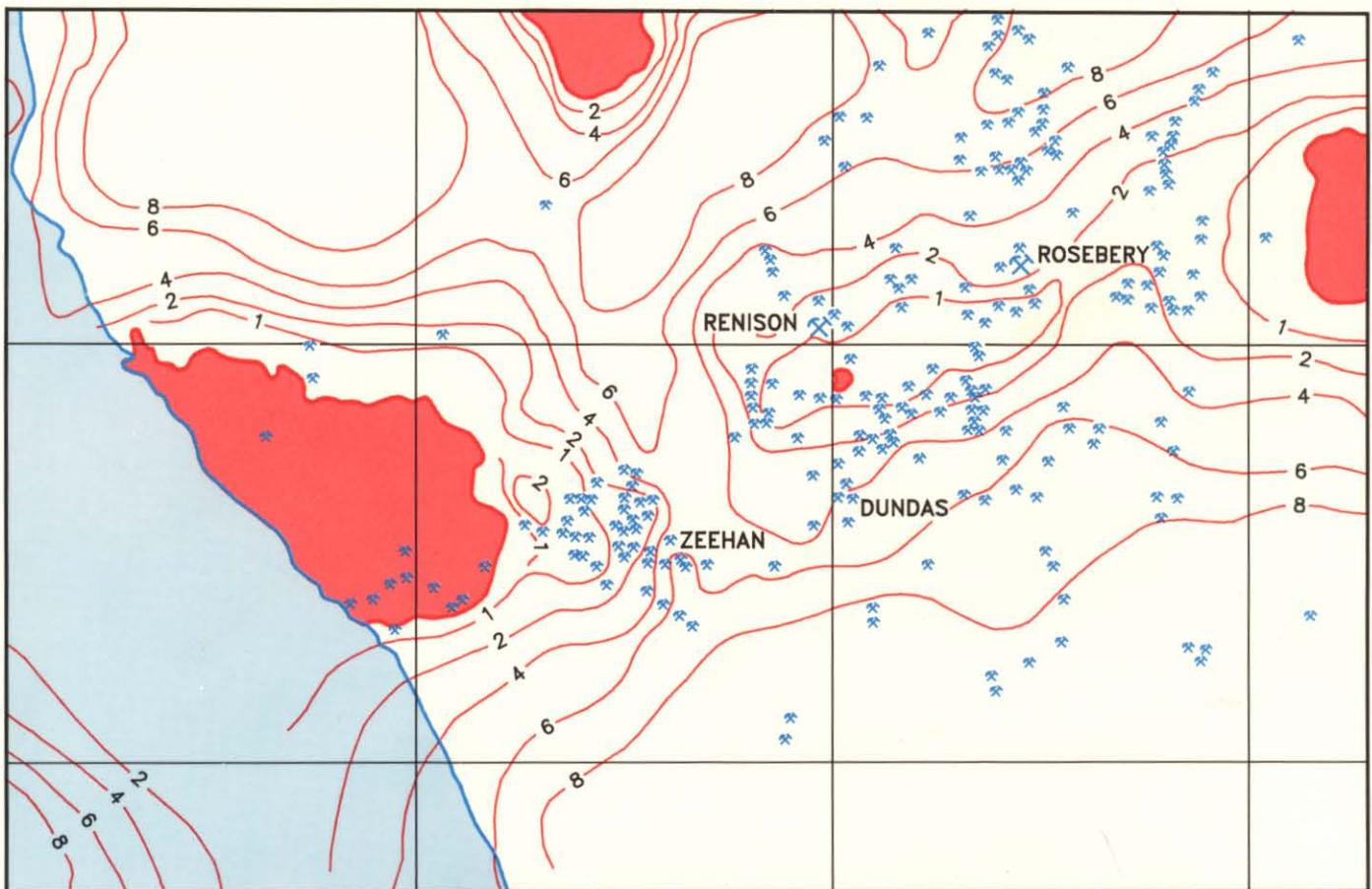


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GEOLOGICAL SURVEY
BULLETIN 66

The granites of west and north-west Tasmania—a geophysical interpretation



TASMANIA DEPARTMENT OF MINES

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The granites of west and north-west Tasmania—a geophysical interpretation

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CONTENTS

	<i>Page</i>
ABSTRACT	7
SPECIAL NOTE	7
Introduction	7
Data and methods	9
CHAPTER 1	13
Granite Tor Granite	13
<i>Interpretation</i>	13
Line 3	13
Line 4	13
Line 6	13
Line 16	13
<i>Mineralisation and exploration</i>	14
<i>Summary</i>	14
CHAPTER 2	20
Pieman Granite	20
<i>Interpretation</i>	20
Line 4	20
Line 11	20
Line 14	20
Line 15	20
<i>Mineralisation and exploration</i>	21
<i>Summary</i>	21
CHAPTER 3	27
Grandfathers Granite	27
<i>Interpretation</i>	27
Line 6	27
Line 7a	27
Line 20	28
<i>Mineralisation and exploration</i>	28
<i>Summary</i>	28
CHAPTER 4	33
Timbertops Granite	33
<i>Interpretation</i>	33
<i>Mineralisation and exploration</i>	34
<i>Summary</i>	34
CHAPTER 5	39
Elliott Bay Granite	39
<i>Interpretation</i>	39
<i>Mineralisation and exploration</i>	40
<i>Summary</i>	40
CHAPTER 6	46
Darwin Granite	46
<i>Interpretation</i>	46
Line 9	46
Line 23	46
Line 435	47
<i>Mineralisation and exploration</i>	48
<i>Summary</i>	48
CHAPTER 7	56
Murchison Granite	56
<i>Interpretation</i>	56
<i>Mineralisation and exploration</i>	57
<i>Summary</i>	57
CHAPTER 8	63
Dove Granite	63
<i>Interpretation</i>	63
<i>Mineralisation and exploration</i>	63
<i>Summary</i>	63
CHAPTER 9	65
Dolcoath Granite	65
<i>Interpretation</i>	65
Line 2	65
Line 6	65
Line 12	65
Line 14	65
Line 18	65
Line 21	65
Line 23	66
Line 26	66
<i>Mineralisation and exploration</i>	66

<i>Summary</i>	67
CHAPTER 10	78
Beulah Granite	78
<i>Interpretation</i>	78
Line 1	78
Line 6	78
Line 8	79
Line 13	79
Line 19	79
Line 23	79
Line 24	79
Line 26	79
<i>Mineralisation and exploration</i>	80
<i>Summary</i>	80
CHAPTER 11	92
Housetop Granite	92
<i>Interpretation</i>	92
Line 2	93
Line 5	93
Line 8	93
Line 12	93
Line 17	93
Line 18	93
Line 21	93
Line 24	94
<i>Mineralisation and exploration</i>	94
<i>Summary</i>	94
CHAPTER 12	108
Three Hummock Granite	108
<i>Interpretation</i>	108
Line 22	108
Line 24	108
Line 25	108
<i>Mineralisation and exploration</i>	108
<i>Summary</i>	108
CHAPTER 13	113
Meredith Granite	113
<i>Interpretation</i>	113
Line 8	113
Line 16	113
Line 22	113
Line 26	113
Line 28	113
<i>Mineralisation and exploration</i>	114
CHAPTER 14	122
Heemskirk Granite	122
<i>Interpretation</i>	122
Line 7	122
Line 17	122
<i>Mineralisation and exploration</i>	123
CHAPTER 15	130
Pine Hill Granite	130
<i>Interpretation</i>	130
Line 5363	130
Line 9	130
Line 10	130
Line 22	130
Line 28	130
<i>Mineralisation and exploration</i>	131
CHAPTER 16	141
<i>Summary</i>	141
<i>Summary of results</i>	141
<i>Discussion</i>	142
Cambrian granites	142
Devonian granites	142
<i>Conclusions and recommendations</i>	143
REFERENCES	143
APPENDIX 1: INTERPRETATION ISSUES	145

LIST OF FIGURES

1.	Granite outcrops, west and north-west Tasmania, and old granite model	8
2.	Distribution of gravity stations	10
3.	Bouguer anomaly contours, western Tasmania	11
4.	Location of profiles and section lines used for models	12
<i>Granite Tor granite</i>		
5.	Regional interpretation: Line 3, Sandown Point–Guilford–Cradle Mountain	15
6.	Regional interpretation: Line 4, Sandy Cape–Heazlewood–Mt Olympus	16
7.	Regional interpretation: Line 6, Strahan–Cradle Mountain–River Tamar	17
8.	Regional interpretation: Line 16, Arthur River–Waratah–Arthurs Lake	18
9.	Form of the Granite Tor granite.....	19
<i>Pieman Granite</i>		
10.	Regional interpretation: Line 4, Sandy Cape–Heazlewood–Mt Olympus	22
11.	Regional interpretation: Line 11, Pieman–Heazlewood–Wynyard.....	23
12.	Regional interpretation: Line 14, Pieman–Deddington	24
13.	Regional interpretation: Line 15, Sandy Cape–Port Latta	25
14.	Form of the Pieman Granite.....	26
<i>Grandfathers Granite</i>		
15.	Regional interpretation: Line 6, Strahan–Cradle Mountain–River Tamar	29
16.	Regional interpretation: Line 7A	30
17.	Regional interpretation: Line 20	31
18.	Form of the Grandfathers Granite.....	32
<i>Timbertops Granite</i>		
19.	Regional gravity model, Line 29A	35
20.	Magnetic model, Line 29A (magnetics line 20120)	36
21.	Magnetic model, Line 29A (magnetics line 20120)—Interpretation showing effect of no contrast volume	37
22.	Contours of total magnetic field.....	38
<i>Elliott Bay Granite</i>		
23.	Magnetic model, Line 21211	41
24.	Magnetic model, Line 20930	42
25.	Gravity model, Line 21211	43
26.	Regional interpretation: Line 27, Elliott Bay–Maydena	44
27.	Magnetic field: Mt Osmund–Elliott Bay	45
<i>Darwin Granite</i>		
28.	Regional interpretation: Line 20	49
29.	Regional interpretation: Line 9, Trowutta–Meredith–South Darwin	50
30.	Regional interpretation: Line 23 (thin cambrian option), Cape Sorell–Eldons–Port Sorell	51
31.	Regional interpretation: Line 23 (thick low density option), Cape Sorell–Eldons–Port Sorell	52
32.	Regional interpretation: Line 23 (thin pile+granite option), Cape Sorell–Eldons–Port Sorell	53
33.	West Coast Range magnetic interpretation: Line 20 (part), Mt Darwin	54
34.	Magnetic field and location of the Darwin Granite	55
<i>Murchison Granite</i>		
35.	Gravity model, Line 5372	58
36.	Magnetic field calculated at 1275 m in Mount Murchison area	59
37.	Introductory magnetic interpretation: Line 1411	60
38.	Magnetic field and outcrop distribution	61
39.	Magnetic interpretation: Line 1500, Murchison Gorge.....	62
<i>Dove Granite</i>		
40.	Magnetic field, Dove Granite.....	64
<i>Dolcoath Granite</i>		
41.	Regional interpretation: Line 2, Brittons–Housetop–Cradle Mountain	68
42.	Regional interpretation: Line 6, Strahan–Cradle Mountain–River Tamar	69
43.	Regional interpretation: Line 12, Wynyard–Eldons	70
44.	Regional interpretation: Line 14, Pieman–Deddington	71
45.	Regional interpretation: Line 18, Penguin–Cethana–Algonkian Peak	72
46.	Regional interpretation: Line 21, Cape Grim–Moina–Steppes	73
47.	Regional interpretation: Line 23 (thin pile+granite option), Cape Sorell–Eldons–Port Sorell	74
48.	Regional interpretation: Line 26, Granville Harbour–Moina–Hillwood	75
49.	Form of the Dolcoath Granite	76
50.	Aeromagnetic coverage of the Dolcoath Granite area.....	77

<i>Beulah Granite</i>	
51.	Bouguer anomaly contours, Beulah area 81
52.	Regional interpretation: Line 1, King Island-Forth-Rowallan 82
53.	Regional interpretation: Line 6, Strahan-Cradle Mountain-River Tamar 83
54.	Regional interpretation: Line 8, Pieman Heads-Meredith-Weymouth 84
55.	Regional interpretation: Line 13, Port Sorell-Tarraleah 85
56.	Regional interpretation: Line 19, Olympus-Beulah-Port Sorell 86
57.	Regional interpretation: Line 23 (thin pile+granite option), Cape Sorell-Eldons-Port Sorell 87
58.	Regional interpretation: Line 24, Hunter Island-Housetop-Poatina 88
59.	Regional interpretation: Line 26, Granville Harbour-Moina-Hillwood 89
60.	Form of the Beulah Granite 90
61.	Aeromagnetic coverage of the Beulah Granite area 91
<i>Housetop Granite</i>	
62.	Bouguer anomaly, Housetop Granite 95
63.	Regional interpretation: Line 2, Brittons-Housetop-Cradle Mountain 96
64.	Regional interpretation: Line 5, Bass-Nietta-Loddon 97
65.	Regional interpretation: Line 8, Pieman Heads-Meredith-Weymouth 98
66.	Regional interpretation: Line 12, Wynyard-Eldons 99
67.	Regional interpretation: Line 17, Henty River-Penguin (invalid light granite option) 100
68.	Regional interpretation: Line 17, Henty River-Penguin (dense granite option) 101
69.	Regional interpretation: Line 18, Penguin-Cethana-Algonkian Peak 102
70.	Regional interpretation: Line 21, Cape Grim-Moina-Steppes 103
71.	Regional interpretation: Line 24, Hunter Island-Housetop-Poatina 104
72.	Form of the Housetop Granite 105
73.	Aeromagnetic coverage of the Housetop Granite 106
74.	Geology, prospects and gravity field 107
<i>Three Hummock Granite</i>	
75.	Regional interpretation: Line 22, Cape Grim-Heazlewood-Eldons 109
76.	Regional interpretation: Line 24, Hunter Island-Housetop-Poatina 110
77.	Regional interpretation: Line 25, Three Hummock Island-Pieman Heads 111
78.	Form of Three Hummock Granite 112
<i>Meredith Granite</i>	
79.	Regional interpretation: Line 8, Pieman Heads-Meredith-Weymouth 115
80.	Regional interpretation: Line 16, Arthur River-Waratah-Arthurs Lake 116
81.	Regional interpretation: Line 22, Cape Grim-Heazlewood-Eldons 117
82.	Regional interpretation: Line 26, Granville Harbour-Moina-Hillwood 118
83.	Regional interpretation: Line 28, Balfour-Zeehan-Hamilton Range 119
84.	Form of the Meredith Granite 120
85.	Aeromagnetic coverage of the Meredith Granite 121
<i>Heemskirk Granite</i>	
86.	Regional interpretation: Line 7, Temma-Strahan-St Clair 124
87.	Regional interpretation: Line 17, Henty River-Penguin (dense granite option) 125
88.	Magnetic interpretation, Heemskirk contact zone: Line 5363 126
89.	Semi-detailed gravity interpretation: Line 5363, Heemskirk-Zeehan cross-section 127
90.	Form of the Heemskirk/Pine Hill Granites 128
91.	Aeromagnetic coverage of the Heemskirk/Pine Hill Granites 129
<i>Pine Hill Granite</i>	
92.	Semi-detailed gravity interpretation: Line 5363, Heemskirk-Zeehan cross-section 132
93.	Regional interpretation: Line 9, Trowutta-Meredith-South Darwin 133
94.	Regional interpretation: Line 10, Port Latta-Waratah-Frenchmans Cap 134
95.	Regional interpretation: Line 22, Cape Grim-Heazlewood-Eldons 135
96.	Regional interpretation: Line 28, Balfour-Zeehan-Hamilton Range 136
97.	Form of the Heemskirk/Pine Hill Granites 137
98.	Aeromagnetic coverage of the Heemskirk/Pine Hill Granites 138
99.	Magnetic field calculated at 1275 m in Mt Murchison area 139
100.	Introductory magnetic interpretation: Line 1411 140

Abstract

The form and economic associations of the Cambrian and Devonian granitoids of west and north-western Tasmania have been regionally assessed using gravity and magnetic data. Although the assessment was part of a gross appraisal of structures in north-western Tasmania, it provides semi-detailed descriptions of five Cambrian and ten Devonian bodies. Other parts of the appraisal now permit more detailed prospect-scale evaluation, within data limitations, using residual and/or three-dimensional methods.

The definition of the form of the granite bodies feasible within the current analysis suggests that much mineralisation throughout western Tasmania is associated with wall, spine or roof irregularities in juxtaposition with suitable host rocks. Many enigmas associated with the known distribution of mineralisation have been resolved by this first-order appraisal of intrusion form.

SPECIAL NOTE

This Bulletin forms one unit of a series of reports devoted to the rocks and structures of west and north-west Tasmania, prepared as part of the Mt Read Volcanics Project. The study, although considered provisional, represents a considerable advance in understanding the granite forms; the interpretation is still evolving although most future changes are now expected to be of detail.

Most future detailed study will be concentrated at critical points or in those regions judged to be of highest economic priority. The prospectivity of areas and materials near the granites can be assessed in light of directly related mineralisation (including replacement deposits), the capacity of the heat engine to remobilise and relocate other deposits or mineralisation (especially within/from the Mt Read Volcanics), and availability of suitable hosts. Particular effort has been expended in order to account for enigmatic sites.

As noted in the Appendix this interpretation was derived as part of an integrated regional study. Other elements of that concomitant regional study, now checked and refined—especially MANTLE88 (Leaman, 1988a)—permit a regional-residual separation of the gravity field, and this will facilitate refined analysis.

INTRODUCTION

The granites of west and north-west Tasmania have long been studied petrologically and chemically. Their relationship, especially the Devonian granites, with economic mineralisation has long been appreciated. Yet, the form and distribution of the bodies has not been assessed nor understood. This has meant some loss in predictive capacity in exploration terms. Unless the subsurface shape and extent of a pluton is known, many mineralised sites may be enigmatic while others may not be inferred at all.

It was felt that the time had come when these deficiencies should be overcome in regional terms and, time and funding permitting, in some particular areas. Geophysical investigation of granite structures in western Tasmania commenced in 1981, when the Department of Mines initiated a survey to examine granite structures in the Zeehan district. This survey continued, as resources and manpower permitted, until October 1985 when the Mt Read Volcanics Project provided the resources to acquire data over much of western and north-western Tasmania. An aeromagnetic coverage of the area was also completed with a uniform line spacing of 500 m and a nominal terrain clearance of 150 m (refer Corbett *et al.*, 1982; Leaman, 1986a).

The first appraisal, though couched in statewide terms, was offered by Leaman *et al.* (1980) (see inset in fig. 1) using the 1975 gravity data base and elemental three-dimensional modelling. It was thought that the exposed granites were pinnacles of a single batholith or complex. The data and

methods used could not resolve any fine detail or confirm this overall implication. In 1986 a series of interpretations of the Mt Read Volcanic Arc and related troughs and basin margins (Leaman, 1986a, b, c) dealt with both the magnetic and gravimetric effects of Cambrian and Devonian granites between Elliott Bay and Burnie. The gravity interpretation, in particular, was forced to consider these bodies (Leaman, 1986c). The gravity data base had, by 1986, been augmented by two seasons of the Mt Read Project and was able to provide considerable improvement in definition for parts of the region. As interpretive effort was concentrated on property implications, regional structures and setting of the volcanic rocks, only limited advances were reported in respect of the granites. Magnetic data remained underutilised. The magnetic data base is now complete for all areas north and west of the Precambrian basement core as exposed near Cradle Mountain. The gravity data base was further enlarged during 1986/87 and 1987/88 and is still being extended. Further refinement of the interpretation presented here will be necessary as new data become available.

The results presented here were recovered as a by-product of extended examination of the Cambrian troughs and their relationship to the basement rocks to the east and west. The granites discussed in this Bulletin crop out in the areas shown in Figure 1 and are:

(a) Granite Tor Granite

This massive and largely unroofed body crops out at Granite Tor, with other small exposures along the valley of the Forth River. The Pine Hill Granite, near Renison Bell, is treated separately, although it is a cupola on a spine extending south-west from Granite Tor.

(b) Pieman Granite

This granite crops out from Sandy Cape south to Conical Rocks and, based on the available data, represents the eastern side of a large pluton. Minor mineralisation has been recorded in the Interview River region.

(c) Grandfathers Granite

The Grandfathers Granite consists of several isolated outcrops of adamellite south of Cape Sorell which are on the eastern edge of a large granite mass that extends offshore.

(d) Timbertops Granite

The Timbertops Granite appears, on the basis of available data, to be a small body located west of Birchs Inlet near the north end of a syncline.

(e) Elliott Bay Granite

This granite consists of at least two parts or exposures, and is a minor set of intrusive rocks exposed north of Elliott Bay.

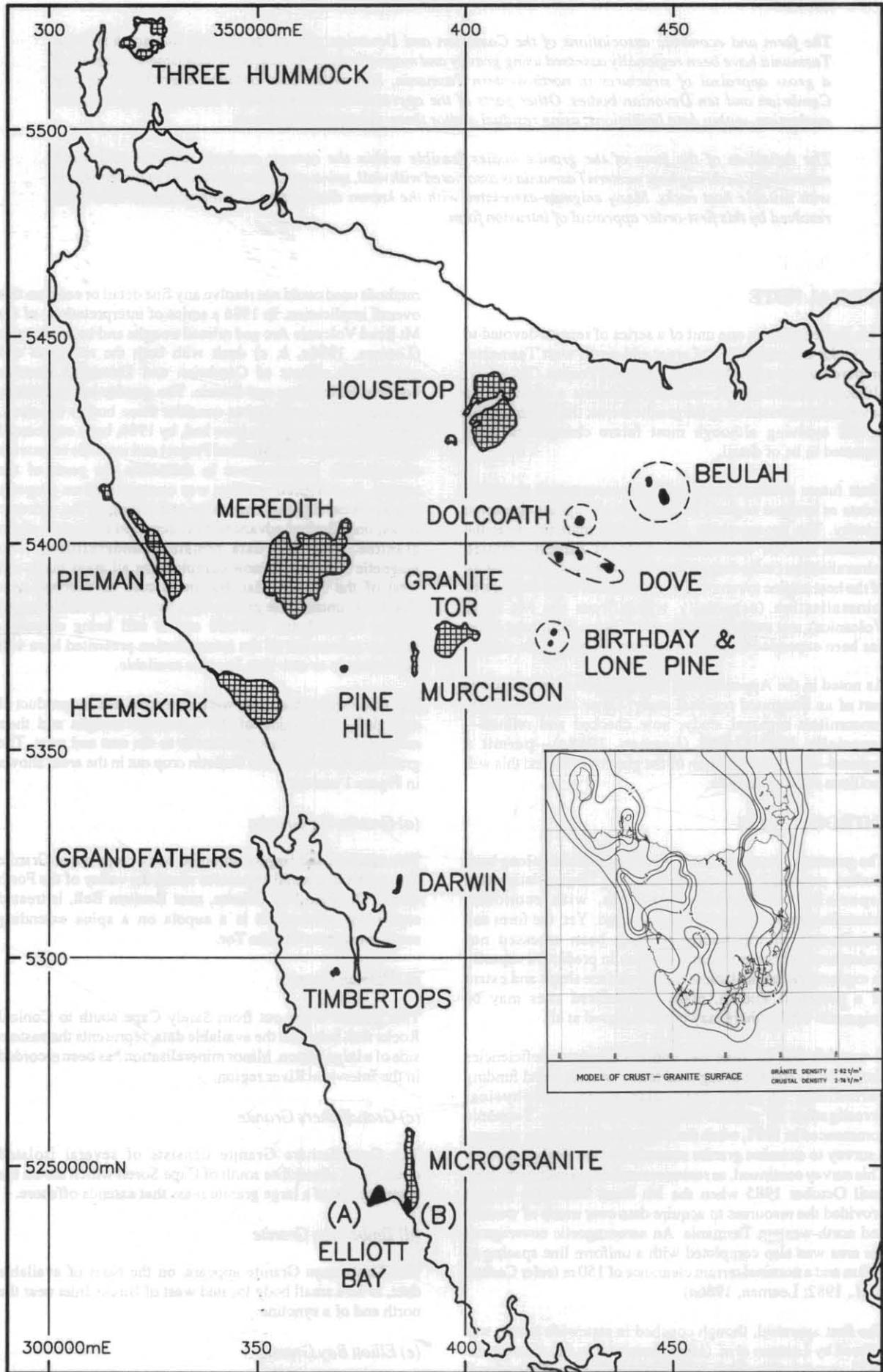


Figure 1. Granite outcrops in west and north-west Tasmania, and old granite model (inset)

5 cm

(f) Darwin Granite

This is a Cambrian granite exposed on the high plateau between Mt Darwin and South Darwin Peak.

(g) Murchison Granite

The Cambrian Murchison Granite is exposed in the Murchison River Gorge. Some mineralisation occurs within and around the margins of the granite.

(h) Dove Granite

The Cambrian Dove Granite crops out at three sites south of Lorinna.

(i) Dolcoath Granite

This granite is exposed over a relatively small area near Cethana but has been associated with much mineralisation in the Moina-Cethana area.

(j) Beulah Granite

This granite is exposed at a number of sites totalling about 15 km² near Beulah and Paradise. There is some associated mineralisation.

(k) Housetop Granite

The Devonian Housetop Granite crops out over a large area and is a mineralising granite directly associated with several skarn and replacement deposits, and some vein deposits.

(l) Three Hummock Granite

This body occupies a large part of Three Hummock Island. No associated mineralisation is known.

(m) Meredith Granite

The Meredith Granite has a large exposure south-west of Waratah and is associated with many significant mineral deposits.

(n) Heemskirk Granite

The Heemskirk Granite, which crops out along the west coast near Trial Harbour, is associated with significant mineralisation.

(o) Pine Hill Granite

This body has a small exposure south-east of Renison Bell.

DATA AND METHODS

Only public domain gravity and magnetic data have been used for this study. All data are available from the Department of Mines, Hobart. The gravity data are held in two data bases; TASGRAV (whole state regional); and MTREAD (data acquired for the Mt Read Volcanics Project sub-projects), which will ultimately be available in combined form. All stations have been reviewed and checked for errors and consistency (refer to Richardson and Leaman, 1987) and fully corrected (including 20 km terrain corrections). The coverage remains somewhat uneven on a state or regional basis. The MTREAD data base contains stations at a nominal observation density of one station per km² across the essentially Cambrian areas of west and north-west Tasmania, while the spacing of peripheral data (in TASGRAV) varies from 0.8 to 7 km. Figure 2 shows the station distribution within the area of interest of this bulletin. The station accuracy

varies somewhat but all stations occupied from 1981 to the present have a positional accuracy of better than 25 m and an elevation error of less than 2.5 m. Earlier work may have positioning errors of up to 150 m and worst case elevation errors of 5 to 10 metres. Contours of Bouguer anomaly are presented in Figure 3.

Four aeromagnetic surveys with nominal line spacing of 500 m and terrain clearance of 150 m cover the region (Corbett *et al.*, 1982; Leaman, 1986a, b; Bishop, 1986; Bishop, 1987). The Precambrian core south of Cradle Mountain and east of the Eldon Range has not been flown at comparable specification.

The provisional results of analysis of these data bases as presented here are based on extended, fundamental evaluation. The evaluation has not been directed solely at extraction of information relevant to the granites. The granites, however, form a significant part of the geology and can only be assessed by solving simultaneously with contributions from basement blocks and forms, Palaeozoic troughs, crustal structure and first order structures in the upper crust. This bulletin thus focuses on only one part of a larger interpretation (Leaman, 1988d). The key elements of the interpretation depend on the gravity data bases, and the various factors listed above have been assessed by a series of long, randomly oriented but overlapping profiles using the current appreciation of rock properties (see Leaman, 1986a, c). The profile locations are shown in Figure 4.

Upgrading of the physical property data base may well modify elements of this interpretation.

The primary objective of the study was acquisition of a regional view of all large-scale components of the geology but in a form which would then allow three-dimensional modelling and refinement. The results provided here, with minor exceptions, are based on two-dimensional methods and are intended to form the feedstock for specific study. Three-dimensional methods always lead to revision wherever applied, and where data permits. This bulletin provides an interim status view of the point at which the use of more advanced methods becomes practical and cost effective.

A secondary use of the broader study relates to the provision of regional components of the gravity field so that more reliable residual analysis of smaller and shallower sources is possible. Tables of values of regional components for the "MANTLE88" water and Moho models are given in Leaman (1988a). Any attempt to generate a regional-residual separation mathematically (filters, averages etc.) must lead to an uncertain result due to the overlapping wide band frequency responses of the various large sources. We have avoided any such processing or separation throughout (including Leaman, 1986c) and have treated the entire crust. Although use of the total Bouguer anomaly results in no loss of precision there is a penalty: models must include entire structures and cannot be artificially terminated at shallow depth. They therefore require more geological input and coherence but the result is sounder and free of filter-induced distortions.

All modelling has been set against some fixed requirements. The observed-calculation shift factor must be consistent. The rock properties must be as factual as possible, and no unsustainable geological discontinuities are permitted. A valid solution must yield a consistent pattern from random profiles against this set of rules to be acceptable, and application of them leads to the highest resolution the methods are capable of, especially in three-dimensional form.

The models presented appear simple and self evident. They are rarely either. Only those solutions which are internally

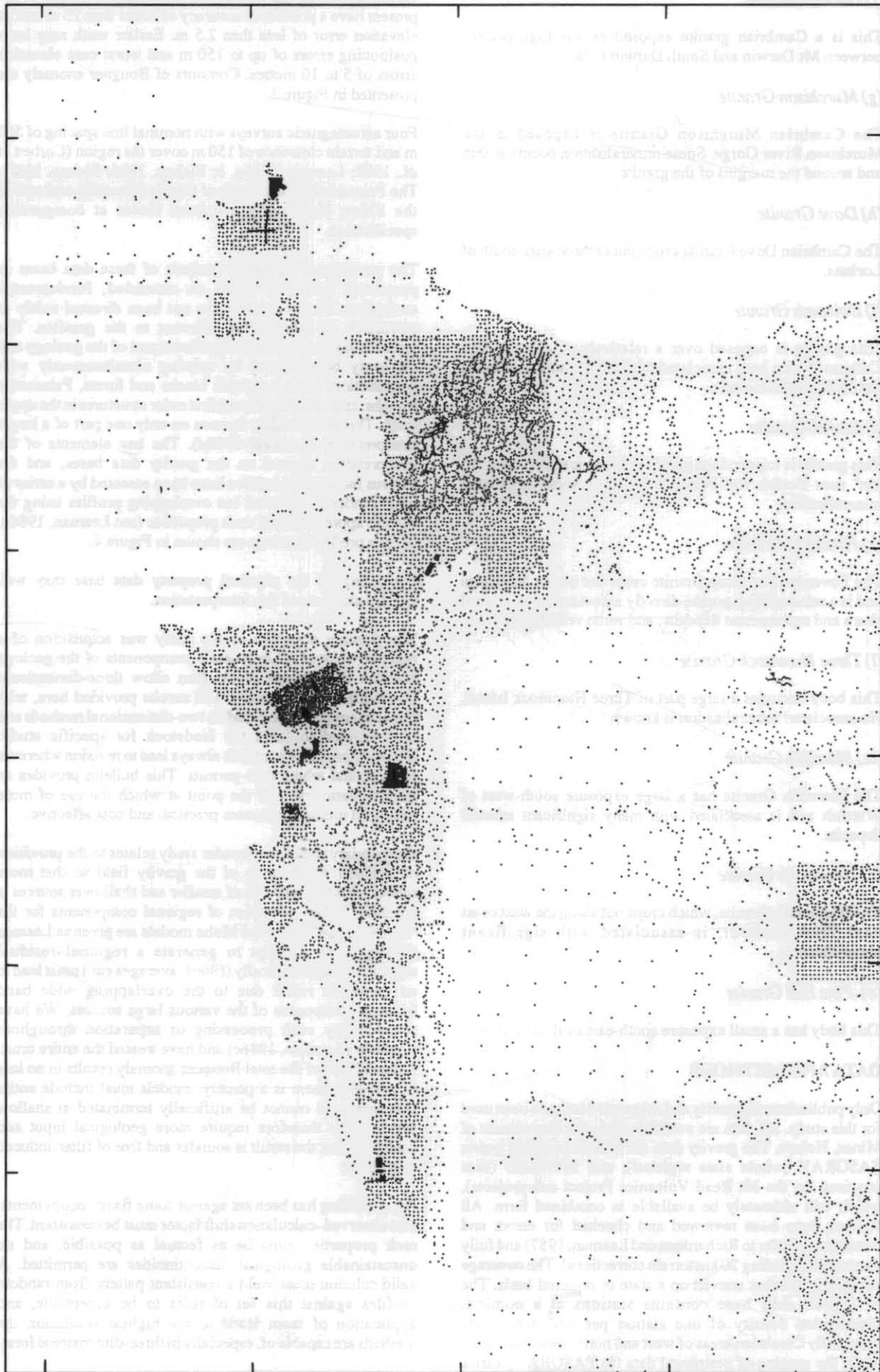


Figure 2. Distribution of gravity stations, west and north-west Tasmania

and externally consistent are accepted and presented. Many variations have been rejected but these refer mainly to Upper Precambrian or Lower Palaeozoic basin forms and sections for which discussion will be provided elsewhere.

The solutions provided are not claimed to be unique or final, and all could be refined. Each is intended to yield gross aspect evaluation and relationships. In many cases, and on many line segments, further detail cannot be supported by the extant data bases.

The mantle reference level is not especially important and cannot be specified absolutely using gravity data alone. Such data does, however, indicate a range of 25 to 28 km for deepest mantle. The variations in form implied, when coupled with seismic data (e.g. Richardson, 1980), indicate a base value of about 27 km, and this has been used throughout. Granite modelling indicates that contrasts are effective to depths of at least 8 km (possibly 11 km in some cases). Errors of assumption at this depth are not significant for the present study.

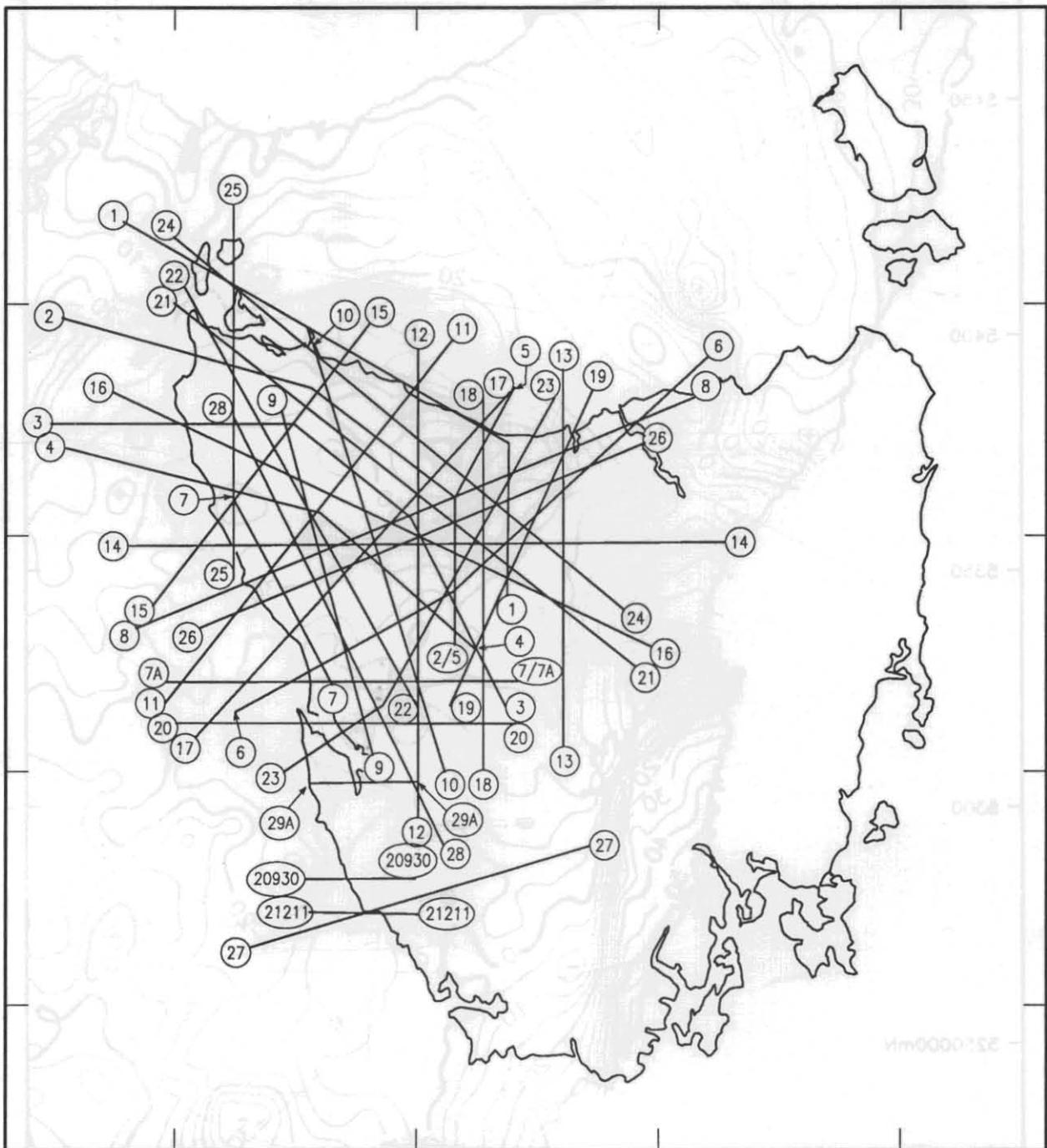
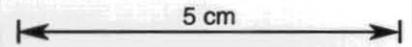


Figure 4. Location of profiles and sections used for models.

CHAPTER 1

GRANITE TOR GRANITE



The Devonian granite exposed at Granite Tor has escaped much attention but Leaman (1986c) showed it to be a massive and economically significant intrusive body. Sufficient evidence was collated to show that only a small part of the body was unroofed at Granite Tor and that the granite extended a spine at moderate but undefined depth towards Zeehan. The Pine Hill intrusion near Renison Bell is a cupola on this spine. The significance of such a spine was discussed by Bamford and Green (1986).

Although the granite spine beneath Rosebery and Renison is part of the Granite Tor Granite it is of such economic significance that it will be the subject of separate discussion (the Pine Hill Granite, Chapter 15).

It was evident in previous analyses (Leaman, 1986c) that the effect of the Granite Tor Granite increased the maximum negative Bouguer anomalies in central north-west Tasmania, and that previous workers using the raw values with no allowance for a granite mass have overestimated crustal thickness. The extent of the pluton was not appreciated until the interaction of these effects was understood (see below).

Some small exposures of granite have been recorded along the valley of the Forth River some twenty kilometres east of Granite Tor. Macleod *et al.* (1961) and Jennings (1963) have described the mineralisation associated with these occurrences. The present work has shown these to be roof irregularities of the Granite Tor Granite and thus they have been discussed in this bulletin.

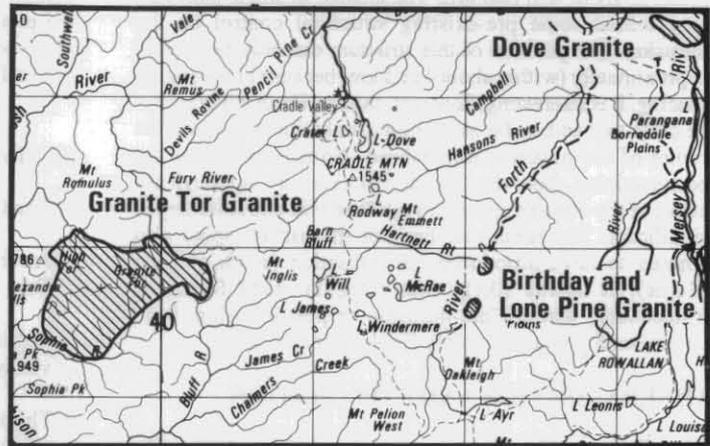
INTERPRETATION

Interpretation of the form, context and effect of the Granite Tor Granite depends wholly on gravity data—no magnetic data of adequate specification is available east of grid line 395 000 mE, and the effect of the western half of the Granite Tor exposure is confused by the belt of Cambrian rocks at 390 000 mE.

Four sections (refer to fig. 4) have been included for discussion purposes. All are elemental and conceptual, having been designed to evaluate only gross aspects of the upper crust.

Line 3 (fig. 5).

This profile suggests the nature of the crust-mantle effect and demonstrates the abruptness and scale of the response due to the Granite Tor Granite a little east of its exposure. The basement 'normal' curve is suggested by the line segments at 10, 50–70, 160 and 225 km. Deviations from this function give some idea of the nature of contrasting materials. Modelling shows that any attempt to estimate such a regional function prior to evaluation is not reliable. The abruptness of the gradients near Granite Tor show that the granite is at shallow depth. The response of the granite allows an estimate of the granite/basement contrast, and thus the bulk basement density, as the granites lie within a narrow density range (2.62–2.64 t/m³). The actual contribution of the granite to this profile is of the order of -20 mGal.

*Line 4 (fig. 6).*

No basement reference line is obvious on this profile, demonstrating the risks with simple regional separations and accounting for the requirement of identification of any reference in retrospect, not prospect. The Granite Tor Granite dominates the eastern end of the line. The profile traverses outcrop but also shows that the effect persists for several kilometres beyond outcrop limits. This indicates a persistent, shallow roof to the body over a large area.

Line 6 (fig. 7).

Although this line is 240 km long, no qualitative reference or regional components are recognisable with certainty anywhere. The Granite Tor Granite, however, dominates the profile and contributes at least -20 to -25 mGal to the central depression in the anomaly. Gradients are very steep in the vicinity of outcrop, and define the shape of the roof and the relevant contrasts. The minimum contrast is shown in Figure 7.

The form of the pluton is shown as bell-like. This distribution is required to explain the field as seen two-dimensionally but three-dimensional study may well show this is not accurate at depths in excess of 3 or 4 kilometres.

Line 16 (fig. 8).

Line 16 samples a spine extension of the Granite Tor pluton to the north-east. The effect of this body is about -7 mGal. A basement reference line is a little more obvious along this profile.

The implications of profile studies have been compiled and summarised in Figure 9. There is scope for considerable refinement of the interpretation presented in Figure 9, not merely because of the methods used, but largely because the gravity station spacing is rarely less than seven kilometres for much of the area. There is little doubt that the Granite Tor Granite is a large body with long spines extending to the WSW from Granite Tor and north-east from Mt Pelion. Only a very small part of the roof has been exposed, and much of the remainder lies at shallow depth. The interpretation has been virtually referenced to the level of the high plains, and estimates of depth to granite range from 200 to 1000 metres. This range is consistent with the level of the valley floors, and shows that the small granite exposures along the Forth River represent roof rises. The granite roof could be expected to be most irregular and the one kilometre contour in Figure 9 is likely to prove a gross approximation. The present data cannot

offer better resolution. Other roof extremities may be concealed beneath talus, glacial sediments, or Permo-Triassic cover, which obscures at least 30% of the pluton area.

The compilation also suggests that the body is irregular or offset at about 420 000 mE. The change in shape indicated may reflect some pre-existing structural control on the intrusion. The position of this structure can only be located approximately (within about 4 or 5 km) because of the station spacing. It is interesting, however, that the Forth River spines lie close to it and, as far as is known, only this belt across the centre of the pluton is mineralised. No mineralisation has been recorded about the Granite Tor exposure, although the effect of the western spine through Pine Hill and Rosebery is significant. The north-east limit of the eastern spine also appears to have introduced mineralisation (south of Emu Plains). It seems likely that irregular roof forms or dislocations, whether pre-intrusion or post-intrusion, have controlled Sn-W and possibly Cu-Au mineralisation.

MINERALISATION AND EXPLORATION

The Granite Tor Granite is clearly economically relevant—the western spine is associated with, or has remobilised, an array of deposits (discussed further in Chapter 16, Pine Hill Granite). While mineralisation is not known in the vicinity of Granite Tor itself, the cupolas and irregularities near the Forth River and the spine to the north-east have introduced mineralisation.

Prospectivity would appear to be limited in the Granite Tor region west of Cradle Mountain but this should not be assumed. Deposit style or host rocks may be factors in apparent absence. Prospectivity is directly related to roof spine irregularities (north-east of Mt Pelion or south-west of Granite Tor) or disrupting structures (Forth Valley east). Although a large part of the pluton may never be explored (Lake St Clair-Cradle Mountain National Park), the extensions to the north-east may be of economic importance.

The most effective means of evaluating this forgotten pluton and neglected geology would be infill of the gravity survey to one kilometre spacing and extension of the 500 m spacing aeromagnetic surveys. These might provide enough information for exploration focus but some ground evaluation of lithologies and pinnacle roof sites will be essential.

It must be admitted that present evidence suggests limited mineralisation styles and compositions—Sn/W crestral or vein systems, or greisens, and shear-controlled alteration systems (Cu/Au).

There are suggestions of various trends in the available data and interpretation; including north-east to south-west and near east-west; but the data coverage and evaluation detail are unable to confirm these or their significance. Vein mineralisation along the Forth Valley is oriented in a manner consistent with the gross offset or distortion in the shape of the pluton (see Macleod *et al.*, 1961). This study has thus resolved some of the enigmas associated with the Forth River mineralisation.

SUMMARY

1. The Granite Tor Granite is a significant pluton.
2. A very small proportion of the roof is exposed near Granite Tor.
3. Limited projections from the roof are exposed along the valley of the Forth River.
4. The roof is probably quite irregular but commonly less than one kilometre below surface over a large area.
5. The granite is irregular in shape with extended WSW and NE-trending spines. Both appear to be of economic significance.
6. A north-south distortion affects the centre of the intrusion. The form of the intrusion may have been controlled by a pre-existing structure or one active at the time of intrusion. This feature appears to have influenced mineralisation.
7. The Granite Tor Granite is located immediately south-east of the junction between the Palaeozoic troughs in north-west and western Tasmania. The overall elongation of the intrusion is ENE-WSW. It is intruded mainly within Precambrian basement rocks.
8. Mineralisation is associated with the western spine, and the presence of many suitable host rocks has enhanced its significance. The absence, or apparent absence, of many suitable hosts east of Granite Tor may have affected frequency, style, extent and depth of mineralisation around much of the body. The eastern side of the intrusion did, however, introduce mineralising fluids. Some small Sn/W and Cu/Au deposits are known.
9. The little known Granite Tor Granite is worth more extensive data coverage, review and exploration than it has received in the past.

2D GRAVITY MODEL

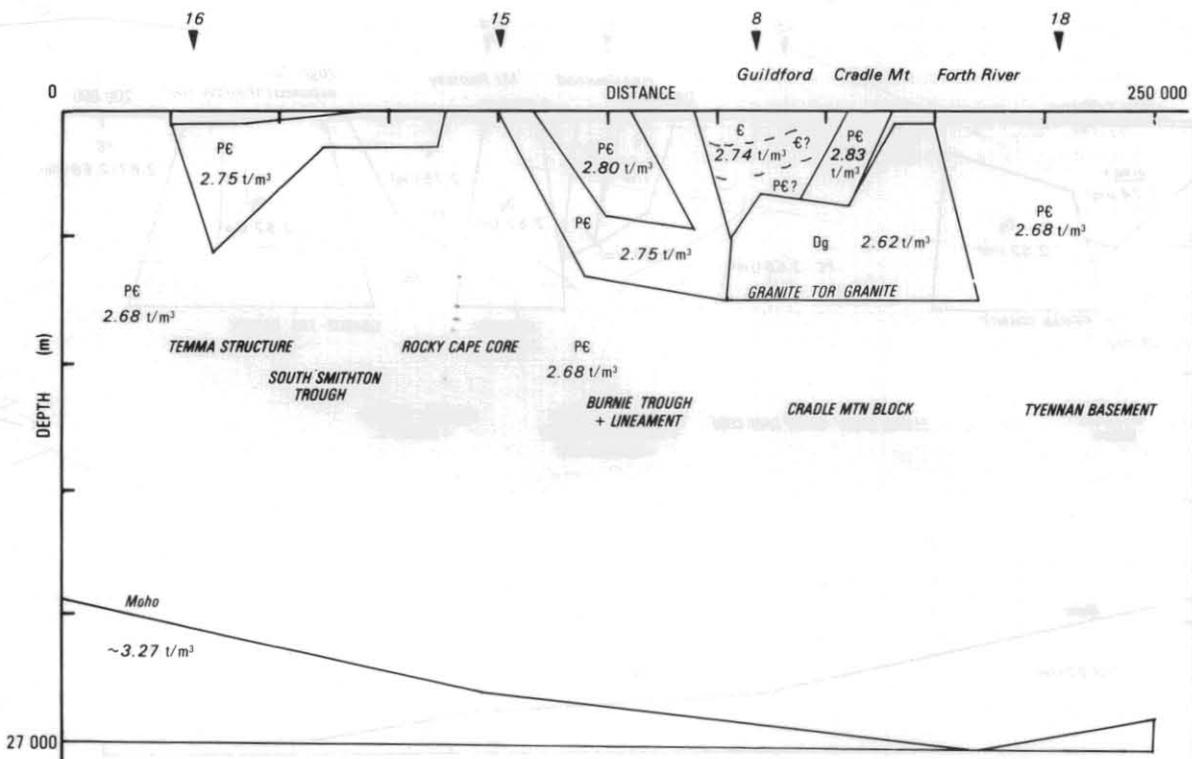
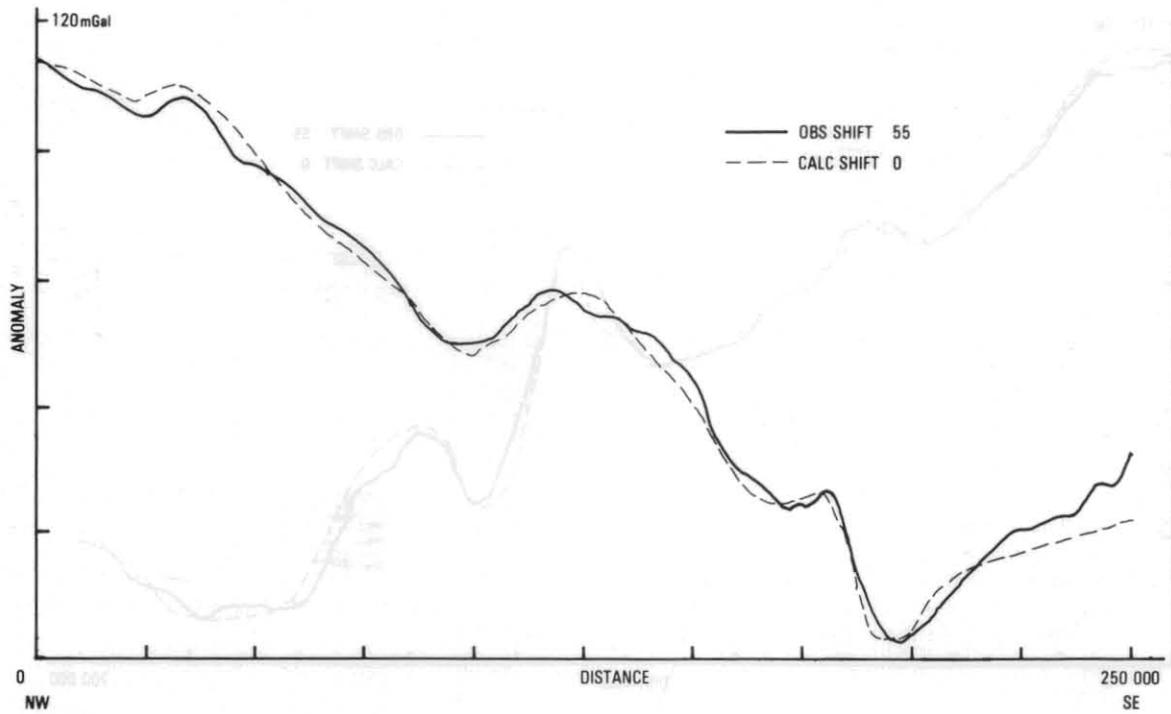


Figure 5. Regional interpretation: Line 3, Sandown Point–Guildford–Cradle Mountain.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

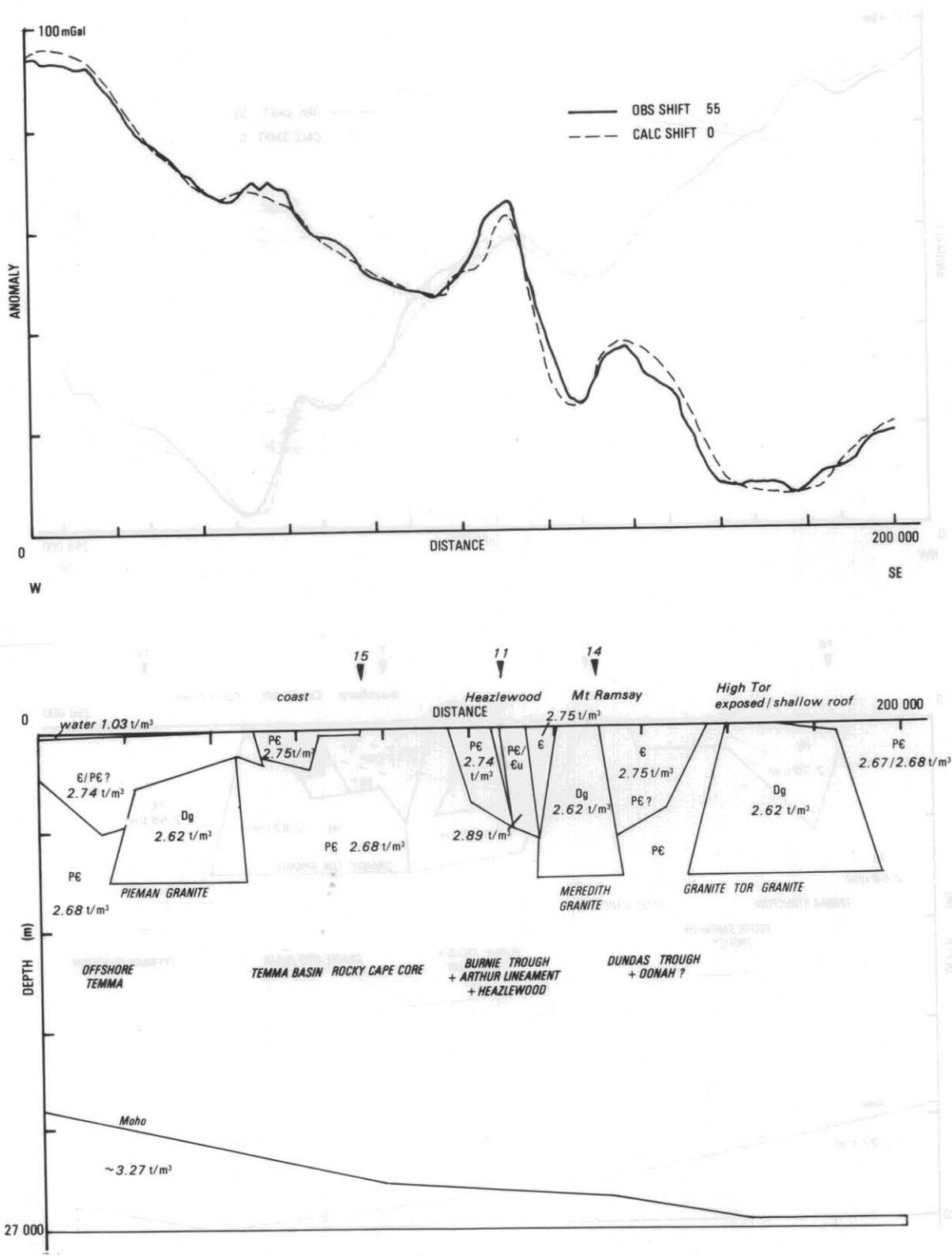


Figure 6. Regional interpretation: Line 4, Sandy Cape-Heazlewood-Mt Olympus.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

