.84 km/s; P_1 velocity 5.9-6.0 km/s. Johnson (1972) also suggested that the crust varied in thickness from about 20-25 km under southern Bass Strait to 30-35 km under central Tasmania. The Bass Strait Upper Mantle Project also suggested a higher mantle velocity (8.0 km/s).

Other unpublished data offer no further resolution due to signal noise problems, range of coverage and equipment difficulties (*e.g.* Webster, 1976; Knight, 1972; Cameron, 1971). However P_1 values of 5.9, 5.73, and 5.4 km/s respectively were observed and a crustal thickness of at least 29 km implied near Savage River. Note that many of these values are not independent, nor free of assumptions. Further, the crust is layered and a range of densities is likely. Light upper crustal materials are known to fall in the range 2.65 to 2.70 t/m^3, while oceanic/lower crust has values of the order of 2.85 t/m^3. Estimated values for the upper mantle range between 3.26 and 3.46 t/m^3, although 3.35 is a median value.

Specifications for the various trial models are given in Table 1. It will be noted that these encompass the range of seismic indications, but explore some other aspects as well.

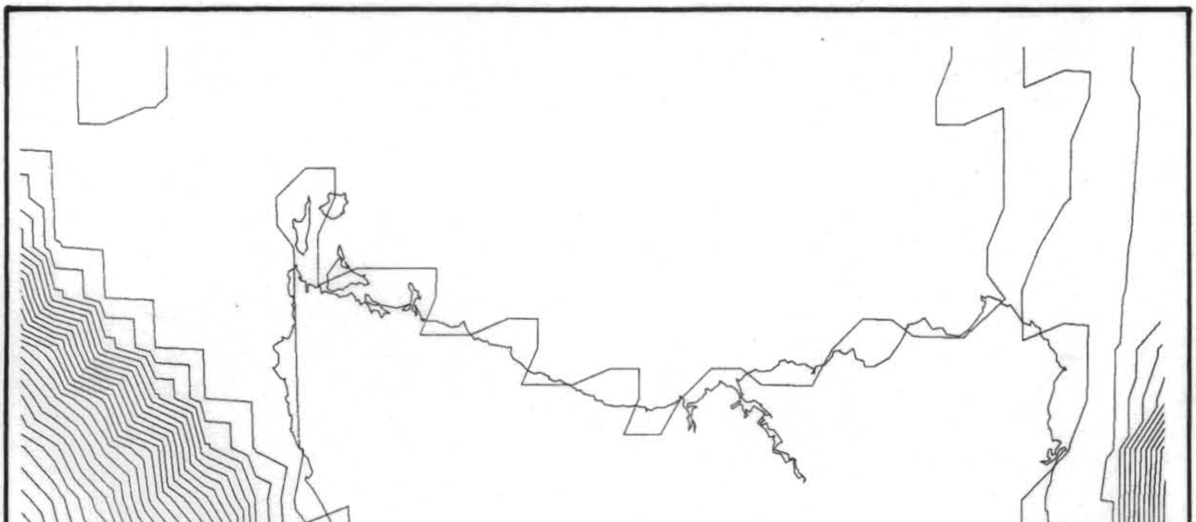