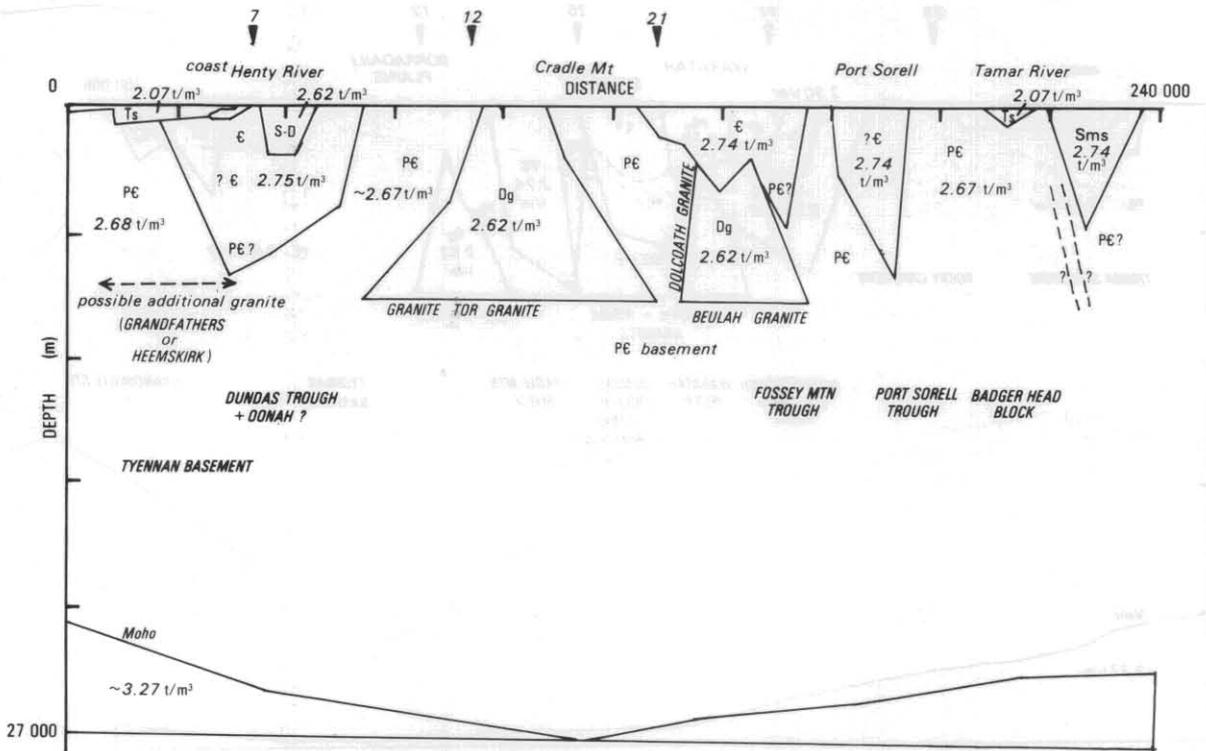
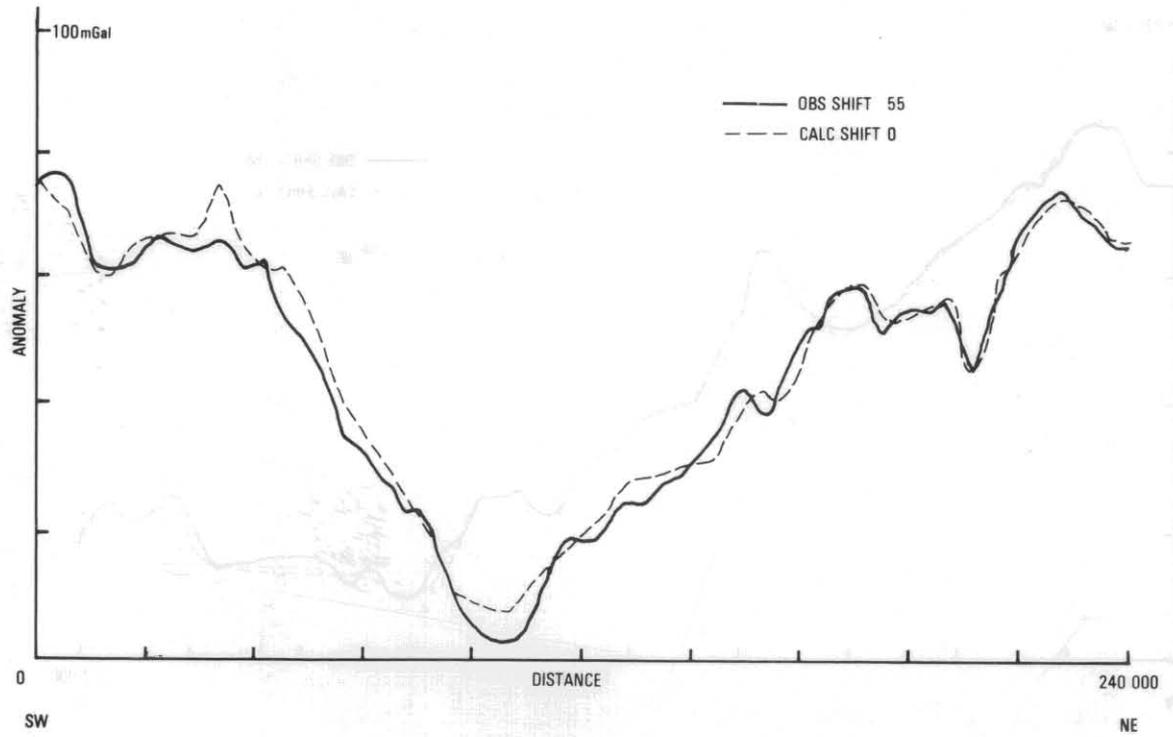
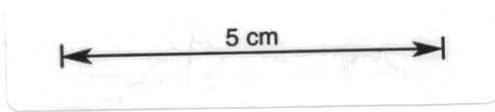


Figure 7. Regional interpretation: Line 6, Strahan-Cradle Mountain-River Tamar.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

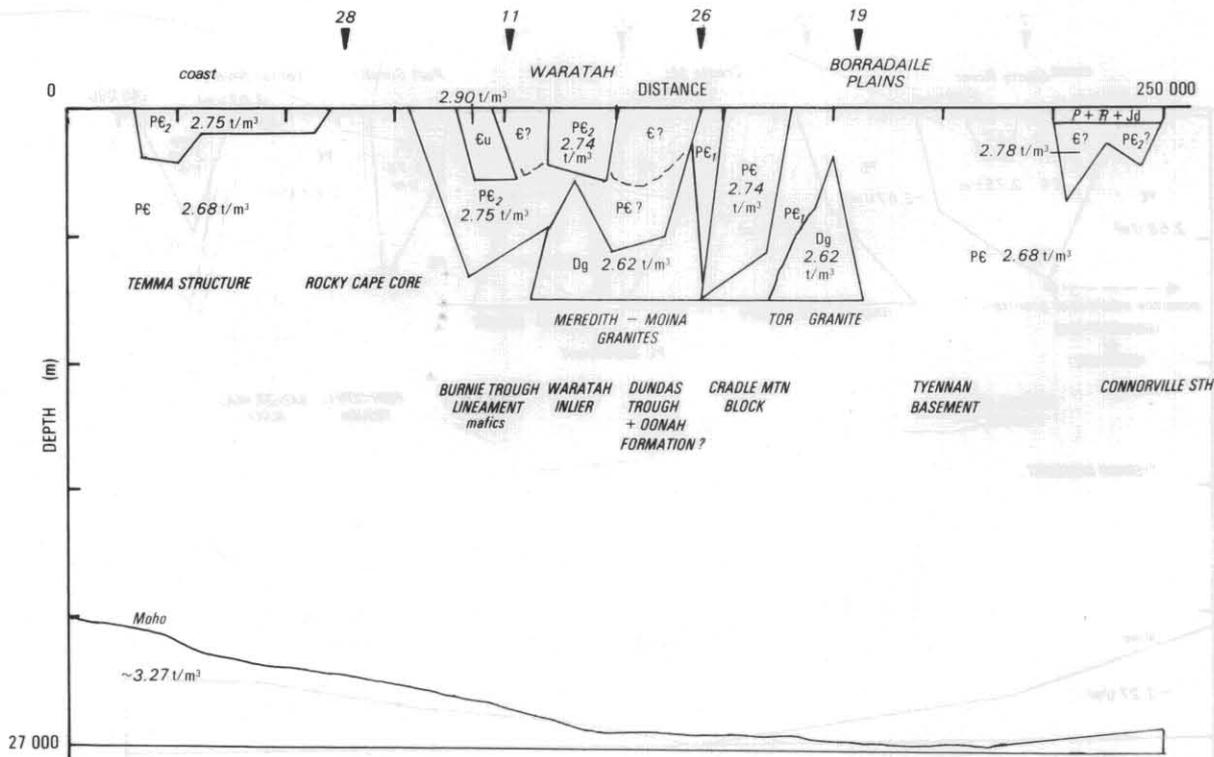
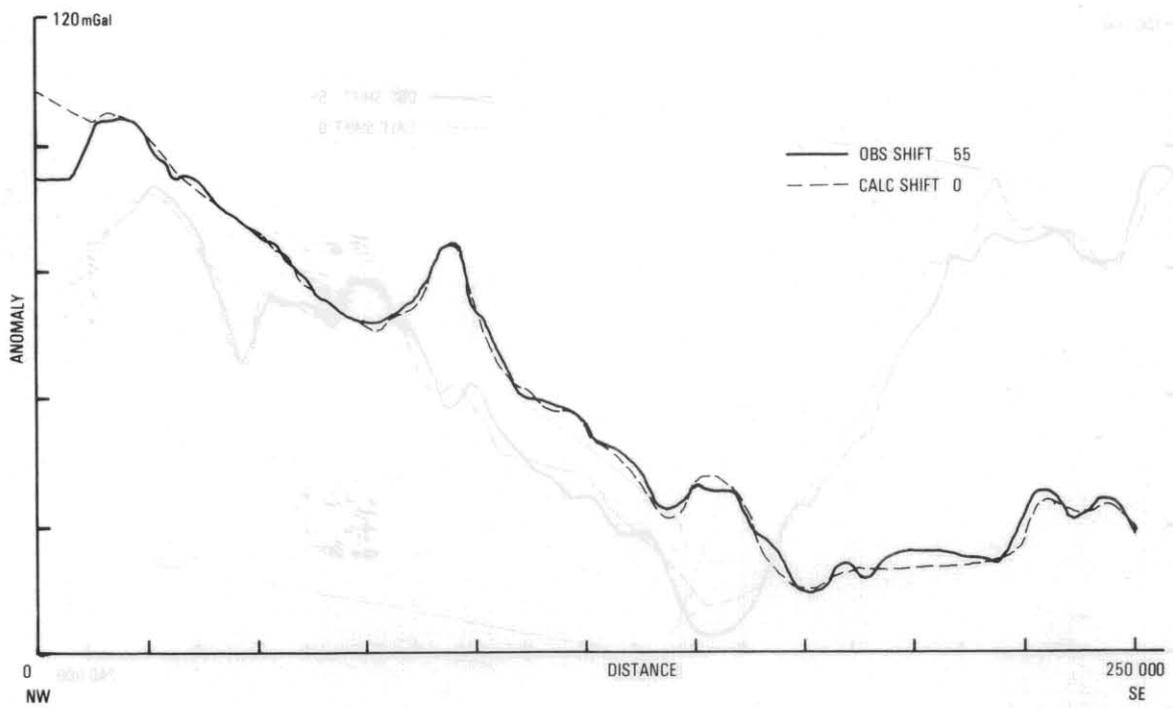
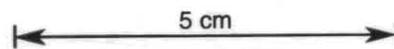


Figure 8. Regional interpretation: Line 16, Arthur River–Waratah–Arthurs Lake.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



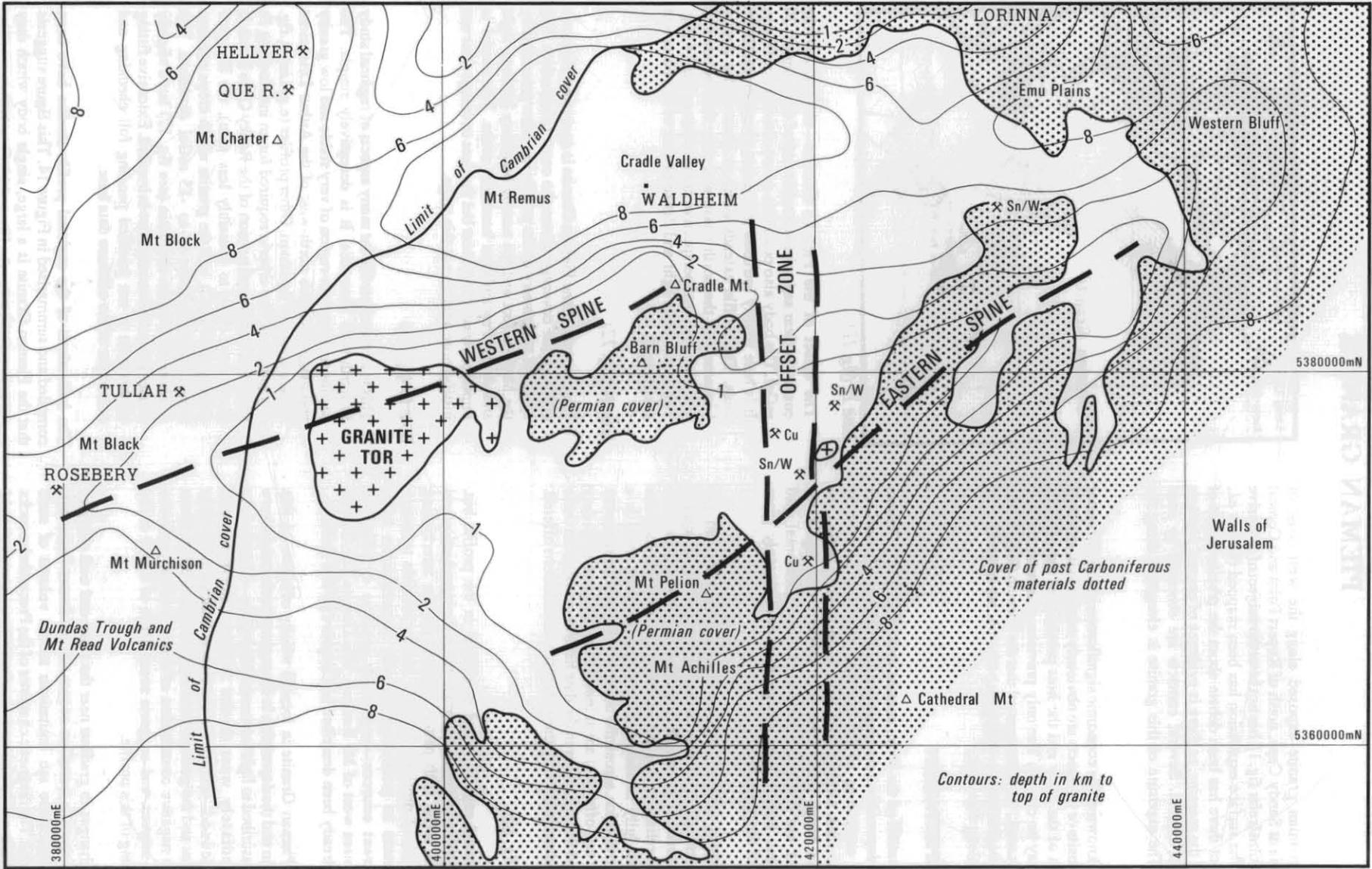
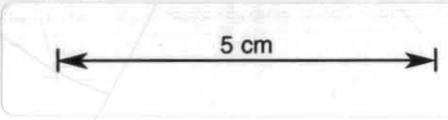
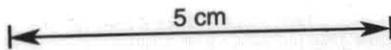


Figure 9. Form of the Granite Tor granite.



CHAPTER 2

PIEMAN GRANITE



The Devonian granite exposed along the west coast of Tasmania at Sandy Cape, north of Rupert Point and Conical Rocks Point (refer fig. 1), has not been the subject of extensive study. The surface expression has been mapped (Gee *et al.*, 1969) but there has been debate about the precise nature of some of the margins, as there is evidence of normal contacts and fault control. Several contacts are obscured by sand cover. The exposure of this granite is elongated along the coast.

Little is known of the economic significance of this intrusion; few deposits or prospects are obviously related to it, although the form of the body and the host potential of the adjacent rocks may be crucial. The only previous structural analysis (Leaman *et al.*, 1980) suggested that the Pieman Granite was a north-west extension of a super batholith, but in the form of a spine along the coast.

INTERPRETATION

Interpretation of the form, context and effect of the Pieman Granite depends largely on gravity data, although the onshore mapped extensions of the intrusion are fully covered by magnetic data. Gravity data have been used to define the pluton in broad terms, and four sections (see fig. 4 for location) are discussed below. All are elemental and conceptual, having been designed to evaluate only gross aspects of the upper crust.

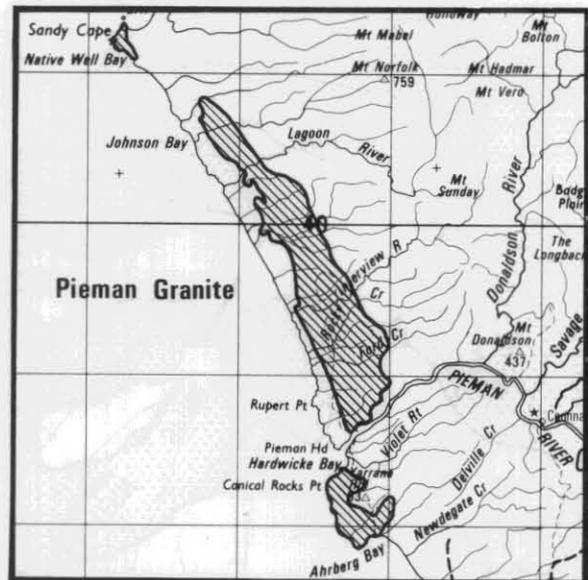
All profiles utilise offshore data not included in the Department of Mines data bases. These data were acquired by the Bureau of Mineral Resources, Canberra prior to 1975, and their reliability has not yet been assessed. Nor have the data been fully corrected. In general, however, there is a smooth transition across the coast, and the profile segments (both on and offshore) are at least internally consistent. Any suspected imperfections in the data have been noted but these do not substantially vary the concepts or conclusions offered.

Line 4 (fig. 10).

A general regional trend is evident in the profile but, without the use of the criteria noted in the introduction and the 55 mGal shift pattern derived for the interlocking network of profiles, it would not be possible to assign contrasts or positively identify contributions from different sources—especially granites or siliceous basement west of Mt Ramsay. The Granite Tor Granite has already been described in Chapter 1 of this Bulletin.

The Pieman Granite is located wholly offshore on this section and the depression in the regional trend might have been ascribed to light basement lithologies—such as occur immediately west of the Arthur Lineament and Heazlewood—except for the clearer indication on other profiles and the general trend of the negative effect. Even so the negative contribution of about -8 mGal precludes most sources, and suggests some depth of burial at the northing of this profile.

The changes in gradient near the coast and well offshore show that the intrusion occurs within denser basement, although there are limitations to the volume of such material. The magnetic character of the Precambrian rocks near the coast may be contrasted with the very smooth field inland (approximately 80 km) and the low Bouguer values associated. This cannot be a thermal effect, as it is too widespread and not matched by gravity evidence.



Line 11 (fig. 11)

The effect of the Pieman Granite—though off the coast—is clear and unmistakable and of the order of -20 mGal. The body also possesses an asymmetric roof form. It is here wholly intruded into dense phase Precambrian units. The profile extends along or close to the Arthur Lineament to the north coast, and may thus be used to provide a regional perspective comparison to Line 4 (fig. 10), where both light and dense phases of the basement are present.

Line 14 (fig. 12)

The response of the Pieman Granite is again unambiguous although the coverage across the coast is imperfect. The apparent asymmetry of the profile has been generated by the Moho effect and the nearby boundary between light and dense Precambrian basement rocks. The model is imperfect west of the coast but the data coverage does not justify more attention at this stage.

Line 15 (fig. 13)

This is a critical profile for many aspects of regional study in north-west Tasmania. It is deceptively simple. The section traverses the region of very stable and low gravity and magnetic fields north-west of the Arthur Lineament but south-east of Smithton. Other profiles (e.g. Line 4, fig. 10) sample it. The criteria required for an interlocking fit show that this central portion of the Rocky Cape Block is at, or very close to (possibly less than), the Bouguer density (2.67 t/m^3), and the granite which crops out near Sandy Cape induces up to -15 mGal deviation. The offshore fit is again uncertain (see fig. 12) but a slightly denser Precambrian sequence is implied. Extensive fitting of this data is not justified pending full checking and correction of the offshore data base.

The indications of the regional profile studies have been compiled and summarised in Figure 14. This figure suggests that the Pieman Granite is a large, single body which may possibly be connected to the Heemskirk Granite (or may abut it). There is insufficient offshore data available to establish if this is so. The onshore presence of a long, single intrusive segment does indicate that the Pieman Granite (offshore

image) might be similar. The Pieman Granite is possibly comparable in size to the Blue Tier Batholith of north-eastern Tasmania.

Significant parts of the roof cannot be described using extant data but much of it is shallow. Unlike the Granite Tor Granite there does not appear to be a large cross-section of unroofed pluton—the body is steep-sided with locally faulted margins—and its roof section is almost fully exposed until well north-west of Sandy Cape.

The steeply-dipping nature of the pluton margins, including the exposed character of the roof coupled with unreceptive country rocks, probably accounts for the paucity of known mineralisation. Additional data south of Balfour is required for complete appraisal.

It is also relevant to consider the structural association of this intrusive. Like the Granite Tor Granite it has been intruded into Precambrian basement rocks but apparently near the junction between different gross lithologies, as these run NNW parallel to the coast. The style of the relationship is best seen in Figure 10. Leaman (1988*d*) argues that these structures represent the onset of basin development in the Late Precambrian—a process which continued into the Cambrian near Smithton, to the Devonian near Waratah and perhaps to the Devonian offshore here. The Pieman Granite may thus have intruded along, or marginal to, a basin axis, and its elongation may thus reflect the appropriate two-dimensional stress field. Some faulting is indicated, and the exposed contacts are suggestive of fracture control.

Magnetic anomalies are not regionally significant in the region of the Pieman Granite. The field is relatively smooth with very subtle variations. The responses due to granite or intruded basement rocks are comparable, and overall both are less than effects induced by some pelitic members—especially near the contacts of the intrusion near Pieman Heads and along the Pieman River. Other contact responses occur at Lagoon River but all are minor and patchy effects clearly related to isolated lithological variations. The apparently steeply-dipping walls of the pluton will also have minimised thermal zone effects as projected onto the present surface.

MINERALISATION AND EXPLORATION

The economic significance of the Pieman Granite is not known. It does not appear to have introduced any substantial deposits. This may mean that too much of the roof has been removed—along with suitable hosts—or that the relevant phases are not exposed. The steeply-dipping east faces of the intrusion do not offer much cupola development potential either. Greater potential may exist offshore or where the roof plunges beneath denser Precambrian or Cambrian rocks. The units along the coast (south-east of Sandy Cape and inland of the eastern margin) could be reviewed for carbonate content, as these might locally offer useful host sequences.

Most mineralisation recorded occurs in the region of the Interview River, where some small Sn, Cu and Pb-Zn shows

have been found. These are mostly vein systems, although the copper was carbonate hosted. Mineralisation east of the Donaldson River–Pieman River junction does not appear to be related to this granite. Similarly, mineralisation in the Balfour–Temma region does not appear to have any relationship to the Pieman Granite. These views may be changed when the station coverage in this region is upgraded but there are no indications of any large-scale extension of the Pieman Granite to the north-east or of another granite in the region using the present data base.

Trends are not easily recognised in the available data as the magnetic responses are very subtle and the gravity data reflect only very large features at the available data spacing. The lower reaches of the Pieman River appear to follow a north-east to south-west feature but this may be related to the roof forms and the offset in the granite apparent near Pieman Heads.

While the magnetic field correlates with lithological variations within the Precambrian rocks (where mapping permits evaluation) there are some unexplained offsets. These occur near the mouth of the Pieman River, near Ford Creek, where the Interview River crosses the eastern margin of the granite, and near Lagoon River. It is probably significant that the dyke swarm within the Precambrian rocks is oriented east-west near the Interview River, the only established mineralised area, at the northing of one magnetically discontinuous zone. It is likely that magnetic data, up to an order of magnitude more resolving than the extant survey (Corbett *et al.*, 1982; Leaman, 1986*a*), may prove of benefit to detailed exploration by outlining detailed lithological and structural variations.

SUMMARY

1. The Pieman Granite is a large pluton, with considerable NNW elongation.
2. Much of the roof is exposed or virtually exposed both on and offshore.
3. No significant irregularities in margins have been identified but this may reflect available data. Several margins appear to have been fracture-controlled.
4. The granite may occupy a major basin margin with the bulk of the basin along the continental shelf.
5. Mineralisation appears to have been limited but may indicate absence or removal of suitable hosts and much roof. Mineralising fluids were present, as shown by the vein and replacement deposits in the Interview River region. There is evidence of east-west structural control on these.
6. The Pieman Granite is rather special. It is large, removed from the Cape Sorell–Beulah axis occupied by most of the other western Tasmania plutons, and has a north-west elongation. The reasons for these differences are not immediately obvious.

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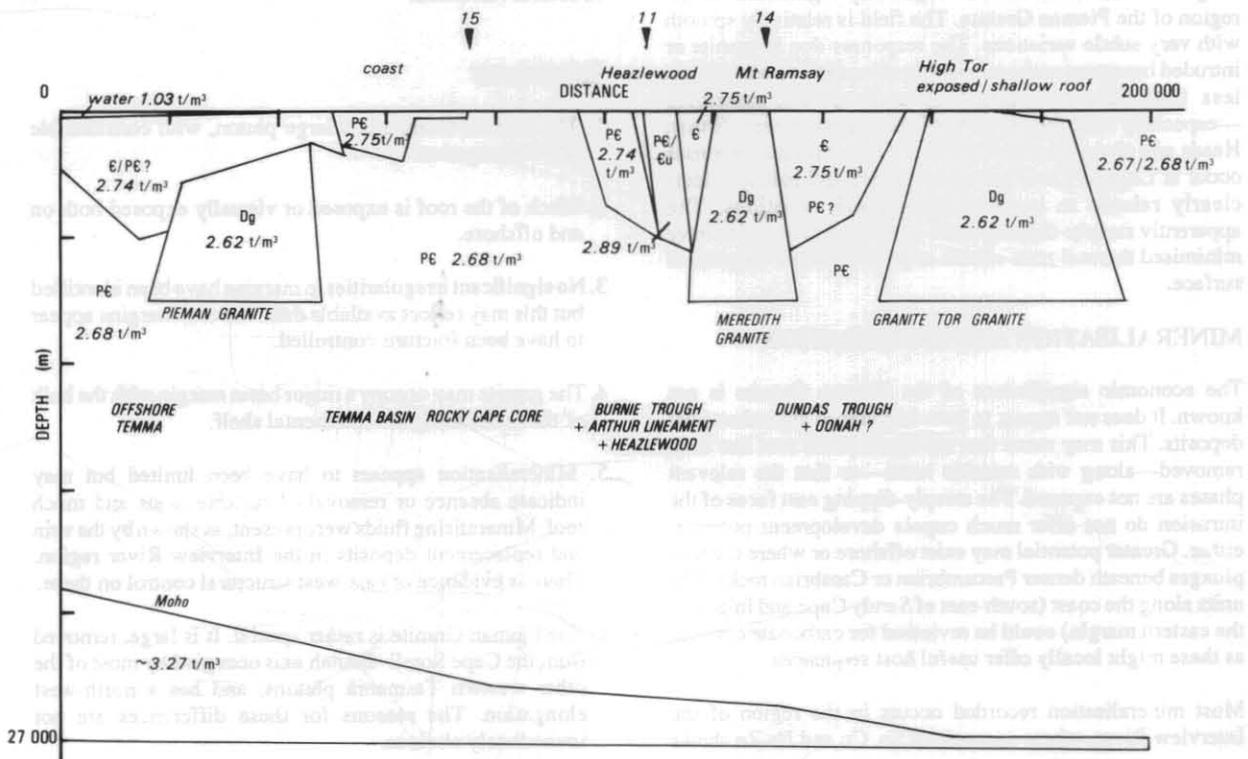
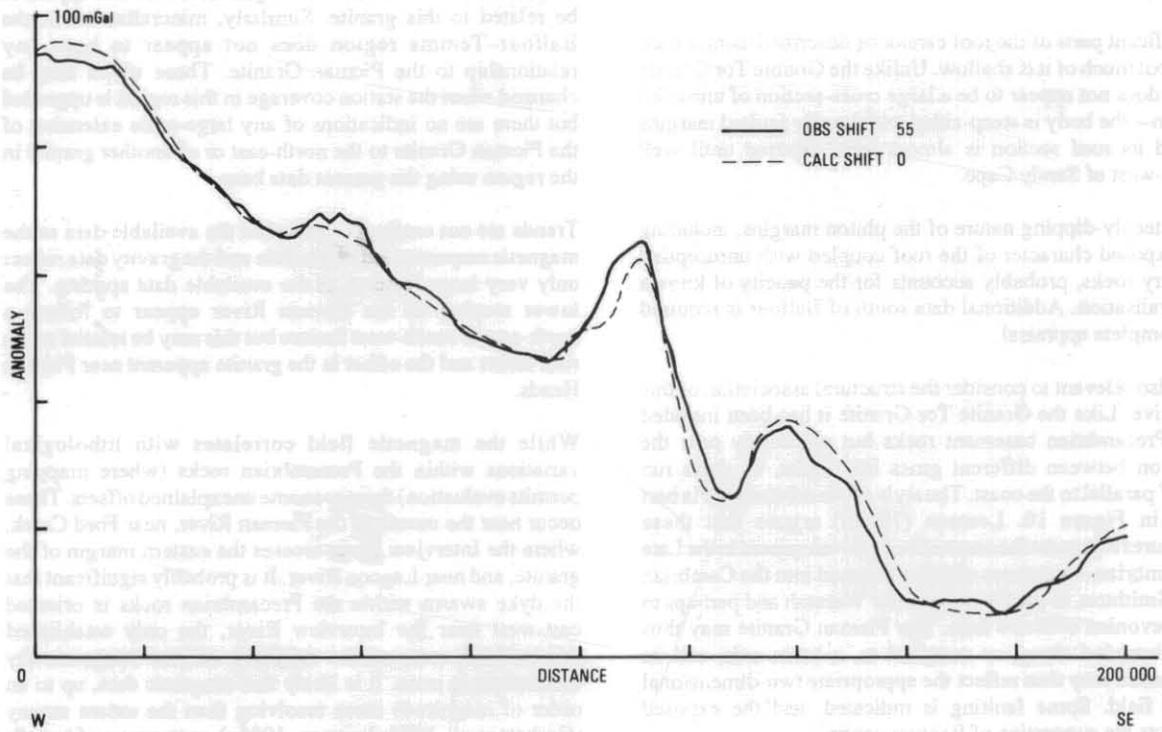


Figure 10. Regional interpretation: Line 4, Sandy Cape-Heazlewood-Mt Olympus.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

2D GRAVITY MODEL

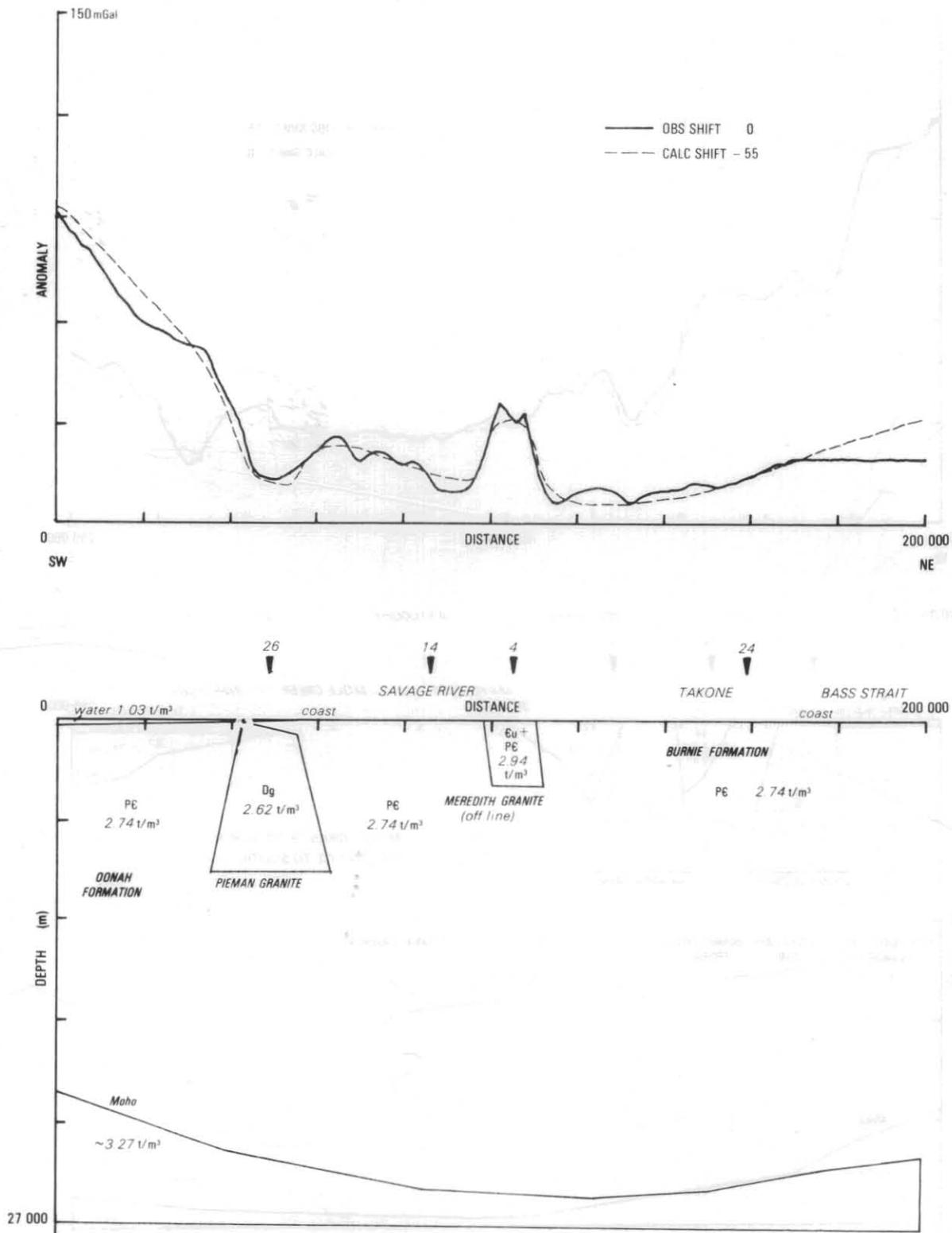


Figure 11. Regional interpretation: Line 11, Pieman-Heazlewood-Wynyard.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

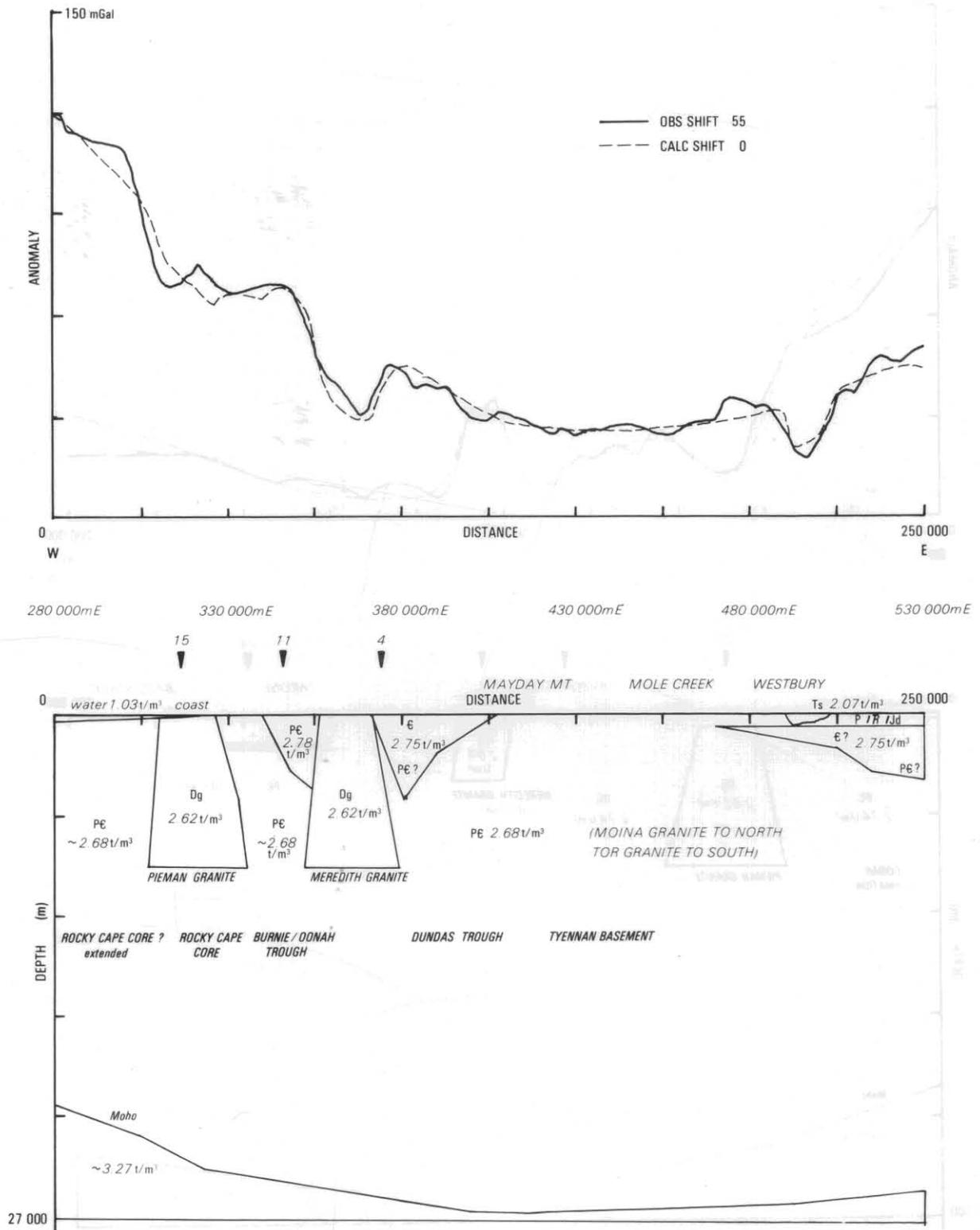


Figure 12. Regional interpretation: Line 14, Pieman-Deddington [5396 000 mN, 280-530 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

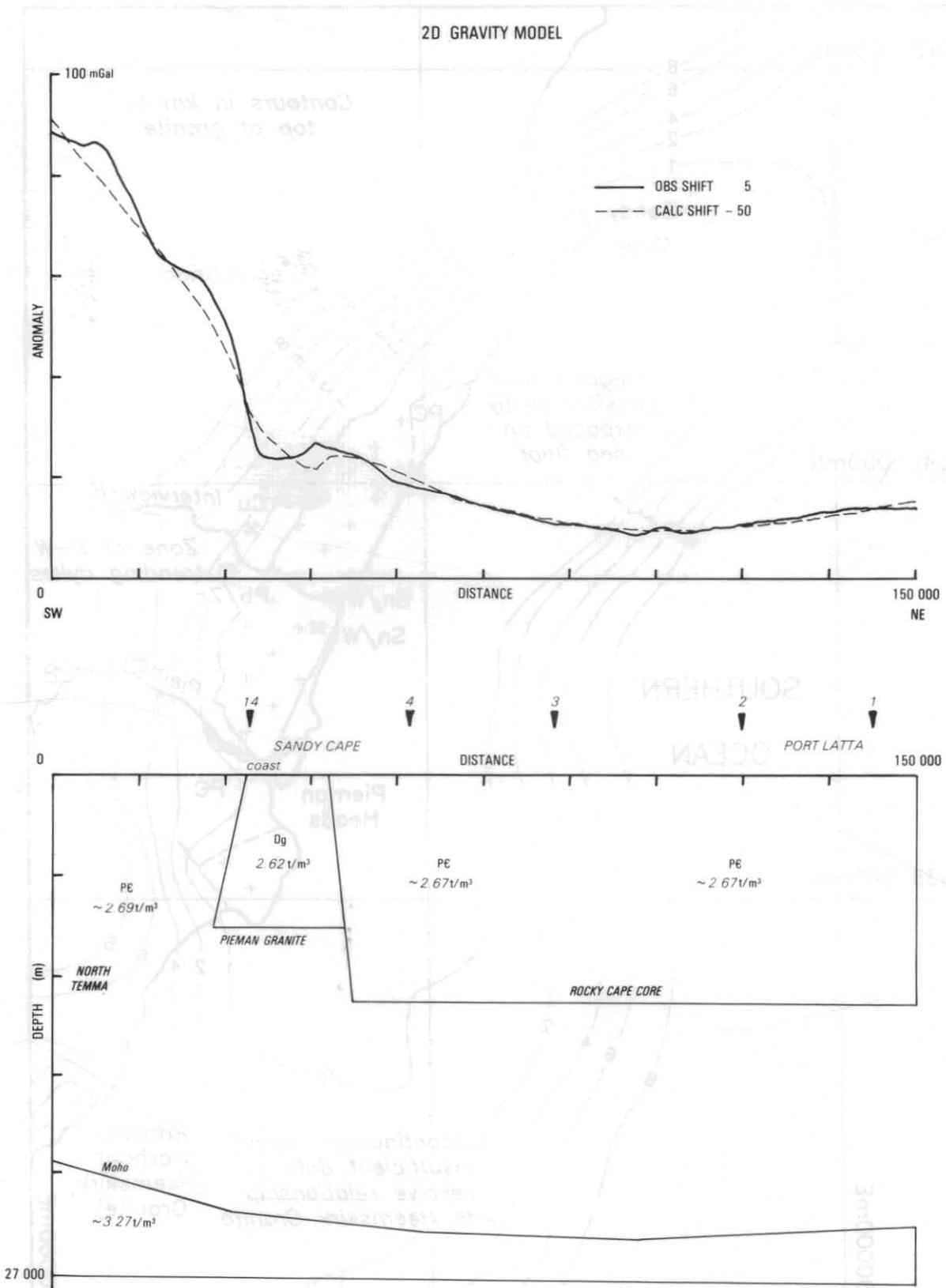


Figure 13. Regional interpretation: Line 15, Sandy Cape-Port Latta.

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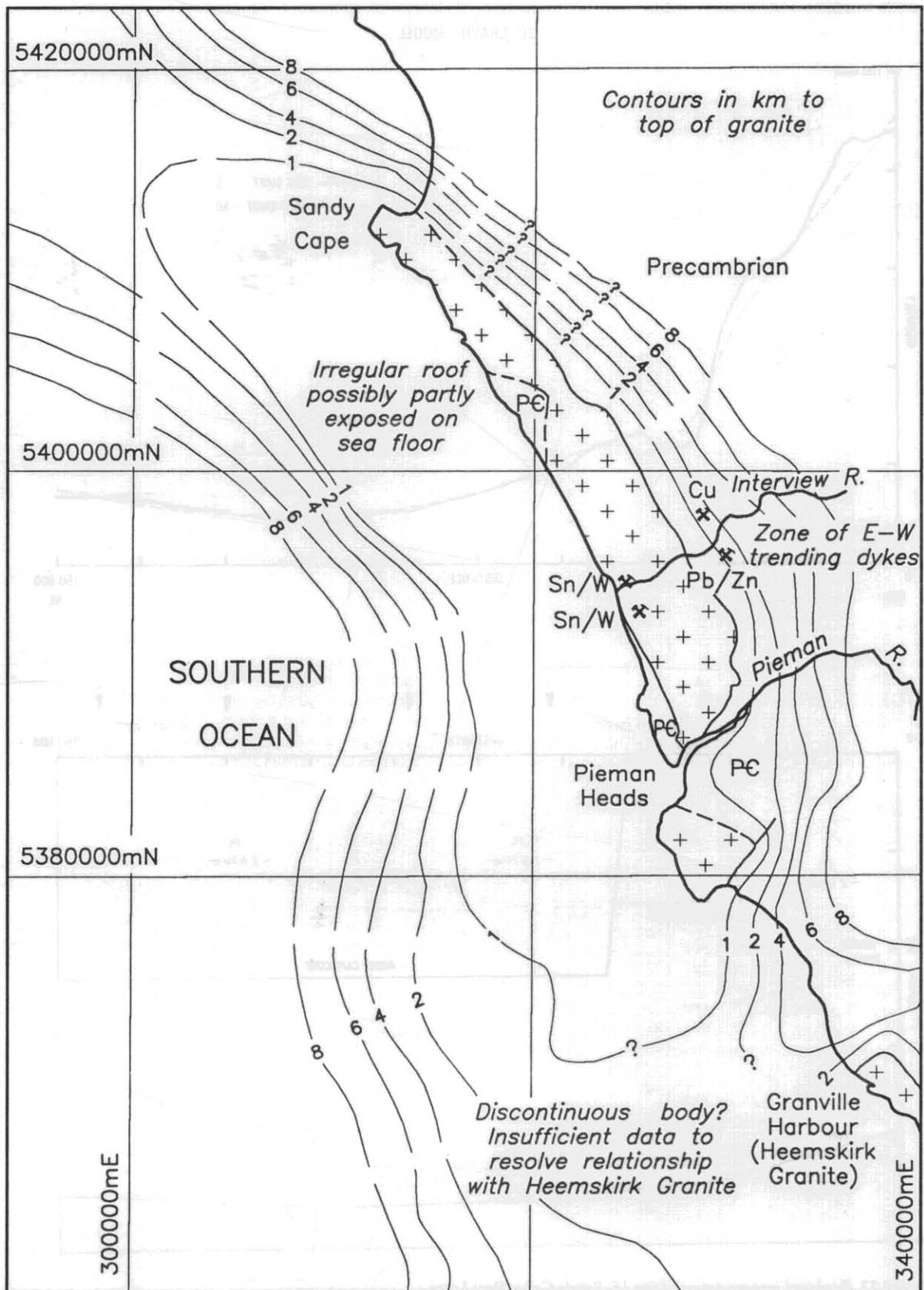
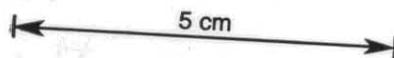


Figure 14. Form of the Pieman Granite.



CHAPTER 3

5 cm

GRANDFATHERS GRANITE

A few isolated outcrops of adamellite occur on the coast south of Cape Sorell (see fig. 1). These were mapped by Baillie *et al.* (1977) but were not known previously and were not considered part of a major intrusive body. Evidence is advanced in this chapter to show that these exposures, on the coast a little north-east of some low hills called The Grandfathers, are part of a large granite mass which extends from beneath The Grandfathers some considerable distance offshore.

A few of the promontories and topographic features are named in this region the term "The Grandfathers" is herein applied to this intrusive body as the nearest, applicable, unused name. The granite body is thus defined as the "Grandfathers Granite".

We will argue below for a Devonian age for this body on structural and rock property evidence.

INTERPRETATION

Interpretation to establish the existence, approximate form and structural context of the Grandfathers Granite depends largely on gravity data but supported by seismic data in the critical zone offshore from Cape Sorell. No usable magnetic data is available.

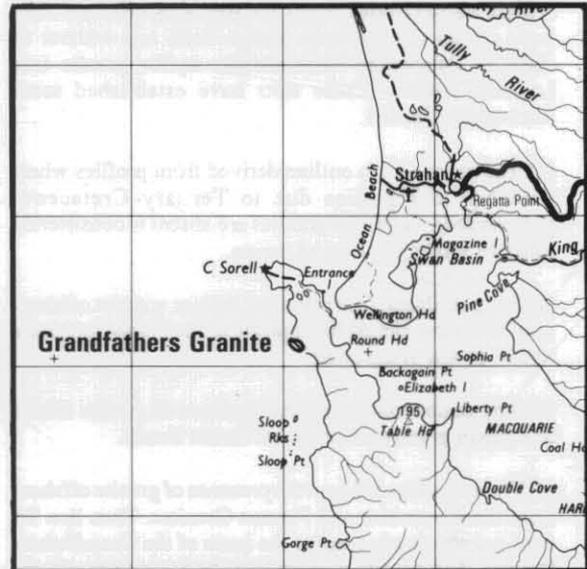
Evidence for the existence of this intrusion was extant and, in hindsight, recognisable in all sections between 5 295 000 and 5 326 500 mN (Leaman, 1986c). This evidence was ignored for three principal reasons: it occurred at the coast end of all lines (modelling extended only to the coast); data coverage and reliability was uneven; and the focus of the work was further east. Since the earlier study, the gravity coverage around Strahan and south of Cape Sorell has been much improved as part of the Mt Read Volcanics Project. Study at Cape Sorell (Leaman, 1988b) and Lynchford (Leaman, 1988c) has exposed the implications of the anomalies at or near the west coast south of Cape Sorell.

Three sections have been included to establish the proposition of the existence of the Grandfathers Granite (see fig. 4). Because the proof depends almost entirely upon offshore gravity and seismic data, whose coverage is uneven, patchy, and of variable quality (not fully corrected) that proof must be one of existence rather than detailed form.

Line 6 (fig. 15)

This line suggests some of the problems and doubts faced by previous interpretations. The Bouguer anomalies do not increase systematically westward onto the continental shelf. A 'flat spot' is common, and this may lie either just on or offshore. It is not directly ascribable to water or sediment.

In this particular case, representative of the region south of the Professor Range, the initial coastward rise in anomaly reflects a thick Cambrian section. This over-steepens any effect due to the Mantle. Such an anomaly will 'roll back' whenever the other side of the section is crossed, and the result will be an asymmetric and often steep gradient pair. Model studies such as Leaman (1986c), where all analysis was based on land data, were unable to assess this effect. Combination of land and marine data profiles does allow this effect to be examined. Such examination is difficult in the region west of Strahan



because of the presence of a significant Tertiary (and perhaps late Mesozoic) section.

The first problem may be stated thus: does the effect of water and sediment wholly account for the negative response? Amoco line W81-12 (see Hinz *et al.*, 1986) has been used to assess the contribution of such sections. We have assumed that some of this thick section is Lower Tertiary and possibly Cretaceous in age, and have allowed densities to scale from about 2.1 to 2.45 t/m³ in proportions typical of the Bass Basin. While this approach is crude it at least minimises errors and constrains the assessment conservatively. The analysis shows that only part, although a large part, of the anomalies can be accounted for in this way. The effects inshore and onshore are in no way explained.

The second problem may be stated thus: what is the contribution due to a western margin to the Lower Palaeozoic basin?

The anomaly due to the basin exposed between Cape Sorell and Dundas is long wavelength and unable to account for the nature of the negative effects observed immediately east of Ocean Beach. It will be noted that Figure 15 reveals a calculated profile which is too positive across some 50 km, most of which is offshore. Further, the marginal gradients observed where the effects of water or sediment cannot be included are excessively positive. This observation suggests that the model allowances for these materials is too great and that the negative source sought is much larger than the analysis of Problem 1 indicated. It is highly likely, in view of evidence in other sections along the coast, that the western side of the Dundas Trough does contribute to this effect but it does not explain it.

A granite body immediately offshore is the only viable explanation for the pattern observed in profiles such as shown in Figure 15, even though such patterns are often complicated combinations of sources.

Line 7A (fig. 16)

Line 7A presents a clearer view of the issues discussed above. The line extends further offshore and thus includes more Tertiary section. The relationship between the

landward segment of the profile and the negative response is given clearer perspective. It will be observed that the response is initially related to materials east of Ocean Beach. The solution east of Strahan is consistent with existing interpretations (Leaman, 1986c) and the rigorous criteria used to determine model acceptability. These criteria also establish limits for solutions offshore. Two basic model streams were tested—with and without an offshore Palaeozoic basin margin and/or granite (see Leaman, 1988c). These tests have established some fundamental factors.

(1) The mantle form outline derived from profiles where potential ambiguities due to Tertiary–Cretaceous sediments or undefined granites are absent is consistently satisfied across this coastal region.

(2) It is possible to find solutions with or without offshore granite but there must be a margin to the Palaeozoic basin within 15 km of the coast.

(3) Any doubt concerning the presence of granite relates to a gap in gravity coverage off Ocean Beach.

(4) There is no doubt about the presence of granite offshore from the Heemskirk and Pieman Granites. Thus line 7A does not absolutely resolve the issue of the Grandfathers Granite. Any granite present must be buried beneath the Tertiary cover. While the seismic data is not ideal, the basement reflection character immediately west of Cape Sorell implies a large crystalline mass (see Hinz *et al.*, 1986, fig. 6).

Line 20 (fig. 17)

This line was included because it utilises the best gravity coverage in the region and also samples the field close to The Grandfathers. The results are unambiguous. Review of the actual Bouguer values (1987 compilation) on Cape Sorell shows that the gravity field is locally depressed in the region of The Grandfathers. The anomaly wavelength is relatively long, suggesting that a major negative source is present and that the effect is certainly not related to water or light sediments. The location is inappropriate as well. This review of the field pattern, not obvious in large scale compilations, confirms the significance of the exposures at the coast. Recognition of this effect enabled revision of existing interpretations. Several such profiles (see Leaman, 1986c) revealed 'flat spots' at or near the coast which could not be assigned to water or post-Carboniferous sources.

Line 20 was previously presented in this 50 km format as 320 250 mN (in Leaman, 1986c). The observed profile has been revised to allow for new data, and the effect is evident between 350 000 and 360 000 mE. Note that the observed profile in this figure is an upward continuation, and the model includes complete topographic contributions. It is not, therefore, directly comparable in terms of shift parameters with Figures 15 or 16 but it does include model elements wholly compatible with all other sections. Remodelling of this line shows that the flat spot and roll

over in profile, which here occurs onshore where Precambrian rocks crop out, is not due to any offshore sediment but a reasonably massive granite body (at least 10 km across). Very few other adjustments were required to the model. The effect cannot be explained by the distribution of local Precambrian rocks, which have been shown to be part of a relatively thin thrust sheet (Leaman, 1988b).

Although some of the data and induction must be considered tenuous at this stage, the only consistent explanation for all observations, including the sedimentation patterns and responses offshore and along trend towards Trial Harbour, is a previously unsuspected and un-named granite whose form is shown in Figure 18. It may be an extension of either the Pieman or Heemskirk Granites but as shown by line 7A the connection is not yet proven. The samples of analysis given above outline the case for the Grandfathers Granite. It is clearly a large body with an effective contrast extending well into the crust. Although at the perimeter of magnetic coverage there is no clear suggestion of any magnetic character.

The scale of the body and the inferred properties imply a Devonian age, as the Cambrian granites are much smaller and have very distinctive (especially magnetic) properties. The body may be intruded into the western margin of the Dundas Trough.

MINERALISATION AND EXPLORATION

The economic significance of The Grandfathers Granite is quite unknown but its presence as an intrusive body into the largely Cambrian Cape Sorell region (and its thrusts) may well be important. Heat and fluids from this source could have mineralised or remobilised mineralisation in these materials. The recognition of this body by Baillie *et al.* (1977), and its proof of scale and presence, means that the Sorell Peninsula has economic potential quite apart from any Cambrian volcanogenic deposits. The thrust zones, and any receptive hosts near them (such as Ordovician limestone), may be worthy targets.

SUMMARY

1. A significant granite mass occurs near the western coast of the Sorell Peninsula.
2. A very small exposure occurs at the coast near The Grandfathers (hills).
3. The body has been named the "Grandfathers Granite".
4. Most of the body is offshore.
5. Current data do not allow definition of intrusion shape.
6. The economic significance of the intrusion is quite unknown but should be assessed.
7. The Grandfathers Granite is probably Devonian in age and intruded into the western margin of the Dundas Trough.