Figure 9. *Attraction of water section of model*

Contour interval 10 mgal
0 contour approximates coast

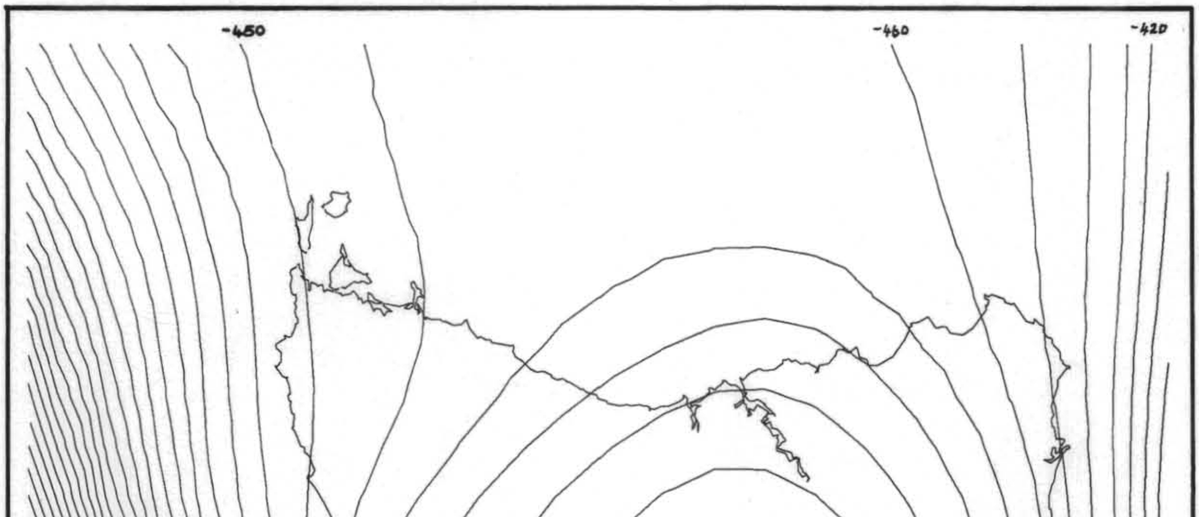


Figure 10. *Attraction of Moho section of model*

Contour interval 10 mgal

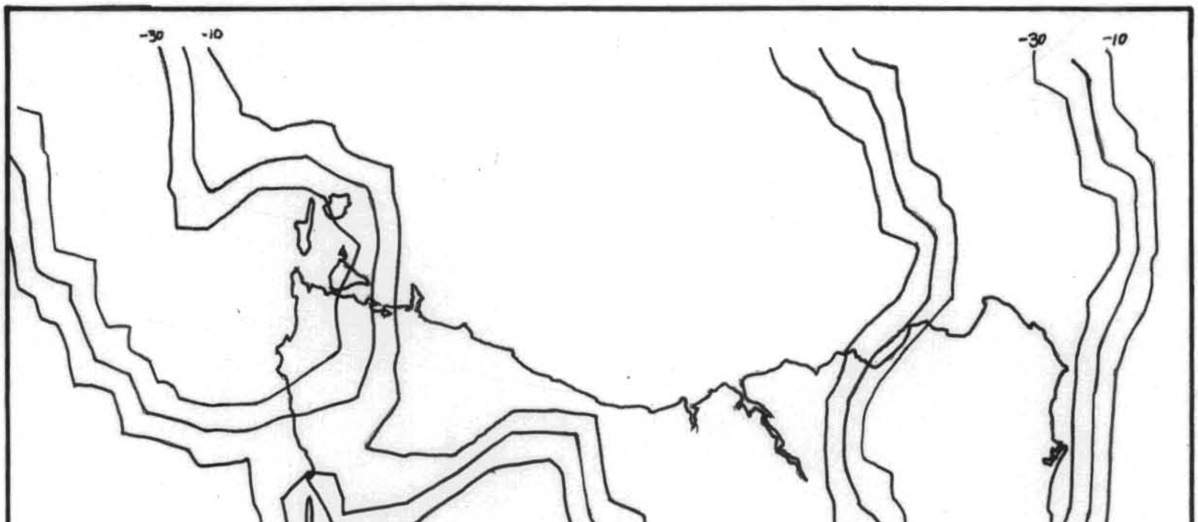


Figure 11. *Attraction of batholith section of model*

Contour interval 10 mgal

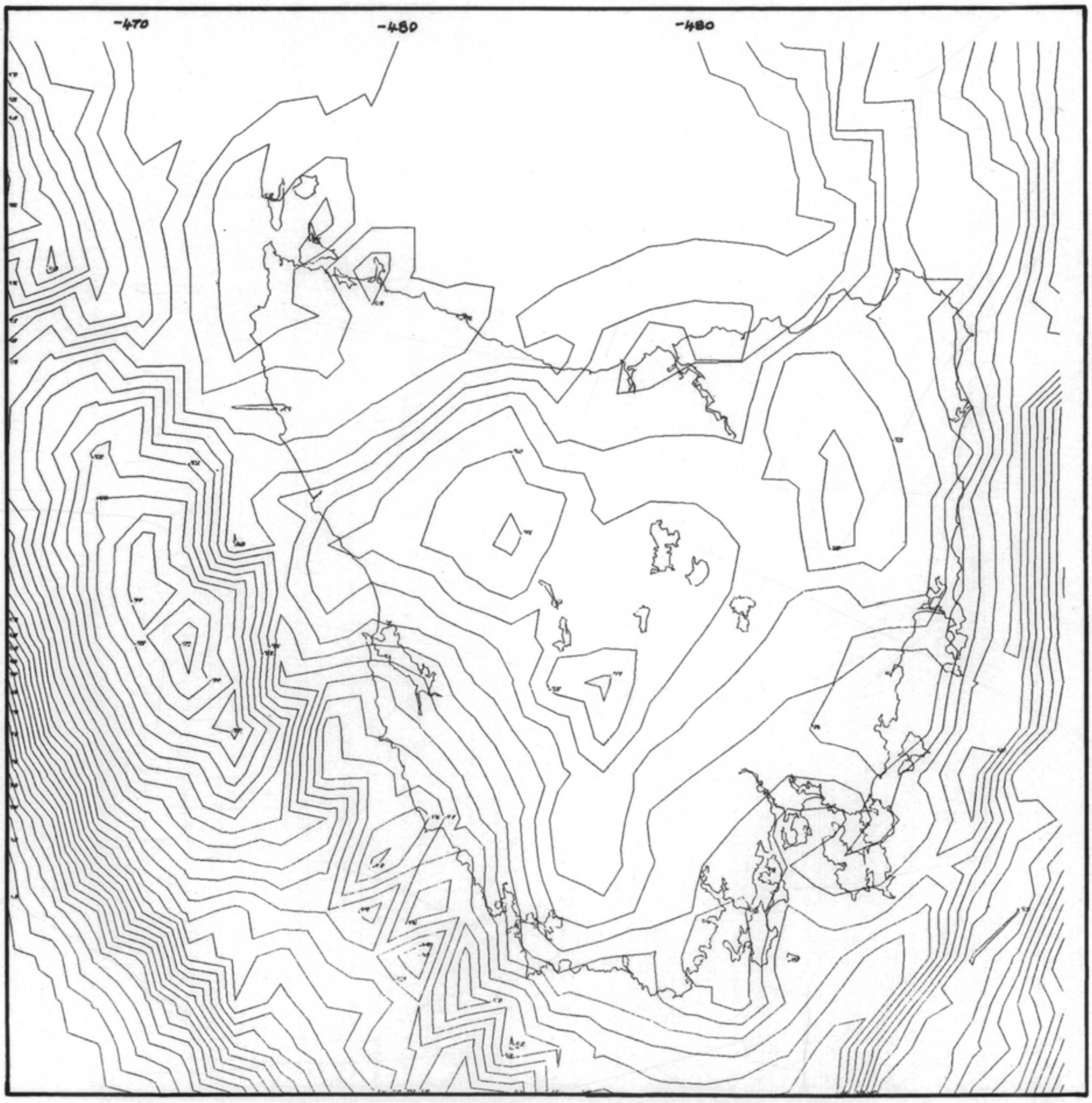


Figure 12. *Resultant attraction. Combined model*

Contour interval 10 mgal

5 cm

01/31

Table 1. SPECIFICATIONS OF TRIAL MODELS

Model	Density (t/m³)						Crust relief range (km)	Model type
	Water	Granite	Crust top	Crust	Crust base	Mantle		
1	1.03				2.85	3.30	29-35	Moho
2			2.65		2.85		8-12	Intracrust
3					2.85	3.30	18-28	Moho
4			2.65		2.85		10-12	Intracrust
5				2.85		3.30	16-26	Moho
6				2.85		3.30	13-27	Moho
7				2.85		3.30	12-26	Moho
8			2.65		2.85		4-10	Intracrust
9				2.78		3.28	5-27	Moho
10				2.78		3.28	5-27	Moho
11		2.62		2.74			1-10	Intracrust
12		2.62		2.74			1-9	Intracrust
13				2.74		3.34	5-27	Moho
14		2.62		2.74			1-9	Intracrust
15				2.74		3.34	4-27	Moho
16		2.62		2.74			1-9	Intracrust
17		2.62		2.74			1-9	Intracrust
18				2.74		3.34	4-27	Moho
19				2.74		3.34	4-27	Moho
20		2.62		2.74			1-9	Intracrust

Models designated 'Moho' include an interface representing the upper mantle, whereas models marked 'Intracrust' include either internal layers or batholiths within the crust. Models 2, 4, and 8 included a subhorizontal crustal layer (2.65/2.85), whereas models 11, 12, 14, 16, and 17 have included vertical discontinuities (granite batholiths) within a uniform, unlayered crust. Clearly these models incorporate gross structural simplifications. However, a sufficient range of features has been considered to assess the impact of the various features.

Various models have been combined during the interpretive process and compared with the 20 or 30 km regional. Not indicated in the table are three bathymetry models. While the differences between the bathymetry models have been slight, substantial changes have been made in the Bouguer anomalies over the continental slope. It has not been possible either to accurately define the bathymetry, nor provide a universally good match of the gradients over the slope. Parts of various models do, however, yield the appropriate gradients and anomaly relief. Deficiencies in the region of the continental slope have not generally led to the absolute rejection of any model.