2D GRAVITY MODEL

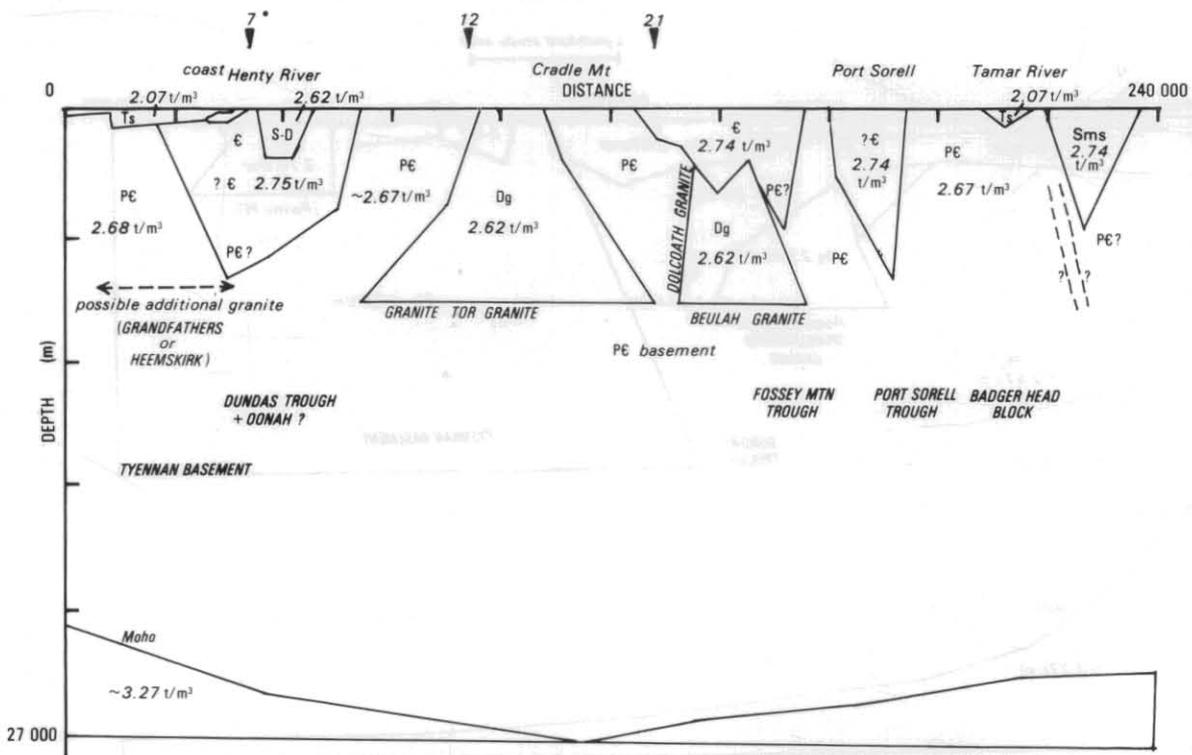
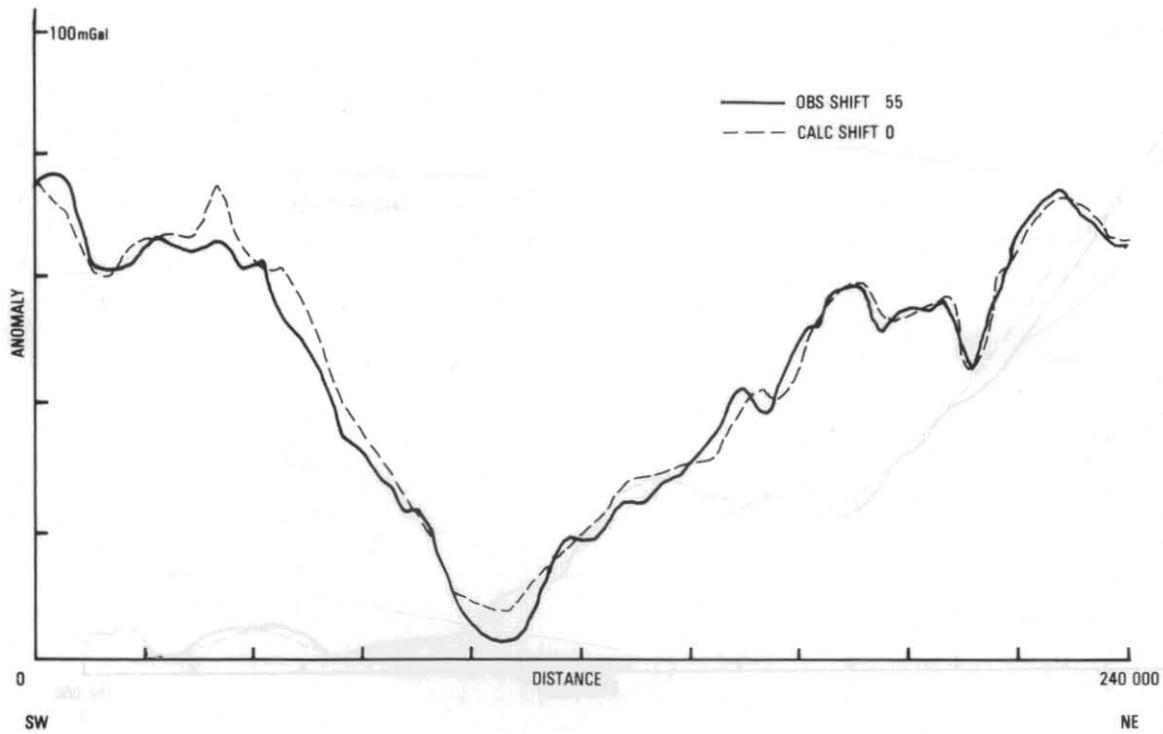


Figure 15. Regional interpretation: Line 6, Strahan-Cradle Mountain-River Tamar.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

2D GRAVITY MODEL

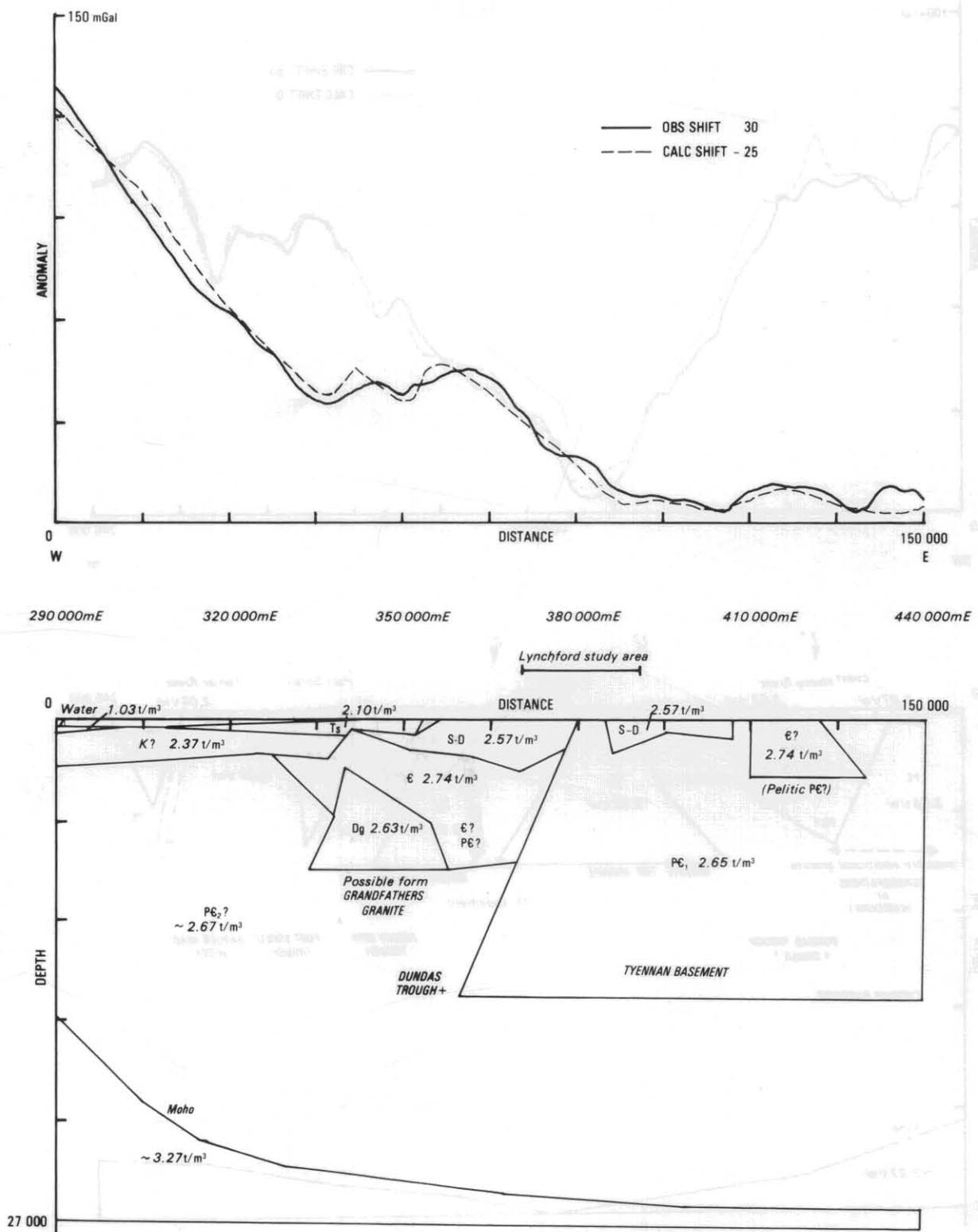


Figure 16. Regional interpretation: Line 7A [5337 000 mN, 290-440 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

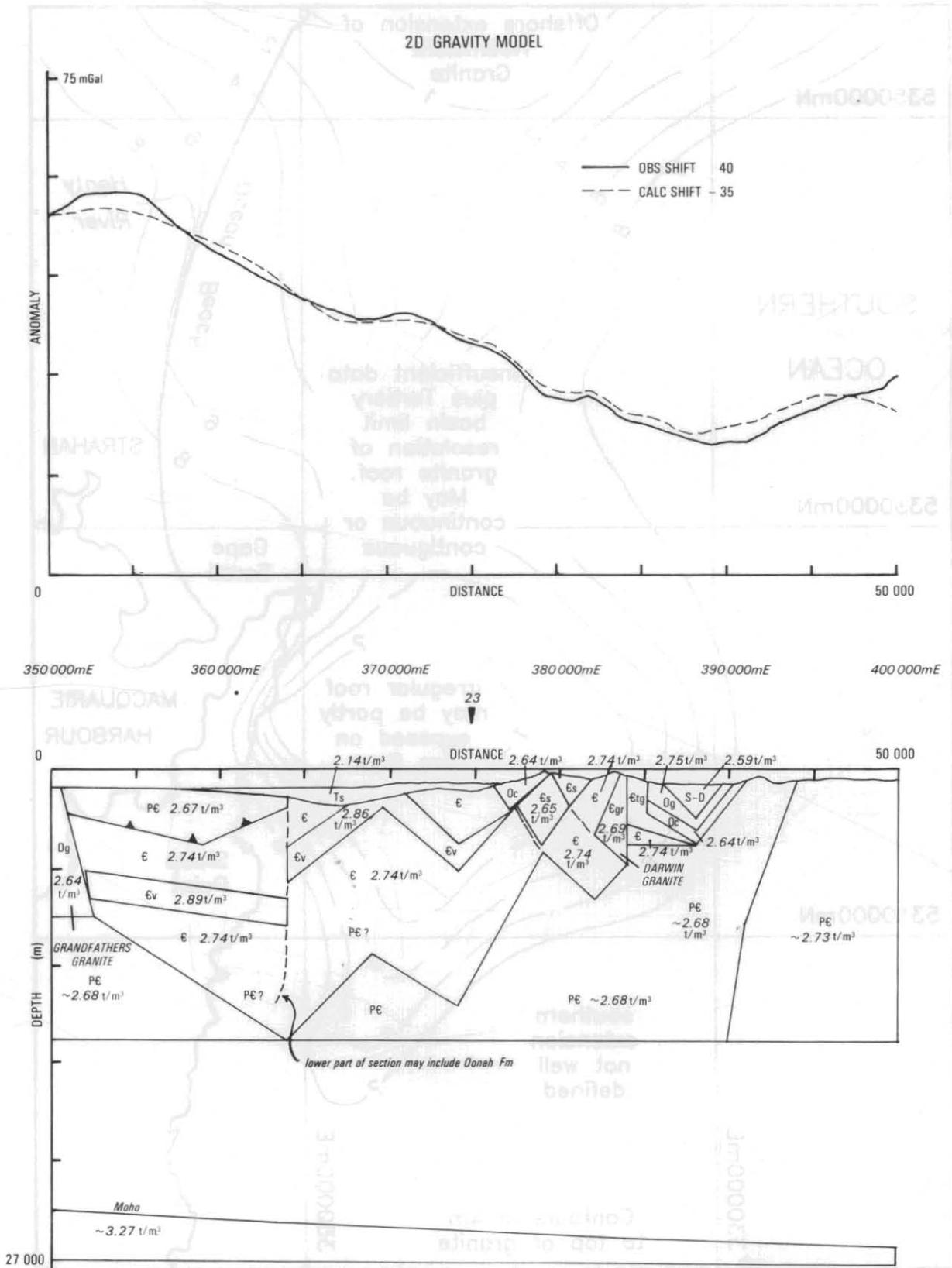
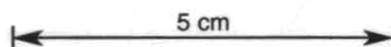


Figure 17. Regional interpretation: Line 20 [5320 250 mN, 350-400 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



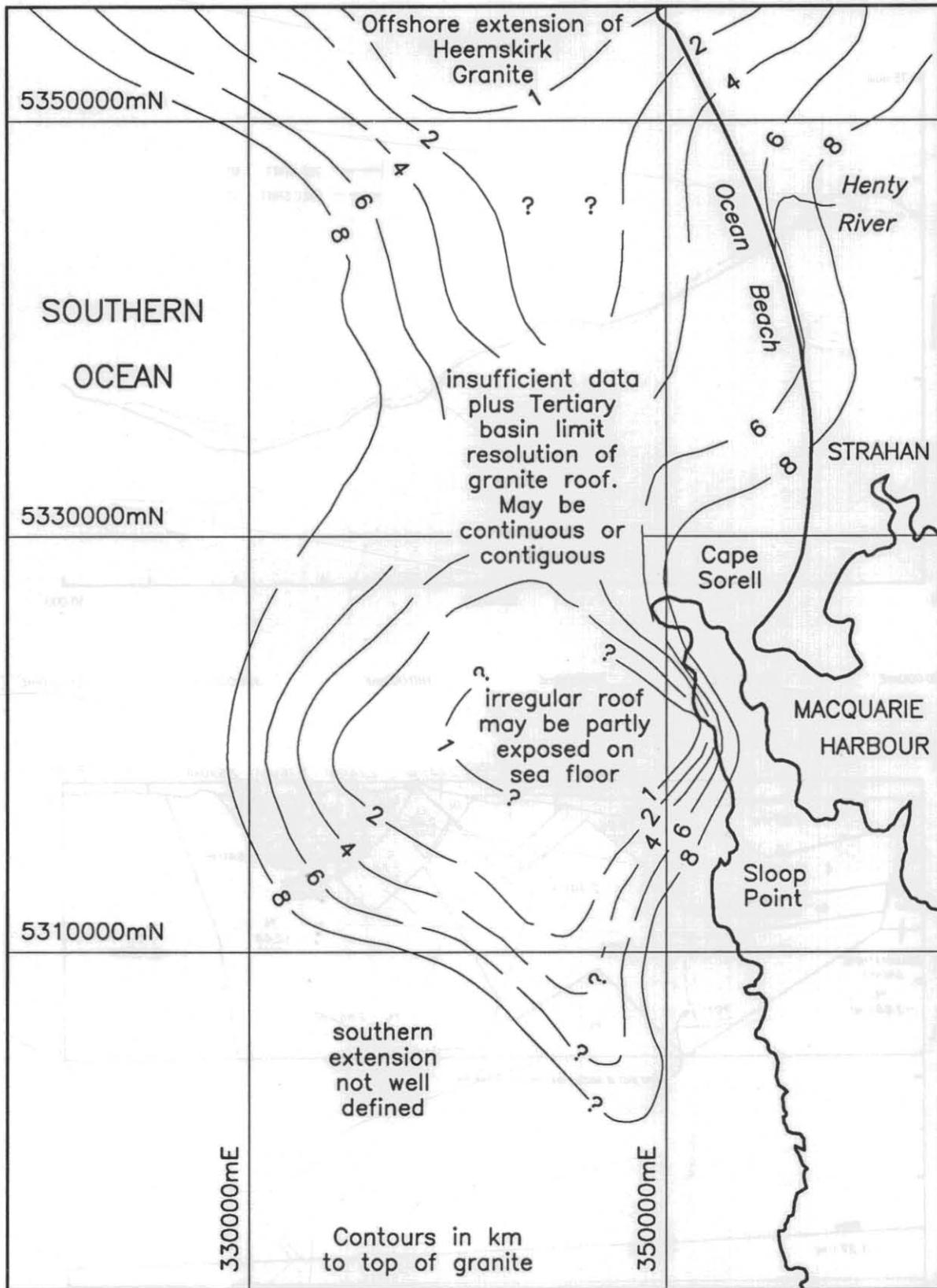
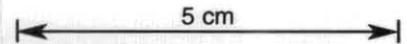


Figure 18. Form of the Grandfathers Granite.

5 cm

CHAPTER 4

TIMBERTOPS GRANITE



The Timbertops Granite is located near the north end of a syncline containing Ordovician rocks west of Birchs Inlet (see fig. 1). The folding in the region is complex and not well understood but the regional map (also Leaman, 1986*b* and this chapter) indicates a parallel anticline with the granite contained in, or near, the core. The granite occurs wholly within Cambrian rocks but reaches close to the unconformity with the Ordovician rocks. The complexities of this region have been discussed by Leaman (1988*b*).

The total area of exposure is small and little is known of the Timbertops Granite. It has not previously been named but the title Timbertops Granite is used throughout this bulletin. The granite body is located in an area known as Timbertops, in the headwaters and catchment of Timbertops and Commandant Creeks. It is presumed to be Cambrian in age.

INTERPRETATION

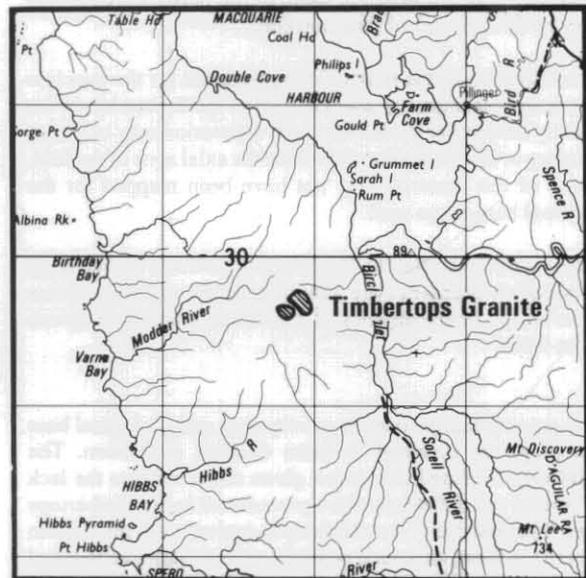
The evaluation of the Timbertops Granite depends on both gravity and magnetic data. The aeromagnetic coverage is excellent (Leaman, 1986*b*) but the gravity coverage is very poor as the region does not lend itself to helicopter surveys.

The best section through the gravity data base is shown in Figure 19. The observed profile is not well controlled west of 373 000 mE, and the features between the coast and this easting are not accurately known. Nor is the profile directly associated with the mapped exposure of the granite. It does, however, allow some assessment of properties and effects. The gravity gradients are relatively subdued, and there is a depression in the region of the Timbertops area. The position of the depression is based on very widely spaced stations.

The interpretation provided is consistent with the magnetic data and all criteria for regional interpretation. The thrust concepts included are consistent with conclusions drawn from better data coverage further north and west (see Leaman, 1988*b*). No attempt was made to over detail the western section of the profile due to lack of usable observed data. The depression of the field in the region of the Timbertops structures and granite exposure cannot be unambiguously correlated with the granite (see below). The model shows a small but substantial granite body of density 2.64 t/m^3 which extends to at least 6 km below the present surface. This density implies an average local contrast of -0.1 t/m^3 . Unfortunately the response could also be generated by the syncline core of post-Cambrian rocks. The model shows a maximum combined volume for both sources presuming the scale of the response to be correct.

However the data are viewed it must be concluded that the Timbertops Granite is relatively small and of reducing effect with relatively shallow depth extent. It certainly cannot possess the character and contrast pattern typical of the Devonian bodies.

The magnetic data impose an array of structural limitations on the Timbertops Granite. The Timbertops region was discussed by Leaman (1986*b*), and Figure 20 has been taken from the earlier work. The figure essentially provides an expansion of the upper part of the gravity solution, with some resolution of units within the Cambrian sequence. The character of the folds is indicated. The section thins rapidly eastward onto basement. The observed magnetic profile reflects the repetition of magnetic units across the Timbertops



exposures and the effect of burial by Precambrian thrust (west) or unconformable Ordovician-Silurian (east) cover.

Very high magnetic contrasts ($>0.005 \text{ cgs}$) are implied for significant volumes of the local Cambrian sequence, suggesting much mafic content, and within this context there is no evidence of a large rock volume where properties are less than 0.003 cgs as shown in Figure 21. This contrast is relevant, as parts of the Murchison Granite possess susceptibilities of this order, but it is far higher than any value recorded for other Cambrian granites and much higher than any Devonian material possesses. Figure 21 represents the magnetic elements of Figure 19 and presumes that the Timbertops Granite directly underlies the unconformity. If the granitic lithology has no density contrast then the profile match shown is representative. It is not possible to fill the void for a profile match with any large pipe or plug-like mass of any contrast. Unless the contrast is relatively high ($>0.004 \text{ cgs}$) and applied at shallow depth, the central anomaly hump cannot be generated. Inspection of Figure 22 reveals that the profile does not provide a realistic representation of this response, which is far greater. Insertion of a plug-like body with the necessary contrast, but terminated by the upper thrust stack so as to limit the depth extent, may be a satisfactory solution if thin enough or of small diameter. The overall character of the profile requires tabular dipping, rather than vertically extended, sources.

The gradients impose other limits. The syncline shown is relatively shallow and probably not as deep as suggested in the section for this northing (see fig. 20).

Review of the contours of the magnetic field (fig. 22) and available but limited mapping suggests that there is no obvious correlation between granite and anomalies unless the isolated peak is mislocated with respect to the granite. Either the granite is locally very magnetic (equivalent to a mafic-rich section), is inconsequential, or it induces a small negative shoulder on the mafic-related feature sourced from a mass directly beneath the syncline and due south(?) of the granite exposures. No major rock property studies are available to separate these alternatives but the second or third are feasible (note positioning comment above).

Two susceptibility determinations are available from samples of the Timbertops Granite (0.0004 and 0.0007 cgs). These

2D GRAVITY MODEL

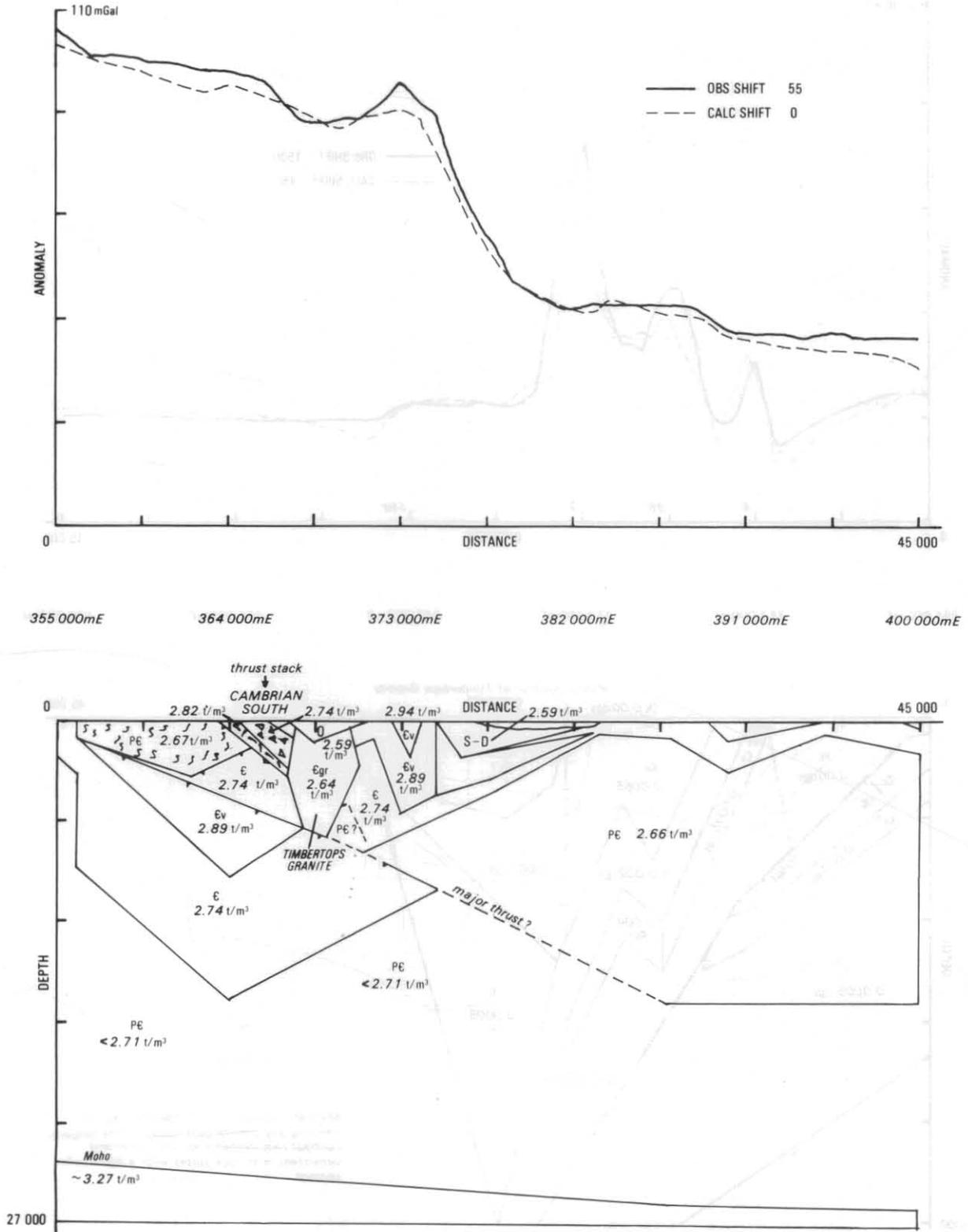


Figure 19. Regional gravity model: Line 29A [5295 000 mN, 355-400 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D MAGNETICS MODEL

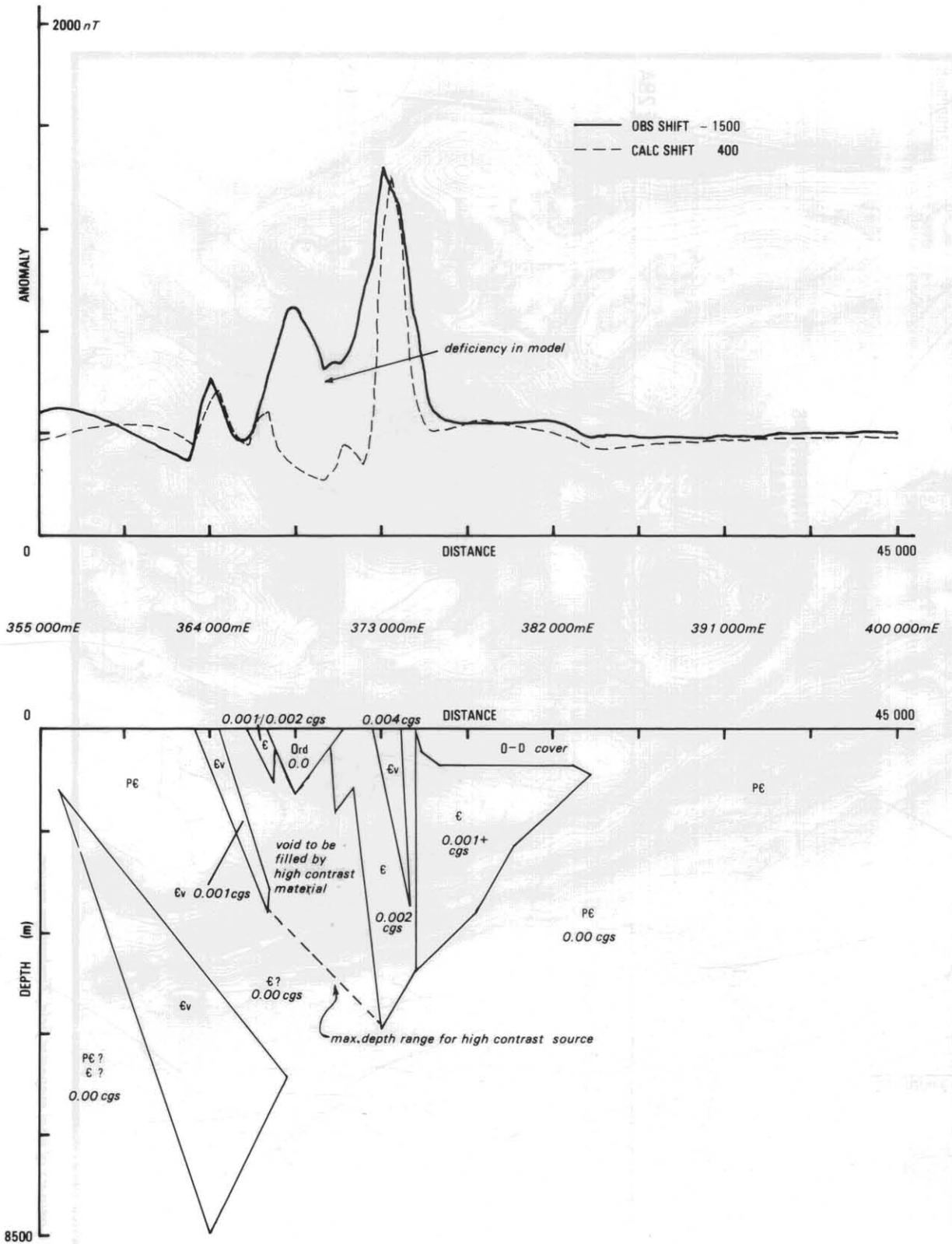
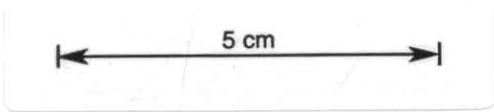


Figure 21. Magnetic model: Line 29A (magnetic line 20120). Interpretation showing effect of no contrast volume.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



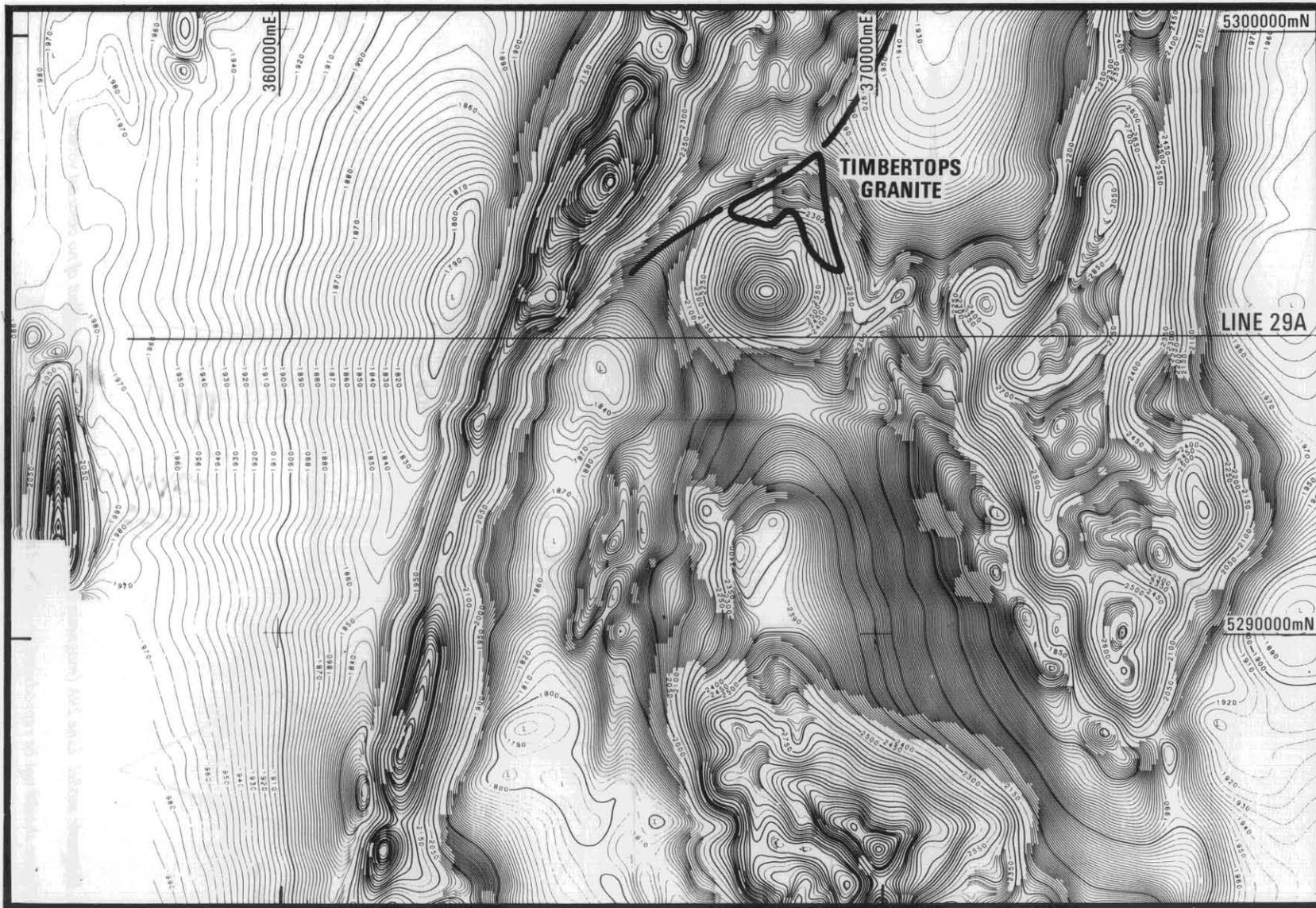
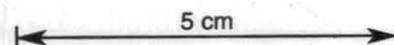


Figure 22. Contours of total magnetic field, Timbertops region.

CHAPTER 5

ELLIOTT BAY GRANITE



The Elliott Bay Granite consists of at least two, and possibly three, parts or exposures (fig. 1). Adamellite is exposed at Low Rocky Point and north of Elliott Point. The first of these bodies has been dated as at least 407 Ma (K-Ar) and thus a Late Cambrian or Ordovician age is probable. The Elliott Bay Granite is not Devonian in age. The third segment, not shown in the original base-map for Figure 1 (derived from Williams and Corbett, 1977), is indicated in regional mapping by Geopeko (Herrmann, 1985a). It has been described as a microgranite but may be a massive part of the Lewis River Volcanics or an extension of the adamellite near Elliott Point. Current geological information is too sketchy to establish relationships or distinguish the components.

The nature of the intrusions was considered in earlier analysis by Leaman (1986b, c). It was suggested that these bodies were magnetic non-entities and gravimetrically miniscule. Some suggestion of alteration within the surrounding volcanic sequences was recognised. The form of the bodies was not resolved.

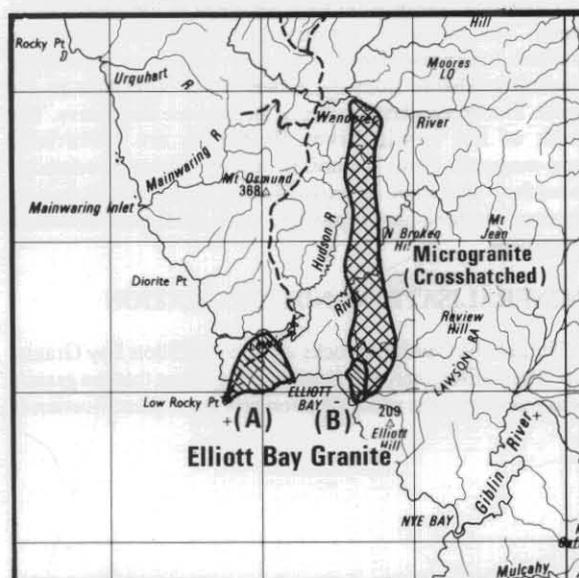
INTERPRETATION

The interpretation prepared for an earlier phase of the Mt Read Volcanics Project has been reviewed and revised (Leaman, 1986b, c). Figures 23 and 24 present magnetic interpretations which require little change with present knowledge. These show that the coastal exposures (fig. 23) and inland microgranite (fig. 24) have no magnetic expression. Both models are unclear about the form of the bodies, as no unambiguous geometric indicators can be identified which might limit shape evaluations. The composition of the coastal material, its surface extent and the lack of response, would suggest a small volume and limited depth range. It must be stressed that no actual property determinations are available to support this presumption but the inferences to be drawn from the contour map of the magnetic field are not complicated by other sources, as was the case around the Timbertops Granite (Chapter 4).

The existing gravity interpretation (Leaman, 1986c) is reproduced in Figure 25. The observed profile is dominated by a 20 mGal step which correlates with the junction between acid and more mafic sequences. This correlation has considerable strike expression, and there is no doubt that it is associated with Cambrian rocks and is not significantly modified by mantle shape changes as the continental margin is approached. The anomaly step reflects a major change in Cambrian deposition or scale.

Review of the gravity station values in the region of Elliott Bay does not indicate any direct correlation between the gravity field and the adamellites. Although the station spacing is about one kilometre, several stations lie on or close to the three mapped exposures. Devonian adamellites induce enormous distortions in the gravity field irrespective of station location, and the immediate inference is that these bodies are of small volume and are depth limited. A contrast of -0.05 to -0.1 t/m³ could be expected in the Elliott Bay environment.

Figure 25 mirrors these conclusions and illustrates how the model contains too much granite. The profile shape appears to be more directly influenced by the depth to Precambrian basement and the folded thickness of the Lewis River Volcanics.



In view of coastal analyses further north (see discussions for the Pieman and Grandfathers Granites, Chapters 2 and 3 of this bulletin) it was decided to regionally confirm the detailed view expressed in Figure 25. This was done by selecting a more oblique transect of Elliott Bay and incorporating more offshore detail. It has been recognised that this might introduce some errors, as the offshore coverage is relatively poor, uncorrected, and ambiguous in this region. The line orientation chosen avoids an apparent east-west offset in shelf structures at the northing of Low Rocky Point. The modelling shown in Figure 26 was controlled by the criteria outlined in the introduction and used across west and north-western Tasmania.

It is clear from the regional analysis, which includes allowance for shelf relief, water and shelf sedimentation, that the basic crustal assumptions are sound, as the model immediately satisfied two-thirds of the profile. The perspective of the detailed segment shown in Figure 25 becomes evident, and the longer section demonstrates that the Cambrian trough is quite narrow.

The Elliott Bay Granite is shown as a large intrusion in Figure 26 in order to illustrate how little these bodies may contribute to the section. Relatively minor adjustments to the local fold pattern or thickness of the Lewis River Volcanics can completely disguise the effect of the granite, and the regional view of the actual anomaly patterns is best explained by such means. These comments are not intended to imply that the various exposures of granite are necessarily sheet-like. It would be possible to explain the observed data with carrot-like shapes which rapidly taper with depth. Such body shapes must be isolated; there cannot be a single large body with roof pendants of the indicated composition. The effect of the microgranite to the east is not noticeable, and this material may be simply a phase of the volcanics.

The insignificant response of the granite at Elliott Bay can be contrasted with the unmodelled response of the Ordovician and Silurian rocks along the Gordon River.

Previous descriptions, above and Williams (1979), have implied uniform compositions and simple bodies for this granite. Detailed review of the magnetic field (fig. 27) shows that this is not so. This was noted by Leaman (1986b).

The Low Rocky Point mass is not uniform. Although the north-west contact is obscured by strongly magnetic units, the granite core (white granite) is evident. The eastern margin, however, is compound and a block of more magnetic material (pink granite) is included. This may be more dioritic in composition. There is no such variation in the Elliott Point body. The extended, presumed, microgranite presents a varied magnetic field, but one which is generally undistinguishable from the Lewis River Volcanics to the west. The Precambrian rocks to the east are distinctive. The bulk of the Lewis River Volcanics are essentially non-magnetic. Many features in this region may be related to boundary alteration or cross-faulting near contacts but no further interpretation is justified until geological control is improved.

MINERALISATION AND EXPLORATION

Although the Cambrian rocks around the Elliott Bay Granite are mineralised there has been no suggestion that the granite was relevant to the mineralisation process or identification of



The map shows the distribution of the Elliott Bay Granite, which is a large, roughly rectangular body. It is surrounded by Precambrian rocks to the east and Lewis River Volcanics to the west. The granite is divided into several zones, including a central white granite core, a surrounding pink granite zone, and an outer microgranite zone. The map also shows various faults and structural features, such as the North-South fault and the East-West fault. The map is oriented with North at the top.

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new prospects. This may, of course, reflect ignorance. Most local mineralisation appears to be volcanogenic in origin.

SUMMARY

1. The Elliott Bay Granite is a physically non-descript and minor set of intrusions.
2. The composition of the granite is reasonably uniform but variations can be recognised.
3. The granite may have been emplaced as sheets or as rapidly tapering carrot-like bodies. There is no significant, massive depth range.
4. The economic significance of the intrusive rocks is not known.
5. The granite is probably Cambrian in age, and intruded close to the trough margin.

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2D MAGNETICS MODEL

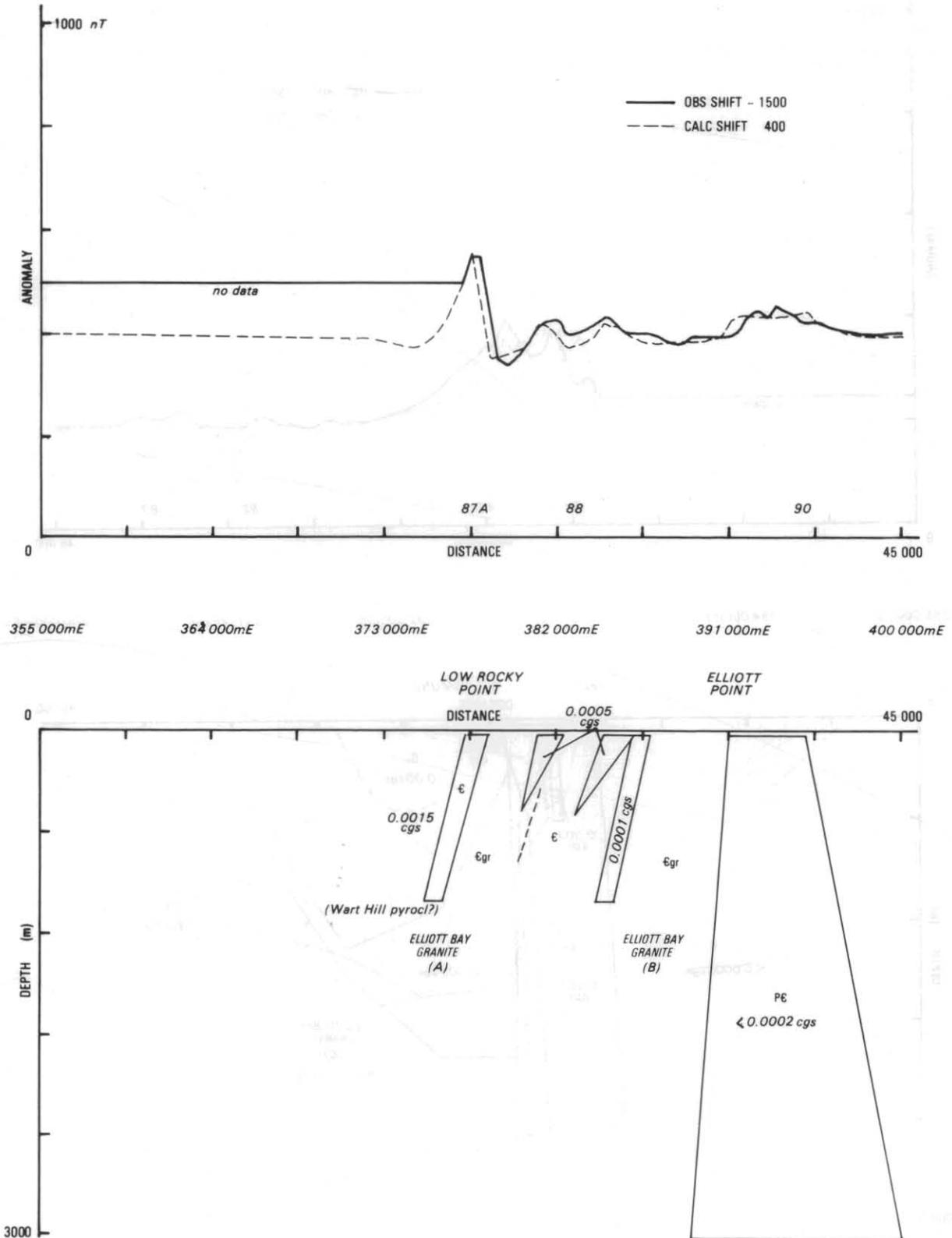


Figure 23. Magnetic model: Line 21211 [5240 500 mN, 355-400 000 mE]. (from Leaman, 1986b).

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D MAGNETICS MODEL

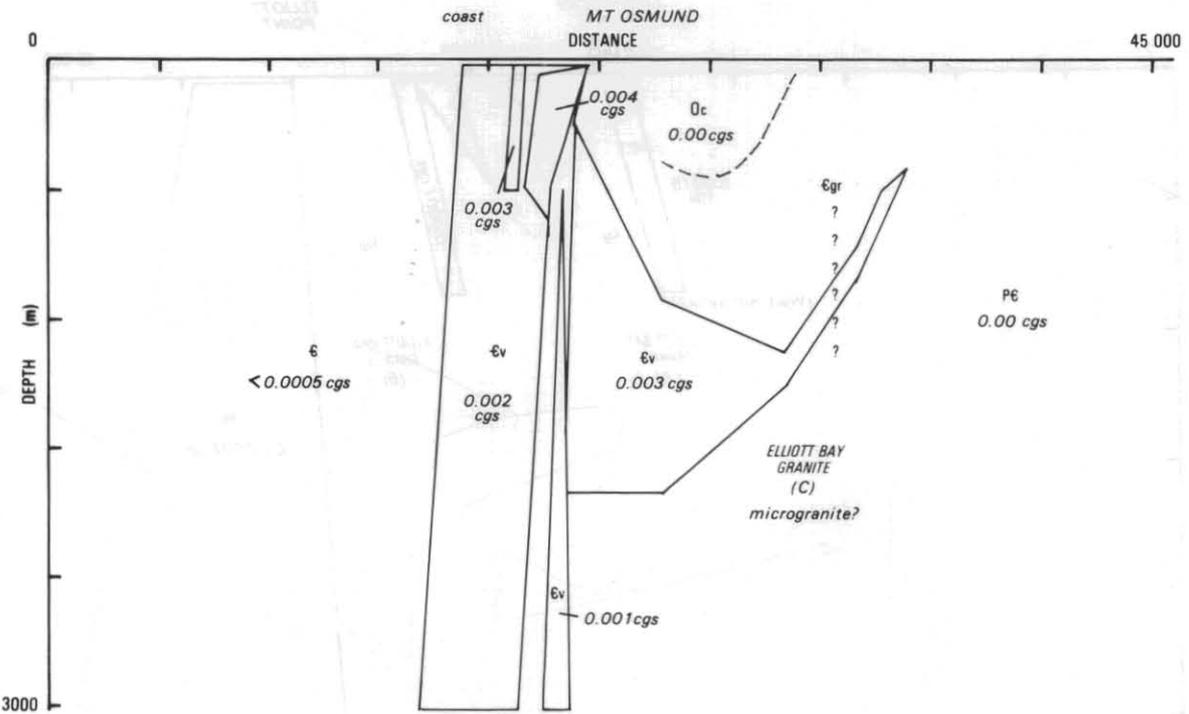
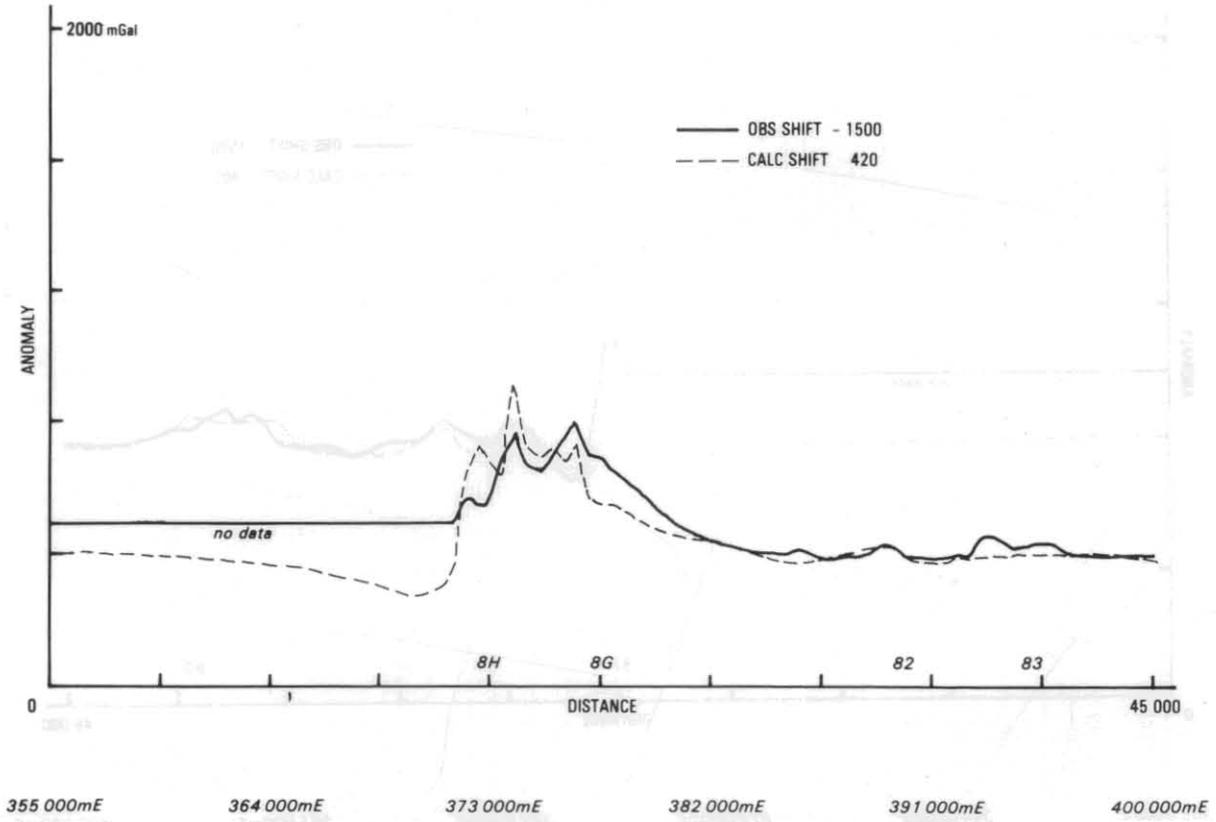


Figure 24. Magnetic model: Line 20930 [5254 500 mN, 355-400 000 mE]. (from Leaman, 1986b).

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

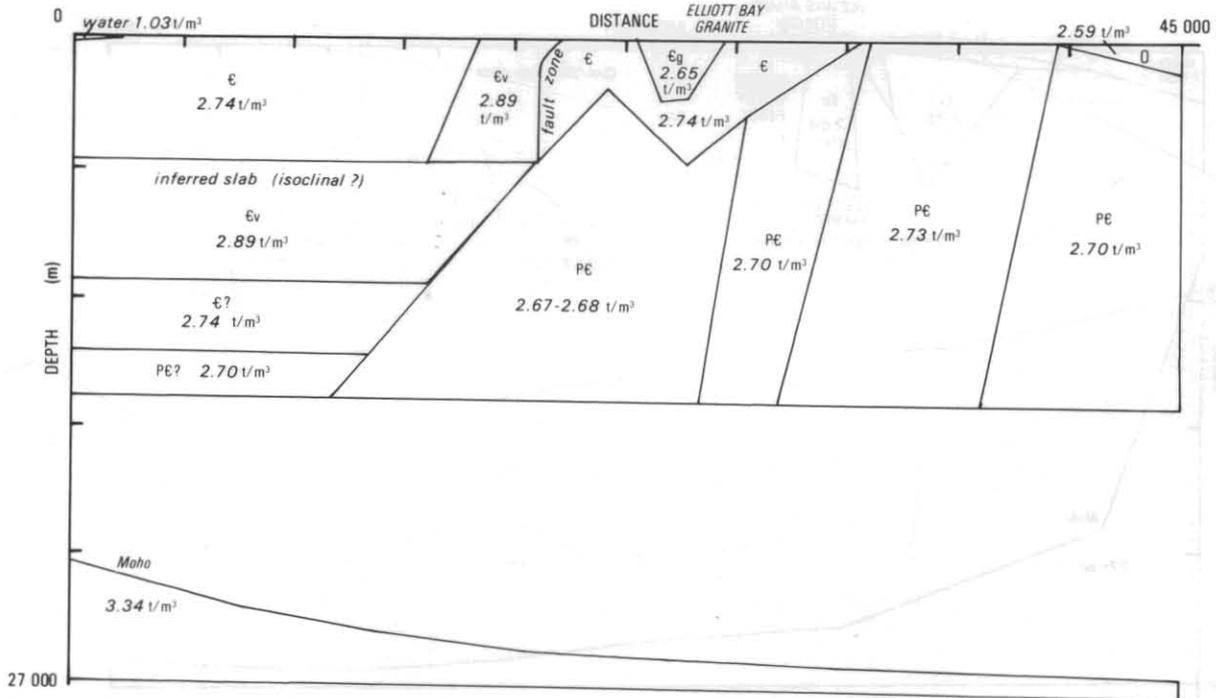
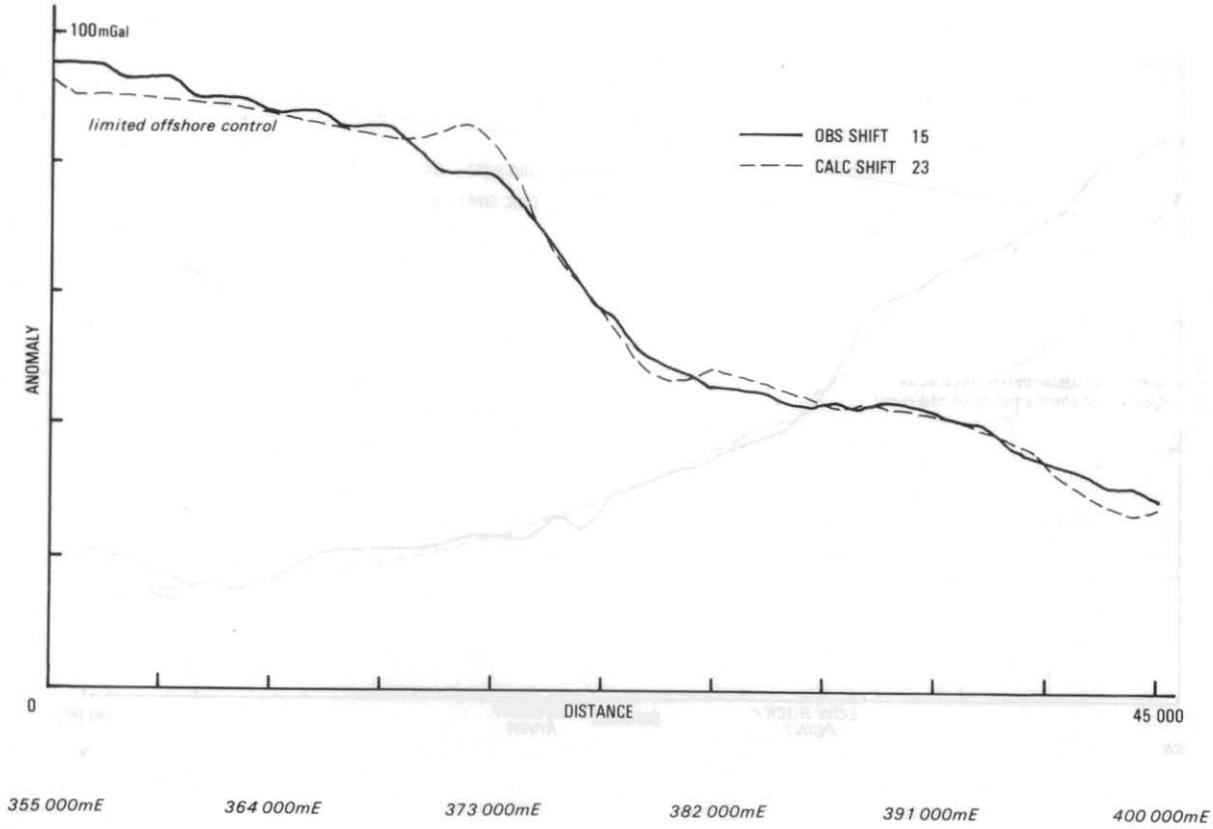
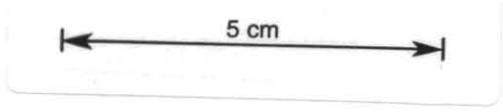


Figure 25. Gravity model: Line 21211 [5240 000 mN, 355-400 000 mE]. (from Leaman, 1986b).