Early models (1, 3, 5, and 7) explored the possibility of a relatively low relief Moho interface at about the indicated depth (25-30 km). It may be concluded that with any reasonable density values (2.7-2.85 t/m^3 for crust, 3.2-3.5 t/m^3 for mantle), such solutions are impossible.

Similarly, test evaluations using a layered crust (models 2, 4, and 8), have shown that while this option is possible, perhaps likely, it is not easily resolved gravimetrically and is not as significant as the batholithic option. The batholithic option (models 11, 12, 14, 16, 17, and 20) is based on the fact that batholiths do occur - especially in the north-east - and that substantial anomalies are related (*e.g.* 3b, 7, 15A).

Models incorporating sizeable, discrete batholiths with a 9-10 km root yield anomaly variations and gradient changes of the order of 350 μm/s^2. No layered model of the crust can generate variations of this magnitude. Consequently the impact of the batholithic models has been examined in more detail.

Comparison of models 1, 3, 5, 6, 7, and 9 has revealed that the major density contrasts must exist at very shallow depths under the ocean basins, and that the overall depth range is in excess of 20 km, given the densities used. Models 10 and 13 represent minor variations of model 9, while models 7, 9, 10 and 13 investigated the effect of small density changes for both crust and mantle. Models 9 and 10 yielded the appropriate anomaly contrast when coupled with the bathymetry models, and the addition of the effects of batholiths led to a recognition of the role of such structures in shaping key parts of the gravity field. In particular the forms indicated by anomalies 7, 8B, 12, 13 and, to a lesser extent, 18 were established, and the tear drop distortions of the triangular first order form were revealed. The combination of models 9/10 + 11/12 or 12 + 13 indicated for the first time all the desired first order features.

Models 15, 18, and 19 were refinements of the major surface and models 14, 16, 17, and 20 were variants of the batholith distribution.

It could be argued that the average crustal density used is too low and that in consequence the relief of the major interface may be decreased from about 23 km to about 20 km (density from 2.74 to 2.85 t/m^3). Similarly the root depth for the granite masses would be reduced from about 9-10 km to around 7.5-8 km. The density of the exposed materials is the only established value; sampling suggests a uniformity of result which places it beyond reasonable doubt for this discussion. Either value is certainly inside the range implied by the frequency analysis tabulated earlier.

Refinements in models 18 and 19 have been directed at production of particular gradients, especially north-west and south-west of anomaly 18. These variations have involved smoothing and reduction of interface relief and displacement of the deepest part eastward.

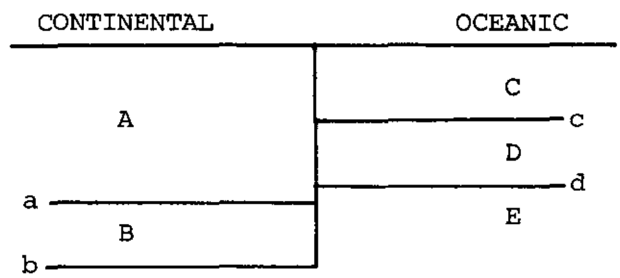
Variants in models 14, 16, and 17, however, have suggested that many key gradients are batholith related and that granitic material is more common in the upper crust than previously thought, even though outcrops, albeit small ones, occur widely. Figure 8 indicates the preferred distribution. It has marked consequences for mineral exploration since it suggests that many of the intrusives in the west and north-west of the state are interrelated and part of a single igneous complex. Most exposures are merely roof projections of much larger bodies.

A clearer insight may be given by the simplistic two dimensional analysis shown in Table 2; this provides the calculation limits for continental and oceanic profiles as specified. As such it reinforces the conclusion that layer D must be less than 5 km thick and that the lower continental crustal density is probably a little lower than first thought. The table clearly shows the types of field interactions possible and although it must understate the depth extent of the continental mass (three dimensional rather than two dimensional shape) it indicates the principal characteristics. It also shows the relative sensitivity of any model to small changes in the level of interface C/D or D/E and the insensitivity to changes in base level.