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

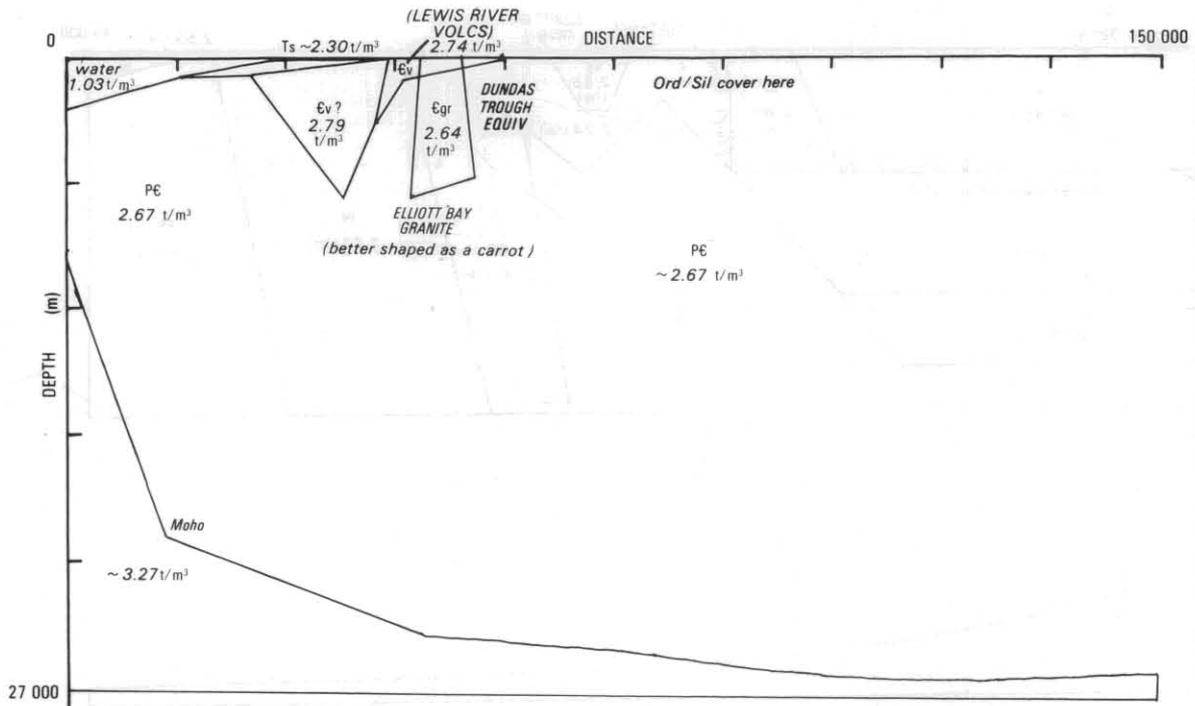
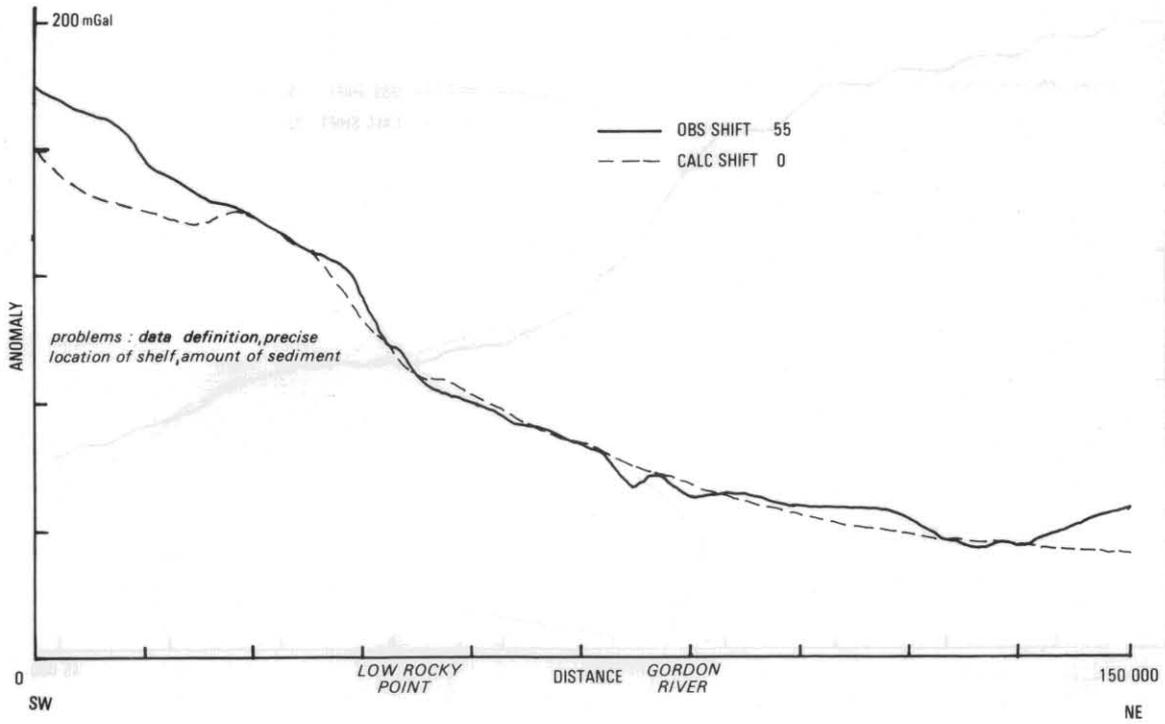
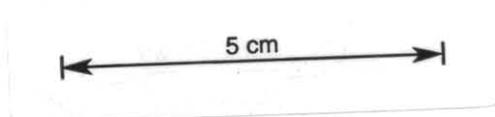


Figure 26. Regional gravity model: Line 27, Elliott Bay–Maydena.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



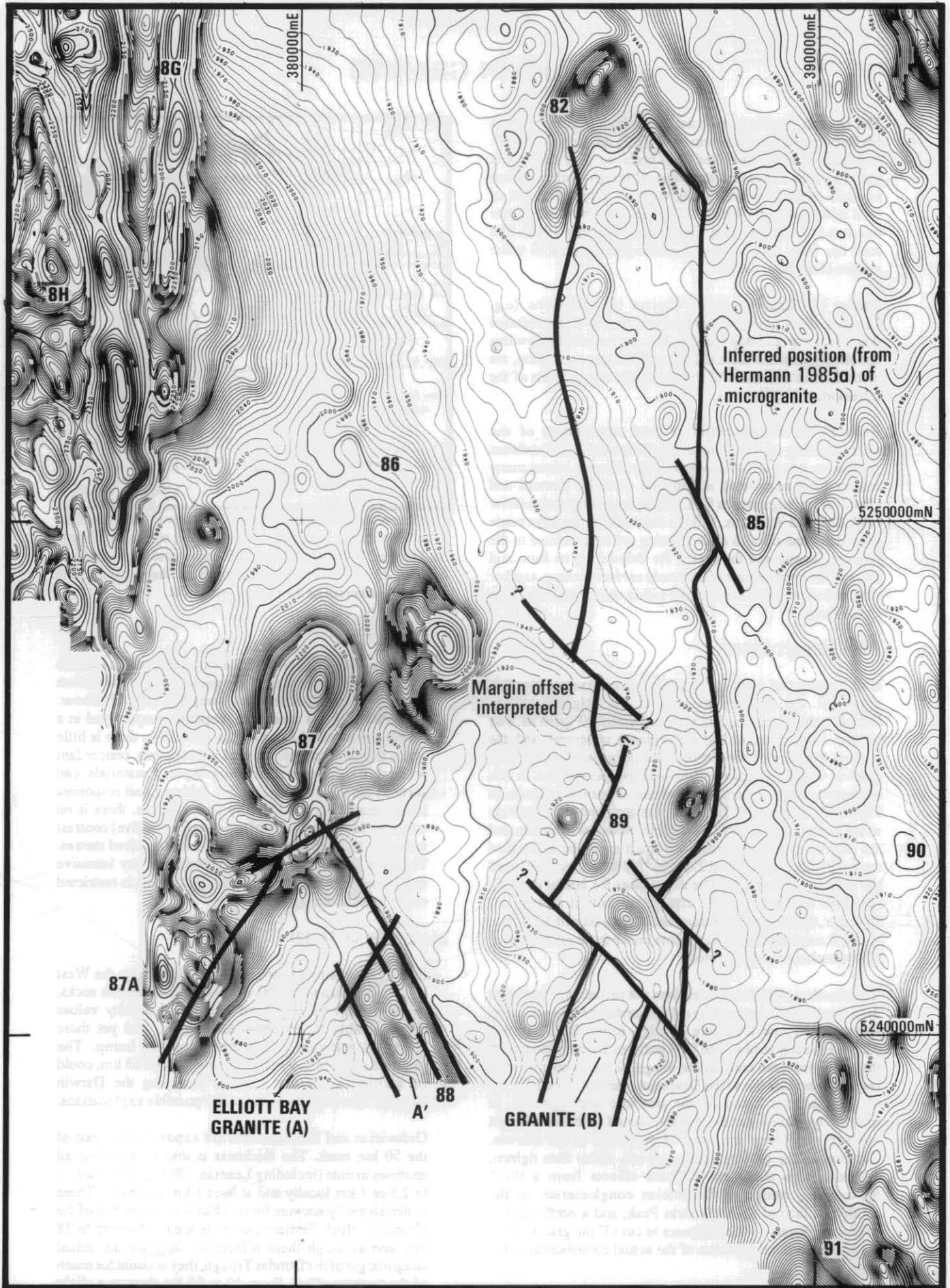
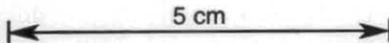


Figure 27. Magnetic field, Mt Osmund to Elliott Bay.

5 cm

CHAPTER 6

DARWIN GRANITE



The Darwin Granite is exposed on the high plateau between Mt Darwin and South Darwin Peak (fig. 1 and Corbett, 1979). Williams (1979) described this body as a granite sheet intrusive into a rhyolitic sequence, although Corbett makes no such suggestion. Most diagrammatic representations of rock relationships in the West Coast Range show the granite as a non-bulbous pipe (e.g. Collins and Williams, 1986). The rock has been described as a coarse-grained pink to white granite (Solomon, 1960).

Earlier Mt Read Volcanics Project interpretations (e.g. Leaman, 1986c) briefly reviewed this granite and concluded that it was a small body (see fig. 28). As discussed below this conclusion, and the difficulties posed for any evaluation, are distinct from the issues of the economic significance of the intrusion.

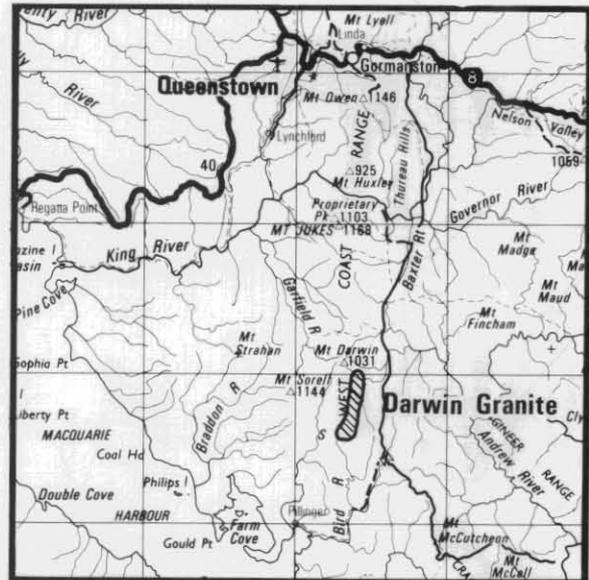
Because of the potential critical importance of the understanding of the form and relationships of Cambrian granites to mineralisation—especially this one, where many writers have associated it with the essential thermal and chemical feeding systems for Lyell-style mineralisation (refer to Collins and Williams, 1986)—some effort has been made to evaluate the streams of conflicting evidence related to the Darwin Granite and the means for delineating its form and extent. The implications of this study are far reaching, as other similar bodies may be concealed within the rocks of the West Coast Range.

INTERPRETATION

Both gravity and magnetic data have been reviewed for this appraisal. An updated version of the original gravity interpretation (Leaman, 1986c) is presented in Figure 28. The gravity field is controlled by regional structures and the general thinning of the Cambrian sequences eastward. The Darwin Granite yields no clear negative perspective in this environment; other Cambrian and post-Cambrian units do. In Figure 28, a density of 2.69 t/m^3 was assigned to a relatively small volume but no actual determinations are available and the density distribution required could easily be assembled from a balance of 2.74 and 2.64 t/m^3 for the volcanic pile and the granite respectively. The allowances for lateral deposits (such as Ordovician) are also important. It is evident, however, that unless the granite has no contrast with basement rocks, it must be of limited volume under these assumptions. This conclusion was reported.

Examination of station values does not reveal any consistent direct correlation between granite distribution and anomaly, although the one kilometre spacing is not ideal for this purpose in such terrain. The field patterns are consistent with the earlier reported conclusion; the granite does not present a response comparable to the Devonian granites. Careful study of the gradients based on the one kilometre spacing, as irregularly placed on the terrain, would indicate a slight positive effect near the crest of the range at Mt Darwin. Contours of the gravity field space out, rather than tighten, and although there are definite effects from a thick SE-trending wedge of Ordovician conglomerate on the south-east face of South Darwin Peak, and a north-west to south-east break—which appears to cut off the granite itself—there is no demonstration of the actual contribution of the granite.

There is therefore a conflict in the implications of the gravity data. Is the granite too small and of such density as to make no contribution at regional scale, or is it in fact slightly denser



than the rocks of the range overall? Two new regional profiles have been drawn across the southern part of the range near Mt Darwin. These are shown in Figure 4 and reproduced in Figures 29 to 32. These serve to stress the conflicts and ambiguity inherent in the present treatment.

Line 9 (fig. 29)

Line 9 is acute to the edge of the basement, which extends N-S immediately east of the range, and also to the eastern side of the Tertiary depression along Macquarie Harbour. While both effects cannot be properly compensated in a simple treatment of a line of this orientation there is little doubt that a reasonable view of the structure, concordant with other sections and based on exposed materials, can account for the observed profile. Although all responses are geometrically modified by strike factors, there is no evidence for a large body of negative (or positive) contrast with any depth extent in excess of a few hundred metres. This line imposes lateral effect limits for any intrusive mass near Mt Darwin. Such a body, if present, is restricted to the heart of the range.

Line 23 (fig. 30, 31, 32)

Line 23 maintains a near-normal relationship to the West Coast Range up to the 50 km mark. Precambrian rocks, exposed from 63 km, have established density values approximating the Bouguer assumption, and yet these materials generate an apparent positive hump. The negative effect to the west, from about 30 to 63 km, could be ascribed to granite sources, including the Darwin Granite. There are, however, other possible explanations.

Ordovician and Silurian rocks are exposed north-east of the 50 km mark. The thickness is unconfirmed but all analyses to date (including Leaman, 1986a, c) indicate up to 2.5 or 3 km locally and at least 1 km generally. These materials easily account for much of the eastern half of the observed effect. Tertiary materials are exposed up to 38 km, and although these effectively disguise the actual steep margin of the Dundas Trough, they account for much of the western effect. From 40 to 50 km there is a slight positive bulge—consistent with earlier comments deduced from the contour presentation of the gravity field—and this would indicate that the materials in, or of,

the range are not denser than basement, as an overall subtraction of effect is still required.

This conclusion is consistent with detailed analysis in the Lynchford area (Leaman, 1988c) where the thinned, presumably Late Cambrian sequence wedging onto basement is less dense (2.6 to 2.64 t/m³) than the mafic or Dundas-style sedimentary sequences. Any granite of comparable density would be difficult to resolve in this situation until all contributions are appraised or combined. This has been attempted.

Figure 30 presents a view of the range based on the Lynchford implications and the materials present. It ignores the granite. It shows that use of a density of 2.63 t/m³ within the axis of the range for the thin section on basement cannot account for the observed profile. Such a density is either too high, the section very much thicker, or granite is present as a significant but relatively small body. Comparison with Figure 28 shows that none of these is likely on a regional basis. The effect observed on Line 23 is local to the Snake Peak region. Figure 31 presents an alternative view using a locally thick but very light Cambrian section within the range. This yields a match comparable with Line 20 (fig. 28). Both solutions (fig. 28 and 31) are too positive across the range overall but this deviation extends some distance beyond the range and would suggest that the local basement over a 30 km band is probably lighter than assumed by about 0.02 t/m³.

Figure 32 shows that it is possible to achieve an equivalent profile match using the thinned section concept, provided it is coupled with a restricted tabular/pipe-like plug of granite. The coupling of a low density section (say 2.60 t/m³) with a small granite plug of 2.63 to 2.65 t/m³ would also account for the enigma of slight positive effects in the heart of the range as noted above.

None of the model fits have been made perfect in order to illustrate the equivalence of the solutions and allow review of the amount of excess mass not included. There is no doubt, however, that only the solutions of Figures 31 and 32 are viable and only that of Figure 32 accounts for all the paradoxes in the gravity field.

Previous magnetic interpretations (Leaman, 1986a) have avoided this part of the West Coast Range. This reflects the difficulties of quantitatively treating the data set, and the time budgets or priorities for the analyses. Leaman (1986a) showed in several profiles across the range that the rocks of the axis and eastern face generated large anomalies which were not easily resolved or explained. It was assumed that most effects were related to members of the Tyndall Group. This appeared, in the absence of direct property measurements, to be a reasonable assumption south of Mt Sedgwick, on Mt Lyell, and east of Mt Owen and has since been partly confirmed in the Lynchford area (Leaman, 1988c). But, as noted below, this view was not held with conviction, as Leaman (1986a) inferred that other granites of the Murchison Granite type might well account for some of the effect, and that such a body might be present near Linda.

If the mapping of Corbett (1979) is contrasted with the observed character of the magnetic field (see fig. 34)—ignoring the inadequacy of the flight 'drape'—it will be found that not only is the Tyndall Group generally absent in the Mt Darwin region, or is at least partly removed or covered by Ordovician rocks, but the principal anomalies correlate most closely with the Darwin Granite. Any relationship with the phytic volcanic pile is less obvious. The correspondence noted in Figure 34 could mean:

(1) its properties are similar to the surrounding volcanic rocks;

(2) the granite has an inconsequential volume; or

(3) the granite contributes the bulk of the anomaly pattern in the core of the range, and is far more extensive than previously thought; i.e., other large, localised anomalies may be of this origin.

Gravity data clearly support the second option on a regional scale but the third is feasible and beyond the resolution of the existing gravity coverage unless the pods are of the type suggested in Figure 32—small, isolated, narrow compared to their length, and not buried deeply (<500 m). But, does the granite possess the necessary magnetic contrast to account for the anomaly pattern? The implications of it doing so, and of other bodies in the range, are economically most important.

Very few magnetic properties are known for the Darwin Granite, and these are of the order of 0.0002 cgs. The Murchison Granite, in contrast, possesses susceptibilities of 0.002 to 0.003 cgs and the Dove Granite about 0.001 cgs (Collins *et al.*, 1981). Although these granites are of similar age, located in a comparable structural environment (see Chapters 7, 8 in this Bulletin), and associated with volcanic rocks, they are of different compositions and the contrasts may not be transferred with assurance. It may be relevant to note here that the Timbertops Granite, whose anomalous and enigmatic character was discussed in Chapter 4, may possess similar properties and be pipe-like. Further sampling of the granite is essential to any resolution of this issue.

Leaman (1986a) observed that if the Darwin and Murchison Granites were decidedly magnetic overall (and the Murchison Granite is) then the anomaly pattern around Mt Lyell may reflect an additional intrusion. This comment, and the above discussion, stresses the relevance of any interpretation or attempt to understand materials such as the exposed Darwin Granite.

*Line 435 (Leaman, 1986a; Corbett *et al.*, 1982) (fig. 33)*

Magnetics line 435 is at the same nominal northing as gravity line 20 (fig. 28). It has been reviewed in order to assess the implied structural styles and property distributions across the crest of the range at Mt Darwin. The work is inferential in the absence of adequate property data.

The observed flight path and observations have been fully compensated, and the reference level in the model is at 1200 m above sea level. The terrain has been incorporated into the model in the same manner as for the gravity solution. A drape profile was also calculated and modelled but this is a more suspect procedure due to the complex interactions of terrain and sources. The discussion is based on a fixed reference correction, as the process is more reliable and the conflicts implied in the gravity study are of such magnitude that a simpler process provides a better test of the elements of the range.

The modelling has been based on the mapping of Corbett (1979, 1984). Regional structures account for the anomalies east and west of the range. A deeply buried anticline containing mafic rocks in the core extends south-east from Strahan beneath the Tertiary cover (see also Leaman, 1986a). East of the range local variations in Precambrian basement accounts for the small anomalies observed. Within the range we have assembled a moderately magnetic but thinning wedge of miscellaneous acid volcanic rocks. These are capped, on one limb of an eroded anticline on the east face of Mt Sorell, by members (?) of the Tyndall Group which dip west and generate the smaller anomaly peak. No such materials have been recorded on Mt Darwin itself.

The peak anomaly correlates with the plateau on the mountain, and the granite. The anomaly cannot be explained by ascribing the source as wholly, or part of, Corbett's phytic volcanic rocks on the western face of the mountain. The granite seems the only feasible source; certainly it is the only material with the proper geometric location to the anomaly. It is very special, pleading to suggest something hidden beneath a granite sheet. Further, the inferred contrast is compatible with the observed values for the Murchison Granite, and any remanence effect (inevitable) would only make the correlation stronger. The presently available property data are an order of magnitude less but may not be representative. The analysis summarised in Figure 33 also shows that only minor changes in geometry are feasible, and that the characteristics of the anomaly imply a narrow, deeply-rooted body. Any broad, or sheet-like slab, of any substantive thickness is not possible nor consistent with the outcrop pattern.

Adequate geophysical data (especially magnetic) exists for a comprehensive resolution of the issues around Mt Darwin, including assessment of the entire form of the granite and alteration patterns within it and the surrounding rocks. Such work is beyond the present regional brief. Some additional data would be desirable. This could include at least one detailed gravity traverse and a surface magnetic profile, coupled with many property determinations. The subsequent analysis may then be reliably based on the aeromagnetic survey (following full data correction) using three-dimensional methods.

MINERALISATION AND EXPLORATION

The economic significance of the Darwin Granite is not known. It has been generally assumed that Cambrian granites of this type, intruded along the active margin of the basin into (or feeding) volcanic piles, have introduced mineralisation, controlled thermal conditions, and influenced fluid conditions for emplacement. The materials surrounding the Darwin Granite are certainly mineralised and, if the implications of this study and that of Leaman (1986a) are

correct, a similar body may account for the Lyell mineralisation.

Until relatively small intrusive bodies like the Darwin Granite have been explored seriously and their form and extent defined, the force of any correlation cannot be appraised. The precise siting of these bodies may be crucial in exploration terms but their size precludes use of regional gravity data in any extensive manner. Such work lies in the province of prospect exploration at licence area scale.

If the analysis reported here proves sound then several small granite bodies may be inferred within the core of the West Coast Range but only the Darwin and Murchison bodies are exposed. Exploration should be concentrated about such centres. This is an induction process which should begin with detailed review of the Darwin Granite to establish methodology and form a foundation for extension of study along strike. The ability to define such bodies, as suggested here, is crucial to deep exploration of the range.

SUMMARY

1. The Cambrian Darwin Granite was emplaced in the heart of the southern section of the West Coast Range as a narrow plug.
2. Although few observed properties are available, the granite probably has a density of 2.63-2.67 t/m³, and an overall bulk equivalent (including remanence effects) susceptibility of 0.0025 to 0.0035 cgs.
3. The total volume of granite is quite small and not easily assessed gravimetrically with regional (one station/km²) data. It is distinctively magnetic.
4. Definition of the shape of the granite is feasible using advanced magnetic methods but further study should be preceded by property acquisition, ground checks, update of the geology, and full correction of the magnetic survey.
5. The granite is intruded very close to the edge of the Cambrian basin margin in a thin volcanic sequence.

2D GRAVITY MODEL

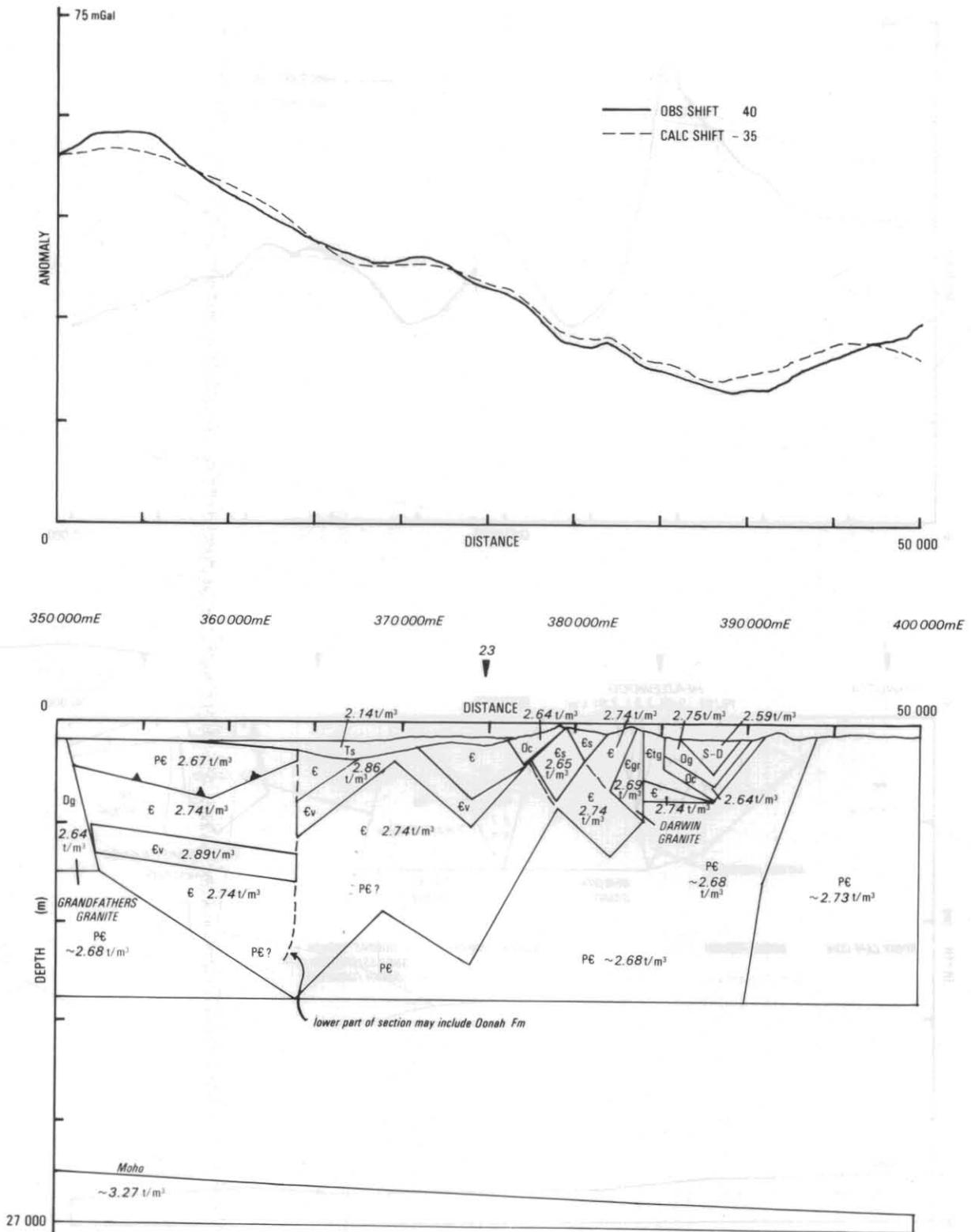
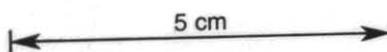


Figure 28. Regional interpretation: Line 20 [5320 250 mN, 350-400 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

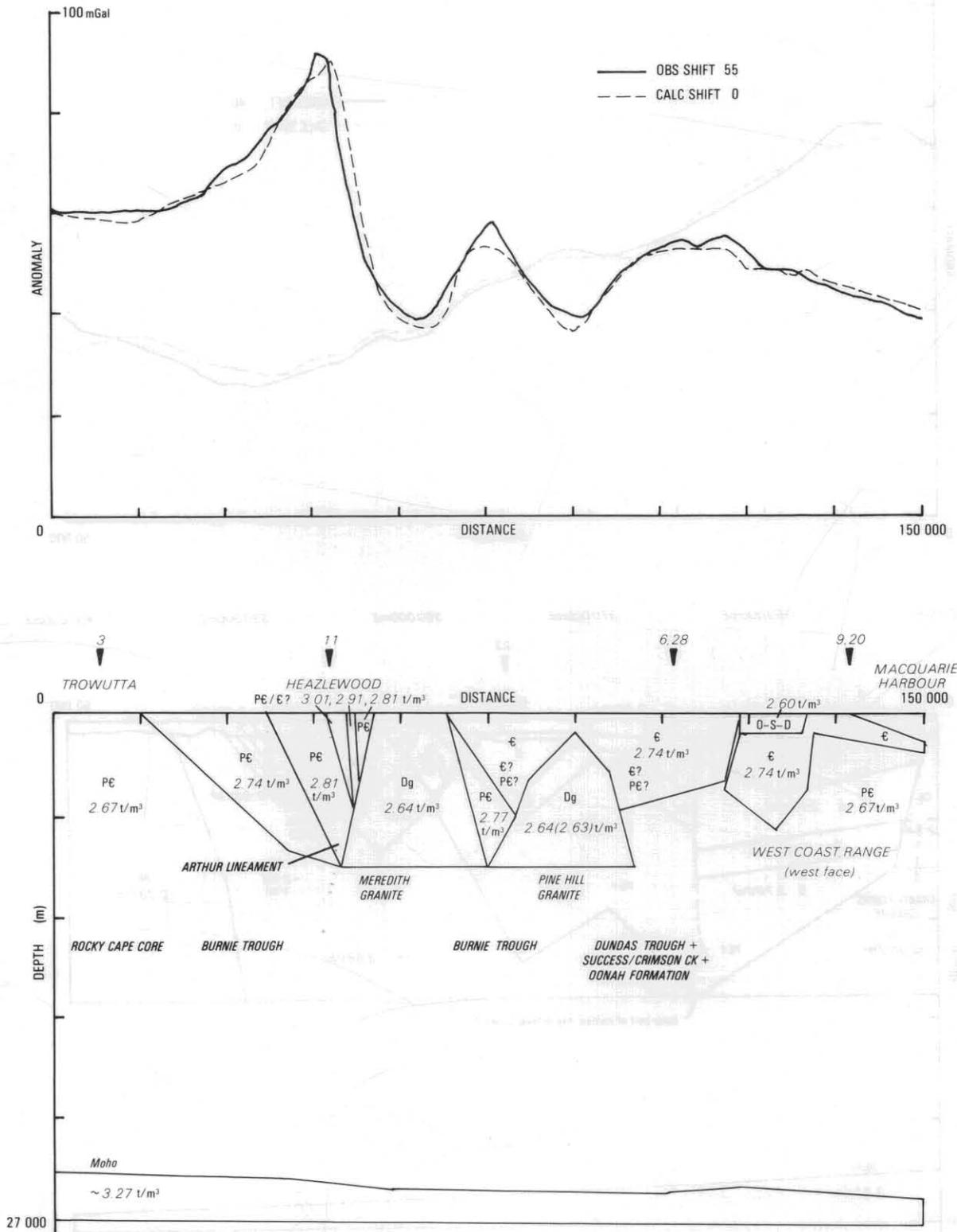


Figure 29. Regional interpretation: Line 9, Trowutta-Meredith-South Darwin.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

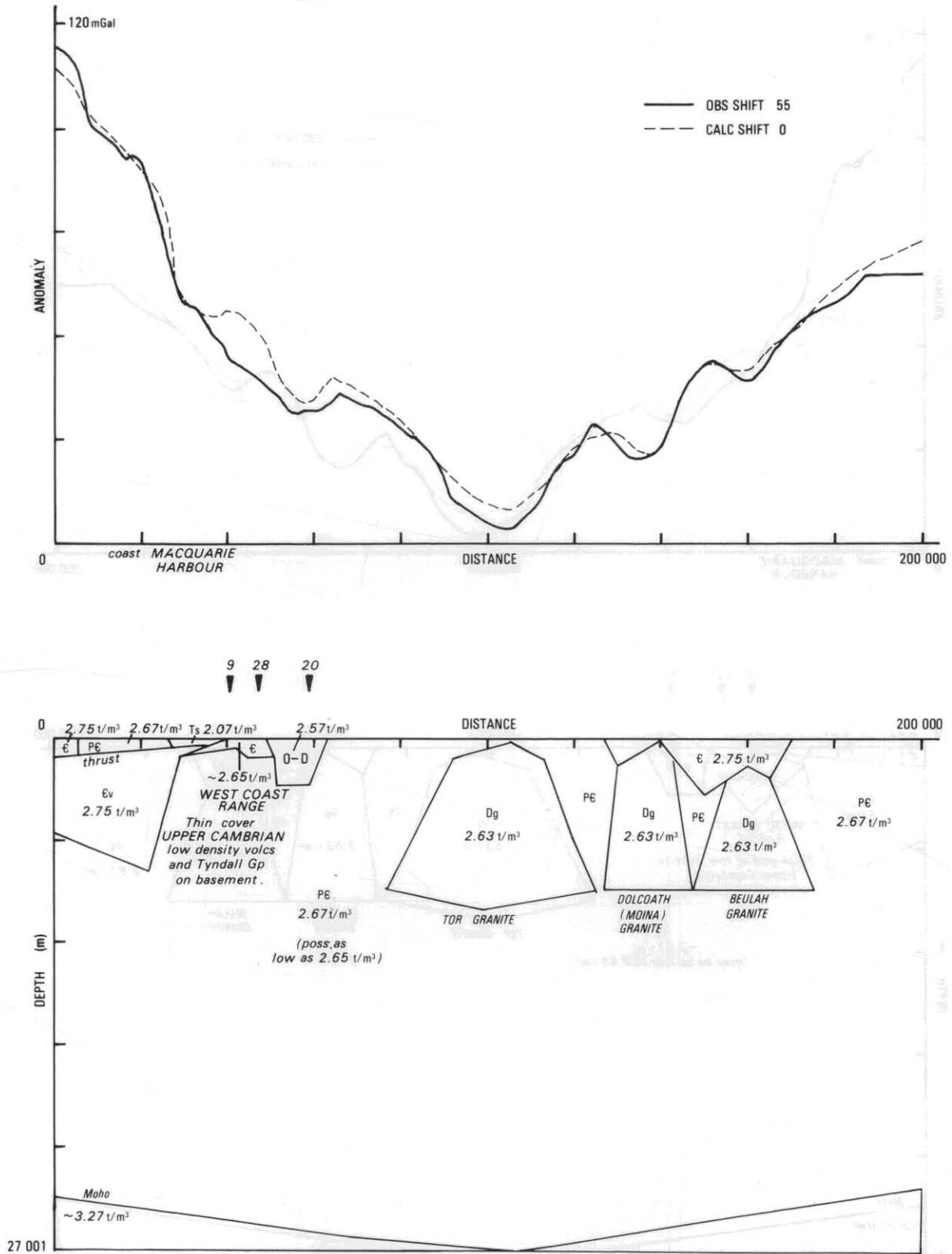


Figure 30. Regional interpretation: Line 23 (thin Cambrian option), Cape Sorell-Eldons-Port Sorell.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

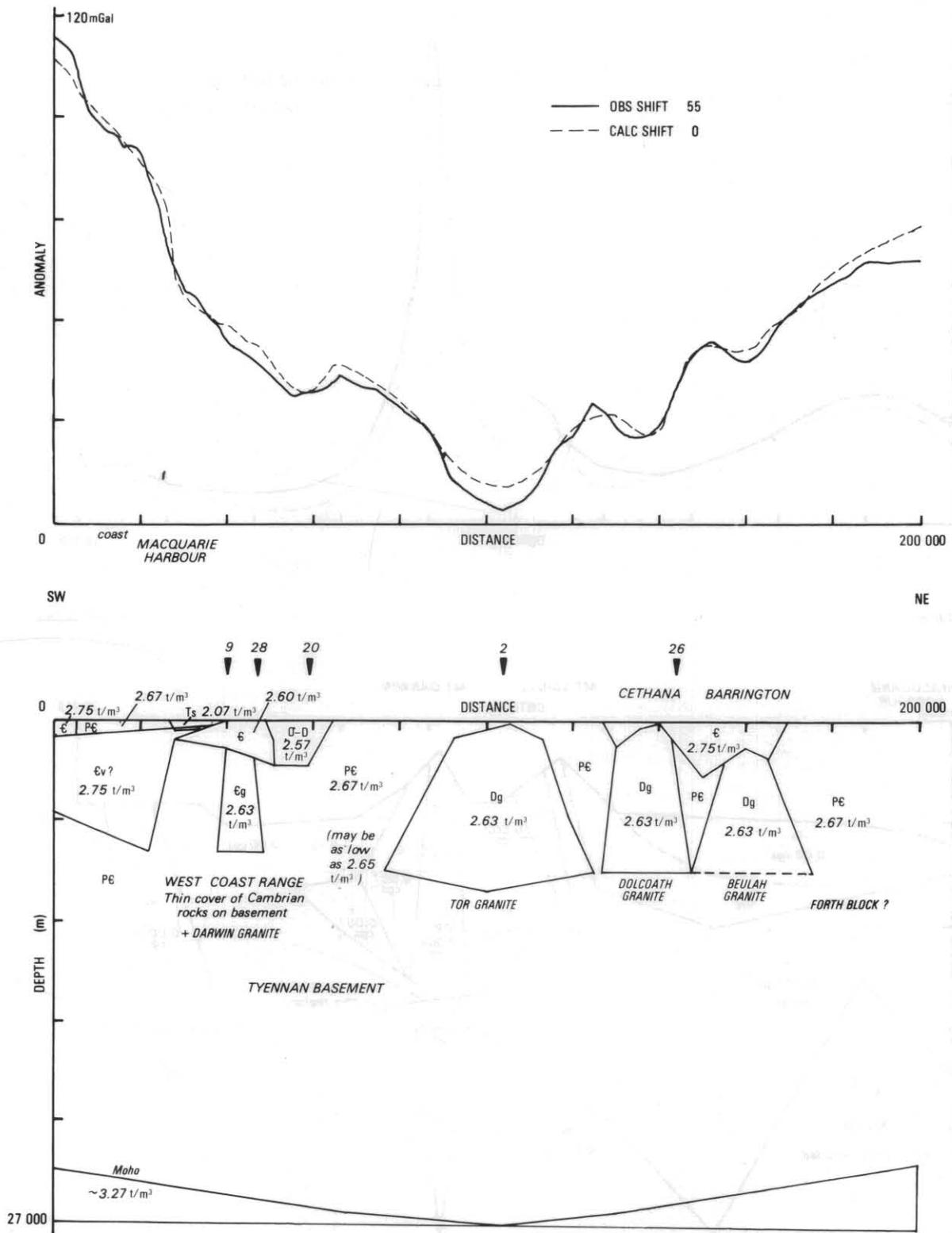
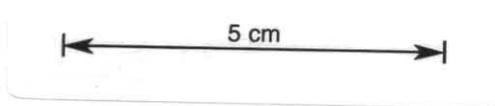
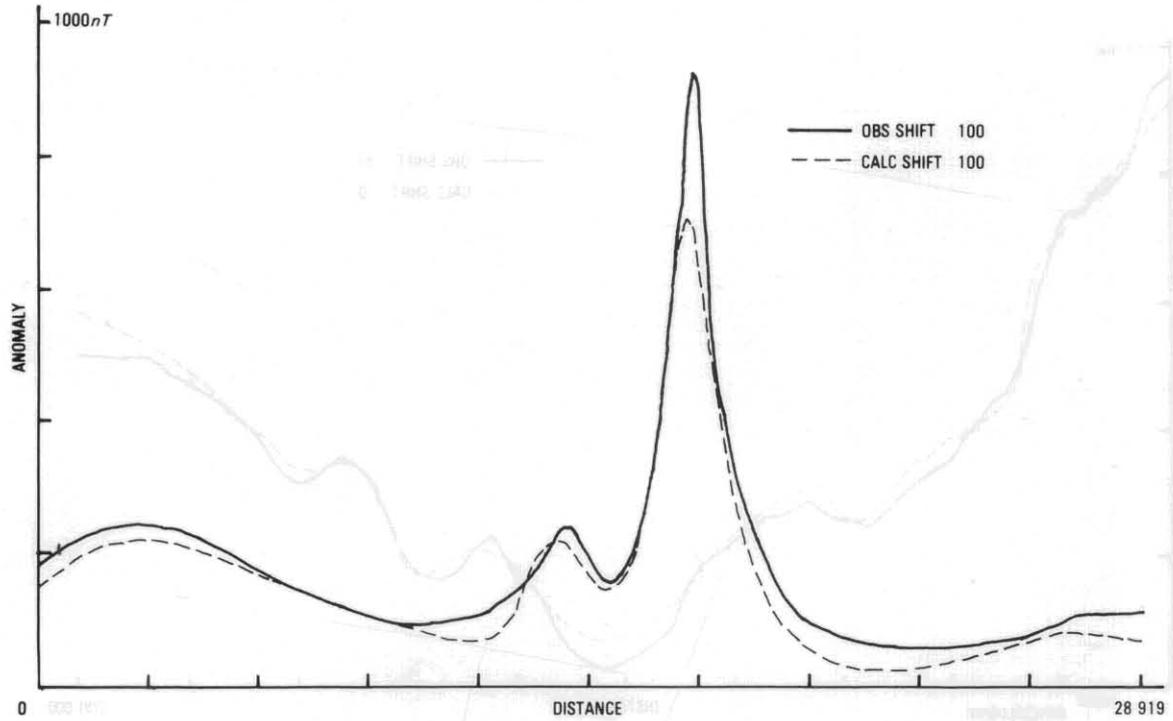


Figure 32. Regional interpretation: Line 23 (thin pile+granite option), Cape Sorell-Eldons-Port Sorell.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D MAGNETICS MODEL



366 400mE

395 300mE

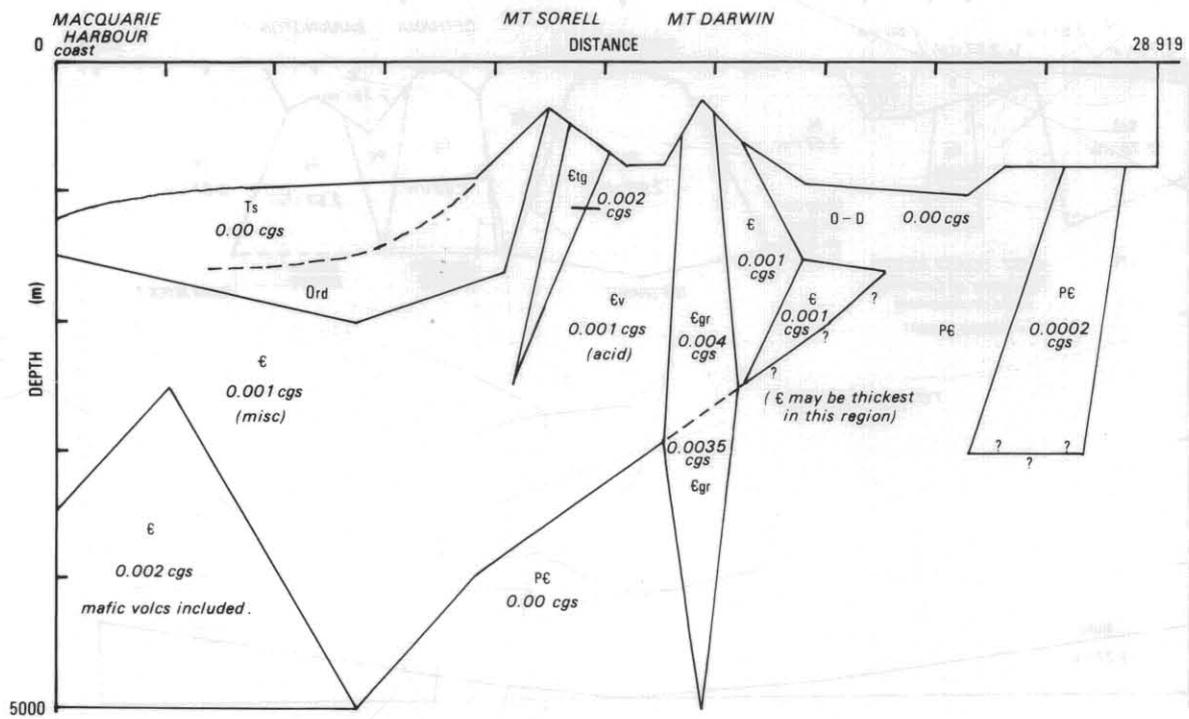


Figure 33. West Coast Range magnetic interpretation: Line 20 (part), Mt Darwin (magnetic line 435)

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

MINERALISATION AND EXPLORATION

The economic significance of the Murchison Granite is unknown but has been surmised on the basis that such granites represent the feeding conduit for the volcanic piles. Some mineralisation occurs within and around the margins of the Murchison Granite (Corbett and McNeill, 1986) but the relationships between these occurrences and the precise form of the granite is not known. Nor is the scale of the deposits established. The present work suggests that the prospects west of the granite outcrop—such as Mace's—may mark the outline of the granite at depth. This work correlates with the discussion offered in respect of the Darwin Granite (Chapter 6).

If it is suspected that a relationship between mineralisation and granite exists, then this work establishes the feasibility of defining the form and extent of these small bodies intruded close to the basin margin. The analysis requires fully compensated magnetic data of the type presented in Figure 36.

SUMMARY

1. The Cambrian Murchison Granite was emplaced along the margin of the Cambrian basin as an elongate plug-pipe.
2. Sufficient measured properties are available to confirm the implications of model-based interpretation. The granite is relatively neutral in density terms but has a strong magnetic contrast compared to the surrounding volcanic rocks.
3. The total volume of granite is quite small but the western outline of the body appears to be marked by a string of small mineralised prospects. It is possible that other larger or disseminated bodies may exist above the concealed roof of the granite.
4. The present work suggests that only about half of the cross section of the plug is exposed in the Murchison River gorge.
5. Complete definition of the shape of the granite is feasible using three-dimensional magnetic methods and fully corrected aeromagnetic data. This has been beyond the scope of this project.

2D GRAVITY MODEL

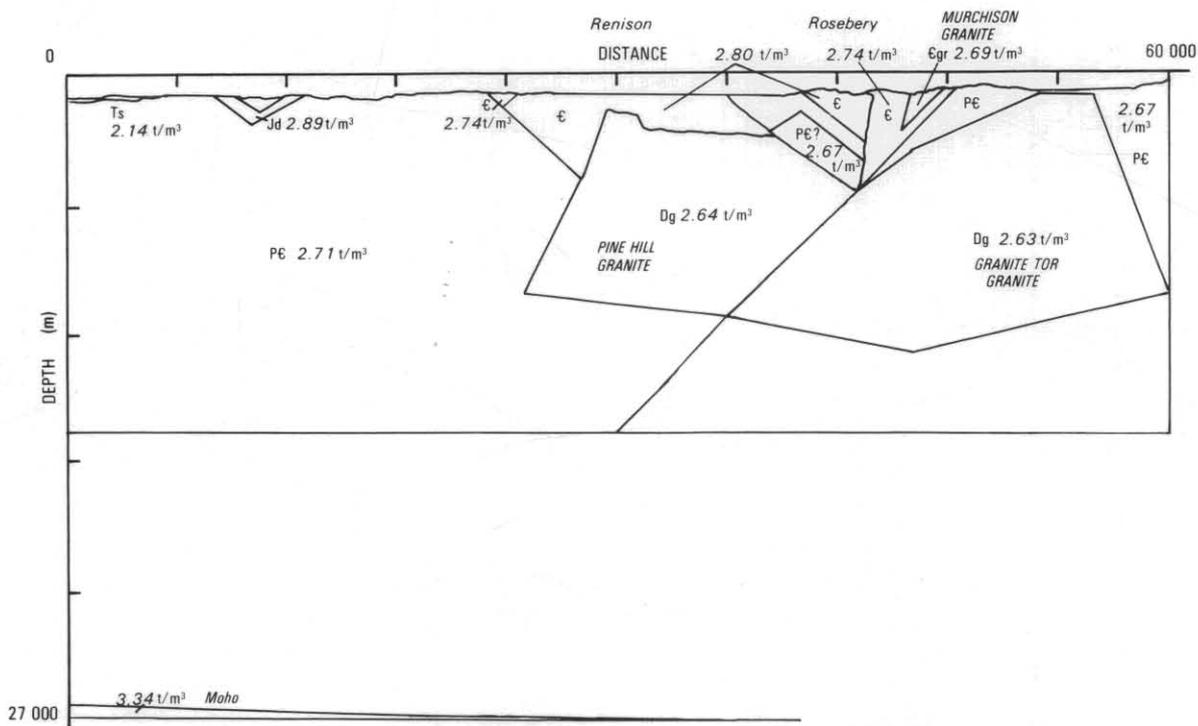
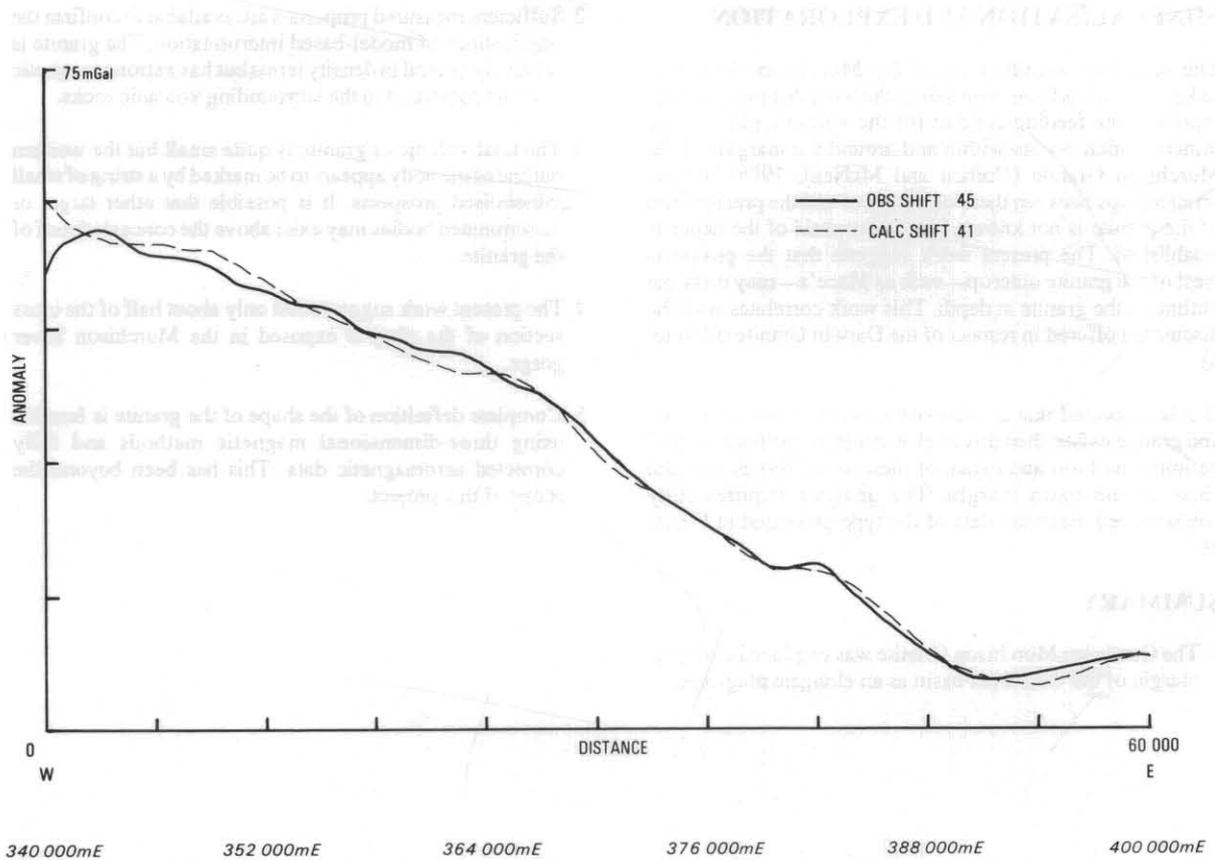
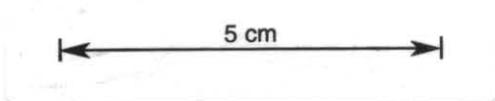


Figure 35. Gravity model: Line 5372 [5372 500 mN, 340-400 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



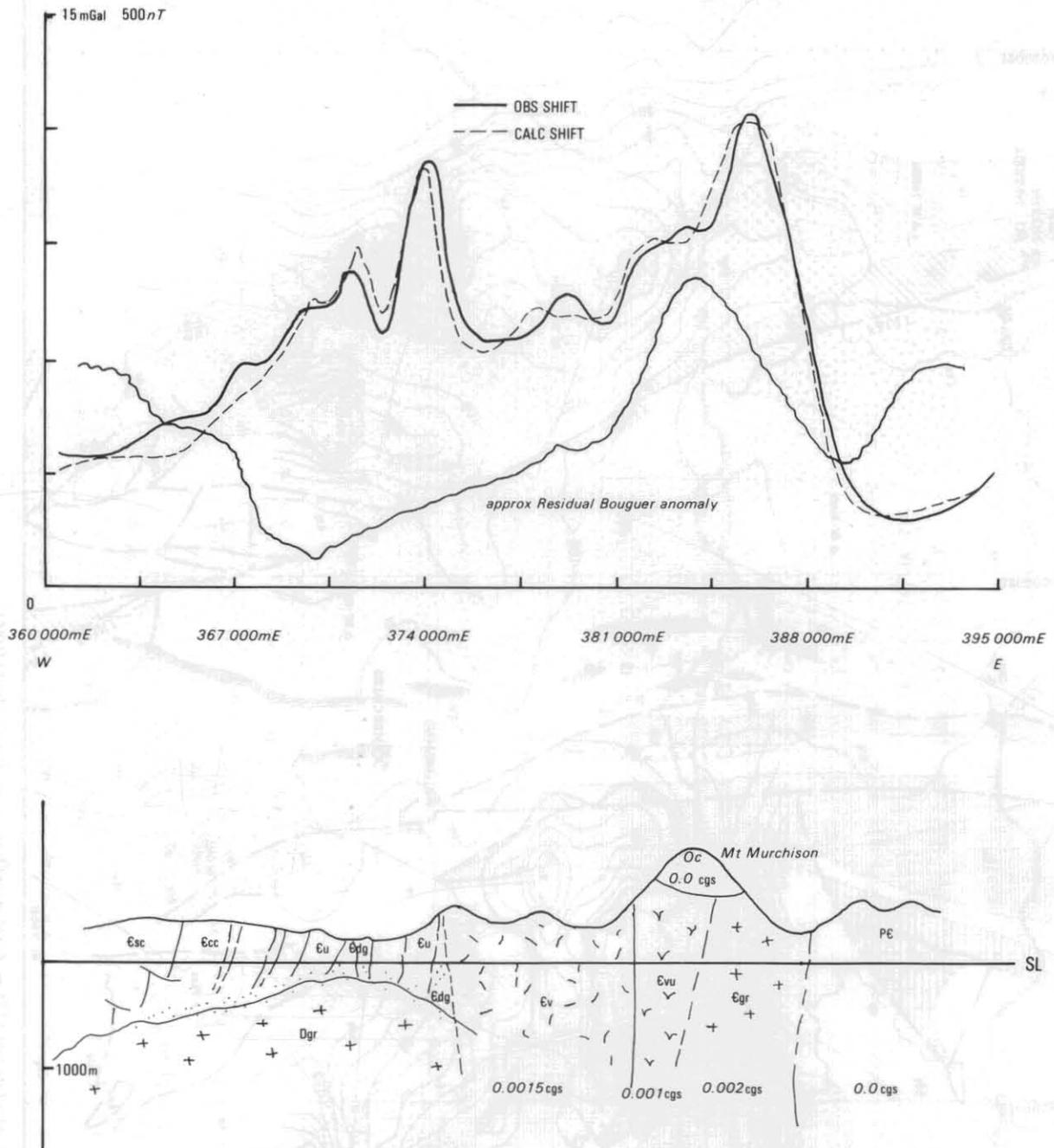


Figure 37. Introductory magnetic interpretation: Line 1411 [5369 500 mN, 360-395 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D MAGNETICS MODEL

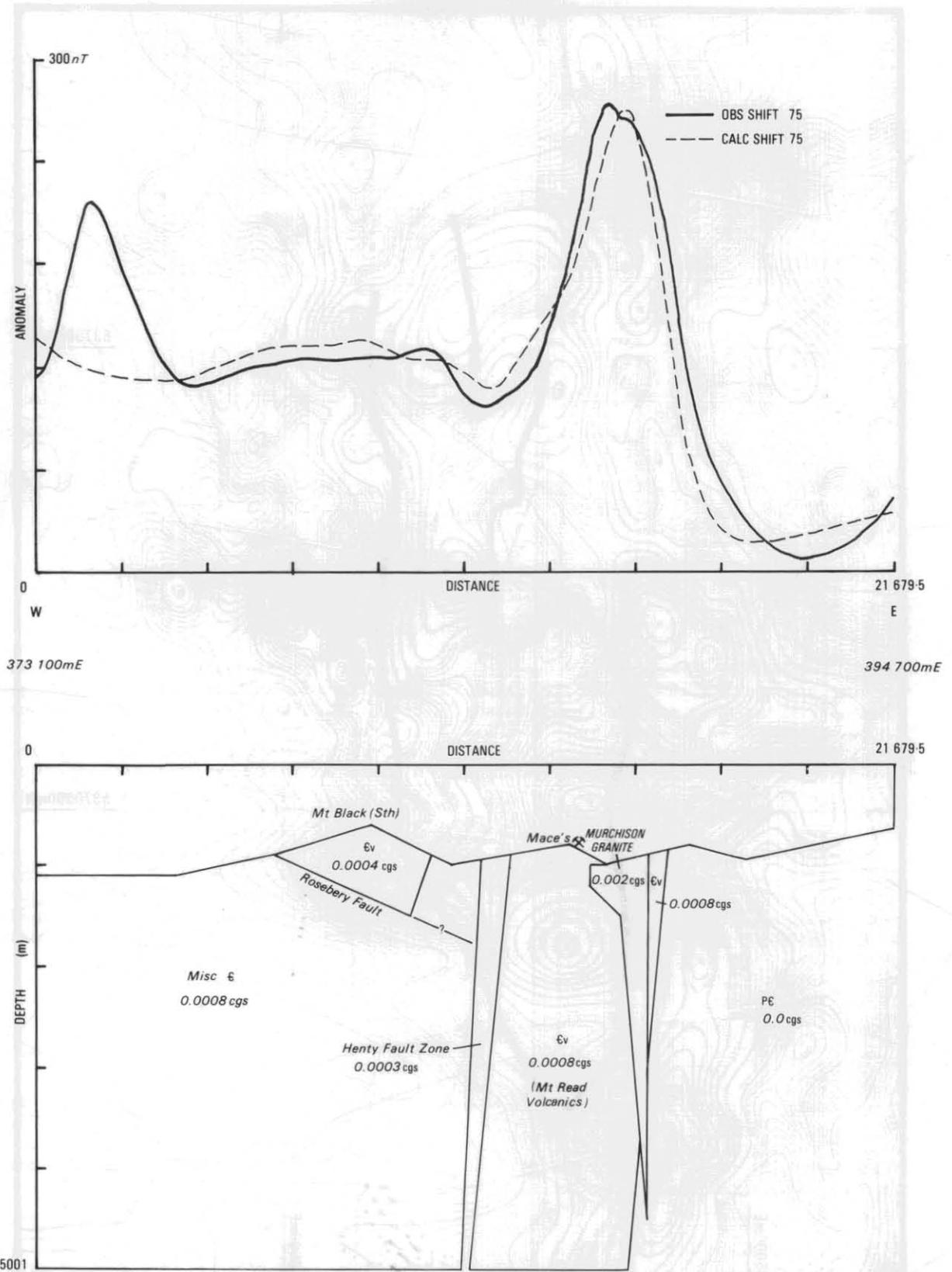


Figure 39. Magnetic interpretation: Line 1500 [5374 000 mN, 373 100-394 700 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

CHAPTER 8

DOVE GRANITE

The Dove Granite crops out at three sites near the Precambrian–Lower Palaeozoic unconformity in north-western Tasmania (see fig. 1). Jennings (1963) provides the basic information on these intrusions, which are noted for their variability of composition, roof pendants, and complex outcrop pattern. The granite is often deeply weathered. Lithologies present include grey biotite-granite, aplite, granite porphyry and granodiorite. Many specimens have been described as granodiorites. The Dove Granite is Cambrian in age and clearly intrusive.

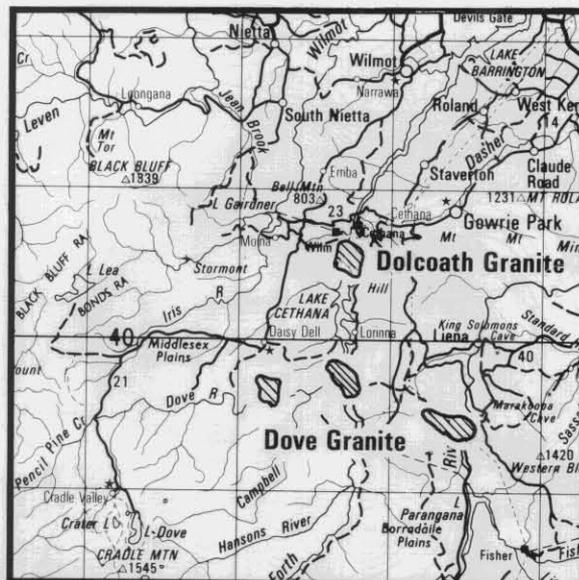
INTERPRETATION

Gravity and magnetic data have been used for the present evaluation.

The Dove Granite is not recognisable in the regional gravity field. Any effect it might have is swamped by the anomaly created by the nearby Dolcoath Granite (Chapter 9). Closer inspection using the actual station values reveals that there is no coverage of the western body, negligible coverage of the central body, but reasonable coverage of the eastern body. There is no obvious gravimetric response which can be related to either the central or eastern bodies. This observation is consistent with response patterns for the other Cambrian granites discussed here (see Chapters 4, 5, 6, 7). No firm conclusions about the form of the Dove Granite can be drawn from extant gravity data. Much effort would be required, coupled with infill coverage, even to appraise the eastern body due to the complex local structure and the Tertiary lead systems which are impressed upon it. Some extension of the Dolcoath anomaly may also compound assessment problems.

Magnetic data are extensive, and all three parts of the Dove Granite have been covered by regional surveys with 500 m line spacing (see Bishop, 1987). As most lines in this region were flown north–south no more than two lines have sampled either of the western or central bodies of the Dove Granite. It is not surprising that there is no definitive response, given this coverage, the variability of the material, and its properties. The central body possesses, at least in part, a susceptibility of about 0.001 cgs (Collins *et al.*, 1981). Many lines traverse the eastern body but no pattern can be recognised because of the effects of basalt on its western side and the more subtle matching patterns within the Precambrian basement to the south (review fig. 40). It is evident, however, that the susceptibilities recorded by Collins *et al.* (1981) are not typical of these masses overall. The average contrast is much less and not dissimilar from some members of the Dove Group or slightly altered, perhaps iron-enriched, parts of the Cambro-Ordovician rocks which are exposed nearby (compare with the first data from the Darwin Granite, Chapter 6).

No detailed interpretation of the Dove Granite is possible using the extant data. It is possible that the cross-sectional areas of the central and eastern bodies are about double the exposed area, and that moderate magnetic responses define them but this remains to be established. The western body seems decidedly anomalous.

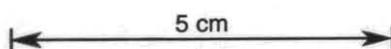


MINERALISATION AND EXPLORATION

The economic significance of the Dove Granite is debatable. Jennings (1963) was ambivalent about its economic place and its contribution to local mineralisation. Dating has clarified some of the issues but the confusion concerning the precise contribution of the Dove and Dolcoath Granites has remained. The presence of some mineralisation within the western and central bodies (but none in the eastern body), and in rocks very close to the central body, has been taken to mean that the Dove Granite is of economic interest. But, as discussed in the next chapter (Dolcoath Granite), these observations are more consistent with both the granite and the younger surrounding rocks merely acting as receptive hosts for the mineralising fluids from the locally very dominant Dolcoath Granite. The reason for the lack of mineralisation near the eastern body then becomes obvious. It seems likely that any Cambrian mineralisation will have been unroofed and eroded long ago.

SUMMARY

1. The Cambrian Dove Granite consists of three small plug-like bodies.
2. The granite is variable in composition and physical properties. There is no distinctive or regular response.
3. The intrusions are located near the margin of the principal Palaeozoic basin.
4. It is not certain that detailed analysis is feasible due to the variability within the Dove Granite and the range of materials around it. Current data is inadequate anyway.
5. It is doubtful that the Dove Granite retains any economic significance (but see Chapter 9 for the control in the region).



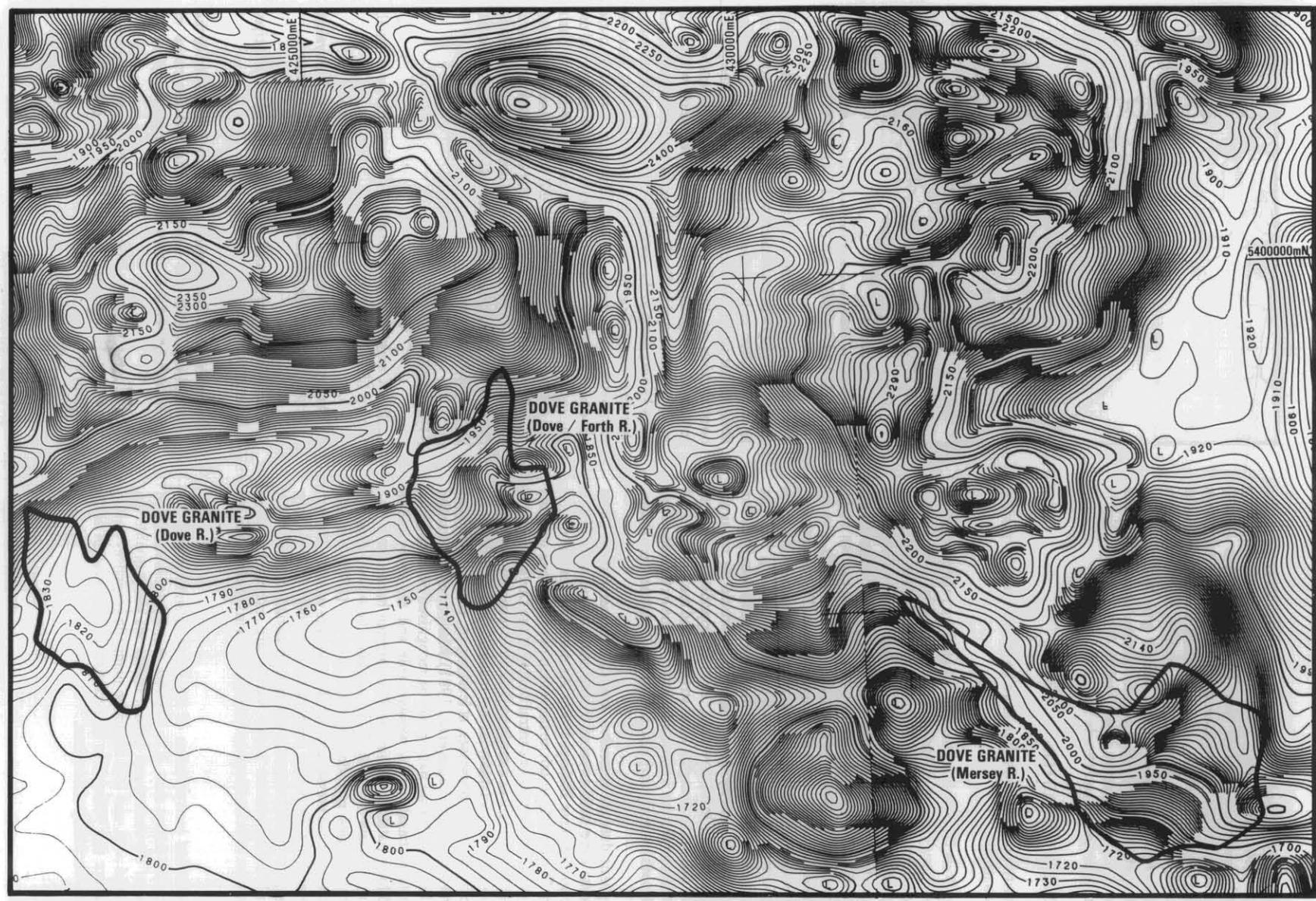


Figure 40. Location of the Dove Granite, and the magnetic field (1985 Department of Mines survey).

CHAPTER 9

DOLCOATH GRANITE

5 cm

The Devonian Dolcoath Granite is exposed near Cethana. The stock-like exposure is relatively small in area (see fig. 1; Jennings, 1963; and Jennings *et al.*, 1959). Even though the exposure is limited, granite is known to occur at shallow depth near Moina and possibly near Stormont. The zone between Moina and Cethana is mineralised.

The Dolcoath Granite is exposed in a structurally complex region. Mineralisation, as outlined by Collins and Williams (1986), is varied in style and content but there is little doubt that the granite has introduced Sn, W and, to a lesser extent, Au, Ag, Pb and Zn. Many local deposits are skarn or replacement occurrences. This reflects the varied nature of the materials in the granite roof. The Dolcoath Granite is unusual, in a Tasmanian context, for the content of the roof and the proportion of Ordovician rocks in it.

The Dolcoath Granite was included in the super batholith concept of Leaman *et al.* (1980). This first crude interpretation was unable, nor intended, to resolve individual masses or suggest intra-exposure relief (see inset in fig. 1). The more recent general interpretation of Leaman (1986c) suggested that the Dolcoath Granite (sometimes referred to as the Moina Granite) was a large body linked with the Housetop or Meredith Granites at depth. While the emphasis of Leaman (1986c) was directed at the Cambrian sequence, these conclusions were supportive of Leaman *et al.* (1980). The principal implication of all previous work has been that the Cethana exposure is a very small part of a major intrusion.

As there is much mineralisation related to the stock exposure near Cethana–Moina (fig. 49), and possibly further mineralisation near the confluence of the Forth and Dove Rivers (all in susceptible host rocks), more detailed examination of this granite than provided here is justified.

INTERPRETATION

The present regional analysis is based primarily on the recently extended gravity data base (Mt Read Volcanics Project 1986/87), with some review of aeromagnetic data (Bishop, 1987). Eight profile aspects form the basis of the consolidated view presented in Figure 49.

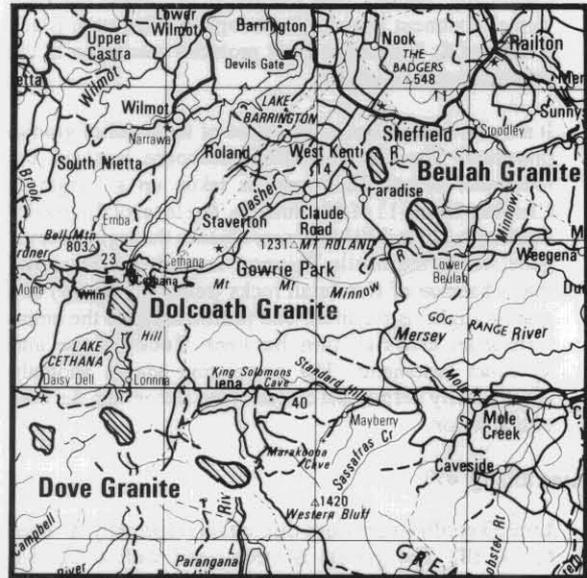
Line 2 (fig. 41)

This section provides a north–south aspect across the region near Moina. It gives a critical perspective of this intrusion. The anomaly is relatively narrow, well-defined, and has strong gradients.

Analysis shows that any asymmetry in the profile is a compound response across the margin of the Palaeozoic basin and the intrusion of the granite close to that margin. The western part of the Dove Granite is an irrelevancy in this perspective (see Chapter 8). Although the model is regional in concept, the forms and gradients indicate granite at depths not much in excess of 150 to 300 m. This profile suggests a steep-sided body with a narrow crest (about 5 km wide).

Line 6 (fig. 42)

Line 6 provides a glancing aspect of the southern face of the Dolcoath Granite. The model suggests that this part of the intrusion does not extend far into Palaeozoic rocks but this may be illusory as the model is a balance of



components and the section volume is not reliably specified.

Line 12 (fig. 43)

This profile is dominated by the effect of the Granite Tor Granite (see Chapter 1). The remainder of this section does not cope well in two-dimensional format, as it glances the arc between Cambrian deposition and Precambrian basement. The granites interrupt this pattern and no part of them is represented by normal cross-section. Parts of the Housetop Granite are exposed on this alignment, and a balance between granite and thick Cambrian section must be found.

Line 14 (fig. 44)

This section was included because it is close to the actual exposure of the granite, and its huge anomaly, and yet there is no representation. The regional crustal assumptions and Precambrian rocks wholly satisfy this profile. This confirms the implication of Figure 41; the Dolcoath Granite has a very steeply-dipping south face and an east–west extension.

Line 18 (fig. 45)

Profile 18 samples the Cethana exposure. The strong response of the Dolcoath Granite is evident. The asymmetry of the effect and gradients reflects mantle trends, and the presence of the basement margin. These complications have prevented a perfect fit in the region of Cethana, as the controlling features require further definition. The tip of the pluton is clearly irregular but narrow—little more than 5 km wide—but at very shallow depth. It is at no more than 1.5 to 2 km beneath the western and central parts of the Dove Granite, and the actual contact would be spatially closer than this.

Line 21 (fig. 46)

This section samples the Moina region. Strong gradients and generally spiky responses indicate virtual exposure of a granite spine. The south face of the body is, as suggested by lines 2, 6 and 12 (fig. 41, 42 and 43) very steeply dipping. The north face, however, dips more shallowly to

the north towards the Housetop Granite. The two bodies cannot be separated; both possess high-relief roof cupolas. Modelling of the type presented cannot yield a reliable estimate of the minimum thickness of deep granite. It may be that the two masses are physically, as well as chemically, distinct (see Collins *et al.*, 1981) but their virtual abutment beneath the trough axis between Black Bluff and St Valentines Peak prohibits resolution at the present stage of analysis.

It may be asked what is the extent of the proof of granite presence? The Cethana-Moina response is clear; the remainder is not. This issue is taken up at length in Chapters 10 and 11 of this Bulletin. The level of the gravity field from 125 to 140 km is very close to the regional level generated by the mantle. This near-neutral resultant shows that a balance of Cambrian rocks (relatively heavy) and granite (light) is required. The profile samples the entire Cambrian cross-section between Rocky Cape and Tyennan basements. The contrasting Moina anomaly emphatically defines the crestal spine rather than the base of the pluton.

Line 23 (fig. 47)

Line 23 confirms previous discussion (especially for lines 6, 14, 18). The granite is steep-sided with a rounded narrow roof. The result is in agreement with line 18, and shows that the point of exposure is very limited. Cambrian cover is minimal.

Line 26 (fig. 48)

The ENE-WSW aspect of line 26 shows that the Dolcoath Granite has considerable shallow east-west extent. The anomalies are more irregular than the modelled shape suggests, which indicates that the roof is stepped, at least, but remains relatively shallow. Depth of roof estimates vary from 200 to 1500 m along this line. The granite is also at shallow depth north of Lorinna.

Figure 49 presents a summary of the implications of the gravity data base. Mineralised sites have been superimposed. The diagram clearly illustrates the east-west extension of the body, and the location of its possible 'fusion' with the Housetop Granite (north-west of Black Bluff). The precise character of the forms and relationships of the granites at depths in excess of four kilometres has not yet been established in this region.

This partly reflects an absence of strong character in the gravity field and partly some uncertainty about the thickness, composition and contrast of the local Cambrian sections through the south Guildford region, where structures swing from essentially north-south to east-west. There is much Ordovician cover in this region, and the diffusion or apparent extension into The Hummocks region or south toward Mt Cripps only slightly distorts the gravity field, and does not significantly affect this first order interpretation.

The unambiguous general response of this granite leaves little doubt of its existence or gross extent. The minor over-deepening of anomalies noted on some lines could mean poor crustal adjustment but in most cases can be related to siliceous Ordovician materials in synclines within the roof complex. It is unlikely that the bulk density of the body is as low as 2.59 t/m^3 , although some phases of small volume may possess such a density.

Regional aeromagnetic data have been reviewed. This review was undertaken with two principal objectives; to partly define the limit of the Cambrian section, and to attempt correlation of gross anomalies and mineralisation patterns in the roof

rocks. Neither objective was achieved in limited analysis. This reflects the multitude and extent of Cambrian sources, some of high contrast, whose effect is little modified by Ordovician cover and local Tertiary basalt cover. It is not possible in these conditions to relate particular mineralised sites to individual anomalies at the scale and line density of the survey. Additionally, it was shown for the Lorinna-Dove-Cethana region that anomaly forms are severely modified by clearance and topographic shape effects. While these could be recognised in the analysis, far more comprehensive treatment is required for meaningful exploration and structural results. There is, however, no obvious correlation between the magnetic field as observed and the gravity-derived model of the granite. This means that no direct method of locating roof alteration forms exists. All other exposed sources must be individually assessed before this is possible. Study of Figure 50 will demonstrate these points. The required treatment, established by Leaman (1986a), has been beyond the scope of this assessment. Data correction, continuation and basalt assessment could be expected to yield some detailed definition of roof segments. Any further study of the granite should include these refinements.

MINERALISATION AND EXPLORATION

Mineralised sites have been overprinted in Figure 49. The display may not be complete, as the departmental data base used is currently under revision.

There has been some controversy concerning the origin of some of the mineralisation and the apparent zonation around Cethana (see fig. 49). Jennings (1963) summarised the problems succinctly. Tin and tungsten deposits are related to the Dolcoath Granite, and are not associated in any way with the Dove Granite (Chapter 8). Silver-lead and gold deposits, however, are more widely distributed and not obviously correlated with any particular granite mass. Elliston (1953) attempted a zonation study which ignored the Dove Granite. Jennings discussed how sulphide deposits adjacent to the Dove Granite might be controlled by structures formed during its emplacement. The subsequent dating of the Dove Granite shows this cannot be so, as most deposits are in Ordovician hosts. The presence of comparable mineralisation within the Dove Granite itself (central and western parts only!) is, in terms of the distribution of the Dolcoath Granite—as established in this chapter—pure coincidence.

The confusion relating to the origin of these deposits, and variation in composition, was largely removed by the dating of the granites. The suggestion by Leaman *et al.* (1980) of a much larger granitoid beyond the small Cethana exposure was accepted by Collins and Williams (1986) as consistent with the observations. The present interpretation resolves such issues.

Figure 49 shows that the Sn-W deposits of various types, and some Bi-Mo associations, occur at the present surface very close to, or within, the granite itself. The distance to granite for such deposits may be less than 300 m. This range is certainly implied near Moina. (All the estimates quoted in this Bulletin were derived by regional analysis and are not compensated for topographic/structural/stratigraphic variations near surface. They could be underestimates). The absence of Sn-W, and the presence of Au and Pb-Zn west of Moina, is consistent with a gently-dipping roof crest with local relief of one kilometre and an overall level 1.0 to 1.5 km below land surface. There is scope for concealed Sn-W mineralisation in this zone and much more Au, Pb-Ag. Such deposits may be identified by evaluation of precise roof form, transverse structure-fracture control, assessment of local alteration (from detailed aeromagnetic surveys) and consideration of the juxtaposition of appropriate host rocks

in the roof. The absence of prospects south-west of Black Bluff is odd, as the granite is present and equivalent host conditions appear to apply. East of Cethana the zonation effect is much more abrupt, possibly due to the steep dip of the east face of the pluton, and beyond the 1.0 to 1.5 km contour only Ag-Pb deposits have been recorded. Identical conditions apply south and west of Lorinna across the Five Mile Rise Goldfield. Note that any mineralisation in the western parts of the Dove Granite is also no more than about 1.5 km from the pluton margin.

Figure 49 poses significant questions. Why is the known mineralisation at or near the east end of the pluton? Is the actual shape of the granite important? Are there other controls? The known mineralised sites are grouped in east-west zones. This may reflect structural control, at least in terms of the fold axes which place suitable hosts within the mineralising window. There seems no obvious reason for the barren nature of the western half of the pluton, unless the roof is consistently more than 1.0 to 1.5 km (unlikely on present indications—see lines 2 and 26, fig. 41, 42). There is no shortage of equivalent host materials. This area would surely repay detailed definition of crestal forms.

Apart from the small deposits at Claude Road (West Mt Roland) or south-west of Hellyer, there is no evidence of significant Cambrian mineralisation or mineralisation remobilised by the Dolcoath Granite. Prospectivity in the region between Cethana and Mt Cattley, Black Bluff and the Dove Granite is directly related to the Dolcoath Granite and its roof forms.

SUMMARY

1. The Dolcoath Granite is a large body whose only exposure near Cethana and sub-exposure near Moina represents a very small part of the intrusion.
2. The granite is elongated east-west, with steeply-dipping north-east and south faces. The west and north-west end of the body dips more gently, and may abut the Housetop Granite at depths in excess of four kilometres.
3. More than half of the cross-section of the body is within 1500 to 2000 m of the surface, and much of that is at depths of less than 500 metres.
4. Roof spines have been confirmed near Cethana and Moina, and there are suggestions of others.
5. Definition of much roof character is feasible with present data, although some infill may be desirable after first pass analysis. Such analysis must consider the detailed impact of folded Ordovician rocks on the gravity field.
6. The relationships between roof irregularities, certain Cambrian units, and Ordovician rocks are worthy of detailed analysis. Any attempt to resolve one aspect automatically defines the association. There is some suggestion that the precise form of the roof irregularities may have controlled emplacement, in association with intersection of suitable hosts, while Sn-W deposits occur very close to, or in, the granite itself. Much mineralisation is hosted within Ordovician sandstone or carbonate units.
7. The mineralisation in the region of the Dove Granite is probably related to the Dolcoath Granite rather than the Dove Granite. This would account for the very patchy and uneven character of any association with the Cambrian granite.
8. The more inaccessible parts of the granite roof appear to be unmineralised. This is anomalous, as the Dolcoath Granite clearly introduced an array of materials. The western half should repay exploration.
9. The observed zonation in deposits can be directly related to the prospect-granite margin distance. Definition of margin forms is thus critical to exploration of this region. Such definition will require some gravity infill, three-dimensional modelling of ALL units, and further use of the magnetics coverage. The latter must be compensated and processed before it is able to support the gravity analysis and resolve subtleties.
10. There is no consistent correlation between uncorrected magnetic data and mineralisation, although some skarns produce sizeable anomalies. Nor is there much evidence of remobilised Cambrian mineralisation in the region.
11. Further study of this pluton is justified.

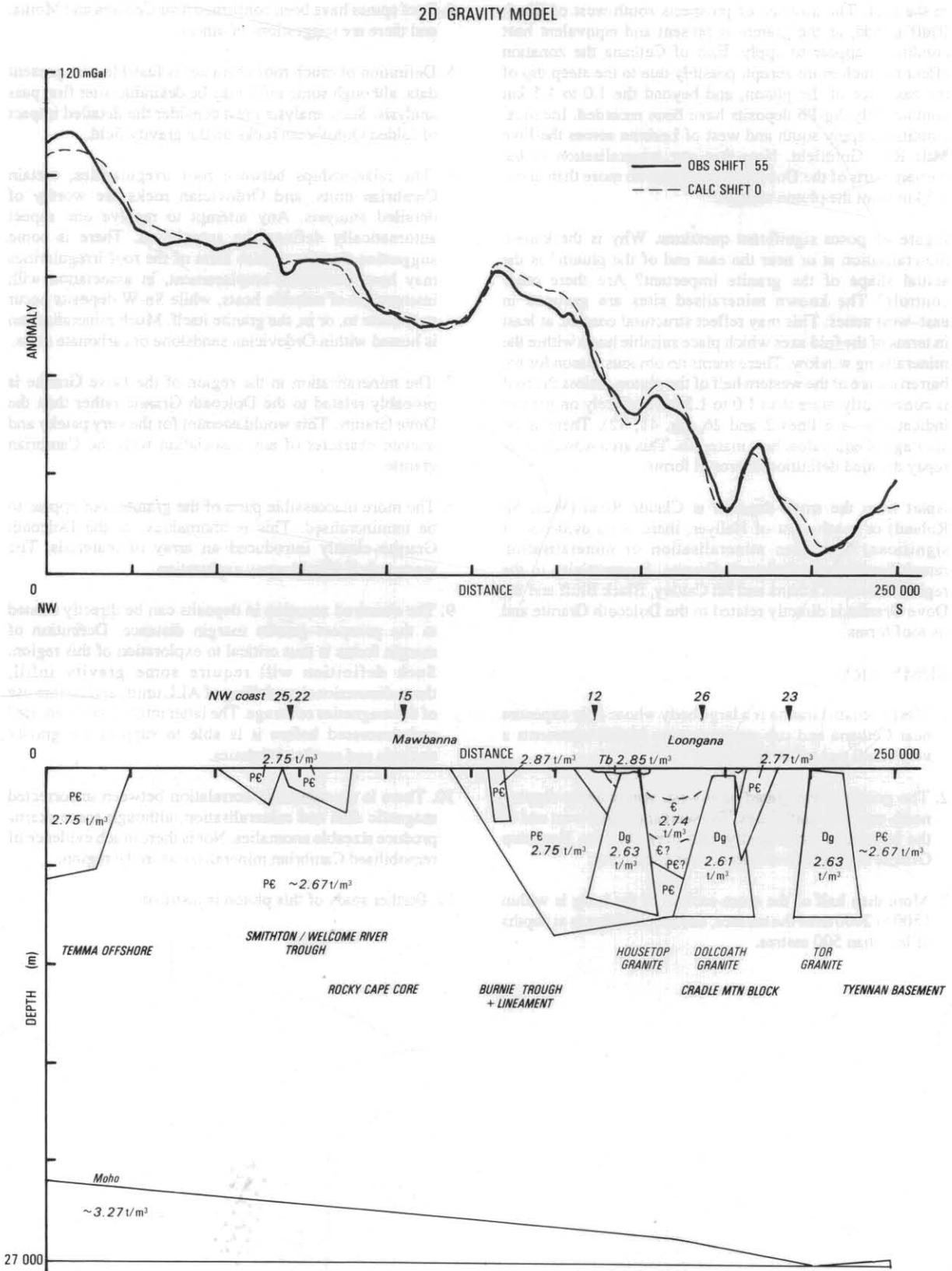
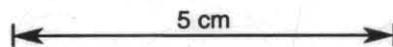


Figure 41. Regional interpretation: Line 2, Brittons-Housetop-Cradle.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



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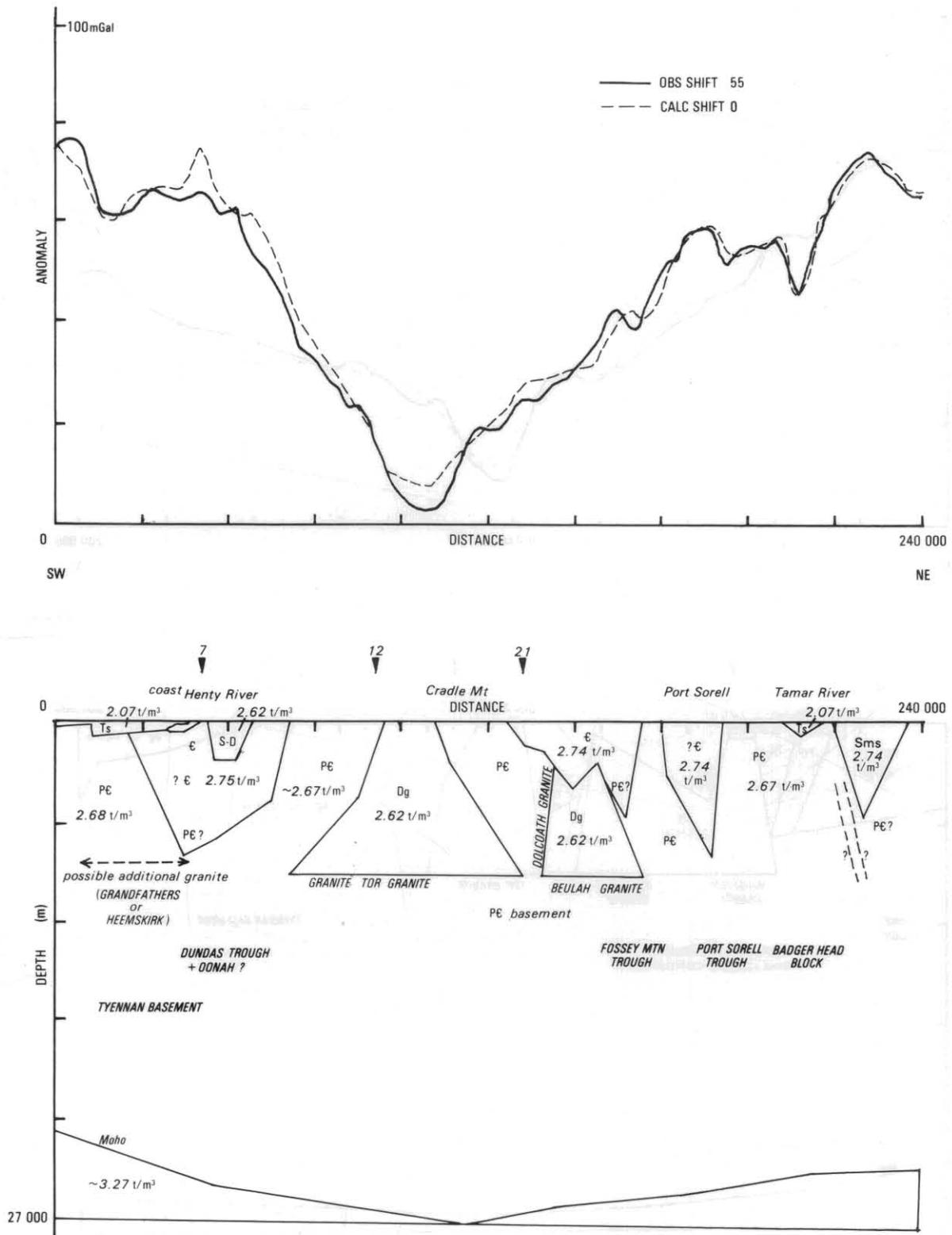
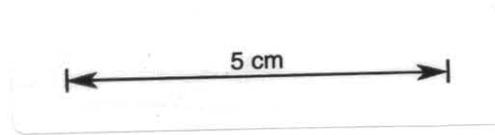


Figure 42. Regional interpretation: Line 6, Strahan-Cradle Mountain-River Tamar.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



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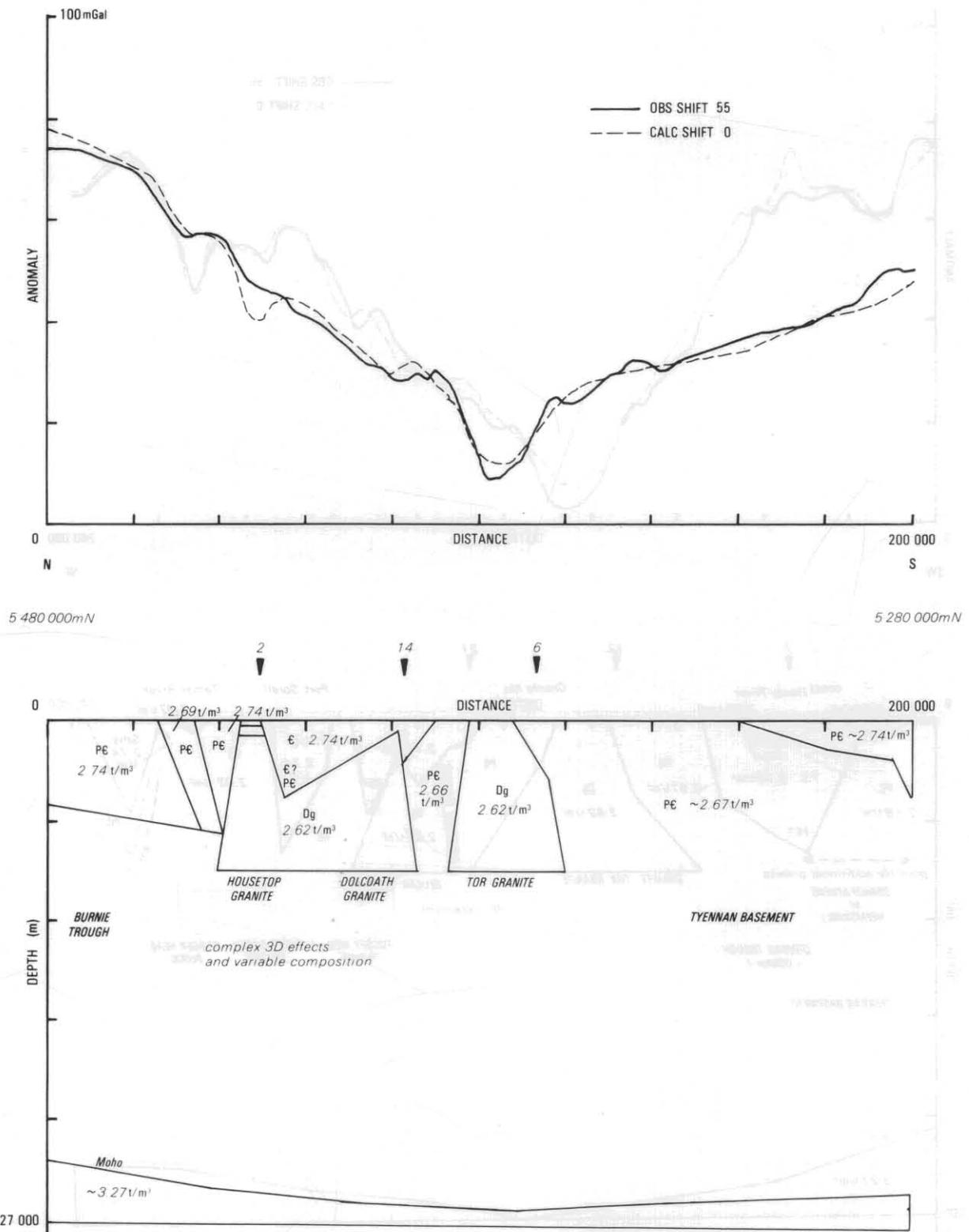


Figure 43. Regional interpretation: Line 12, Wynyard-Eldons [400 000 mE, 5480-5280 000 mN].

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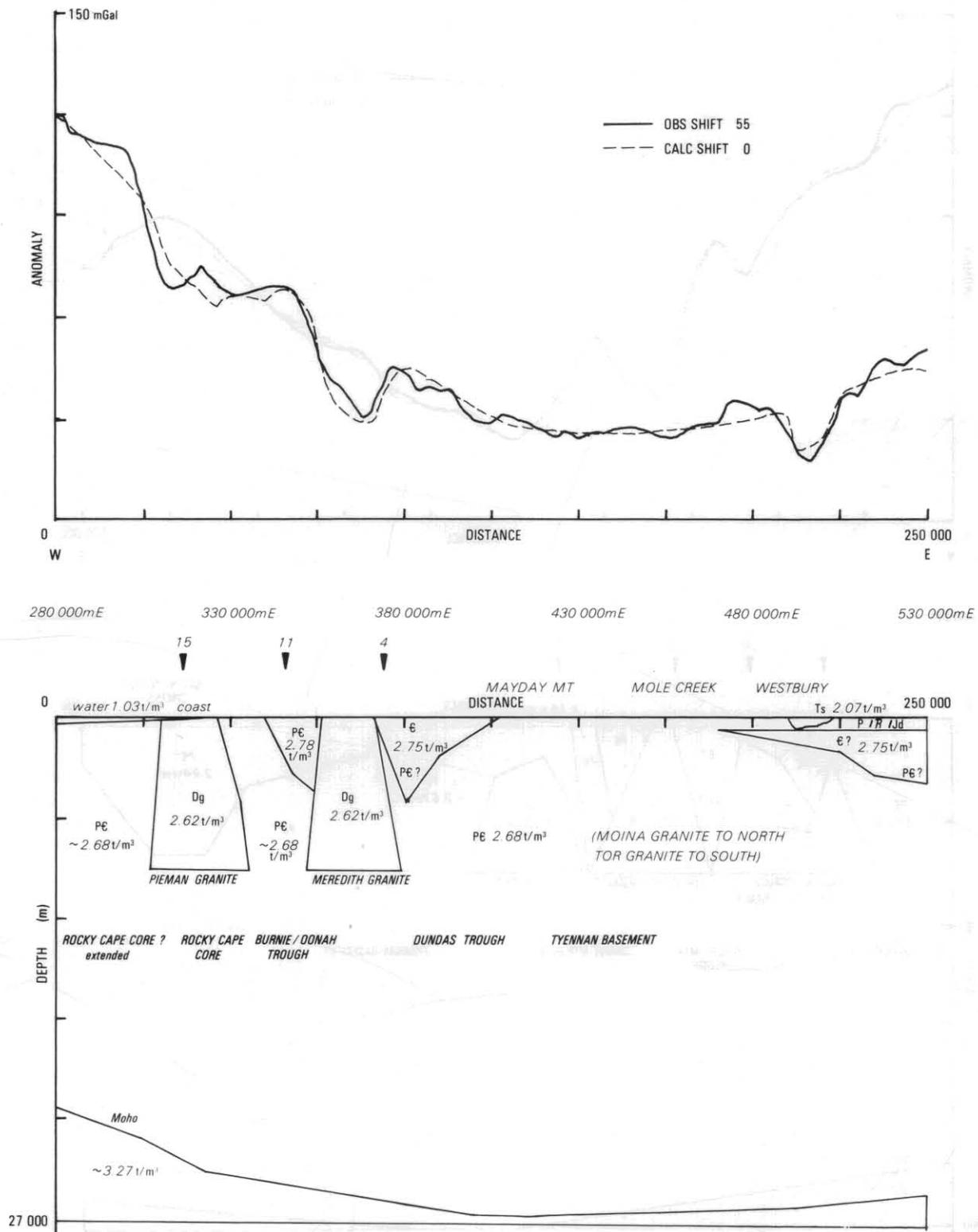


Figure 44. Regional interpretation: Line 14, Pieman-Deddington [5396 000 mN, 280-530 000 mE].

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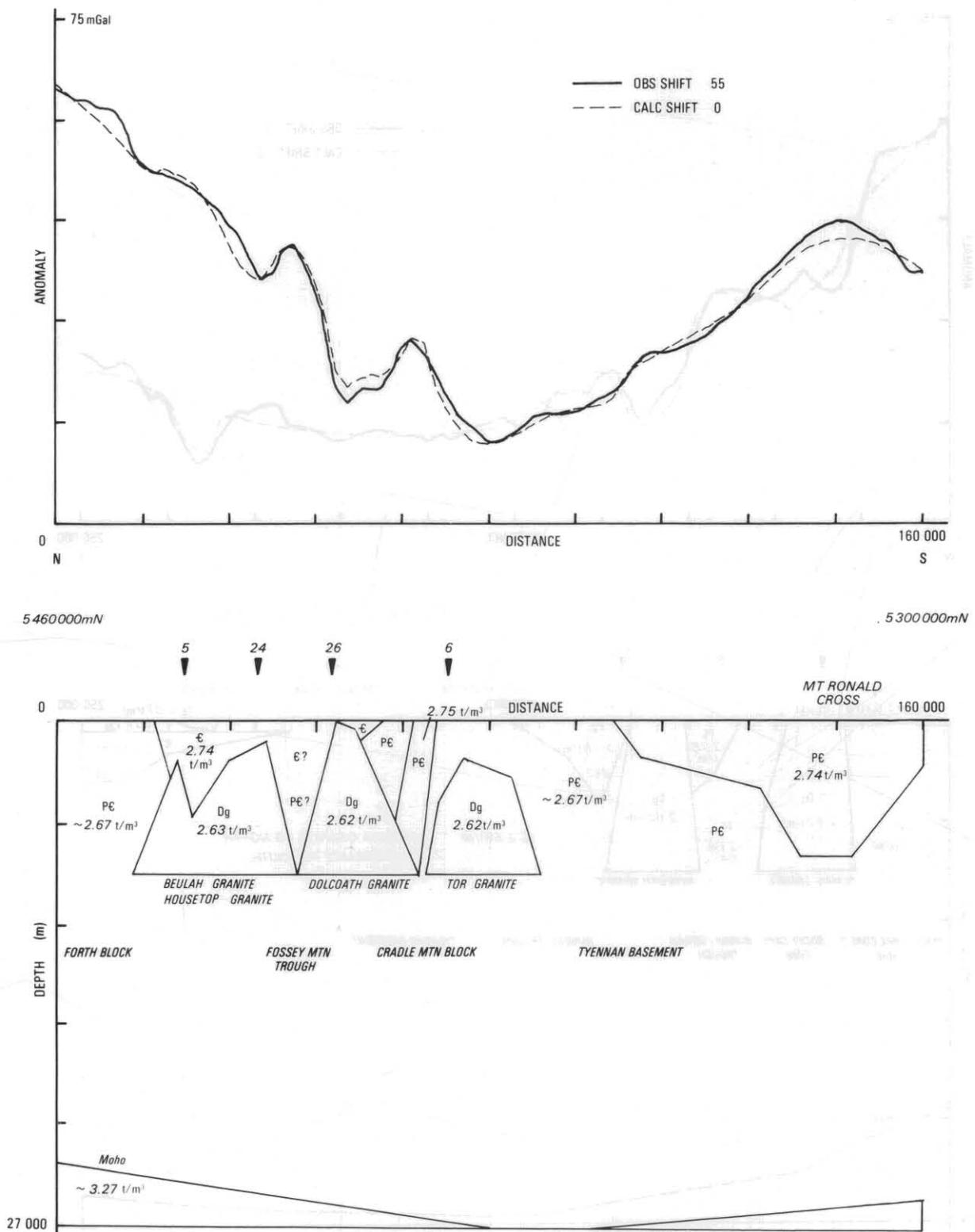


Figure 45. Regional interpretation: Line 18, Penguin-Cethana-Algonkian Peak.

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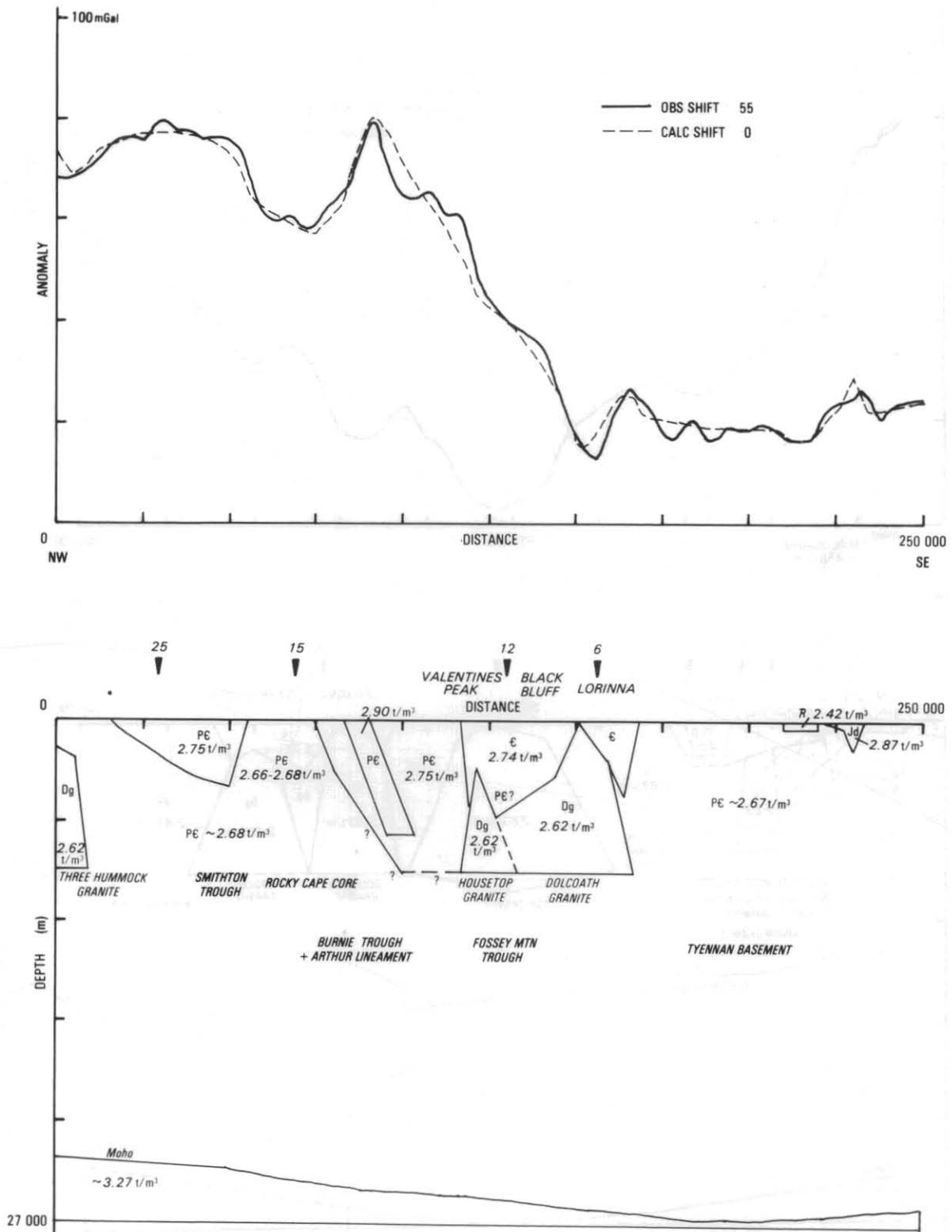


Figure 46. Regional interpretation: Line 21, Cape Grim-Moina-Steppes.

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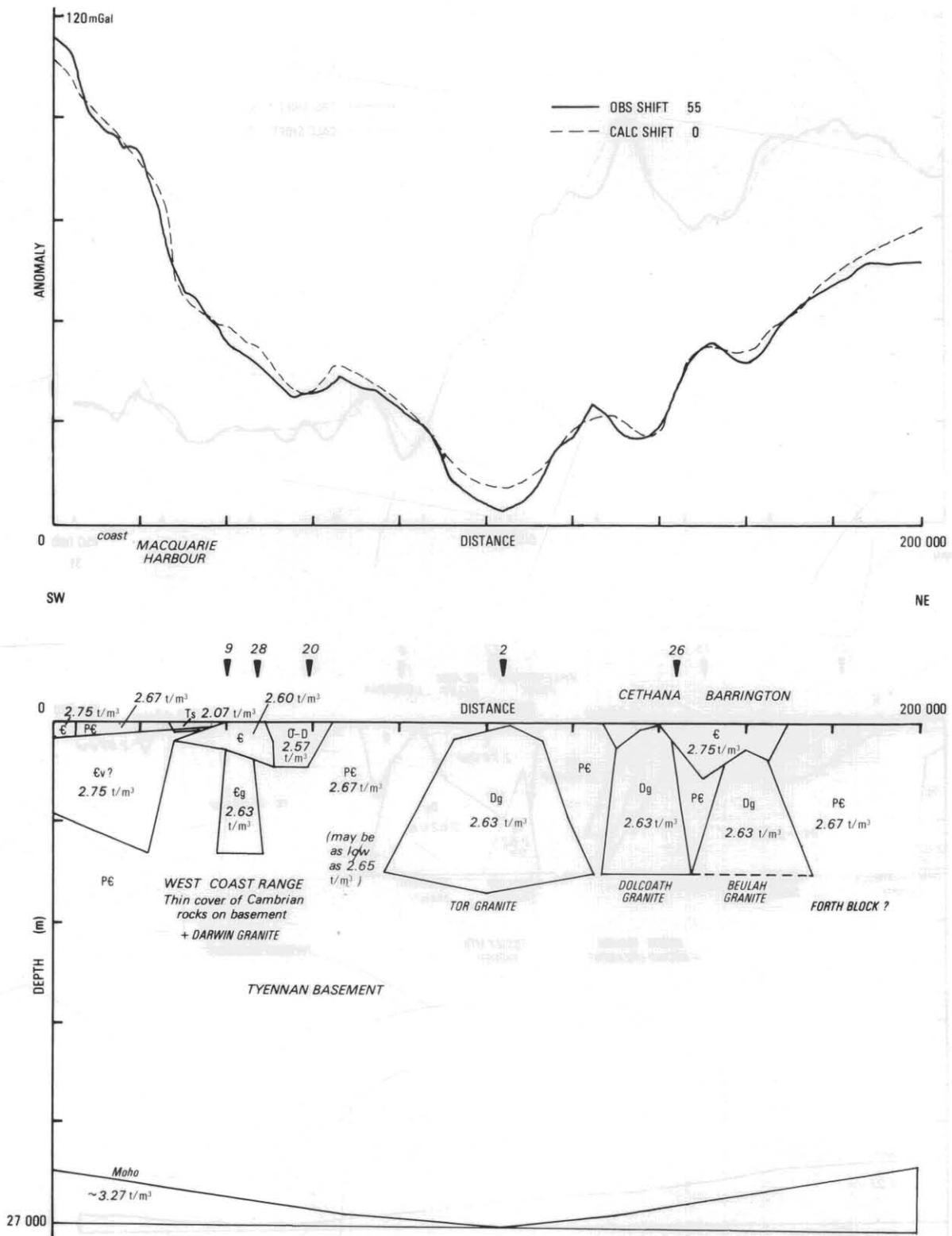
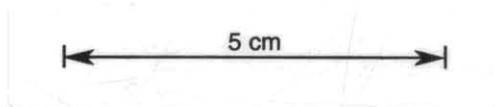


Figure 47. Regional interpretation: Line 23 (thin pile+granite option), Cape Sorell-Eldons-Port Sorell.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



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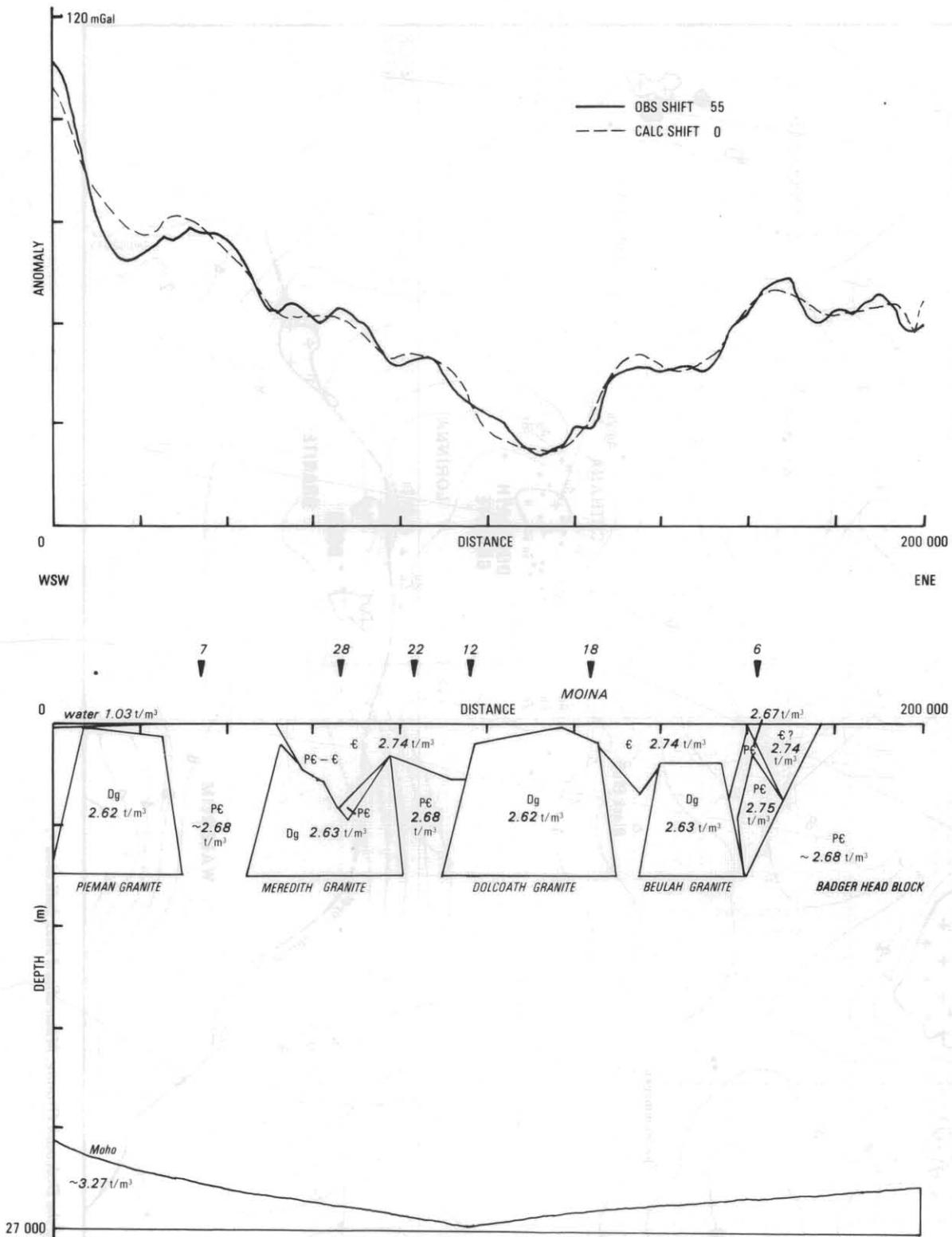


Figure 48. Regional interpretation: Line 26, Granville Harbour-Moina-Hillwood.