The two and three-dimensional analyses suggest that if the seismic

Table 2. TWO DIMENSIONAL ANALYSIS OF MODELS

Model	Density (t/m^3)					Depth (km)				Approximate anomaly differences $(\mu m/s^2)$ AB to CDE
	A	B	C	D	E	a	b	c	d	
1	2.67	2.77	1.03	2.87	-	10	30	5	30	-1970
2	2.67	2.77	1.03	2.87	3.37	10	30	4	10	+2850
3	-	2.77	1.03	2.87	3.37	-	30	4	10	+2410
4	-	2.77	1.03	2.87	3.37	-	30	4	7	+3030
5	-	2.87	1.03	2.87	3.37	-	30	4	7	+1830
6	-	2.87	1.03	2.87	3.37	-	27	4	7	+1220
7	-	2.77	1.03	2.77	3.37	-	27	4	7	+2230
8	2.67	2.77	1.03	2.87	3.37	10	27	4	7	+2730
9	2.67	2.77	1.03	2.87	3.37	10	28	4	7	+2980
10	2.67	2.87	1.03	2.87	3.37	10	28	4	7	+2240
11	2.67	2.87	1.03	2.87	3.37	10	28	4	6	+3170



interpretation is valid, that the crustal density must average 2.74 t/m^3 or less, that the oceanic base density is at least 2.87 t/m^3 and that the mantle density is at least 3.37 t/m^3. Lateral variations are restricted within these range limits.

Minor variations will be noted between such implied values and those actually used in the models. Unfortunately the gravity processing is unable to unambiguously resolve any extant differences. As mentioned above no model is final and no model on this scale with data of the quality used can resolve all the features displayed. A further example of this may be observed by comparison of the impact of the batholith model specification. Many of the bodies outcrop and a one kilometre deep first slice is used. Since many exposures are virtual roofs and the next slice is at four kilometres, gradient errors can easily be introduced. These are apparent, for example, for the postulated intrusive in western Storm Bay.

CONCLUSIONS

(1) Relief on the Moho in the Tasmania region is at least 20 km. If any allowance is made for lighter continental materials under Tasmania this value may be increased to about 23 km. However, if such light materials are absent beyond the continental slope, and the normal crustal density beneath the ocean basins is about 2.85 t/m^3, then the total relief of the 2.85/3.35 t/m^3 interface remains 20-21 km.

(2) The crustal thickness, including water, in the ocean basins is in the range 5-8 km, depending on whether a two density model is used for the continental crust.

(3) The maximum crustal thickness under Tasmania is about 27 km with a lateral relief toward the coast of about 5 km - values deduced from a range of density contrasts, and simple layering yields a variation of no more than 2-3 km. However, the seismic data would suggest by agreement that layering is not a significant feature.

(4) The second order gravity field components are controlled by extensive batholithic masses of granitic materials. These effectively control the shape of the island of Tasmania and the wrench faulting which has taken place along the lines of the current continental slope. These bodies have root depths not exceeding 9-10 km. Anomalies 1, 3, 7, 8B, 9, 12, 13, 15, and 18 are directly related to them. Positive embayments such as 10, 11, 14, 15B, and 16 are indirectly related and reflect their absence (refer fig. 2).

(5) Several anomalies have very shallow post-Mesozoic sources (5 and 8A, 6 and 14 in part), whereas others are related to major sedimentary or igneous piles. 2A and 4 are related to section thickenings of 4-6 km. Anomaly 3 (western part) reflects the large ultramafic complex at Heazlewood. However most of the effect of the latter is shallowly derived and enhanced by contrast with the nearby Meredith Granite.

(6) Anomaly 17 is probably not real and appears to be related to the topography of the island. Resolution of anomaly 6 is most unsatisfactory. The structure appears to represent a zone of strike faulting as suggested by low frequency trends in the Tamar region. However, it has been exhumed by more recent faulting and concealed by subsequent sedimentation. Structurally induced contrasts persist at least halfway through the crust, but shallow to the south-east.

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[8 October 1980]

APPENDIX 1

Notes on nomenclature

Fraser (1976) has suggested four gravity province names which were recommended for use by other authors in the Tasmania region. These were

(1) Bass Regional Gravity Platform - essentially Bass Strait between King and Flinders Islands.
(2) West Tasmanian Regional Gravity Ridge - a belt of positive free-air anomalies associated with the west coast continental slope.
(3) East Tasmanian Regional Gravity Ridge - a belt of positive free-air anomalies associated with the east coast continental slope.
(4) Mersey Regional Gravity Complex - the remainder of Tasmania.

These features have been recognised in the maps of Symonds and Wilcox (1976). None have been used in this report.

The reasons are simply stated

(1) Little data is available from the Bass Strait Region and it has therefore been largely ignored in the interpretive process.
(2) The Ridges are only 'ridges' of free-air anomalies and do not exist in any Bouguer anomaly presentation. In the latter case the term 'gradient' would be more appropriate.
(3) The term 'Mersey' is considered inappropriate since it covers most of Tasmania. On the regional scale used by Fraser a more appropriate title would be 'Tasmania Regional Gravity Complex'. The present authors recommend a change of name for this division in the list of provinces.

    Furthermore, the term is of no use, where internal features are being examined and it has therefore not been used.