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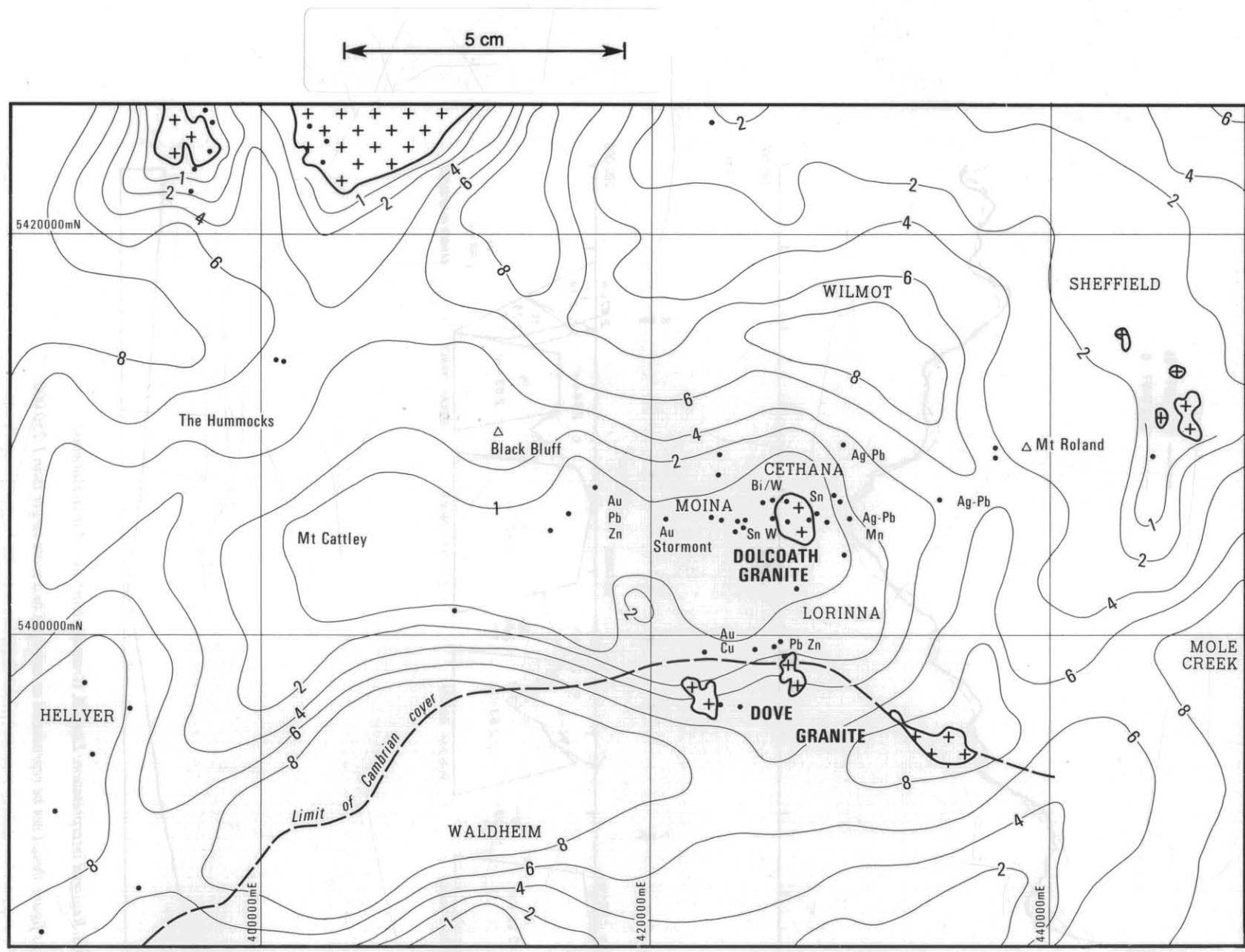


Figure 49. Form of the Dolcoath Granite. Mineralised sites indicated •.

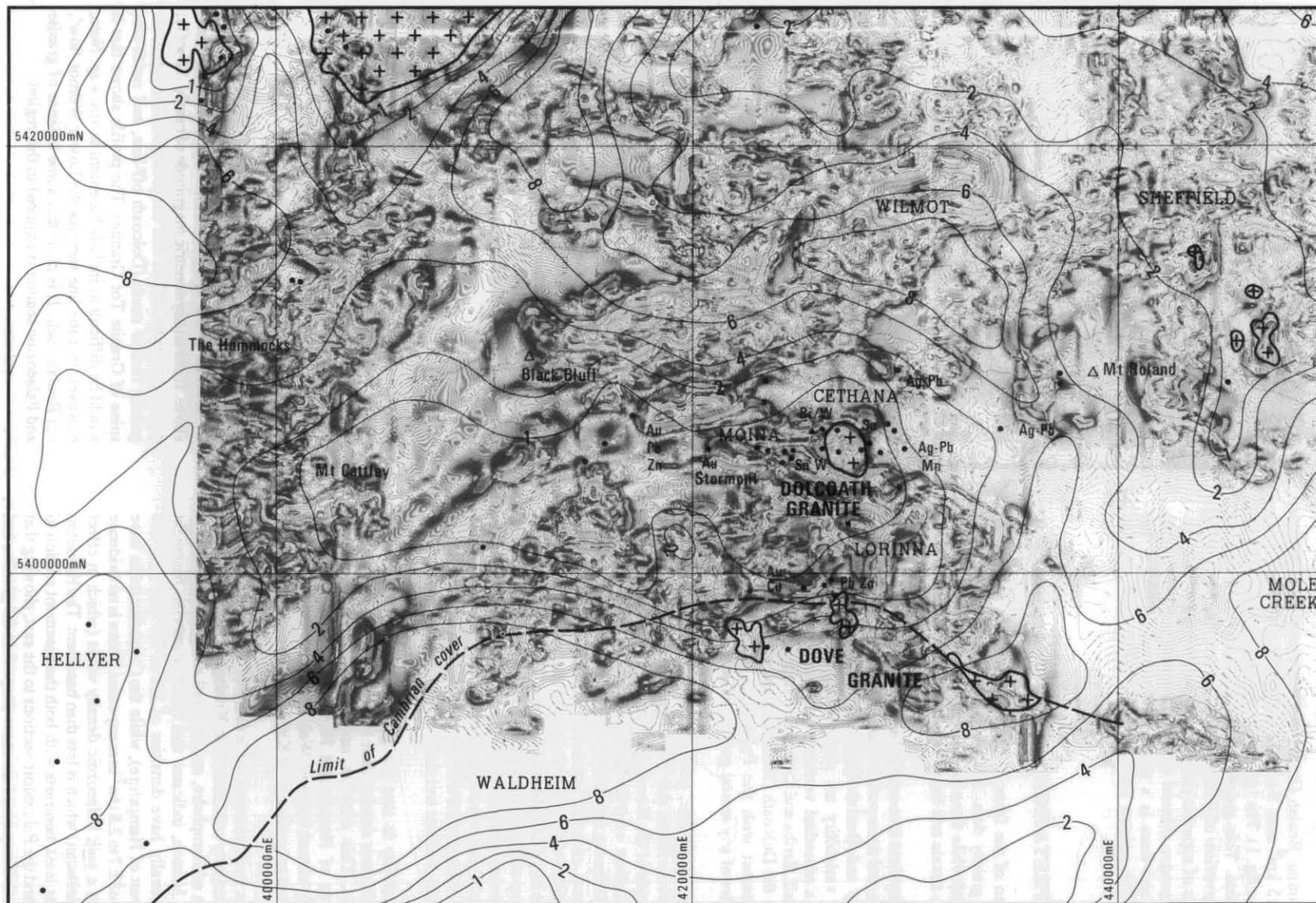
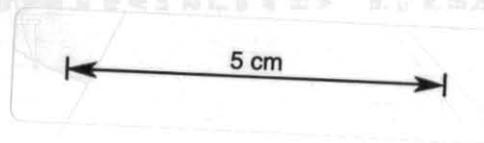
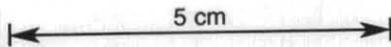


Figure 50. Department of Mines aeromagnetic coverage of the Dolcoath Granite area. Contours from the provisional interpretation of the form of the intrusion are also shown.



CHAPTER 10

BEULAH GRANITE



The Devonian Beulah Granite crops out patchily across an area of 15 km² near Beulah and Paradise (Jennings *et al.*, 1959) (see fig. 1). The 'granite' is an 'I-type' granodiorite in composition. This granite is not mentioned in the recent economic review of Collins and Williams (1986), reflecting judgments of apparent prospectivity and current knowledge. Various gangue mineral systems are associated (including barytes) and there is a single gold prospect ('Star of the West'). The present work explains some other deposits nearby.

INTERPRETATION

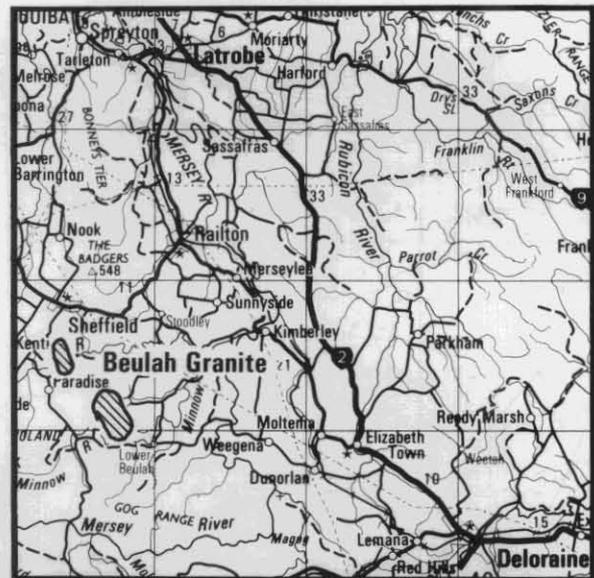
Evaluation of the form of the Beulah Granite is based on regional gravity data. Aeromagnetic data are not directly usable, and while these may assist, more detailed correction for flight, terrain and basalt conditions is required.

The gravity field is compound and complex in north-western Tasmania, and these problems affect interpretation of both the Housetop and Beulah Granites. Their composition and possible variability are complicating factors. Figure 51 presents a smoothed version of the gravity field. South of Black Bluff, Erriba and Cethana the strong negative gradient is due to the Dolcoath Granite (Chapter 9), which offers a clear contrast with the Palaeozoic rocks to the north irrespective of any crustal gradient effects.

A similar, but weaker, gradient extends from south-west of Hampshire to Riana and West Pine Road. This defines the western side of the Housetop Granite (see Chapter 11). Part of this gradient extends from Riana to Loyetea, and from Loyetea to Sprent and Palooka. The gradient steepens east of Sprent and extends beyond Kimberley as a result of recombination with the northern segment of the gradient from West Pine Road to Sprent via Spalford. The anomalies around the outcrop of the Housetop Granite are locally negative but at Beulah they are locally positive. These properties of the gravity field need some consideration. Generation of reliable residuals using the MANTLE88 formulation is expected to clarify these features and their geological correlation.

One possibility is that the granites intrude a Palaeozoic section of lower density than the surrounding Precambrian basement. This may be suspected from the gradient south-west of Natone and Hampshire, where granite is apparently absent; between West Pine Road and Sprent; and from Sprent to south-east of Kimberley.

There are two principal difficulties with this explanation. Present property evidence, near Kimberley and Mole Creek and south of Hampshire, and in detail along the Dial Range to North Motton, indicates that the Precambrian basement rocks generally have densities of 2.6 to 2.7 t/m³ (2.7–2.8 locally west of Hampshire), while the Cambrian rocks have densities of 2.7 to 2.8 t/m³ in many cases. There is no evidence to support a bulk Palaeozoic density value (which in effect means Cambrian) which is less than basement. The Housetop Granite, at least, contrasts with both the basement section to the west and the Palaeozoic sections to the east, showing that both intruded sequences are more dense than the granite, and that density values of at least 2.7 t/m³ are implied for them. As described in Chapter 11 the Housetop Granite protrudes into the northern end of the Dial Range within the area covered by the northern half of the split gradient east of Iron Cliffs. Thus, as far as the Housetop Granite is involved, the gradients largely reflect granite. On this basis granite must be



involved as far east as Spalford, and this is presumably a minimum extent, as the gradient persists.

Clearly the negative anomaly near Lower Wilmot implies more granite, as the only alternative would be to argue for a basement rise in an anticlinorium core, or a much-thinned Cambrian section on a basement high of low density (say 2.6–2.63 t/m³) materials. This argument is inconsistent with previous Precambrian requirements and fact. The Beulah anomaly is distinct but then so is the granitoid composition. It could be locally more dense than the country rocks but overall could be less dense than the entire Palaeozoic section. It is relevant to note here the special argument introduced by Longman and Leaman (1971) to explain the positive anomaly south-east of Weegeena from the perspective of the Tertiary basin and marginal materials further east. Dense Cambrian rocks were implied but granodiorite could be a satisfactory explanation.

The complexity of contrast and pluton forms is stressed by the effect of the Dolcoath granite within the same environment, and it is apparent that both the Housetop and Beulah Granites are different. The extent to which the bodies can be resolved, and the impact of the crustal gradient towards Bass Strait, has been assessed by a number of profiles.

Line 1 (fig. 52)

This line has been included to illustrate the nature of the gradient steps in north-western Tasmania. The first, near Ulverstone, is the Spalford–Iron Cliffs effect described above. It has an asymmetric magnitude of nearly -20 mGal due to the crustal effect and the presence of much other granite further south (Dolcoath off-line, and north-east spine of Granite Tor Granite). The profile shows that it would be difficult to include basement in any way. Note, however, that the line samples the Lower Wilmot 'low', not Beulah itself. It is clear that some balance of granite and Palaeozoic section is required in this region.

Line 6 (fig. 53)

This line passes through Beulah and supports the conclusions from Line 1, even though some glancing effects from the Dolcoath Granite cannot be separated with the basic methods used.

Line 8 (fig. 54)

Profile 8 presents the regional form of the gradients sub-parallel to Moho strike. The large western Tasmania plutons are identifiable in asymmetric anomaly forms but the effects of the Dolcoath and Beulah granites are not. This shows that line orientation is important, as the Dolcoath Granite has an effect on the field comparable to the Pieman or Meredith Granites (see Chapters 2, 3 of this Bulletin).

Close inspection, and the need to find a mass balance given the exposed materials, shows that the part of the Dolcoath Granite known to be involved in the section accounts for a small negative dip and part of the central depression. The absence of strong gradients to the north-east of the Dolcoath Granite shows that more granite is present (compare Line 1), and this can be resolved at a crestal point. Present data and methods cannot resolve, with certainty, whether the plutons abut.

This section demonstrates more clearly than Line 6 that the granite extends to the northern margin of the Palaeozoic basin, and that the gradient related to basement exposure is enhanced by a granite edge with a similar spatial limit. The case for a large granite sheet at moderate depth is discussed further in Chapter 11 (Housetop Granite), where its recognition and presence or absence is critical to intrusion appraisal.

Line 13 (fig. 55)

Line 13 is located east of Beulah and was designed to test overall basin form between the exposure of basement north and east of Railton, and the virtual exposure of limestone south of Mole Creek. When this is done the negative gradient within the Palaeozoic rocks has a sense opposing the southern edge, and as the effect correlates with exposed Cambrian rocks it can only be due to a large, relatively negative source within them (i.e. a granite). The suggested section at this easting is shown. The fit of the remainder of the section is adequately made by considering only normal crystalline basement.

Line 19 (fig. 56)

Several comments can be made about this ambiguous section. It would not be possible to offer any realistic model solution without the unified crustal concept developed from the entire profile matrix. The fit could be obtained by excluding granite but only by greatly thinning the Cambrian sequence. It may be that these rocks are less dense than assumed, and some of the present discussion would then require modification. There are, however, negative effects at 85 and 100 km which cannot be explained by more recent (Tertiary) materials, and which relate directly to the core of Cambrian rocks. There are significant density contrasts in the section, and other profiles indicate the scale of the depth-contrast function.

The Beulah 'high' is seen clearly in this section at 92 km (and also Line 6, Figure 53). The high correlates directly with Cambrian section (with granite exposed), and must reflect non-basement influences. The magnetic data (fig. 61) show that no substantial increase in mafic or ultramafic rocks occurs. The simplest solution is that presented in Figure 56.

Line 23 (fig. 57)

Line 23 provides clear evidence (compare Line 19) of the negative source within the basin section, and confirms that the source is major and modifies gradients across the

nearby basement for up to twenty kilometres. Only a granite pluton could produce these effects in these rocks.

Line 24 (fig. 58)

Line 24 presents a glancing view of the Beulah Granite but the modifications in section requirements and gradients are wholly supported by other profiles.

Line 26 (fig. 59)

A classical asymmetric response may be observed with an effective magnitude of -15 mGal. This section supports the implication of Line 8 (fig. 54), which suggests that any granite north and west of Beulah must have properties and a scale comparable to the Dolcoath Granite.

The present interpretation is largely assumptive with respect to the rock properties inferred for the pre-Ordovician section although some determinations are available. But, on the basis that the Precambrian-Cambrian rocks of north-western Tasmania are not markedly different from those of western Tasmania, the gravity field consistently implies a large granitic body centred near Lower Wilmot.

The discussion has referred to a number of potential ambiguities but the pattern deduced is too consistent regionally to be grossly in error conceptually. Considerable refinement of the detailed form of any granite in the region, or evaluation of the consistency and thickness of any basin/trough fill is possible, indeed inevitable. The negative response pattern cannot be assigned to post-Carboniferous materials generally, although these may locally contribute to some parts of some profiles.

The interpretation implies a significant siliceous granite (density about 2.63 t/m^3) and not a granodiorite as locally exposed at Beulah (Collins and Williams, 1986), which could be expected to have a density of 2.68 to 2.70 t/m^3 . It appears likely that the exposed material is not representative of the entire pluton, although Lines 19 and 24 can be fitted (with adjustment of basin assumptions) at other densities (see Chapter 11 for Housetop Granite). Much property work is required in the region of the Beulah pluton, and the study reported here may actually define two bodies, much as in the Blue Tier and Scottsdale Batholiths—a granodiorite sheet diapirically disrupted by adamellite. Such an arrangement would be consistent with surface and gravity implications. The form of the external outline, single or multiple body, is suggested in Figure 60. The interpretation may be a fairer representation of the diapiric adamellite member than of the disrupted granodiorite, if such is indeed the case.

Although the aeromagnetic data have been reviewed no detailed appraisal is feasible without some evaluation and removal of basalt effects. These confuse anomalies at a number of sites. Even so, there are several large and, for the Cambrian rocks exposed, abnormal features present. Examples are located east of Beulah and north-east of Wilmot, where the roof of the granite is of the order of two or three kilometres deep. These are presumably anomalous Cambrian sources or induced variants. There are no definite patterns recognisable within the magnetic field which can be correlated with the provisional interpretation offered (refer fig. 61)

The present interpretation, although an improvement on earlier work (Leaman *et al.*, 1980; Leaman, 1986c), leaves much to be resolved. The problems associated with definition of the Beulah and Housetop Granites are such that no preliminary study, especially in absence of a high-quality property data base for all units in the region, can resolve them. The aeromagnetic coverage also needs extensive analysis.

Such evaluation and resolution is feasible but was beyond the scope of the Mt Read Volcanics Project as presented here.

The interpretation does, however, account for several subsequent structural developments. The eastern Precambrian margin of the Palaeozoic trough in north-western Tasmania is evident in the magnetic data, lying immediately east of Deloraine–Railton. The margin has been partly occupied by the Beulah pluton, and the mass of granite has increased the rigidity of the region, with the result that subsequent Jurassic and Tertiary tension impacted further east within the basement blocks. The presence of large plutons west of Deloraine and Railton has controlled recent fault and trough systems in the region, resulting in fracture vent basalt sources but no significant extension.

The distribution of granite in northern Tasmania (from St Helens to west of Scottsdale, and Deloraine to Savage River) has controlled seismic refraction and reflection ray paths. This has affected the seismic interpretation of Richardson (1980), which was based on reciprocal shots but no centre shot. Seismic interpretation assuming consistent crustal velocities along the data line implies a central mantle depression south of Launceston—the presumed Tamar lineament effect. Such a depression does not appear to be supported using gravity data, and the present work suggests the opposite effect. We now believe this deviation to reflect a zone of lower velocity between two pluton groups. The pluton groups affect velocities to depths of at least eight kilometres. Inspection of the time–distance curves shows that the onset of high velocities, and stable plots, occurs in the region between Beulah and Deloraine. The offset is consistent with the dipping surface likely on the pluton, and the spacing of seismic stations. The seismic data, although misleading crustally at the centre of the spread due to variable velocities, provides independent support for the present gross interpretation and its inference of a large Beulah Granite.

MINERALISATION AND EXPLORATION

Mineralised sites have been overprinted on Figure 60. The display may not be complete, as the Departmental data base used is currently under revision.

The Beulah Granite has not been studied and its composition is debatable. The above discussion illustrates some of these issues. Need this matter as far as mineralisation and prospectivity is concerned? Possibly not. Apparently similar 'I-type' granodiorites, if that is what this granite really is in bulk, have produced significant scheelite deposits on King Island, and other granodiorites are arguably related to gold systems in north-eastern Tasmania. The nature of the 'Star of the West' prospect must be better understood in this context before the prospectivity of the Beulah Granite can be appraised.

On a more regional basis, the mineralisation of central north-west Tasmania has not been the subject of much study,

and the small Ag-Pb, Ba, Cu and Au prospects appear unrelated, until plotted on the current interpretation map of the Beulah Granite. With the exception of two copper occurrences near Spalford, which may be related to a local spine, all occurrences lie within two kilometres of the roof crest. Precise controls on these sites is not evident with this analysis or the available data in some cases. It may be possible to define specific cupola effects. As was the case for the Dolcoath Granite, most mineralisation in the region would thus seem to be granite-related, with minimal evidence for remobilisation of Cambrian deposits. The particular chemistry of the deposits may reflect distance from the granite roof.

There is therefore a case for careful review of the granite roof form and correlation with possible host rocks. Unfortunately few carbonates are present in the roof of this granite, and large deposits may not be likely. We would predict, on the basis of two granite compositions, that tin mineralisation is likely at moderate depth in the Wilmot–Castra area, and that more gold is likely closer to the present topographic surface.

SUMMARY

1. The Beulah Granite is a significant pluton.
2. Very little of its roof is exposed.
3. The Beulah Granite as described in this Bulletin may be a multiple body similar in style to parts of the Blue Tier Batholith, as there are implications of a wide property range.
4. The roof of the body is irregular and of high relief but most of the intrusion lies at depths of two kilometres or more.
5. Detailed analysis of both gravity and magnetic data would be required to properly evaluate this granite. Some additional gravity coverage and rock property information would also be essential.
6. Limited mineralisation appears to be related to the suggested roof distribution, and the nature and composition of the deposits may reflect distance from granite. The presence of gold up to 1.5 km from the granite may be significant, and close study might reveal other prospective sites. Barium and silver-lead occurrences near Castra may reflect the more adamellite part inferred for this pluton. This could well be tin-bearing, and could be associated with other mineralisation at moderate depth.
7. The Beulah Granite, like many other western Tasmanian granitoids, was intruded near a recently active basin margin. The presence of the pluton has controlled subsequent development of Jurassic and Tertiary tensional systems.

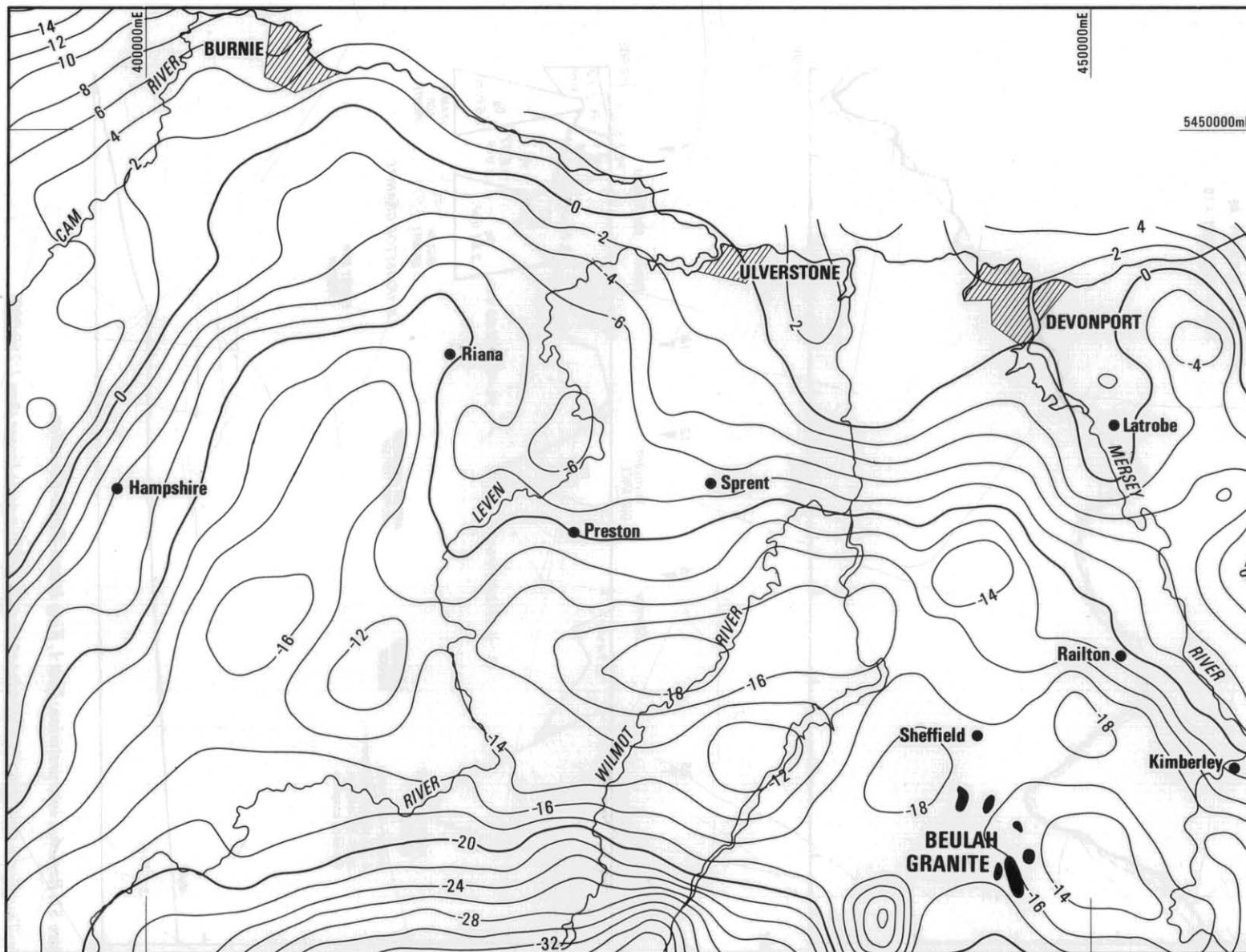
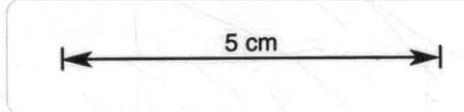


Figure 51. Bouguer anomaly contours (smoothed TASGRAV set) and Beulah Granite outcrop.



2D GRAVITY MODEL

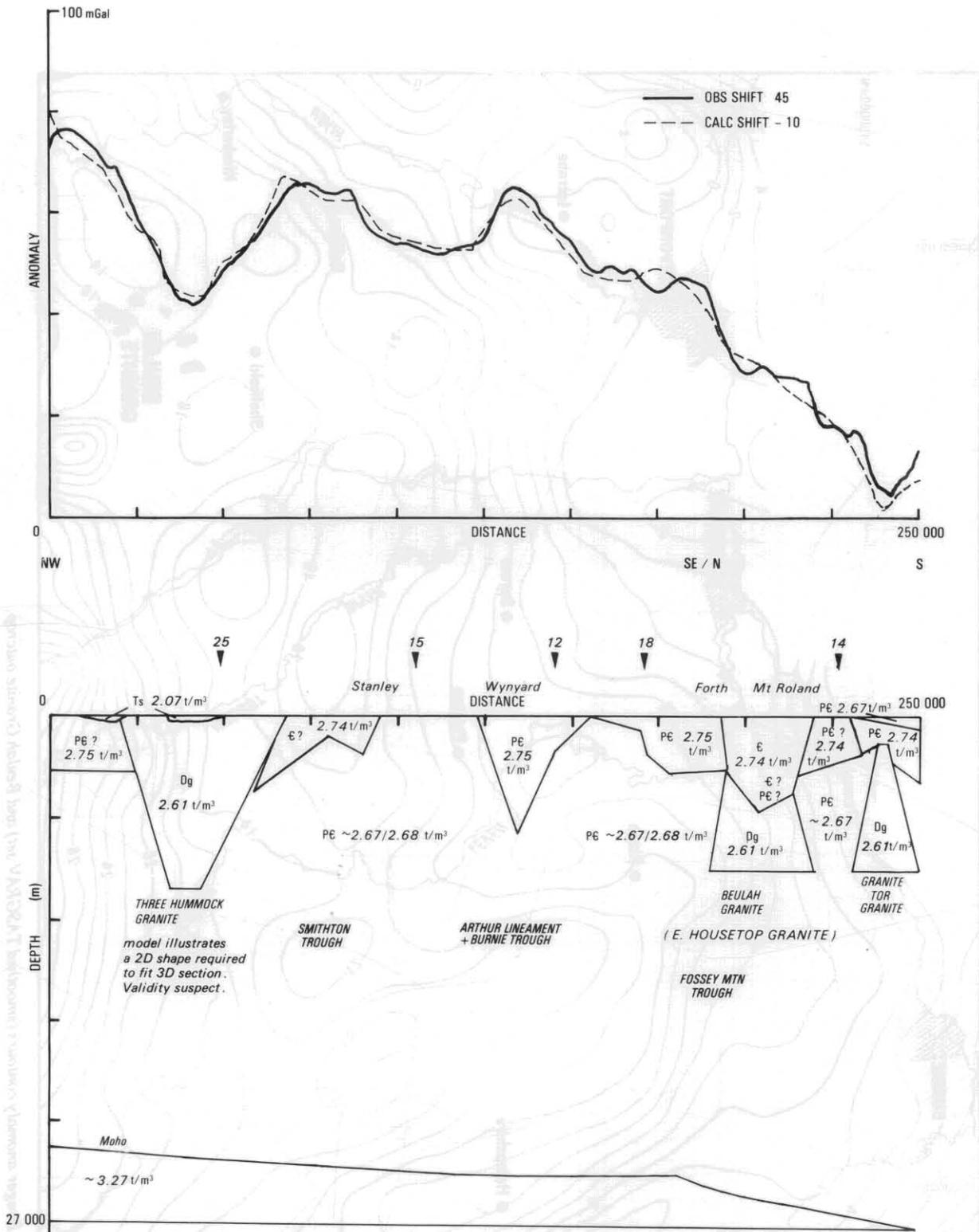


Figure 52. Regional interpretation: Line 1, King Island-Forth-Rowallan.

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2D GRAVITY MODEL

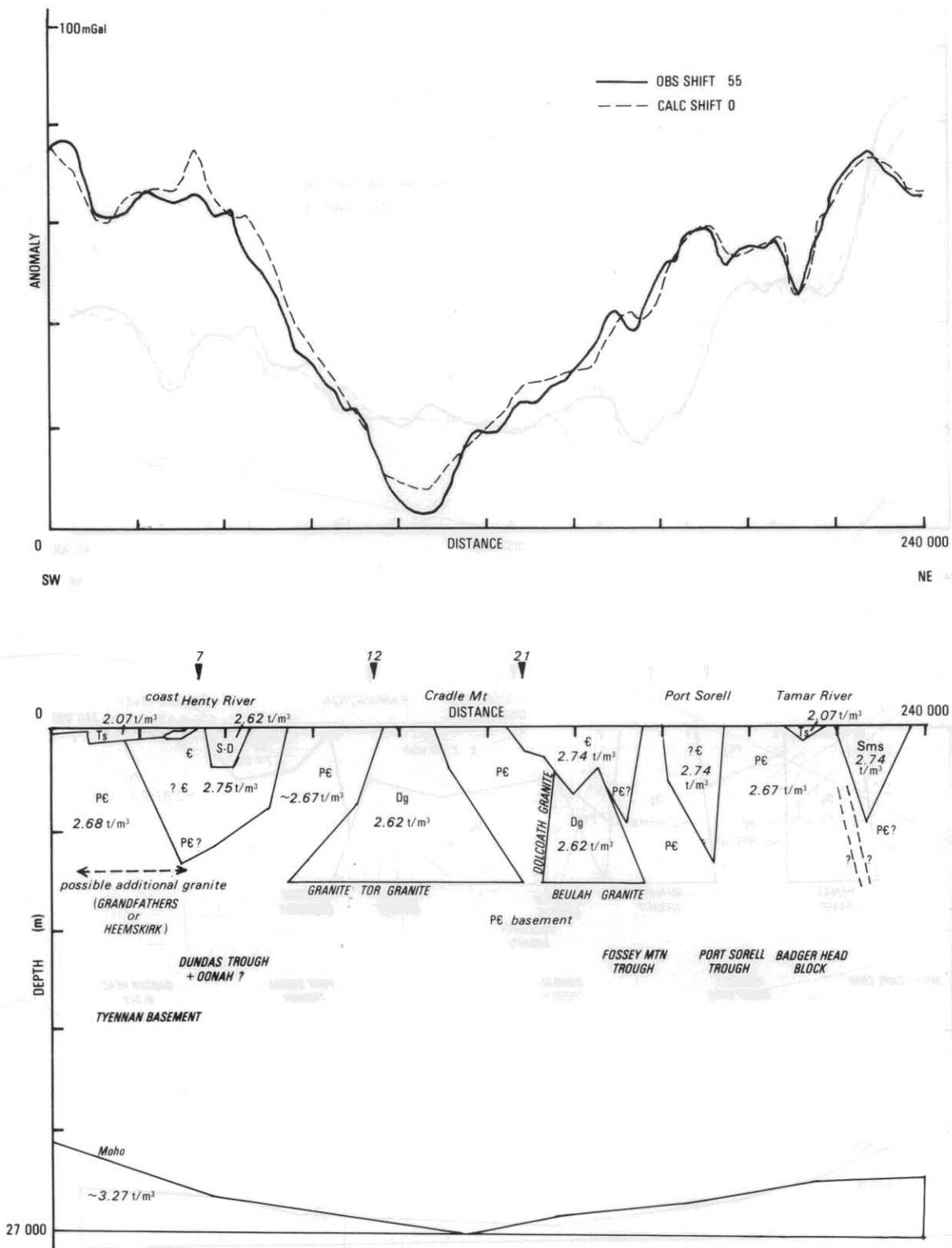


Figure 53. Regional interpretation: Line 6, Strahan-Cradle Mountain-River Tamar.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

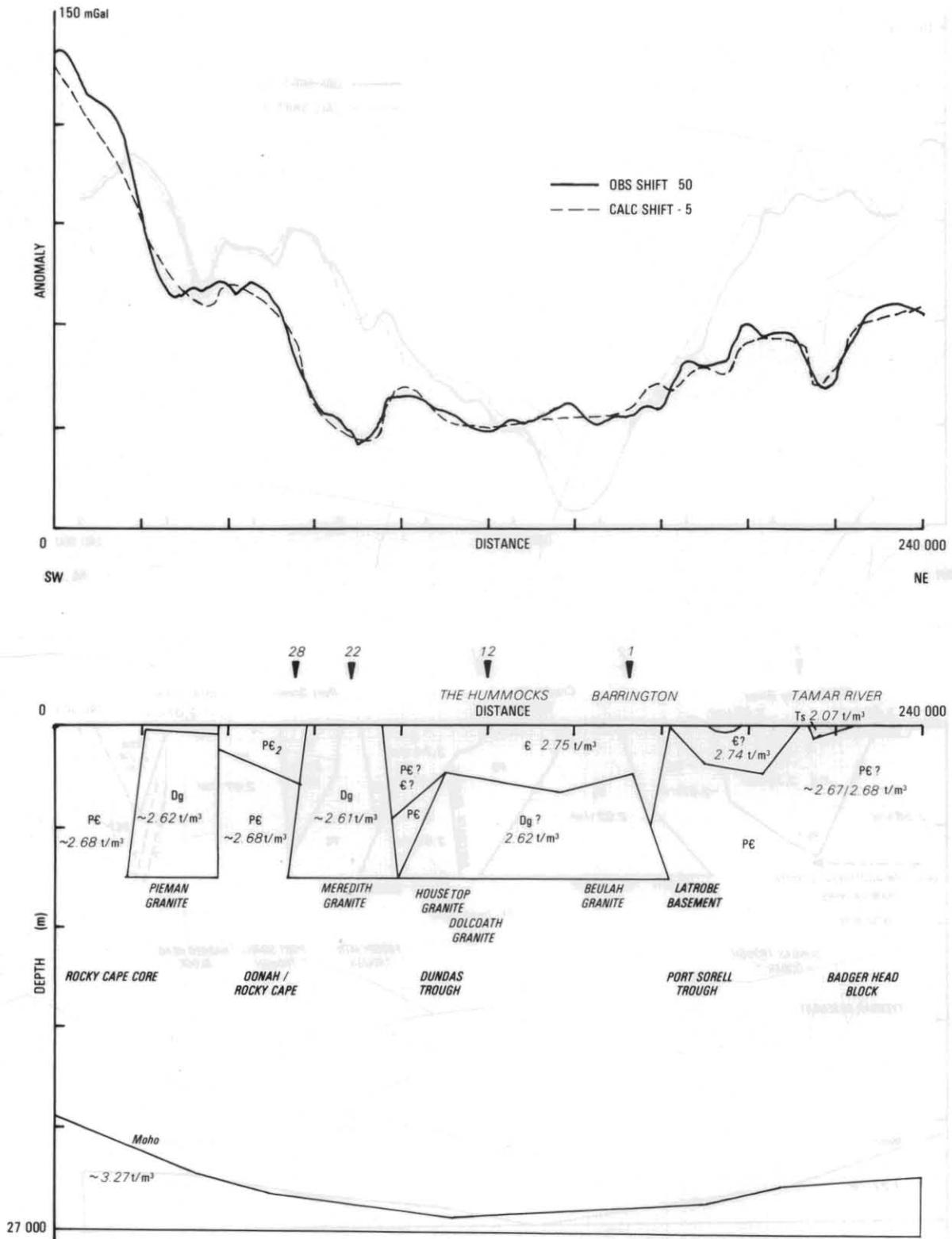
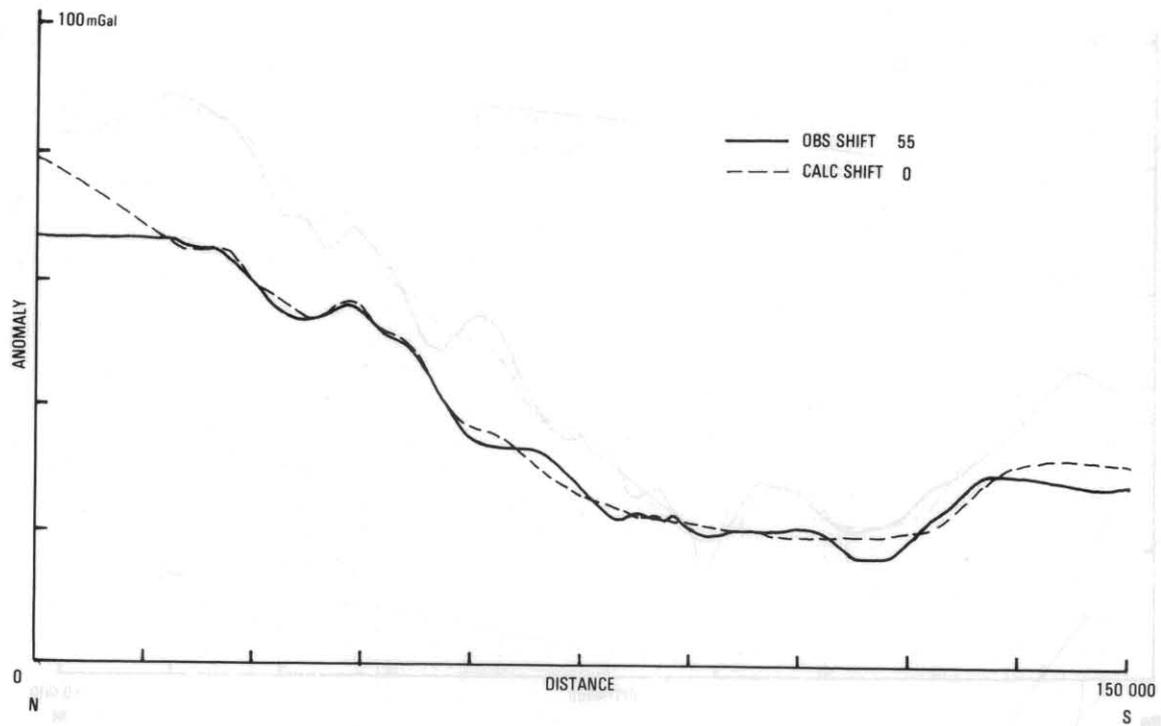


Figure 54. Regional interpretation: Line 8, Pieman Heads–Meredith–Weymouth.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL



5 470 000mN

5 320 000mN

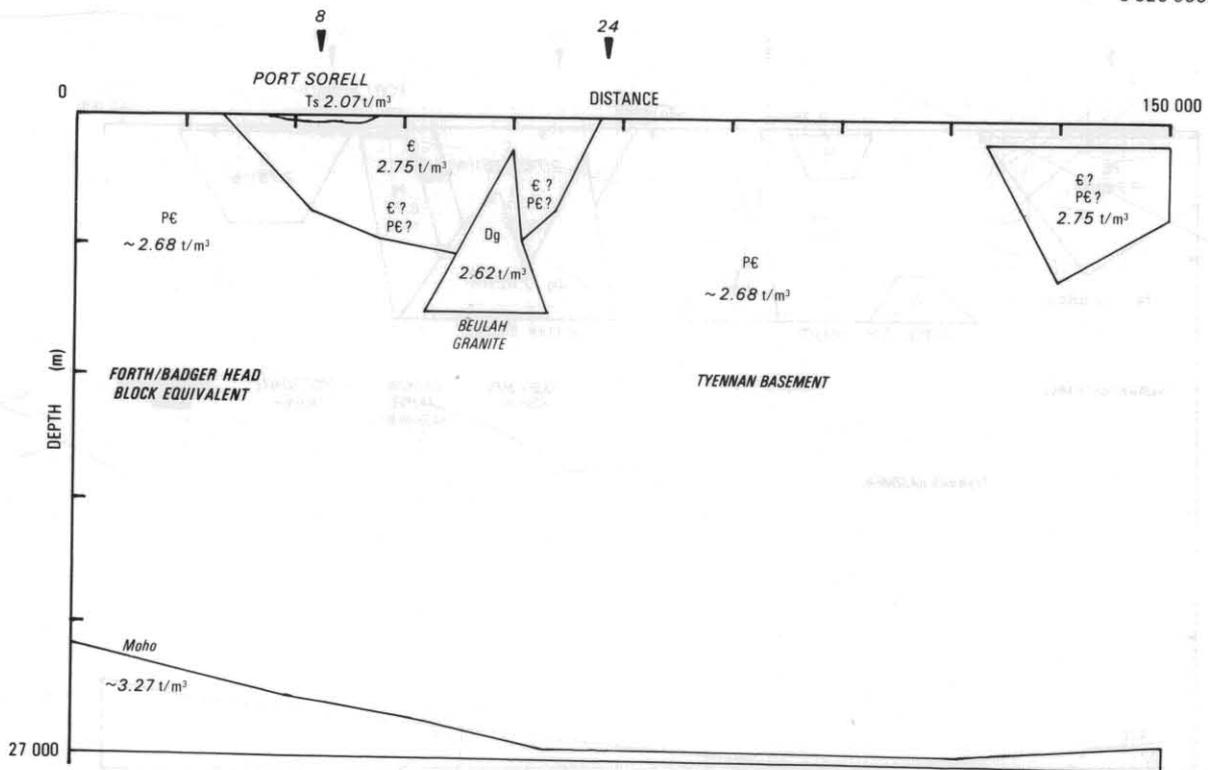


Figure 55. Regional interpretation: Line 13, Port Sorell-Tarraleah [460 000 mE, 5470-5320 000 mN].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

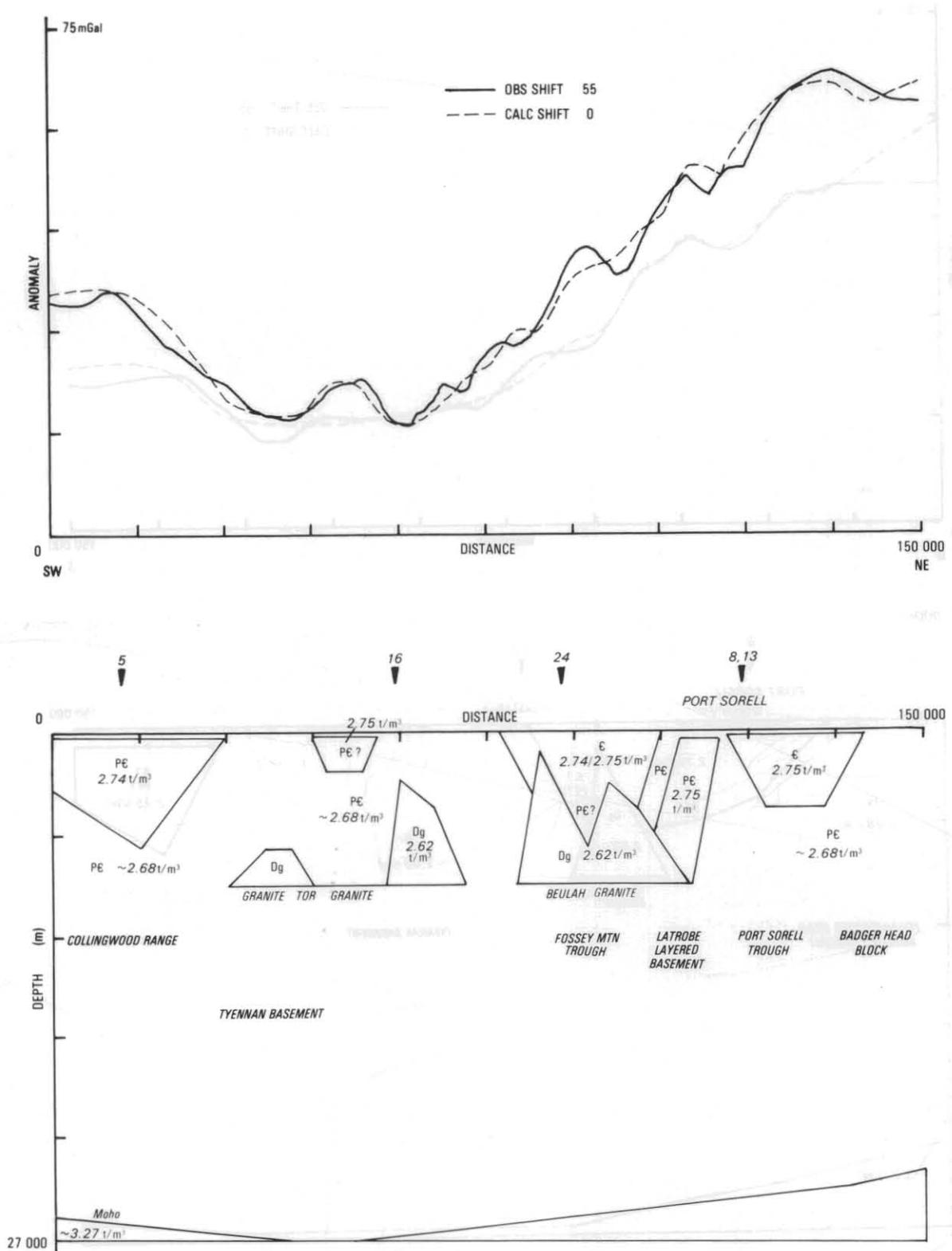


Figure 56. Regional interpretation: Line 19, Olympus-Beulah-Port Sorell.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

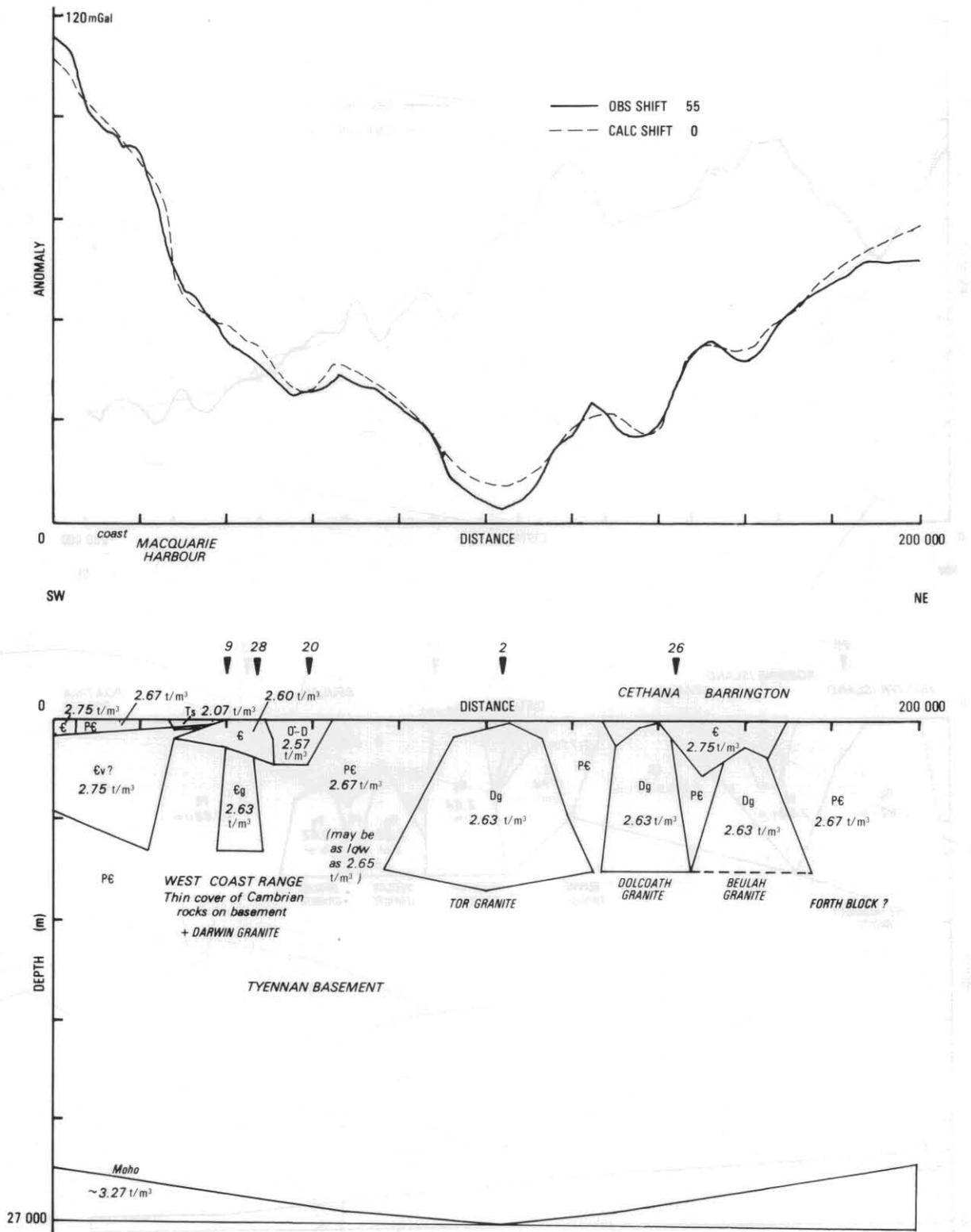


Figure 57. Regional interpretation: Line 23 (thin pile+granite option), Cape Sorell-Eldons-Port Sorell.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

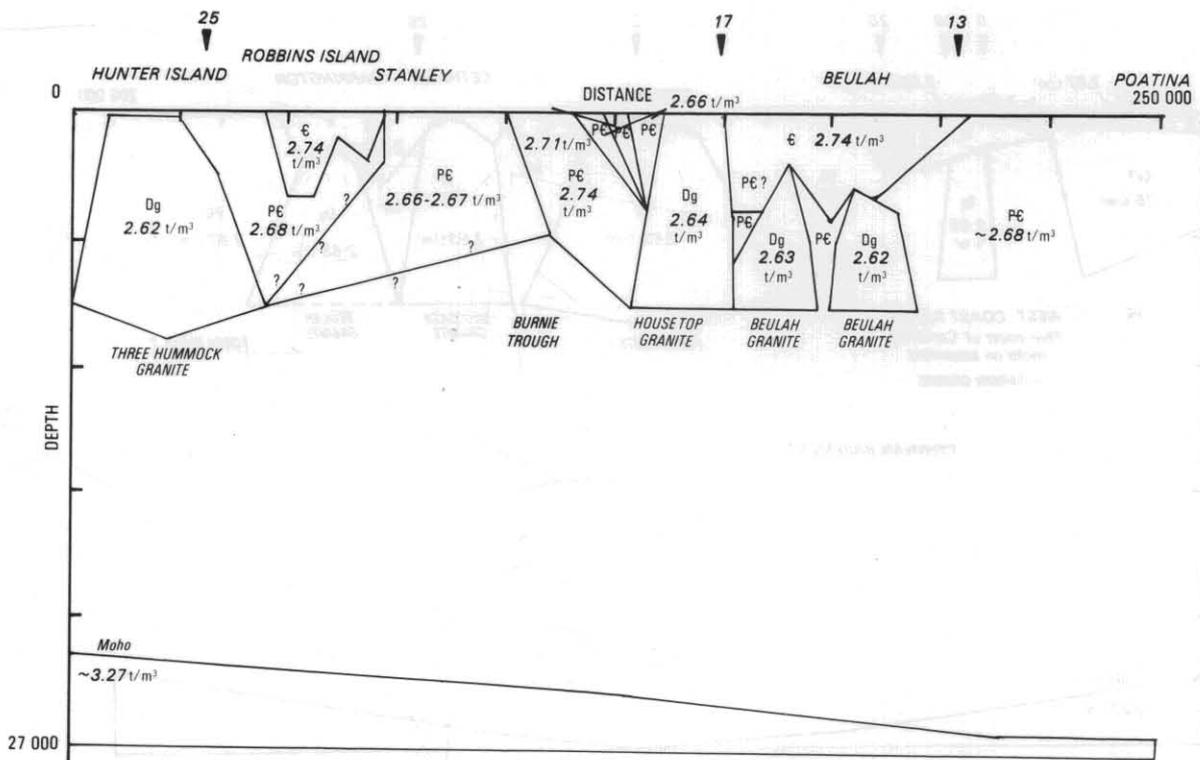
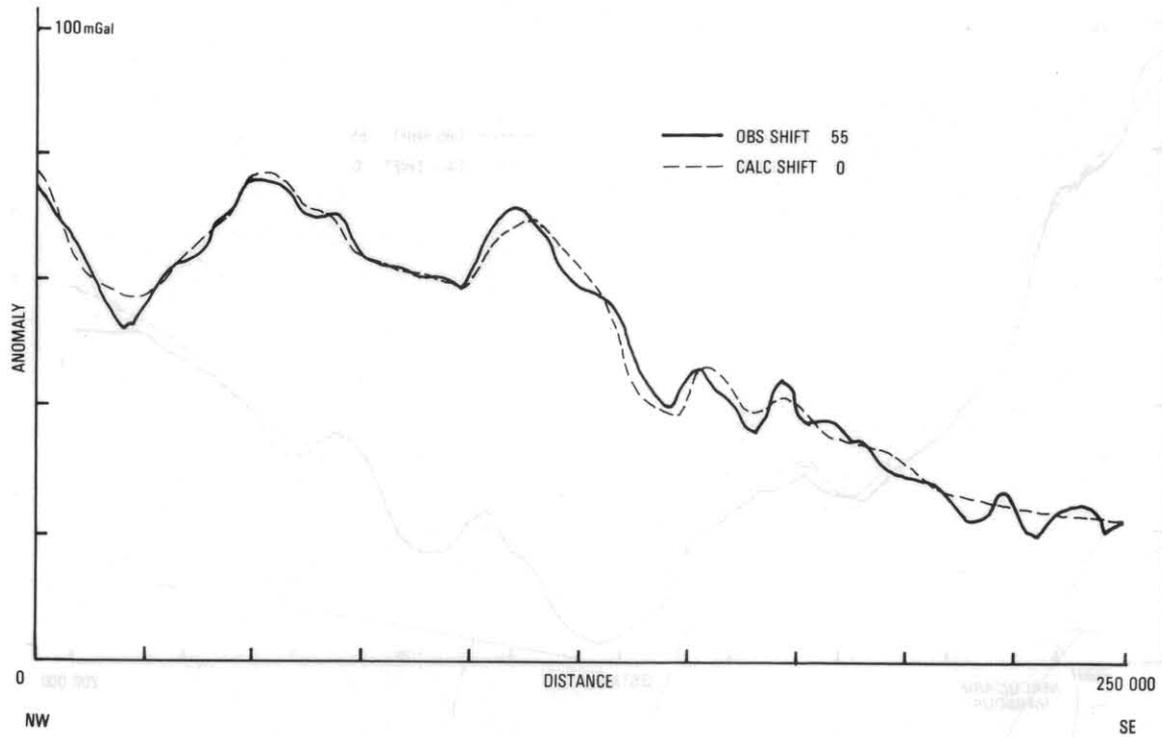
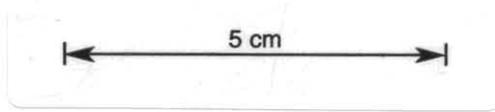


Figure 58. Regional interpretation: Line 24, Hunter Island–Housetop–Poatina.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

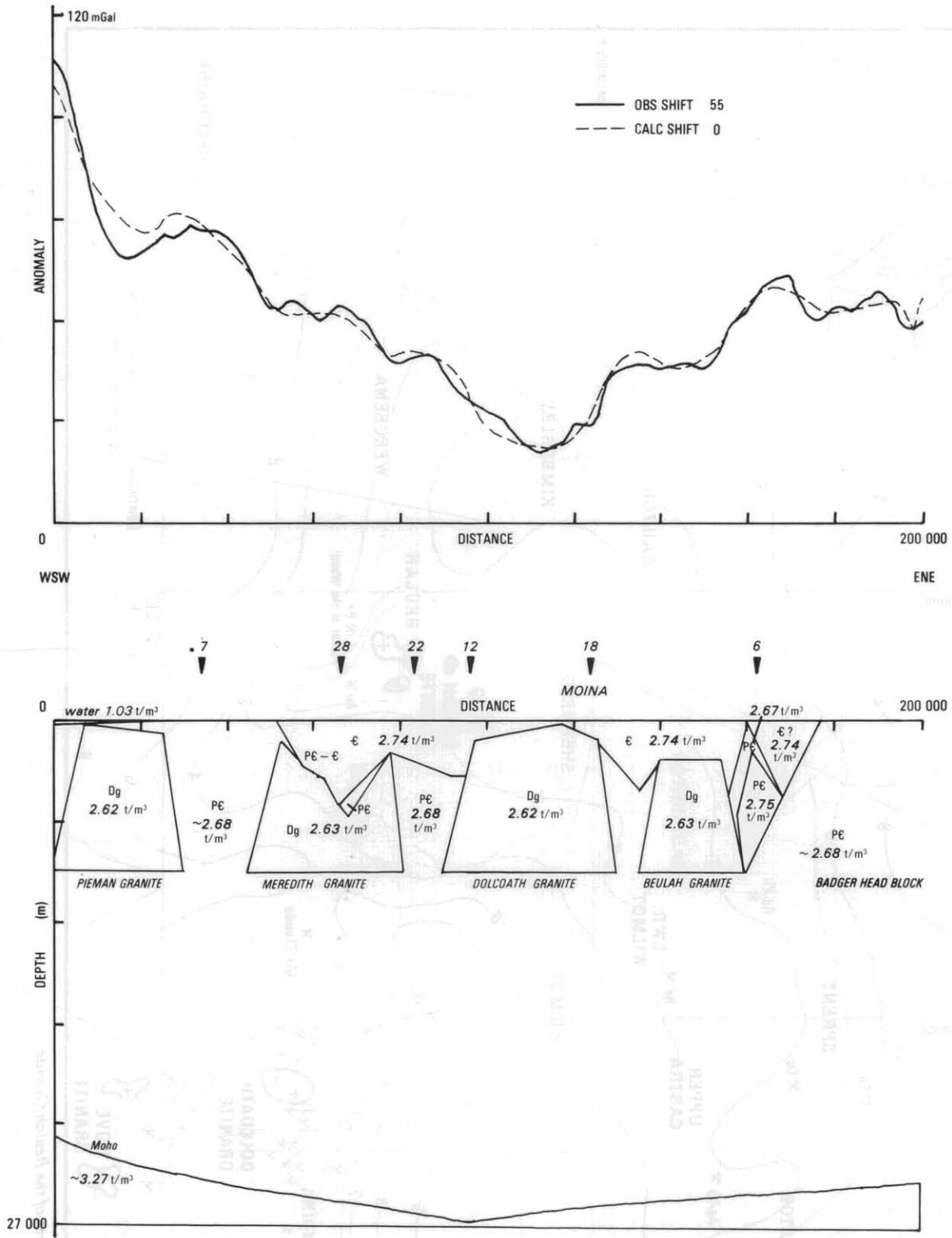


Figure 59. Regional interpretation: Line 26, Granville Harbour-Moina-Hillwood.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

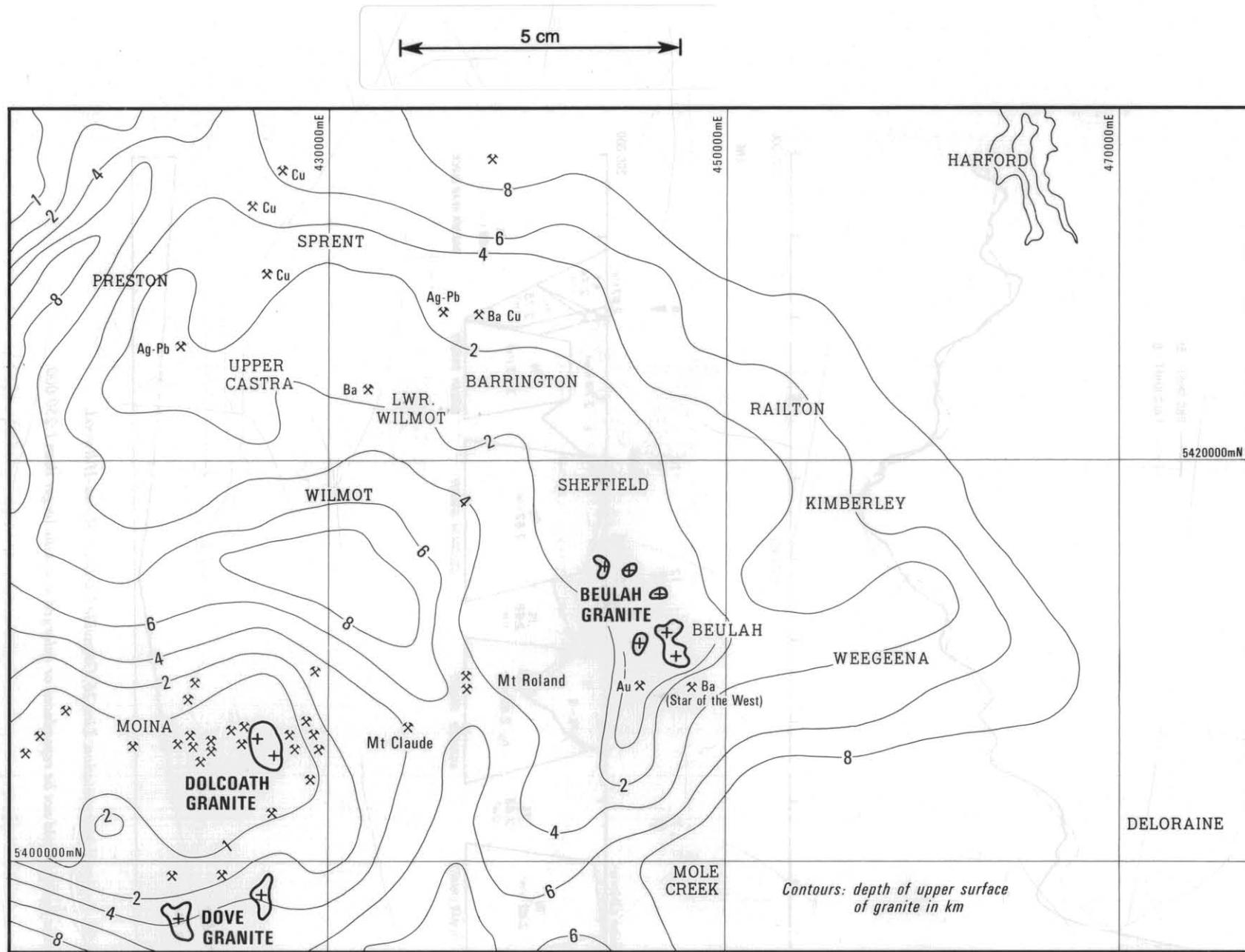


Figure 60. Form of the Beulah Granite.

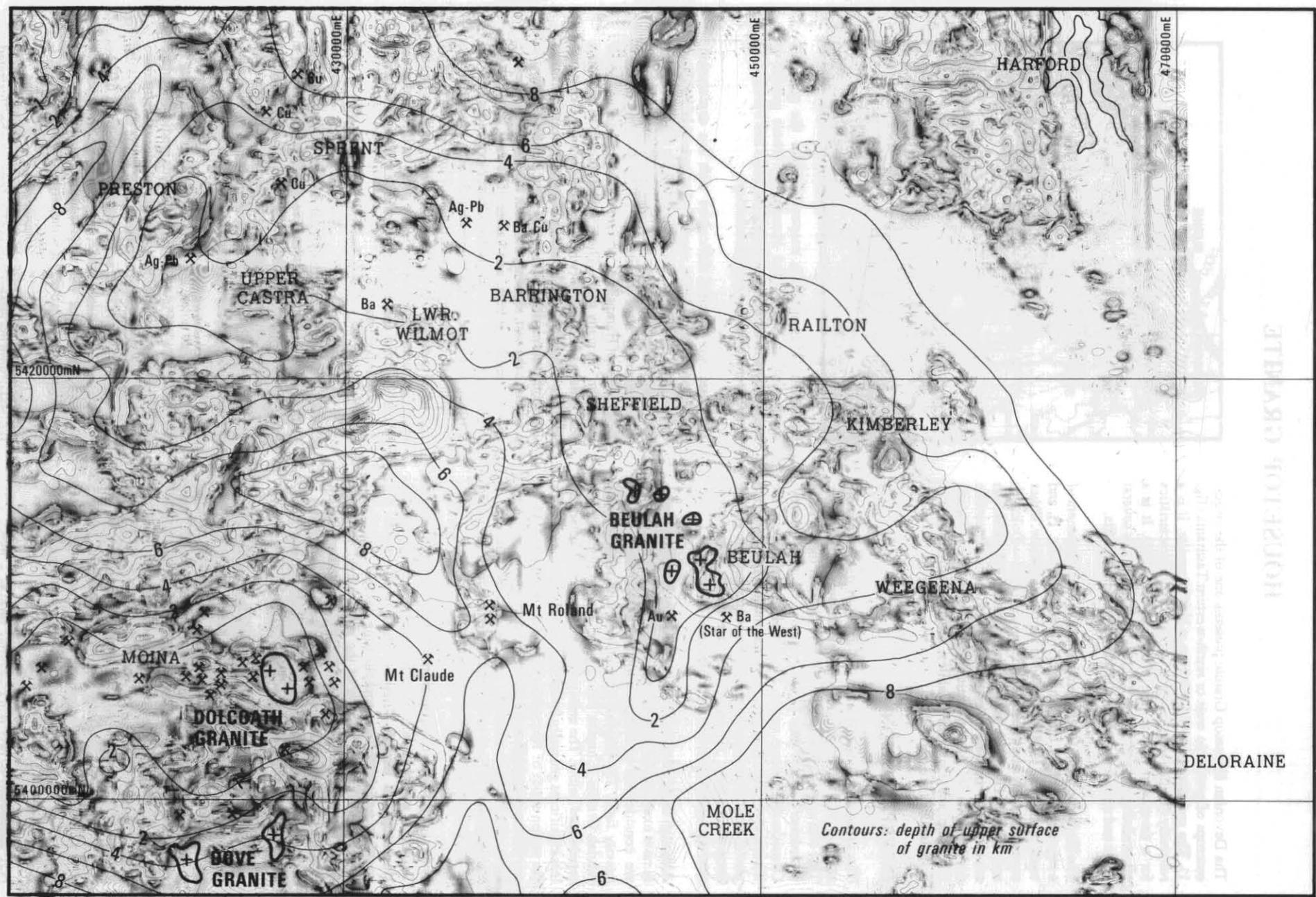
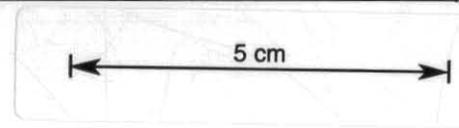
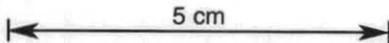


Figure 61. Department of Mines aeromagnetic coverage of the Beulah Granite area, with interpreted contours of upper surface of granite shown.



CHAPTER 11

HOUSETOP GRANITE



The Devonian Housetop Granite presents one of the largest outcrops of granite in west or north-western Tasmania (fig. 1). The rock has been described as a biotite granite. It is a relatively distinctive lithology with abnormal characteristics for a tin-related granite (see Collins *et al.*, 1981). It is a mineralising granite, and is directly associated with several skarn and replacement deposits and some vein deposits.

The Housetop Granite was considered a major component of a super batholith by Leaman *et al.* (1980) (inset fig. 1), and work by Leaman (1986c) tended to support that view. Other segments of this study (especially Chapters 10, 11—Dolcoath and Beulah Granites) have shown that improvements in coverage and analysis cannot yet distinctly resolve possible deep points of pluton abutment between the Beulah, Housetop and Dolcoath Granites, although differing bulk compositions are implied.

INTERPRETATION

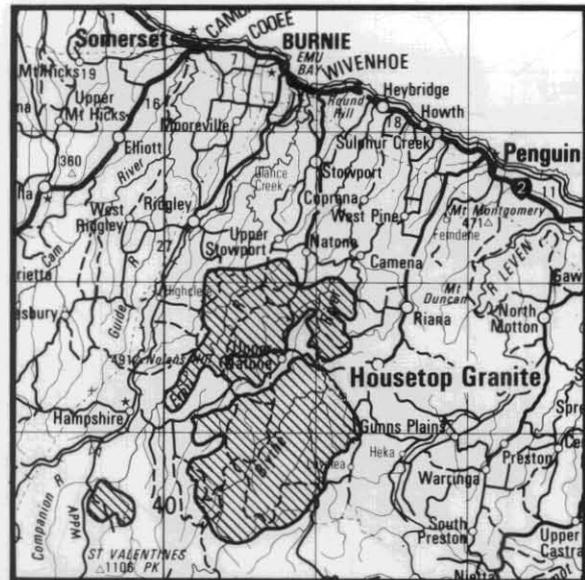
The present analysis depends on the high quality gravity coverage of the Housetop region of north-western Tasmania. This was upgraded during the 1986/87 phase of the Mt Read Volcanics Project and is still subject to infill survey. Considerable scope exists for detailed analyses in the Housetop region. Extensive regional magnetic surveys are also available but these are not of direct assistance to granite form evaluation, although they are highly relevant to near-surface skarn and margin location.

Although the gravity data base in the Mount Housetop region is now excellent in regional and semi-regional terms, there are considerable problems with the interpretation of the gravity field. The issues were outlined with respect to the Beulah Granite (Chapter 10), and the relevant discussion is reproduced below. The ambiguities and uncertainties are far less significant generally for the Housetop Granite (except for the region south of Hampshire) but must be appreciated, as any failure to recognise the interpretive and geological-mass trade-offs made, or existing, may weaken the status of an interpretation, or lead to inadequate definition of the extent of the granite. Not all the problems are yet solved.

The gravity field, is compound and complex in north-western Tasmania, and these problems affect interpretation of both the Housetop and Beulah Granites. Their compositions and possible variability are complicating factors. Figure 62 presents a smoothed version of the gravity field. South of Black Bluff, Erriba and Cethana the strong negative gradient is due to the Dolcoath Granite (Chapter 9), which offers a clear contrast with the Palaeozoic rocks to the north, irrespective of any crustal gradient effects.

A similar, but weaker, gradient extends from south-west of Hampshire to Riana and West Pine Road. This defines the western side of the Housetop Granite. Part of this gradient extends from Riana to Loyetea, and from Loyetea to Sprent and Palooa. The gradient steepens east of Sprent and extends beyond Kimberley as a result of recombination with the northern segment of the gradient from West Pine Road to Sprent via Spalford. The anomalies around the outcrop of the Housetop Granite are locally negative but at Beulah they are locally positive. These properties of the gravity field need some consideration, and may require generation of reliable residuals for a satisfactory appraisal.

One possibility is that these granites intrude a Palaeozoic section of lower density than the surrounding Precambrian



basement. This may be suspected from the gradient south-west of Natone and Hampshire, where granite is apparently absent; between West Pine Road and Sprent; and from Sprent to south-east of Kimberley.

There are two principal difficulties with this explanation. Present property evidence, near Kimberley and Mole Creek and south of Hampshire, and in detail along the Dial Range to North Motton, indicates that the Precambrian basement rocks generally have densities of 2.6 to 2.7 t/m³ (2.7–2.8 locally west of Hampshire), while the Cambrian rocks are 2.7 to 2.8 t/m³ in many cases. There is no evidence to support a bulk Palaeozoic density (which in effect means Cambrian) less than basement. The Housetop Granite, at least, contrasts with both basement section to the west and the Palaeozoic sections to the east, showing that both intruded sequences are denser than the granite, and values of at least 2.7 t/m³ are implied for them. The Housetop Granite protrudes into the northern end of the Dial Range within the area covered by the northern half of the split gradient east of Iron Cliffs. Thus, as far as the Housetop Granite is involved, the gradients largely reflect granite. On this basis granite must be involved as far east as Spalford, and this is presumably a minimum extent as the gradient persists.

Clearly the negative anomaly near Lower Wilmot implies more granite, as the only alternative would be to argue for a basement rise in an anticlinorium core or a much-thinned Cambrian section on a basement high of low density (say 2.6–2.63 t/m³) materials. This argument is inconsistent with previous Precambrian requirements and fact.

The discussion noted the western gradient south-west of Natone. Review of Figure 62 shows that this gradient overlaps the actual exposure of the granite, and provides some measure of the Precambrian rocks nearby as well as the effect of the crustal gradient. The apparent contribution of the Precambrian rocks is notable, as modelling and property studies suggest that the units south-east of the Arthur Lineament are of relatively low density (<2.65 to 2.67 t/m³).

The nature of the Housetop Granite, and the problems associated with the interpretation of its form, can be illustrated by eight profiles.

Line 2 (fig. 63)

This line illustrates directly some of the problems described above. The response of the Housetop Granite is apparent but it is more subtle than that of either the Dolcoath or Granite Tor Granites. Closer inspection reveals a -20 mGal asymmetric anomaly; the distortion is related to the combination of crustal form and the large granites inland. Thick basalt does contribute to the problems but cannot obscure the principal effect.

Line 5 (fig. 64)

Line 5 overlaps Line 2 south of Nietta but traverses the south end of the Dial Range instead of the main northern exposure of the granite. Even so, there is a subtle suggestion of the presence of the granite as far east as North Motton.

The granite-Cambrian balance seems debatable until the contribution of the crust is evaluated. It is then evident that the sedimentary section is either very thin, very light, or intruded by a massive granite. The first two options cannot be sustained, and the presence of the third can be proven although there are no exposures within 15 km of this line. See also Dial Range detailed discussion below.

Line 8 (fig. 65)

Lines 8 and 17 present the critical issue for this granite. Does it exist much beyond its exposure and if so, how deep and with what bulk density? Some of the problems posed by the Beulah Granite are relevant, as the two bodies may abut or coalesce. The region south of Mt Housetop is almost entirely covered by Tertiary basalt. While this contributes little to the gravity field it does obscure important indicators. It has been beyond the scope of this study to resolve the basalt issue (although this is feasible—see Leaman, 1986a) and obtain an improved interpretation of the gravity data base.

Section 8 presents a Palaeozoic section-granite balance based on a density of 2.62 t/m^3 for the granite. This is possibly too low (see discussion for Line 17). A lower contrast results in more granite in the section, and the barytes occurrences near The Hummocks may reflect a crestal rise much as suggested. Note that the absolute minimum in the observed field profile occurs near The Hummocks. The gravity field north-west of the Dolcoath Granite, north-east of the Meredith Granite, and south of the outcrop area of the Housetop Granite is not strongly featured and this, coupled with basalt blinding for surface control, raises ambiguity issues.

Line 12 (fig. 66)

This is a particularly interesting section, as it glances along the western margin of the exposed pluton and traverses some parts of the exposure. Yet there is no classical negative anomaly, and the response can be contrasted with that of the Granite Tor Granite. Nor is there more than a -8 to -10 mGal step anomaly, and this is diffused across the body. Some of the non response can be ascribed to the geometric relationship between the granite and the section, and the methods used are deficient in such circumstances. The methods probably account for the deviation in the calculated effect across the exposed granite. It was not found possible to insert any density in the range 2.63 to 2.70 t/m^3 in the upper 1.0 to 1.5 km of the intrusion which might modify the effect. Residual analysis based on a separation using MANTLE88 may clarify this issue.

Line 17 (fig. 67, 68)

This section is the most important of the selection presented because it demonstrates a fundamental property of the Housetop Granite. The mantle portion of the model is fixed by the consolidated network of sections and their requirements. This may not be altered to suit the particular needs of a single profile.

If this section is modelled with normally accepted granite densities, namely 2.61 to 2.64 t/m^3 , then a 2.5 to 5 km thickness of mainly Cambrian rocks must be present as roof cover across the entire pluton (fig. 67). This encompasses the gentle gravity depression from 110 to at least 160 km. This cannot be correct. Granite is actually exposed from 145 to 165 km.

The problems posed by the orientation of this profile are not surprising and were anticipated (see also line 8, fig. 65). The profile was selected specifically because no obvious east-west gradient terminations could be recognised between the Housetop and Meredith Granites. This may partly reflect limited coverage around the Meredith Granite but the specific response of both the Dolcoath and Meredith Granites in the region between Mt Ramsay and Black Bluff suggested numerous other complications or unexpected property differences between the granites. In brief, what is concealed by the basalt cover? Was there another more fundamental reason for the presence of so much Tertiary cover in this region? These questions are discussed elsewhere (Leaman, 1988d) but the ramifications for definition of the Housetop Granite are evident.

Figure 68 presents an equivalent curve match but is predicated on different assumptions. It shows that a bulk density of 2.65 to 2.66 t/m^3 is implied for the granite in the outcrop zone. This abnormal density is consistent with anomalous susceptibilities (see Collins *et al.*, 1981; fig. 12). However, if this density is used for the entire body—to the south-west, for example towards the Meredith Granite—then conflicts arise with other profiles (see also line 12, and Chapter 13 of this Bulletin).

These models indicate that the Housetop Granite is variable in properties, and often approaches the Bouguer density of 2.67 t/m^3 . It may be a compound intrusion, or two intrusions improperly combined by this study. Some normal adamellite is also inferred.

Line 18 (fig. 69)

The response of the granite within the region east of the Dial Range is apparent but complicated by a central bulge. The effect is generally only of the order of -7 mGal which reflects, believably, both depth of burial and possibly raised density. The gradients observed are more consistent with a normal 'light' granite. Tertiary effects are not significant. The spines included in the model can be supported by detailed analysis of the Dial Range region (below). The Housetop and Beulah Granites are not readily separated at this level of appraisal.

Line 21 (fig. 70)

Although this profile possesses many of the characteristics of the Housetop Granite in other sections, the initial steep gradient and asymmetric response (anomaly range -15 mGal) defines onset of the pluton, which cannot be differentiated spatially from the Dolcoath Granite (see Chapter 9).

Line 24 (fig. 71)

This line traverses the northern outcrop of the granite, and there is little doubt of its presence and effect. The granite is inferred to be denser than other plutons but the response is relatively normal.

The difficulties presented during the interpretation of the form of the Housetop Granite may be appreciated from the discussion. The granite is clearly variable, denser to the west and south-west, but perhaps not of abnormal density for the entire volume. It may not be a single intrusive body. The Beulah Granite was also deduced to be a compound intrusion (see Chapter 10).

It must be stressed that this interpretation would not have been possible without a whole crustal view and multiple-section orientations. Any attempt to smooth the field and extract a residual in these conditions would have destroyed the subtle relationships between the large sources. Such extraction may now be feasible using the tested and revised MANTLE88 concept. The analysis for this pluton alone vindicates the interpretation methodology outlined in the introduction. It is also essential, in such cases, that the data coverage be far-reaching, although local coverage may identify pinnacles in the roof.

The provisional compilation of the form of the Housetop Granite shown in Figure 72 is based on a presumption that the minimum bulk density of the intrusion is 2.64 t/m^3 . The Dolcoath and Meredith plutons contrast with this density (each is no more than 2.62 t/m^3) but ambiguity arises in the basalt-covered region. The inferred form is less reliable in this zone. The mapped metamorphism of the Ordovician limestones south of the exposed granite (Baillie *et al.*, 1986) implies, as indicated in Figure 68, a shallow granite roof. The diagrams suggest the maximum depth, approximately 4 km for the belt south to The Hummocks. A large shelf of granite of uncertain composition and contrast underlies a large area east of Guildford. Its properties suggest that it forms part of the Housetop Granite, and not either the Dolcoath or Meredith Granites.

Aeromagnetic data are unable to resolve any of these issues directly. Figure 73 reveals the magnetic character of the granite but the basalt cover south of the Mt Housetop limits evaluation by inspection. The metamorphic and mineralised margin of the granite is recognisable, and other sources may be identifiable once the basalt contribution has been assessed.

The Dial Range area has been reviewed in more detail as an example of the value of further development of the interpretation. In this case the actual Bouguer values have been used, not the smoothed field as in Figure 62, and some further limited calculations undertaken. These have not exhausted the potential of the available data but serve to show what remains to be learnt. Details of the gravity field are shown in Figure 74. The field is very irregular (contrast Figure 62). Analysis indicates granite at very shallow depth at two points. In the region of West Pine Road, granite probably forms effective basement to the Tertiary deposits, locally at a depth of little more than 100 metres. South of Mt Duncan the crest of a spine or cupola is probably little deeper but still retained wholly within the Cambrian rocks. There are a number of small prospects in the region which have some copper, silver-lead and pyrite mineralisation. 'Revells' is a replacement deposit, and there is evidence of some remobilisation. Recent work by Geopeko (e.g. Herrmann, 1985b) revealed unexpectedly high levels of tin in and around these deposits. This had not been anticipated but the location of the inferred granite spines is consistent with the introduced

tin. The more detailed review of the Cambrian rocks of the Dial Range Trough indicates that the implied regional density of 2.75 t/m^3 is supportable, and that parts of the Lobster Creek Volcanics may have densities as high as 2.85 t/m^3 .

MINERALISATION AND EXPLORATION

The Housetop Granite is an economically important mass. It has introduced mineralisation in marginal skarns and alteration deposits. Examples include tungsten along the western contact (e.g. Kara 1), Fe-Sn (e.g. Kara 2) along the southern contact, and tin within the body. Some silver-lead has also been recorded around the northern perimeter. One suspects that many more deposits exist but are covered by Tertiary materials. All known deposits (Sn, W, Pb, Fe) occur within the granite mass, or very close to the margin. The present interpretation indicates that most deposits lie within 1.0 to 1.5 km of the granite roof.

Future exploration clearly depends on improved knowledge of the location of granite contacts near-surface, or beneath basalt, and juxtaposition with suitable host and replacement candidates.

The present treatment has considered only the regional implications and form of the Housetop Granite. There is sufficient detail in both gravity and magnetic data bases to enable definition of exploration significance. Assessment of the basalt question is a first priority in such a process. While resolution of the basalt problem is of regional significance, the greatest benefits are likely to be realised near the limits of its exposure, where depth to potential targets is less than 50 or 100 m. The presence of barytes at The Hummocks, more than 10 km south of the nearest exposure and in a zone where this crude analysis indicates a roof rise at moderate depth (uncertain as discussed above, 1.5 to 3 km?), confirms the presence and potential of the intrusion, and is a fine demonstration that the basalt must be stripped.

Mineralisation in the Dial Range area is, as noted above, consistent with the interpreted distribution of granite. The metallogenic association of this granite not only accounts for the anomalous mineral chemistry along the River Leven, especially in terms of tin, but also suggests that economic deposits may be present near spine crests (vein systems) or within Lower Cambrian sandstone (if replacement has been possible). This work shows that the data permit this style of evaluation, and the granite roof details can be resolved.

While it is likely that most of the mineralised sites shown in Figure 62 are directly related to the granite there are two site groupings. In the first, and largest, sites lie within 1.5 km of an inferred margin or body roof. Some other small deposits are located in Cambrian and Precambrian rocks, at least four kilometres from the nearest granite in any sense. This could mean that some primary Cambrian deposits occur in the area around the Housetop Granite. There have been suggestions that some of the deposits along the River Leven are of this type, and that the granite caused some remobilisation. This is not established; they may be granite related. The deposits near Penguin are much further removed but Figure 64 reveals that the granite may have sent a north-trending spine into this region. This is suggested by the negative spine at 420 000 mE. This reaches within one kilometre of the northing of the Penguin deposits. We suspect that few mineralised sites in this region are older than the granite; it is simply that the granite is not well enough described yet to account for known prospects, or infer other origins.

SUMMARY

1. The Devonian Housetop Granite is a large pluton, and a large part of the roof is exposed.

2D GRAVITY MODEL

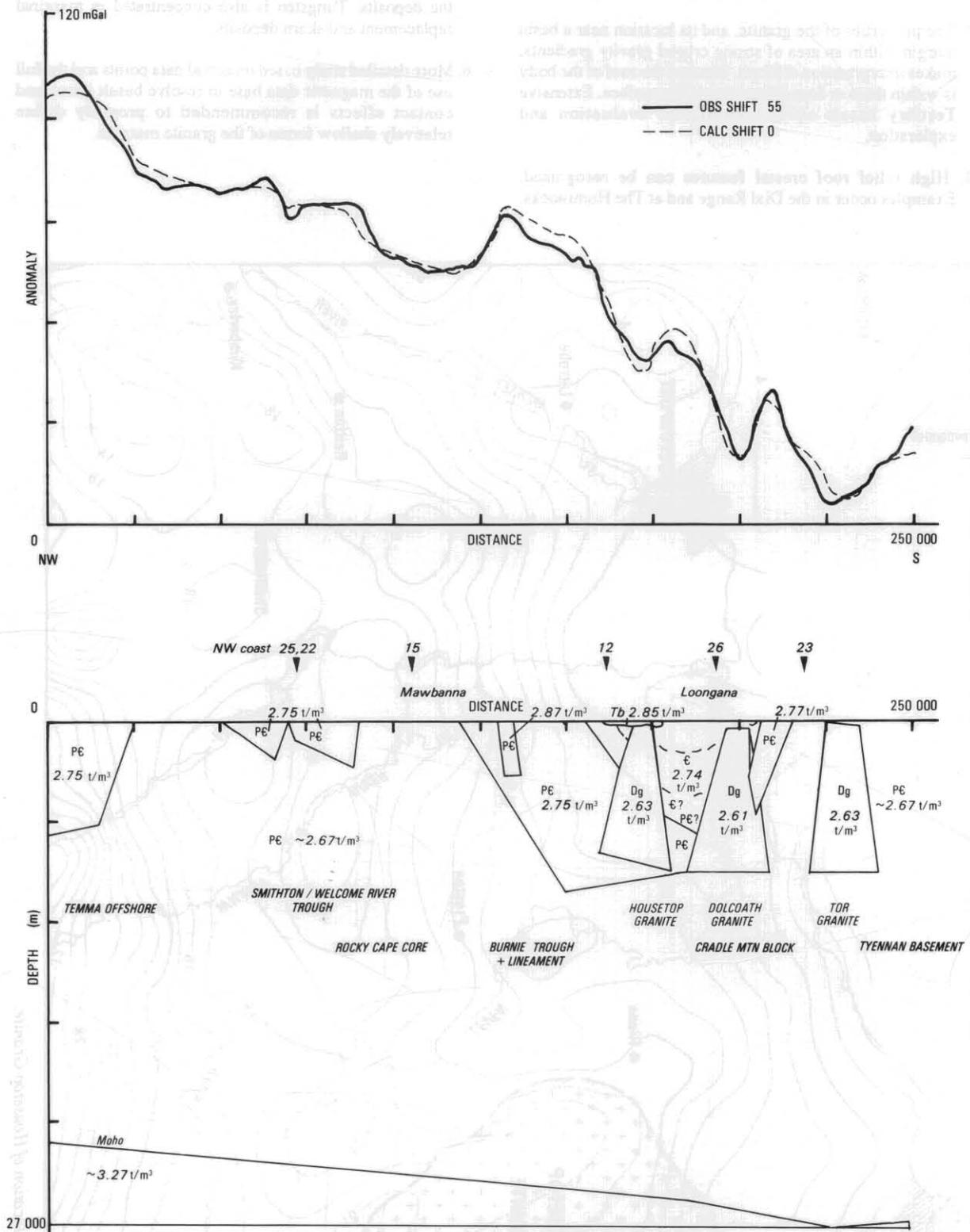


Figure 63. Regional interpretation: Line 2, Brittons–Housetop–Cradle Mountain.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

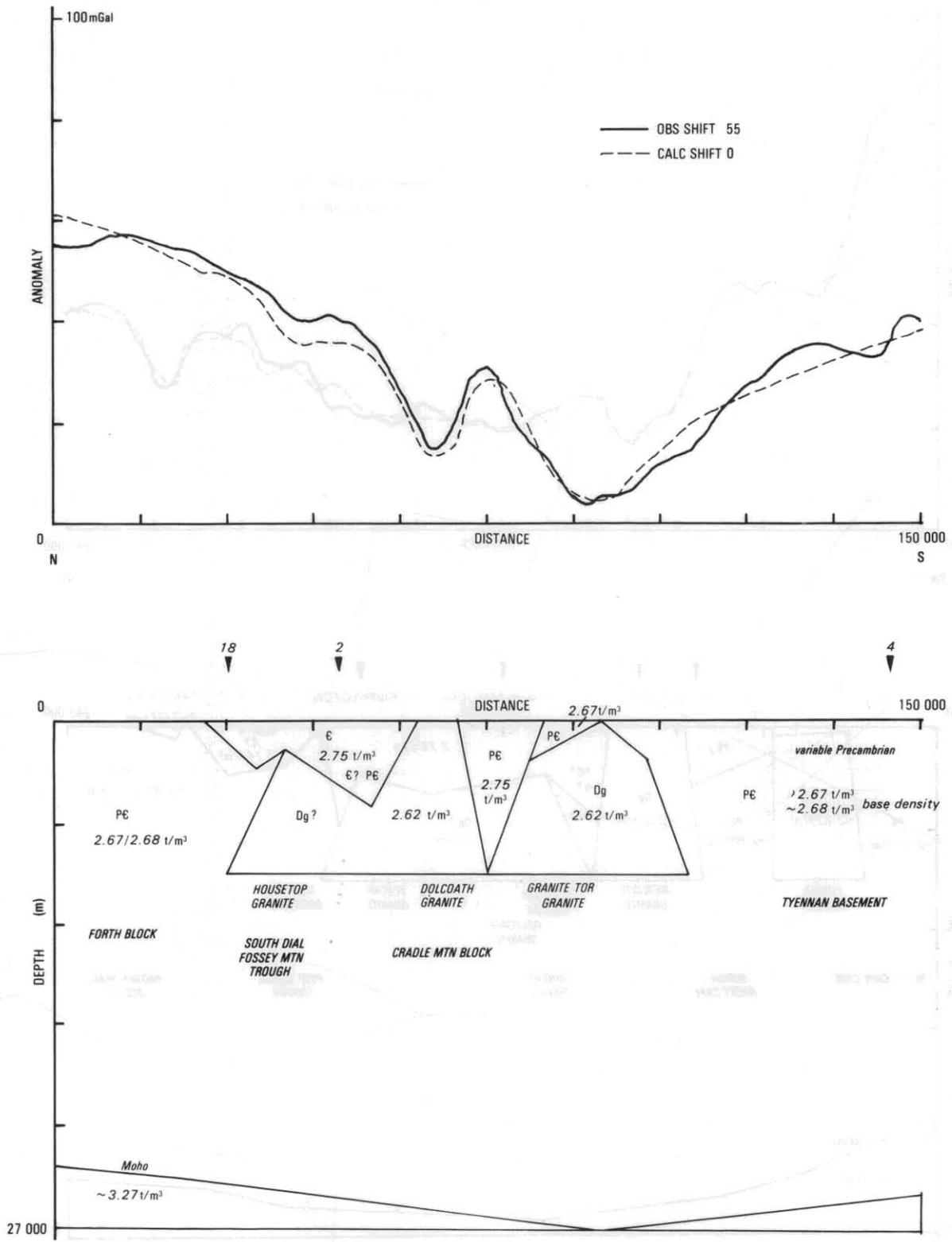
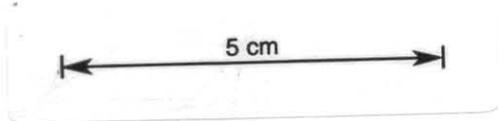


Figure 64. Regional interpretation: Line 8, Bass-Nietta-Loddon.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

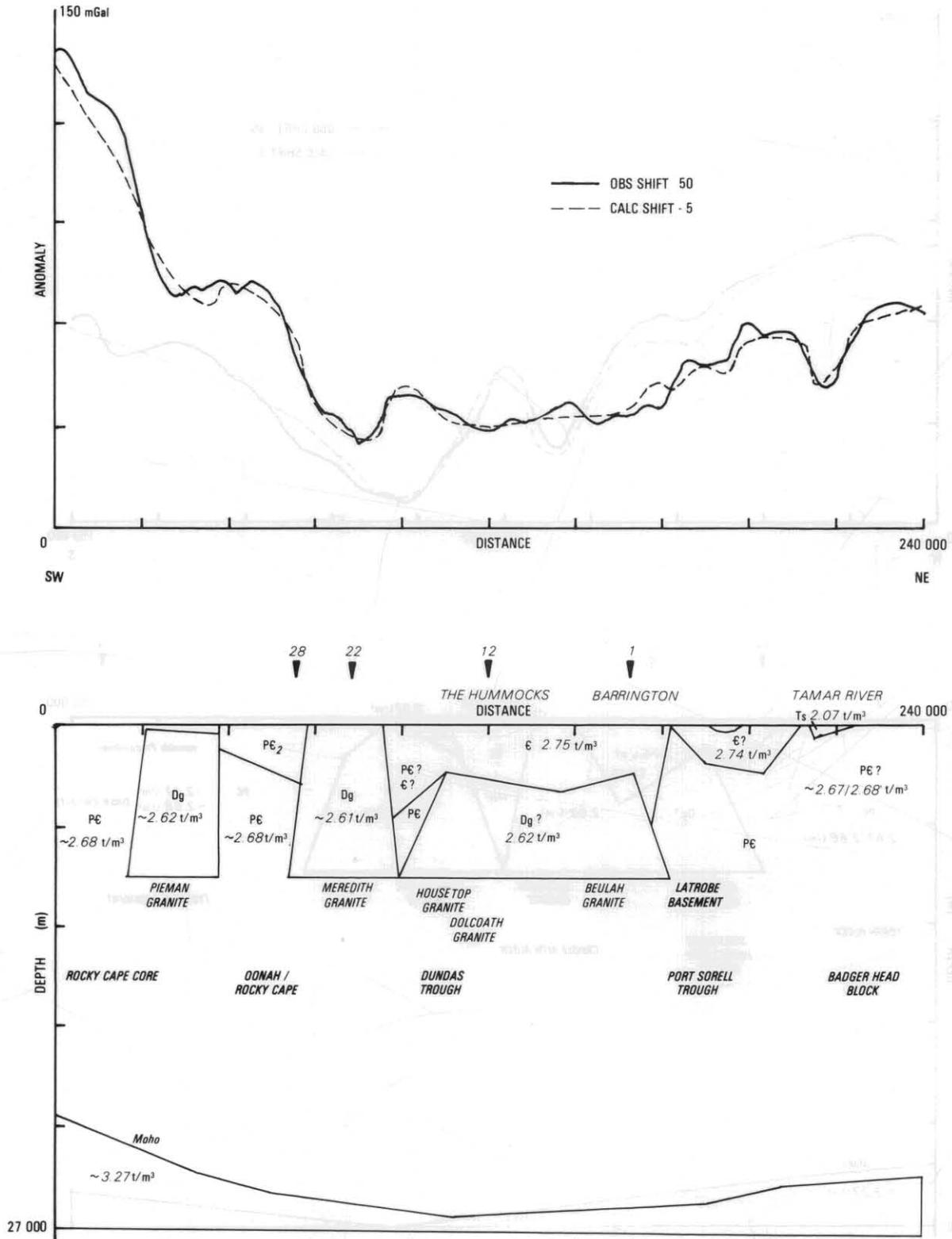


Figure 65. Regional interpretation: Line 8, Pieman Heads–Meredith–Weymouth.

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2D GRAVITY MODEL

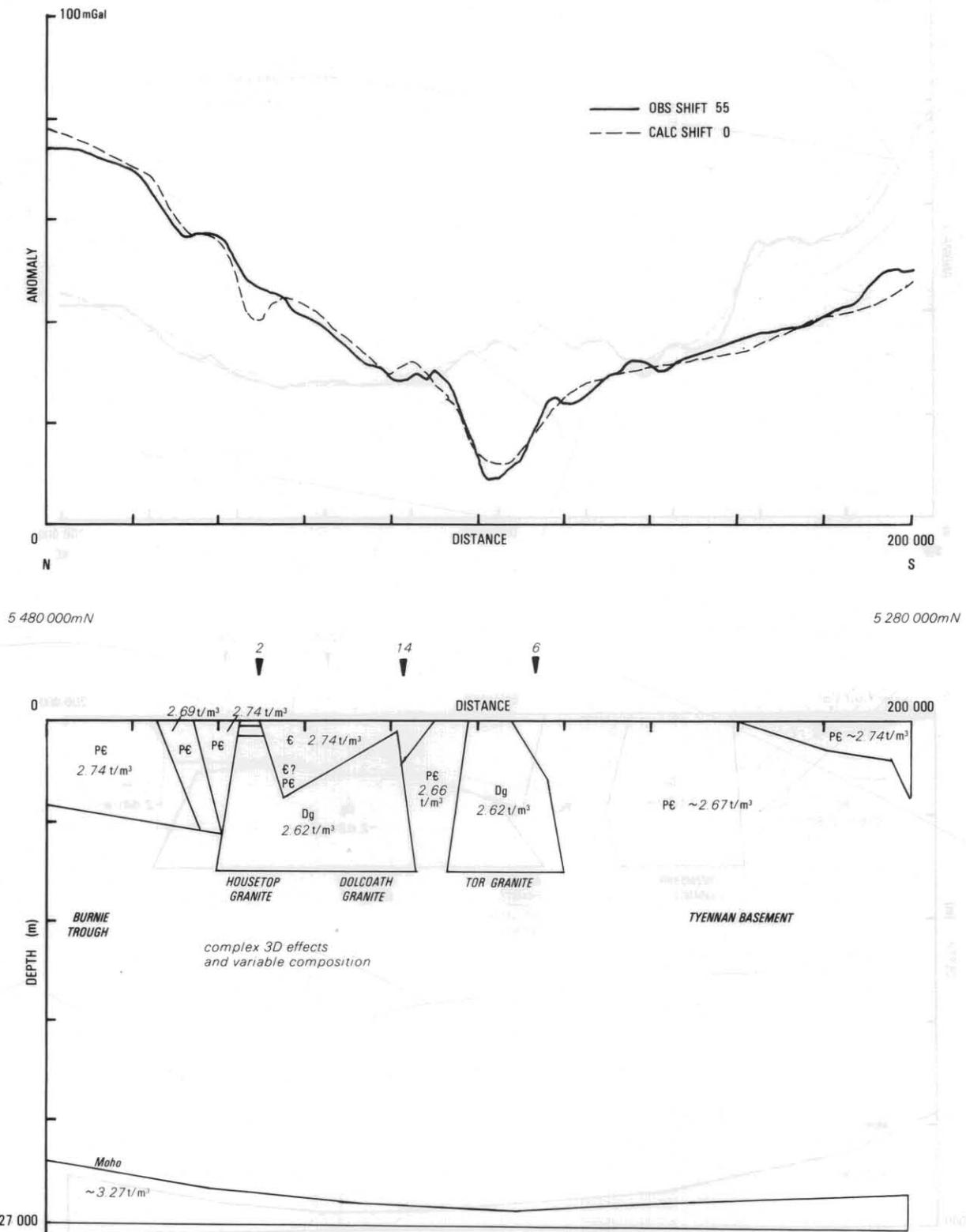


Figure 66. Regional interpretation: Line 12, Wynyard–Eldons [400 000 mE, 5480–5280 000 mN].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

2D GRAVITY MODEL

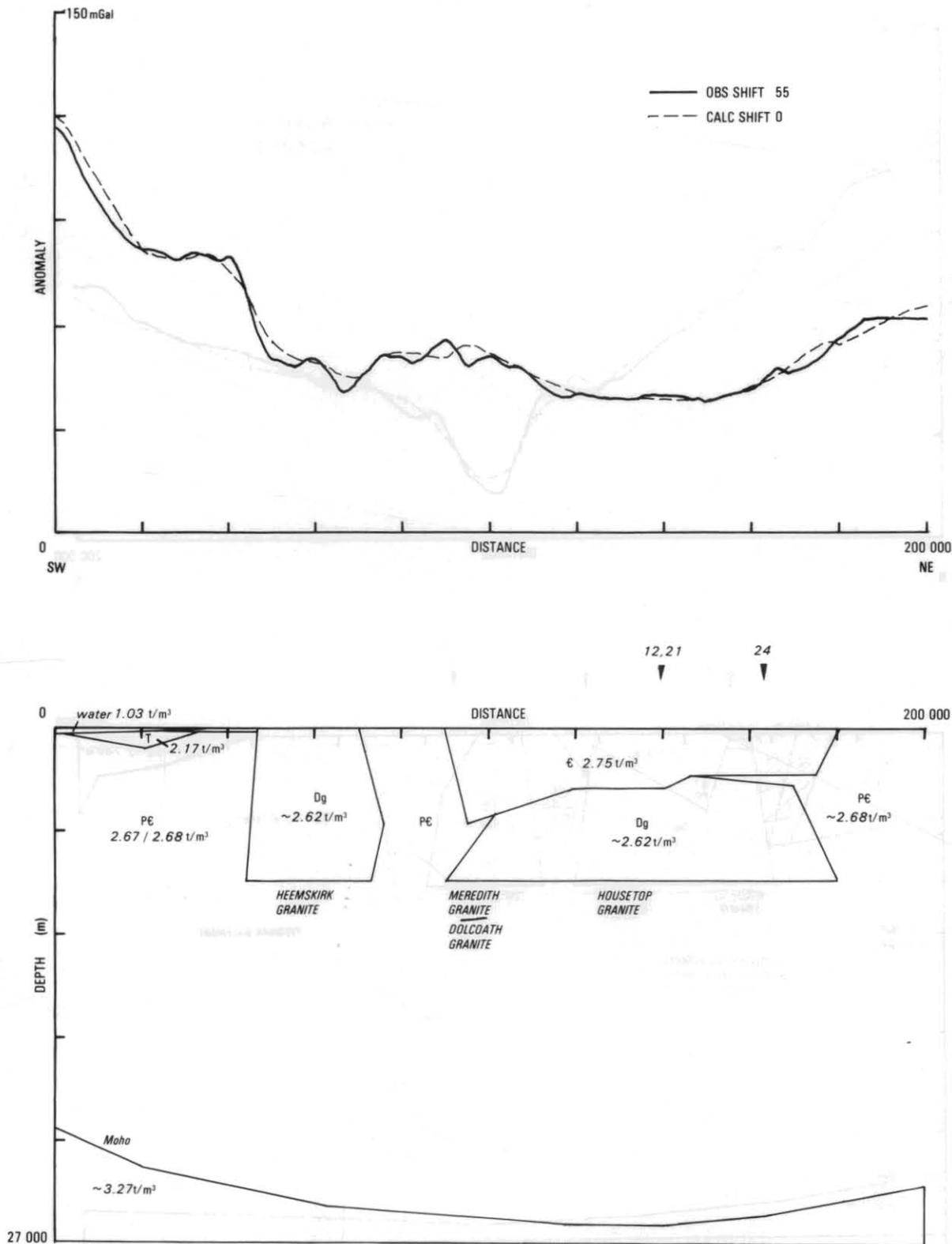


Figure 67. Regional interpretation: Line 17, Henty River-Penguin (invalid light granite option).

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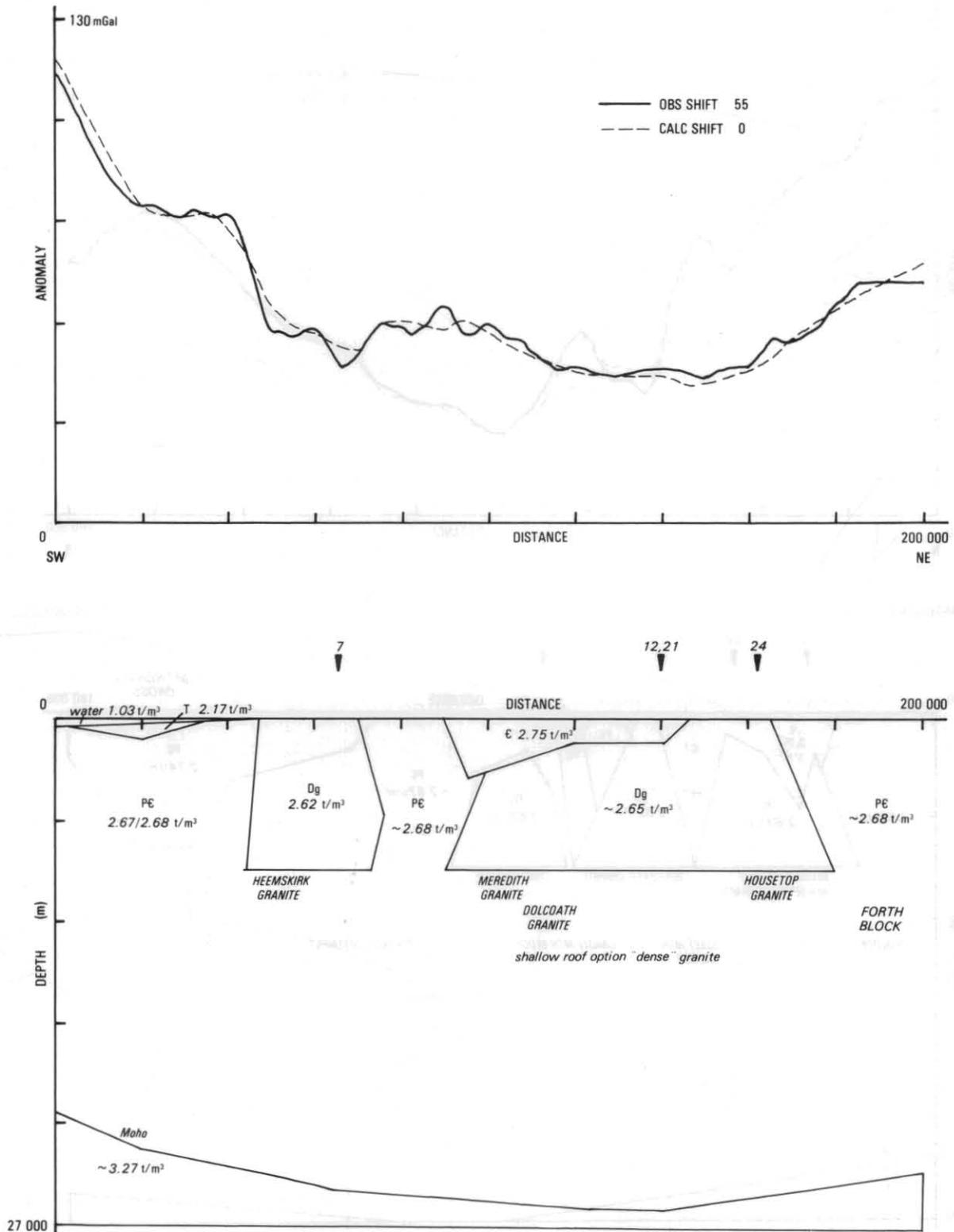


Figure 68. Regional interpretation: Line 17, Henty River-Penguin (dense granite option).

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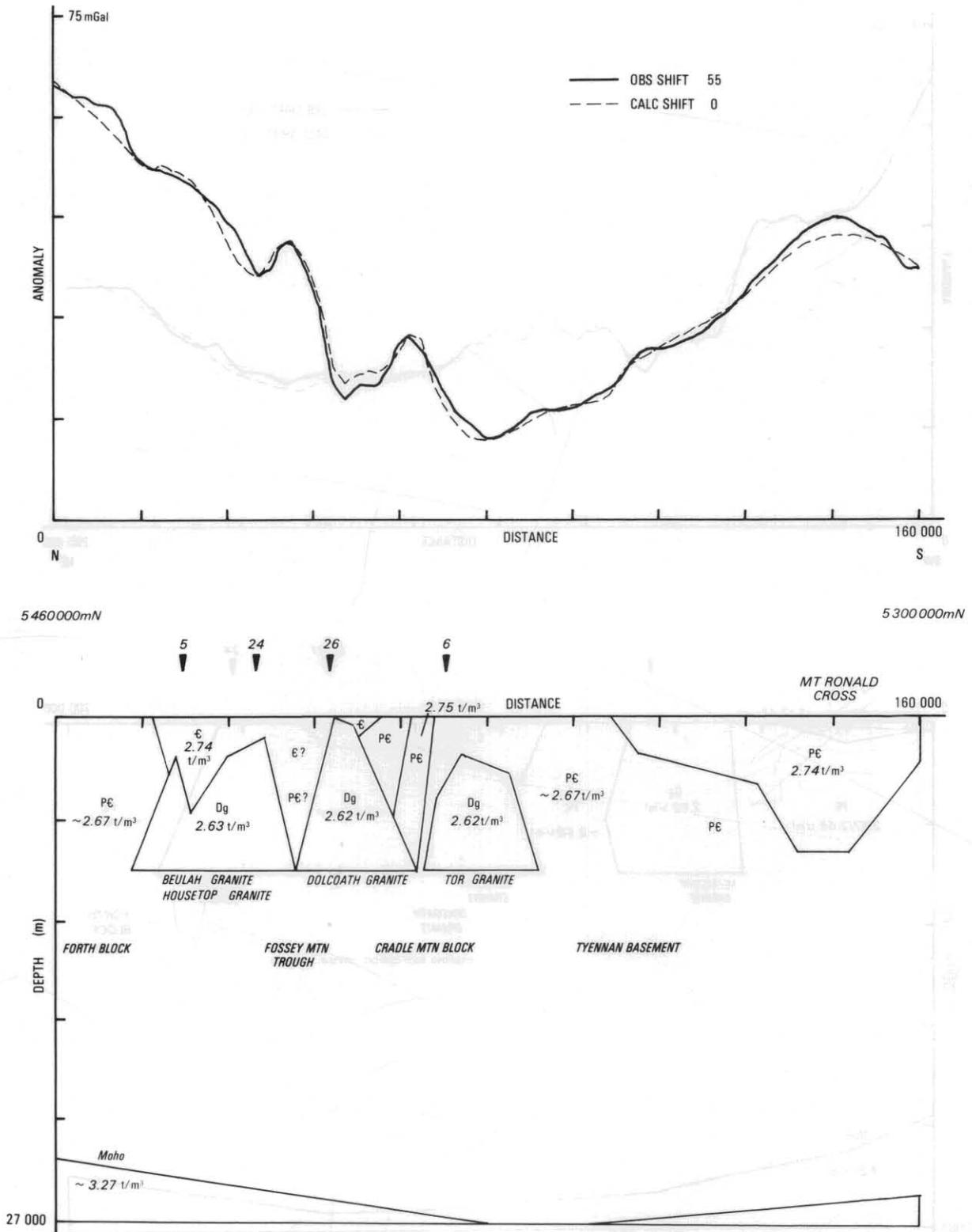


Figure 69. Regional interpretation: Line 18, Penguin-Cethana-Algonkian Peak (427 000 mE, 5460-5300 000 mN).

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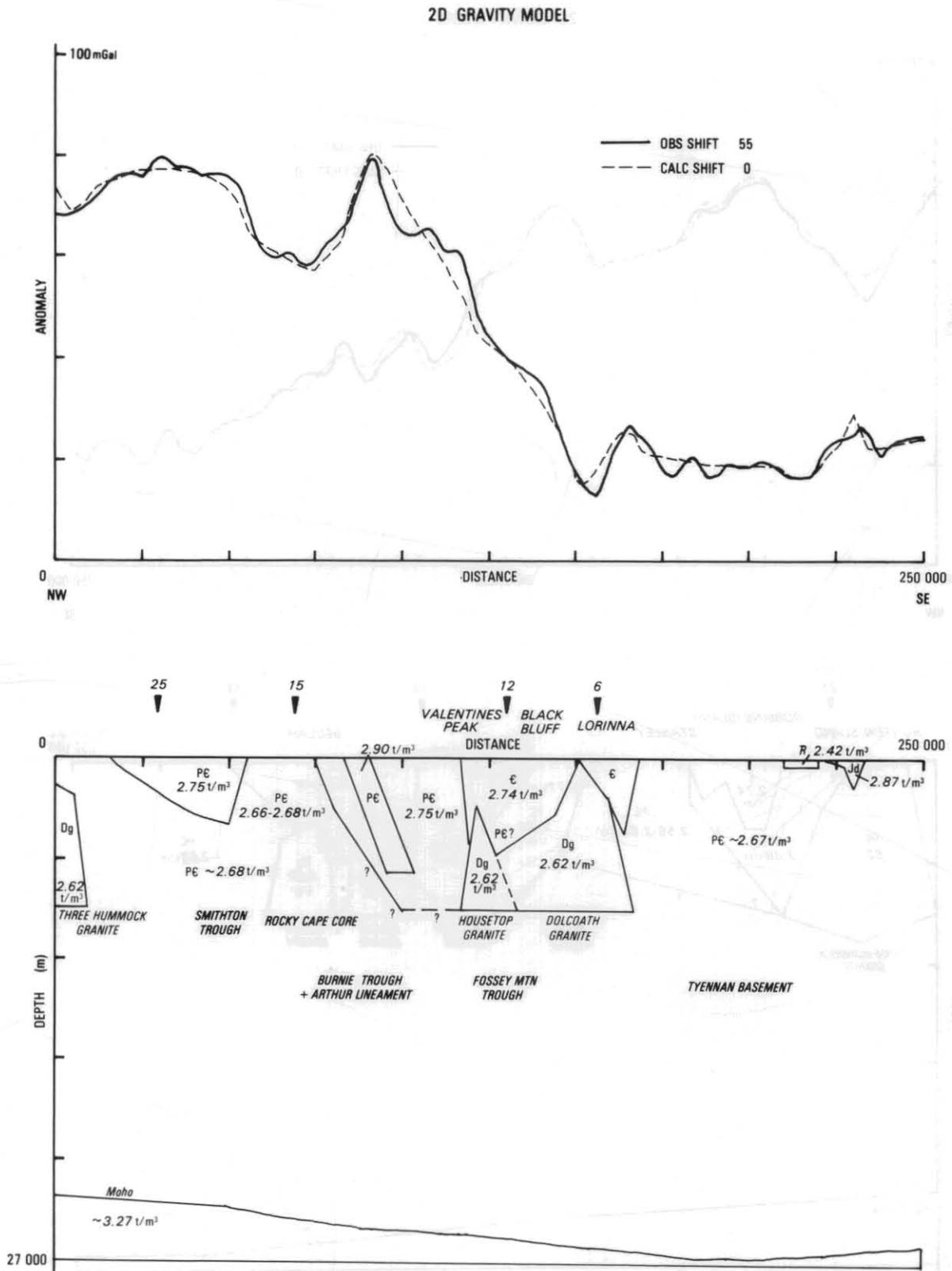
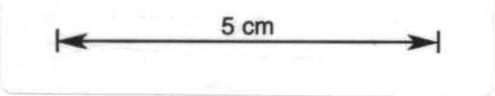


Figure 70. Regional interpretation: Line 21, Cape Grim-Moina-Steppes.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

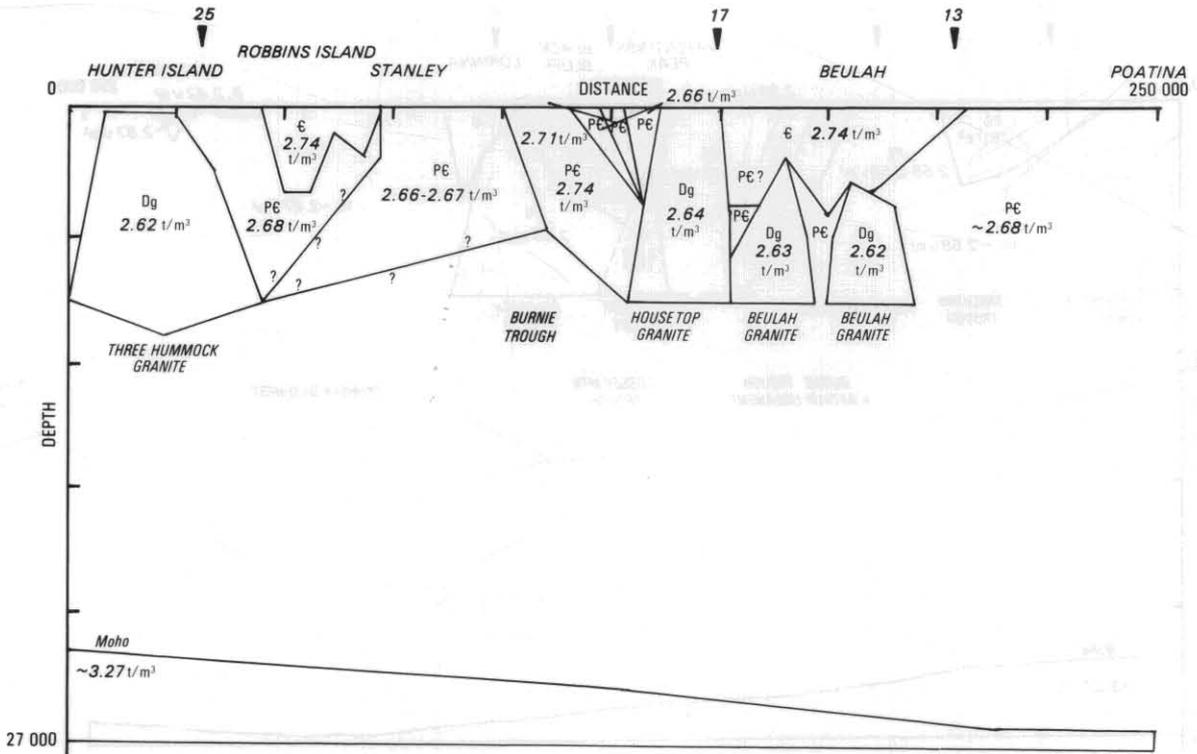
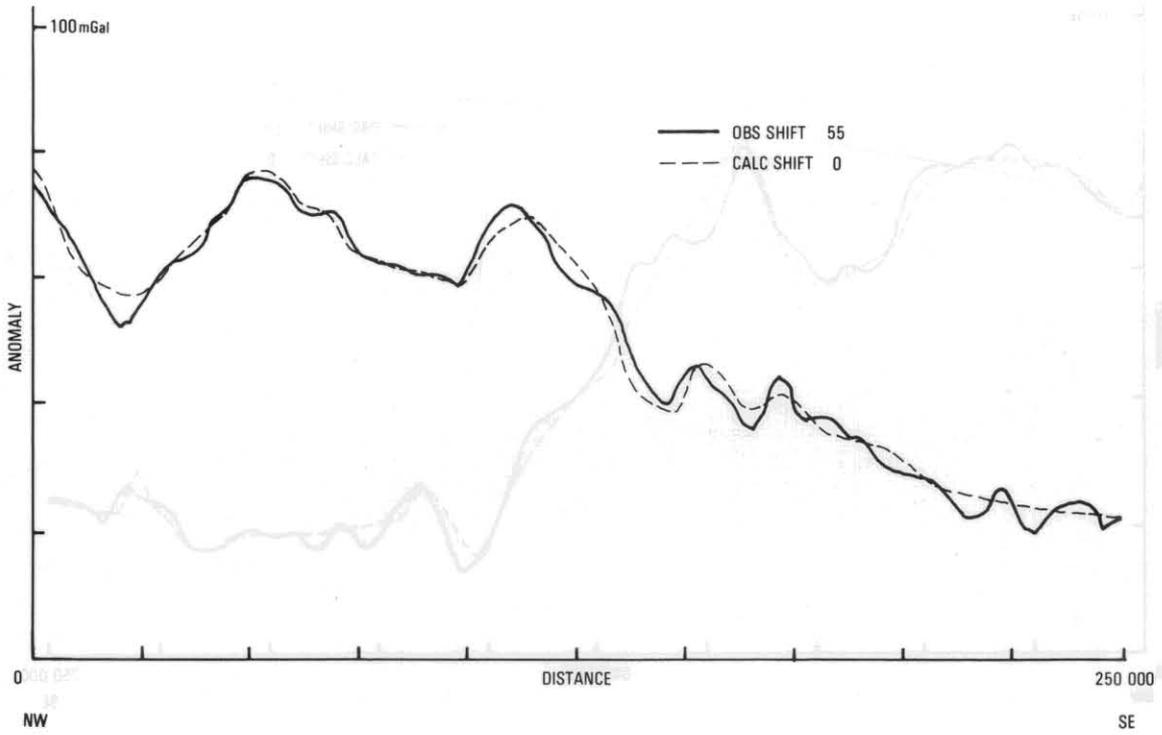


Figure 71. Regional interpretation: Line 24, Hunter Island–Housetop–Poatina.

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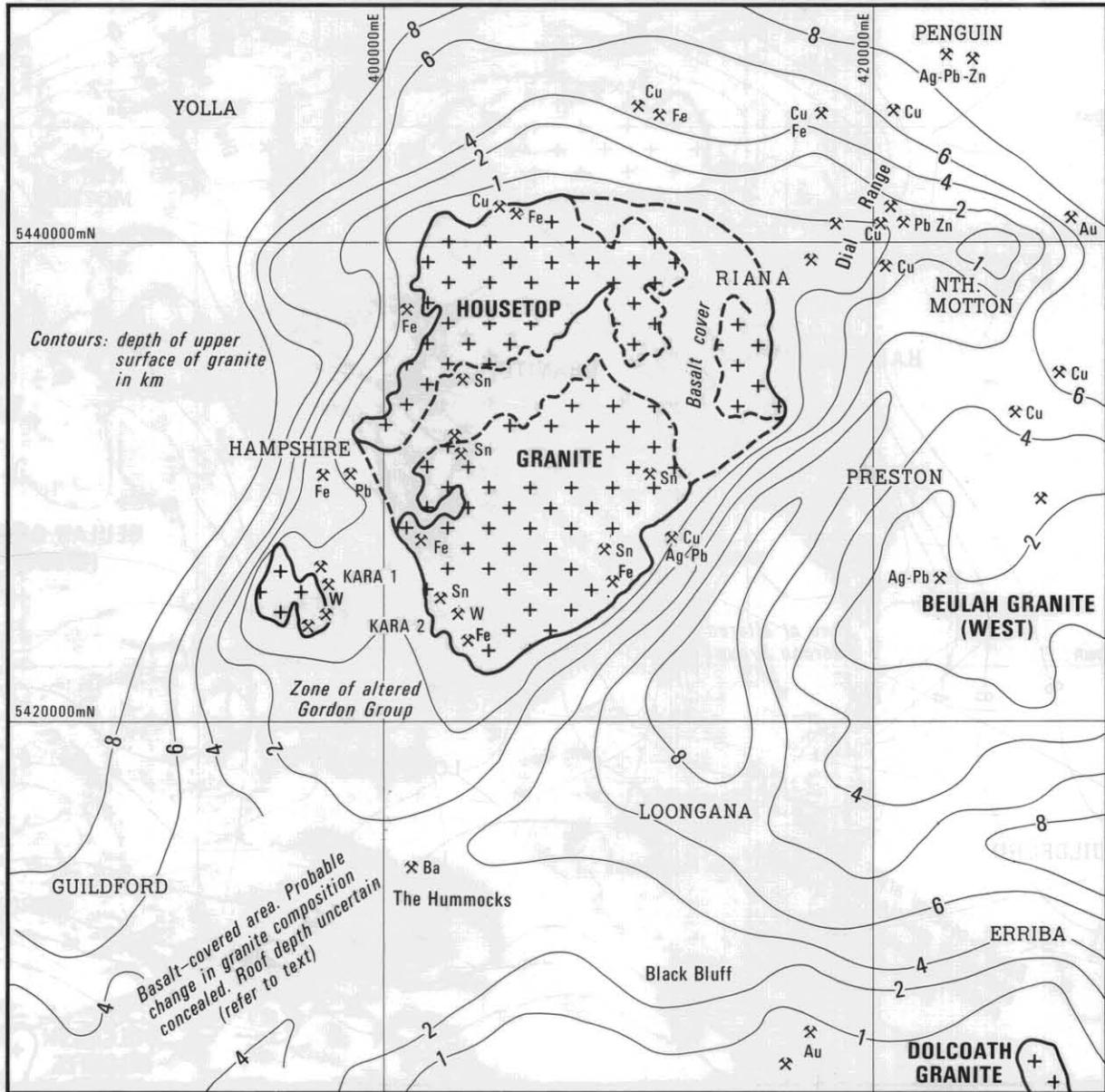


Figure 72. Provisional interpretation of form of the House Top Granite. Interpretation includes some additional detail in the Dial Range area. Note that the contours for the region near The Hummocks are not confirmed because of uncertainties about the density of the granite and the possible sectional balance with Cambrian rock, as discussed in the text. Basalt cover in this region compounds these problems by limiting surface control information.

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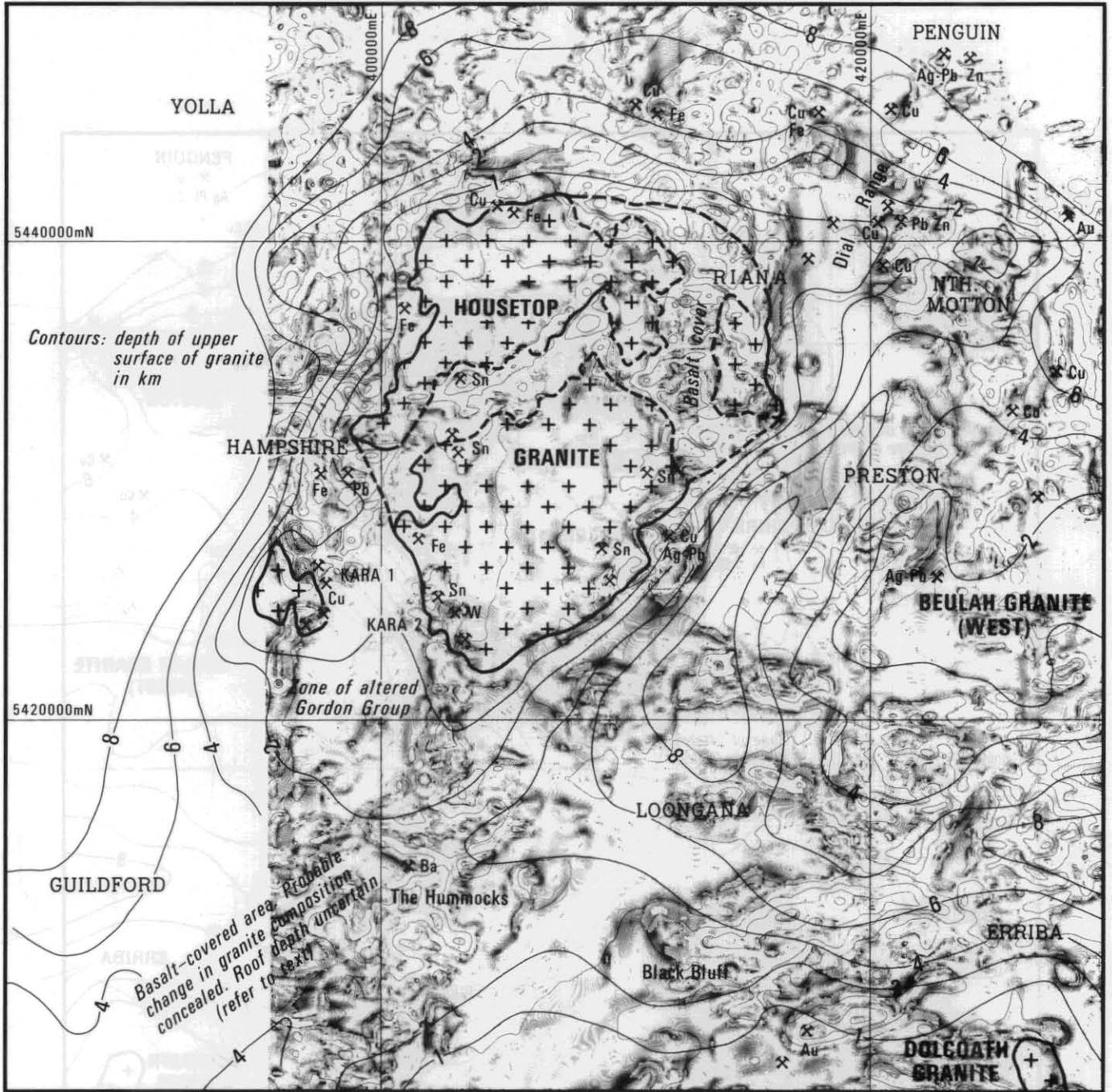
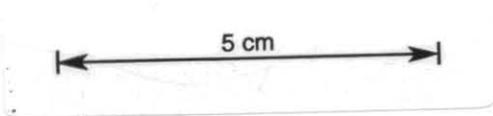


Figure 73. Department of Mines aeromagnetic coverage of the Housetop Granite. Contours from the provisional interpretation of the form of the intrusion are also shown.



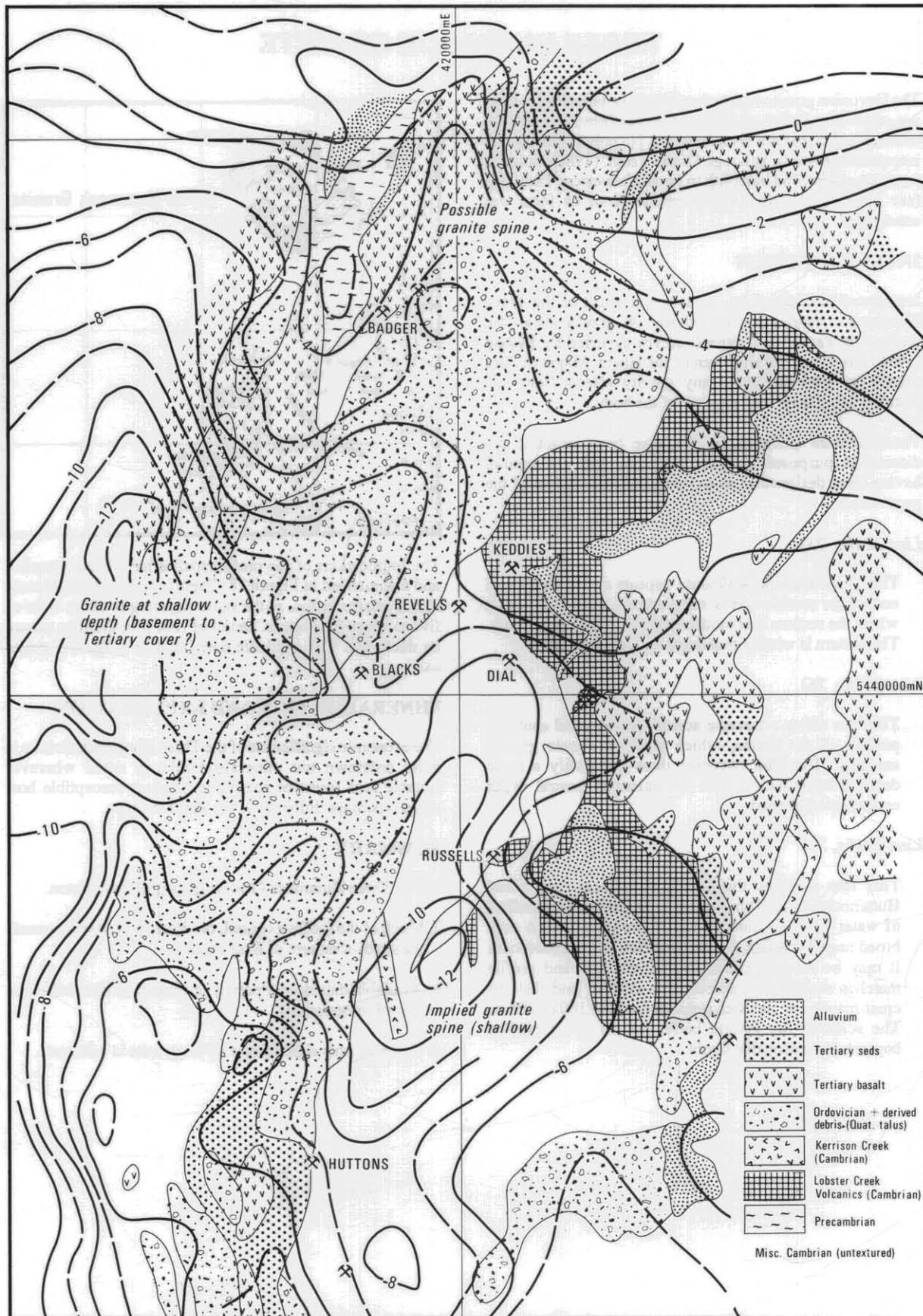


Figure 74. Detail of geology, prospects, and gravity field, Dial Range area. Geology simplified from Burns (1965).

CHAPTER 12

THREE HUMMOCK GRANITE

The Devonian granite exposed on Three Hummock Island has not attracted attention, and in the absence of obviously related mineralisation, has not been explored. No previous structural interpretation exists, although Leaman *et al.* (1980) included it as part of a second batholith in far north-western Tasmania (see inset fig. 1). No detailed resolution of its form was attempted.

INTERPRETATION

Interpretation of the form, context and effect of the Three Hummock Granite depends wholly on gravity data—the north-west Tasmania magnetic survey reported by Bishop (1986) terminates 20 km south of the island. Magnetic data cannot be correlated with any gravity effects from this distance away from the exposure of the body.

Three profiles (refer to fig. 4) have been included for discussion purposes. All are elemental and conceptual, having been designed to evaluate only gross aspects of the upper crust.

Line 22 (fig. 75)

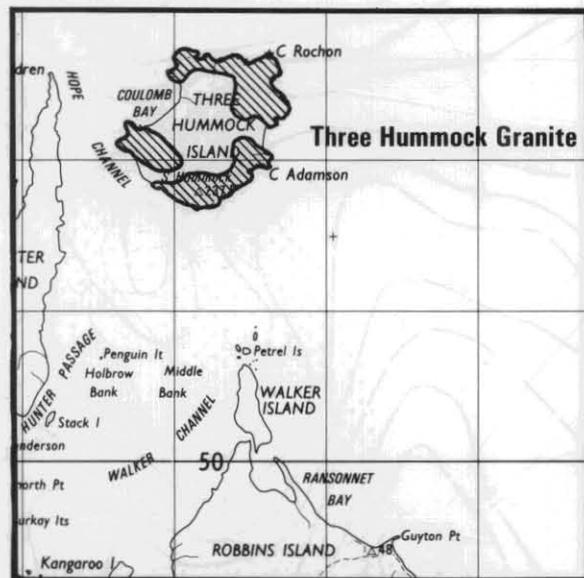
The Three Hummock Granite appears at the north-west end of the section and is sampled obliquely in a region where the surface is at moderate depth and dipping south. The pattern is wholly consistent with other profiles.

Line 24 (fig. 76)

This line offers a traverse across the extended southern portion of the pluton, which yields a classic gravity anomaly. The data coverage does not justify a more detailed examination, and the extended central depth cannot be confirmed.

Line 25 (fig. 77)

This line samples the principal exposure on Three Hummock Island. This exposure, coupled with the effect of water between islands, wholly accounts for the very broad negative effect extending 45 km along the section. It may be remarked here that all sections and profile matches satisfy the interpretation criteria, and that the crust-mantle concept was supported within 100 or 200 m. The scale of the granite body implied is established beyond any reasonable doubt.



The implications of the profile studies have been compiled and summarised in Figure 78. There is scope for refinement of this interpretation, as the station spacing is of the order of five to seven kilometres. Detail of roof irregularities cannot be described. The available data indicate a NE-SW major axis.

MINERALISATION AND EXPLORATION

The economic significance of the Three Hummock Granite is quite unknown but mineralisation may occur wherever suitable roof forms or structures intersect susceptible host rocks—perhaps dolomite of the Smithton type.

SUMMARY

1. The Three Hummock Granite is a significant pluton.
2. Much of the roof is exposed, or virtually exposed, beneath the south-west arm of Bass Strait.
3. Available data do not permit resolution of detailed shape or roof irregularities.
4. The economic significance of the granite is unknown.

5 cm

2D GRAVITY MODEL

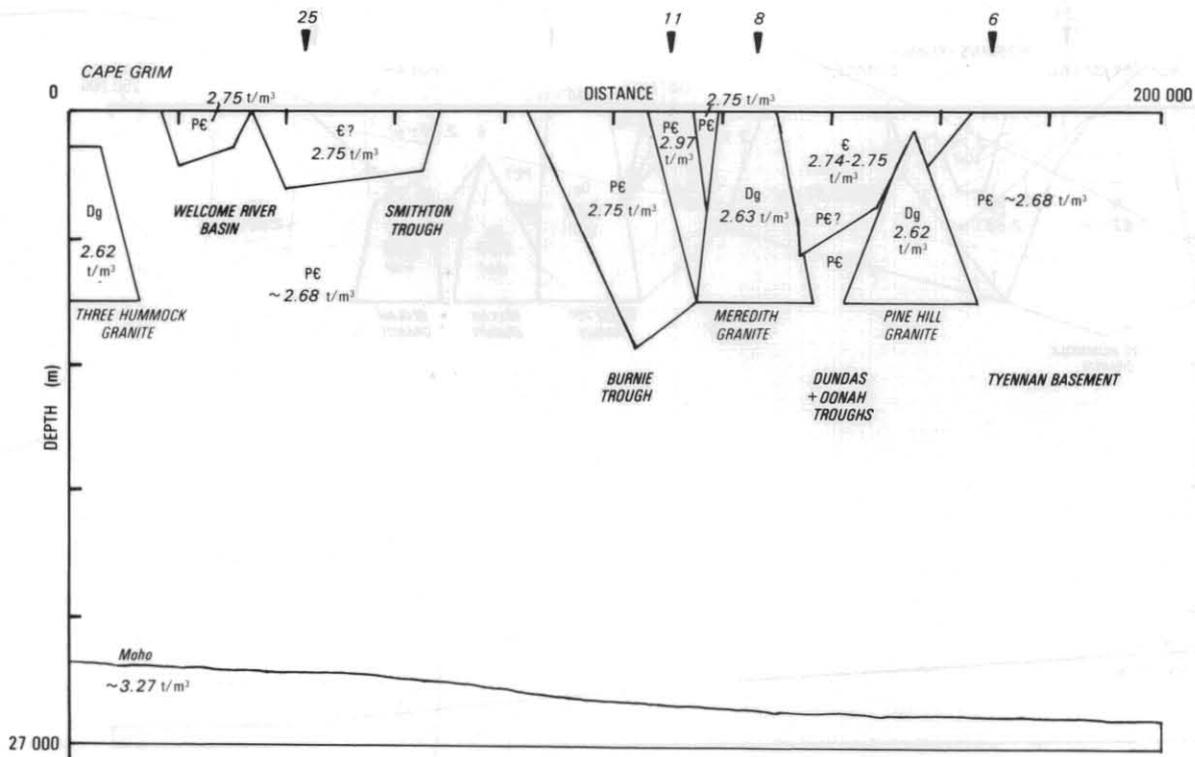
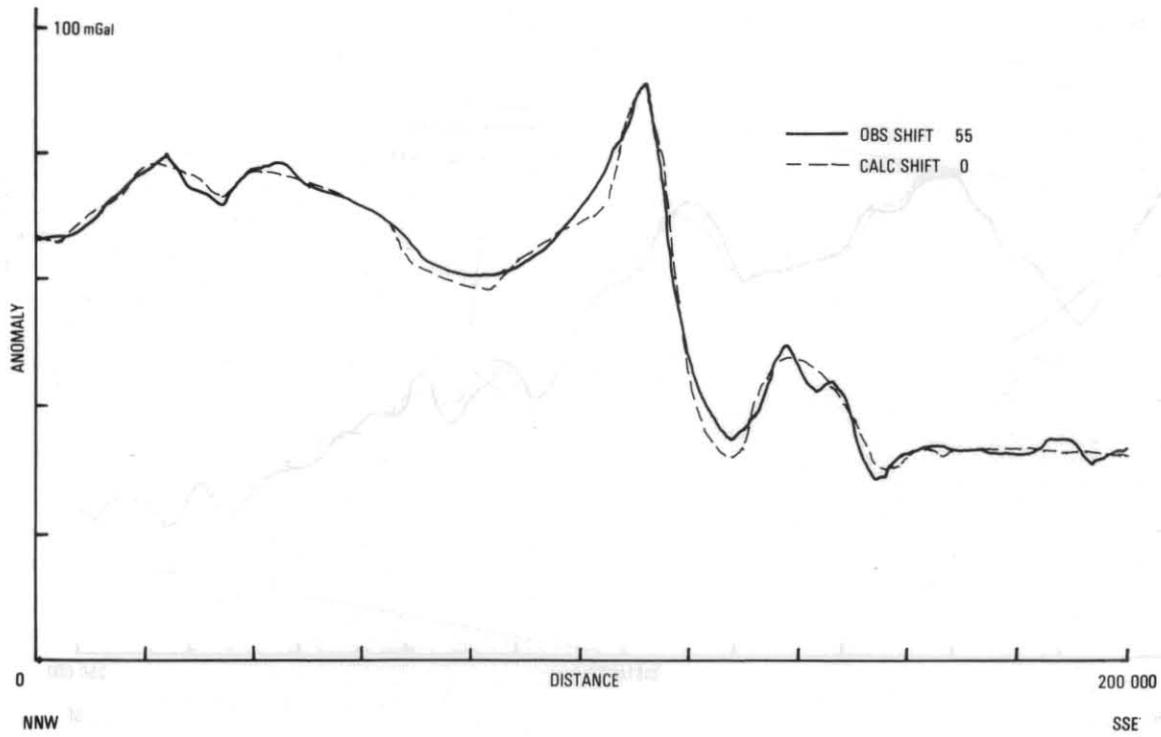


Figure 75. Regional interpretation: Line 22, Cape Grim-Heazlewood-Eldons.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

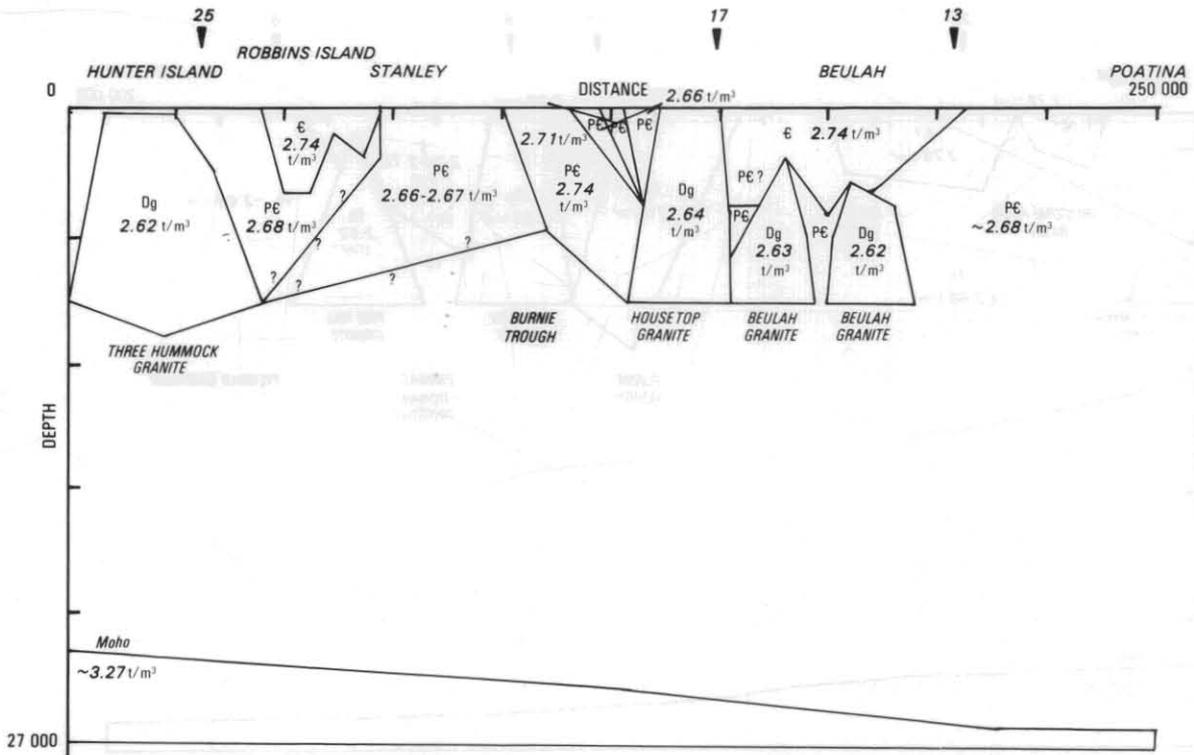
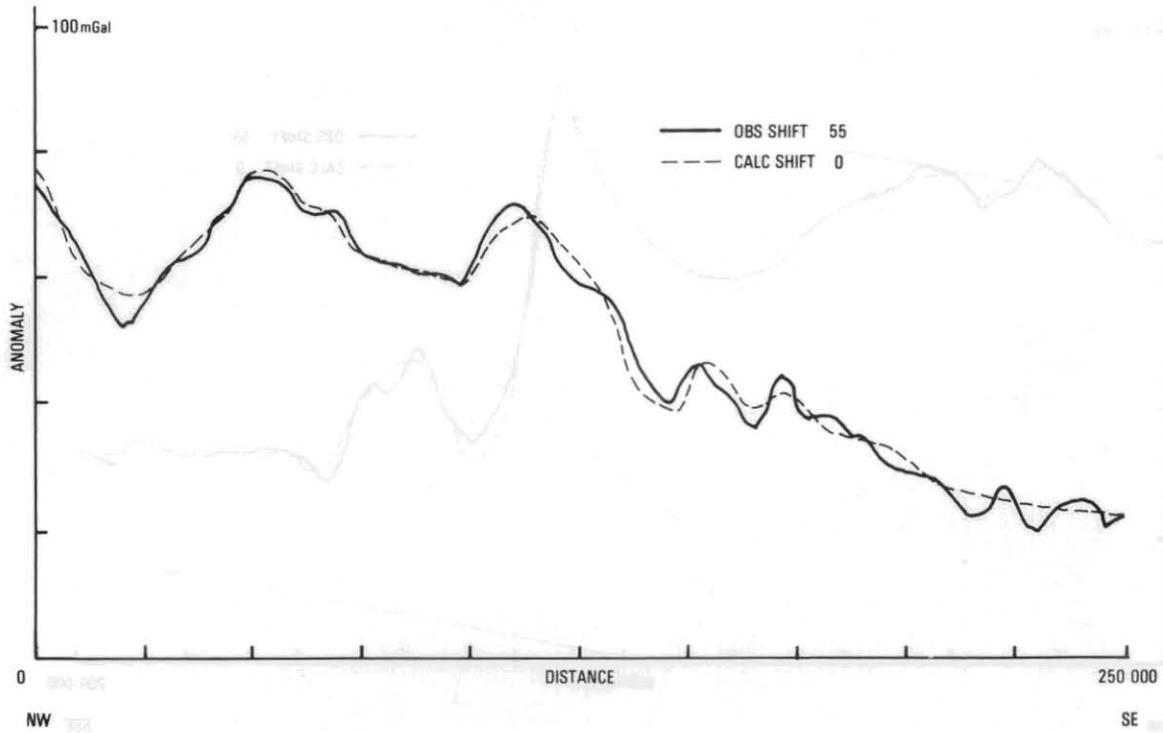


Figure 76. Regional interpretation: Line 24, Hunter Island–Housetop–Poatina.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

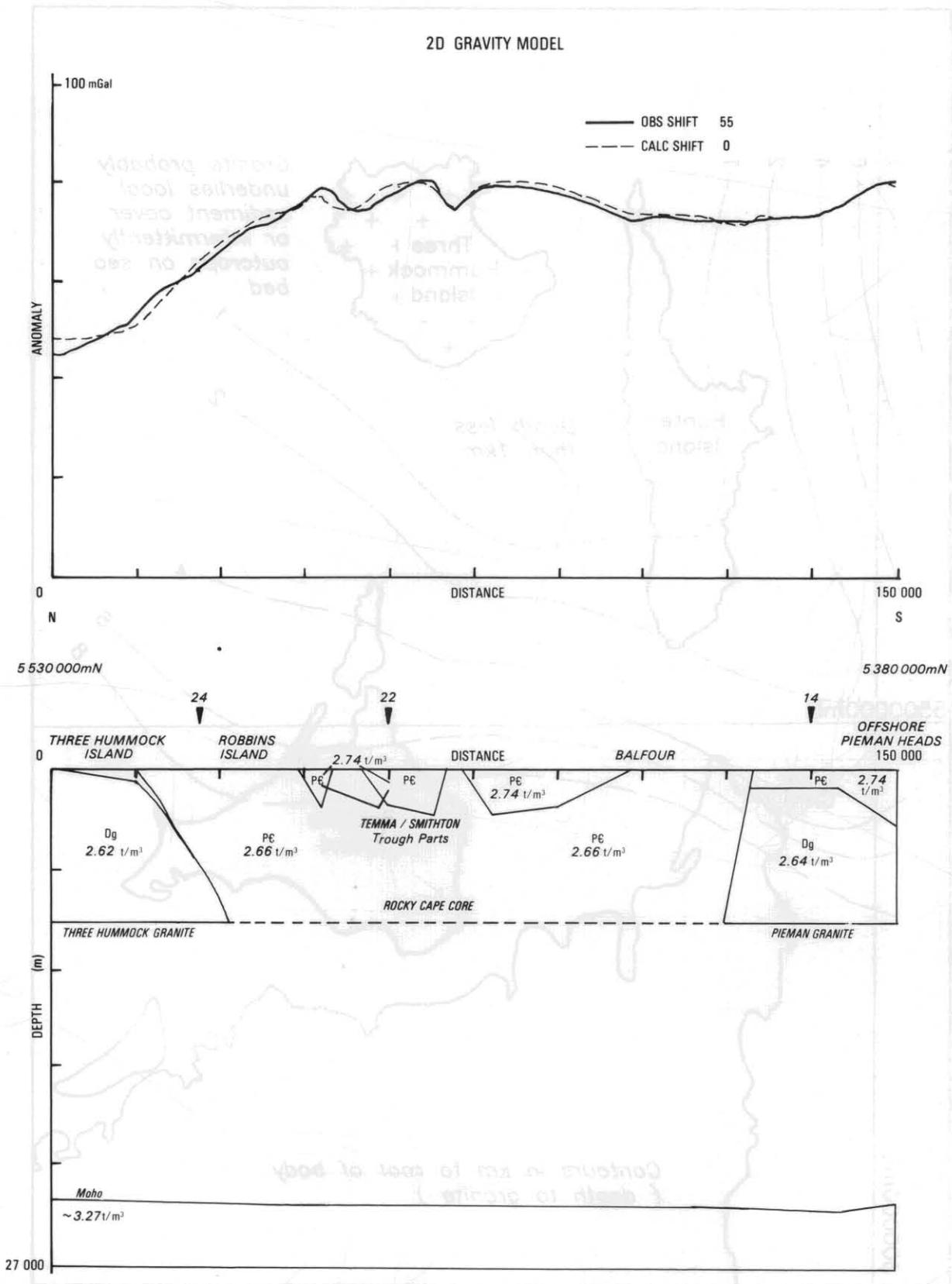


Figure 77. Regional interpretation: Line 25, Three Hummock Island–Pieman Heads.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

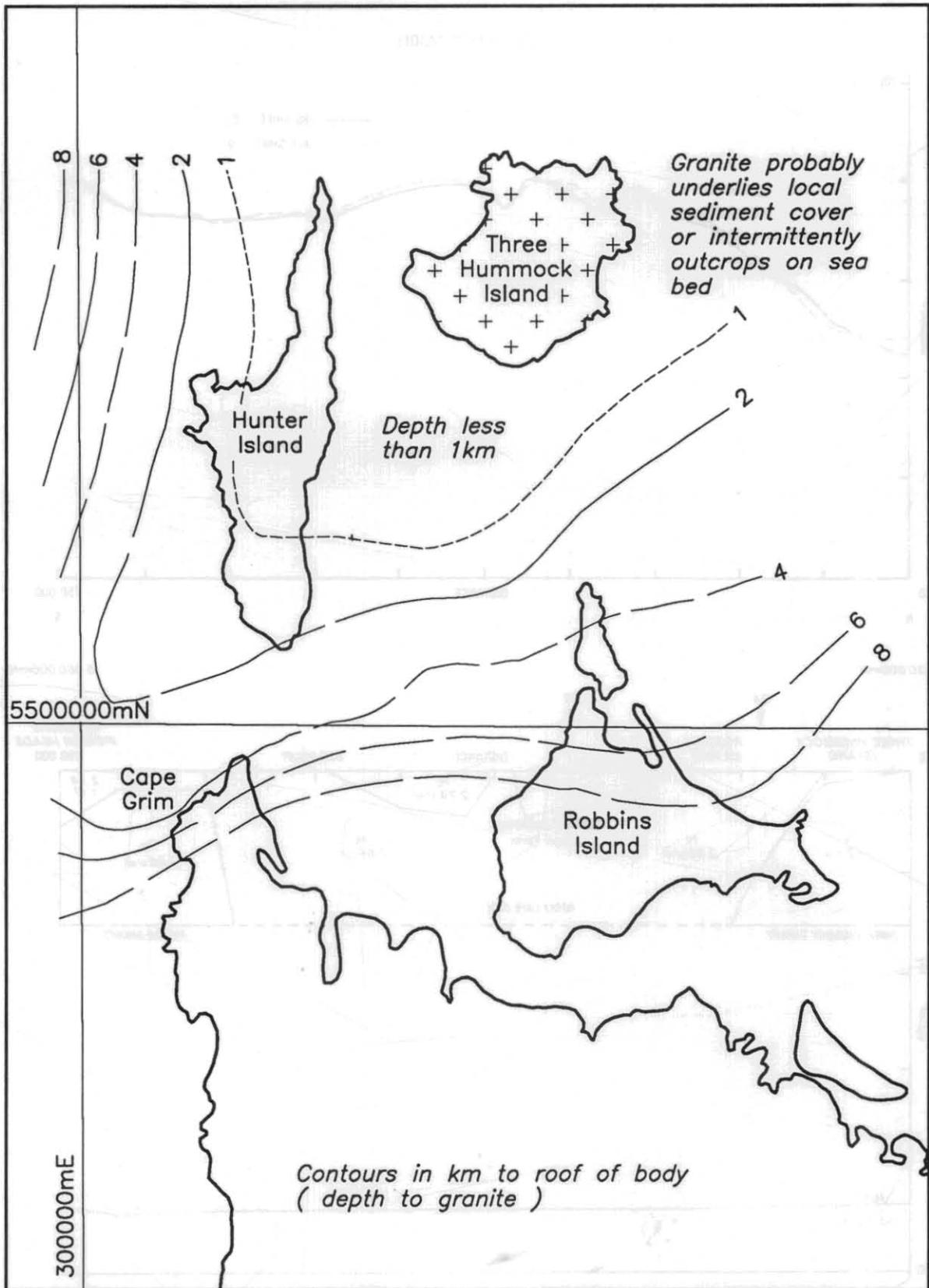
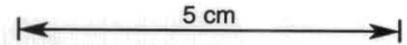


Figure 78. Form of the Three Hummock Granite: provisional interpretation.

CHAPTER 13

MEREDITH GRANITE



The Devonian Meredith Granite has been described as the largest granite in western Tasmania (e.g. Collins *et al.*, 1981). It has the largest outcrop area but some other granites with minimal exposure are very large plutons. The Meredith Granite has been described as a normal Tasmanian adamellite, and is associated with a number of mineralised sites (Collins and Williams, 1986). The granite has not been intensively studied and its structural position and chemistry are only sketchily known. Its location is shown in Figure 1.

The Meredith Granite was included in the super batholith proposed by Leaman *et al.* (1980) (inset fig. 1). The present study has, within the limits of extant data, largely resolved structural issues related to this intrusion, and established the Meredith Granite as an individual pluton.

INTERPRETATION

The present analysis depends on available gravity data and limited review of the 1981 Department of Mines aeromagnetic survey. Gravity coverage of the region around the Meredith Granite is relatively poor at the present time, but will have been upgraded by the time of publication of this Bulletin. This study has been limited as a result but the review is sufficient to define the granite to the minimum standards set in other parts of the granites study.

Five profiles have been used to illustrate the style of the present interpretation. The lines were selected to optimise the available coverage, and allow sampling of the heart of the pluton exposure as well as the southern and eastern faces of the body.

Line 8 (fig. 79)

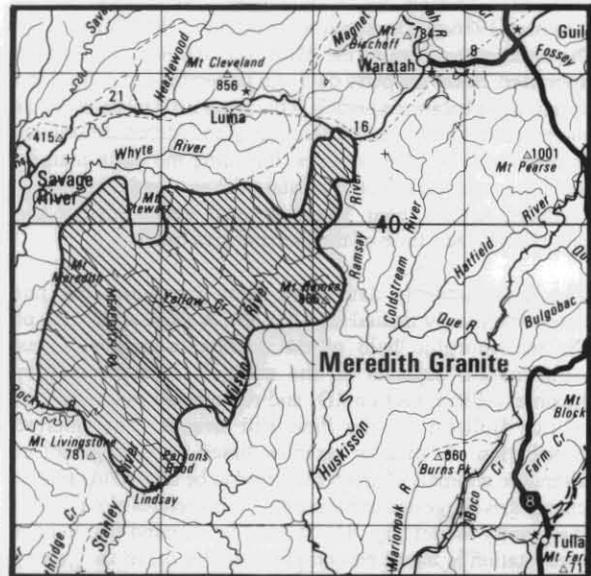
A moderately asymmetric response can be related to the Meredith Granite. The asymmetric form of the anomaly is due to the inland position of the pluton, crustal forms, and other granites further inland. The observed profile presents gradients on each face and the response is more distinctive than, for example, the Pieman Granite. The magnitude of the effect is approximately -20 to -25 mGal. The anomaly is clear cut and well defined, and suggests a steep-sided pluton with minimal surface irregularity.

Line 16 (fig. 80)

This line provides an indication of the difficulty to appraise northern end of the Meredith Granite and its relationship to the Housetop Granite. The response is somewhat diffuse, and a mass balance exists between the granite and the Cambrian section. Major irregularities in the roof are indicated. These may be relevant to mineralisation in the Waratah area.

Line 22 (fig. 81)

This line provides a transect of the main exposure of the granite. The results on this line are comparable with those presented in Lines 4 and 9 (fig. 10 and 29). The granite response appears very asymmetric but is in reality very much more symmetrical than in many other profiles. The distortion and asymmetry in the profile derives from the nearness of the dense Cambrian and Precambrian rocks of the Heazlewood region. The gravity survey is adequate around the southern face of the granite, and a steeply-dipping south face is implied. The north face is not



clearly resolved by this section pending upgrading of the Heazlewood data base.

Line 26 (fig. 82)

This profile samples the southern face of the granite. The response is asymmetric and uneven, and consistent with a section subparallel to a steeply-dipping margin off line. The irregularities probably represent the geometric relationship between this line and the curved southern boundary of the granite. More comprehensive analysis would be required to confirm or refine this conclusion.

Line 28 (fig. 83)

This section lies close to the far western exposure of the granite. Modelling shows that the western margin is steeply dipping but the south-west contact appears to shelve more shallowly. This effect may be an artifact of the application of two-dimensional methods to a three-dimensional shape and relationship. Any evaluation of the body depends on a balanced appraisal of both granite and Cambrian/Precambrian sequences.

The interpretation has been summarised in Figure 84. The Meredith Granite is generally a steep-sided pluton of 'normal' granite density. The interpretation ambiguities have not been stressed in the above discussion. Although the gravimetric effects of the Meredith Granite are not generally obscured by crustal effects, as is the case with many other bodies, it has been intruded into a section of the Palaeozoic trough margin where the materials are dense or altered. The presence of Cambrian ultramafic rocks increases the effective contrast locally, and the array of materials about the body complicates analysis and requires simultaneous evaluation of all components.

The pluton appears to shelve markedly only in the region north and east of Mt Ramsay, and may abut or coalesce with the Housetop or Dolcoath Granites. It is not likely that there is any relationship with the Housetop Granite, as the bodies possess differing properties (see Chapter 11). Refinement of this study or detailed appraisal of the roof structures north of Mt Ramsay must await infill of the data base to a spacing of about one kilometre.

Other problems are concealed beneath the basalt cover east of Waratah. Some of the issues are suggested in Figure 80 but a more complete discussion was given for the Housetop Granite (Chapter 11). The problems are believed to be soluble but the contribution of the Tertiary rocks must be assessed first. The methods for achieving this were illustrated in Leaman (1986a). The south-west extent of the Housetop, or the north-east extent of the Meredith Granite, may then be appraised. Some property data will be required to control the depth-mass balance equation. This is not a trivial exercise, as the gravity field between the Housetop and Meredith Granites is dominated by other sources, including the basin margin, and the combined effect of crustal thickness and all granites. Detailed review near Waratah must also consider the contribution and form of the Precambrian inlier.

The aeromagnetic data have been inspected but not comprehensively treated (see fig. 85). A qualitative view of the metamorphic halo of the granite is suggested but confirmation depends on the methods demonstrated by Leaman (1986a, section 4D) and reproduced in Chapter 15 of this Bulletin for the Pine Hill Granite. The inferred distribution of 'shallow' granite, based on a judgment of alteration anomaly character inferred to be related to thermal changes, is suggested in Figure 85 and correlates closely with the gravity model (fig. 84). It must be stressed that neither presentation is based on complete studies or, in the gravity case, sufficient data. A crude correlation certainly exists.

The magnetic survey shows the Meredith Granite to be non-magnetic for all practical purposes (see also Collins *et al.*, 1981).

MINERALISATION AND EXPLORATION

Mineralised sites in the region of the Meredith Granite are shown in Figure 84. Various types of mineralisation are represented. These include gold in Precambrian rocks, massive sulphide/oxide deposits in altered rocks of the Arthur Lineament, lead-zinc-silver and tin-tungsten vein, skarn and replacement deposits, and some platinoids and nickel. The origin of the gold is uncertain but the platinoids are derived from the ultramafic rocks which have been diluted by intrusion of the granite. The massive sulphide/oxide deposits appear to have a Proterozoic volcanogenic origin (Collins and Williams, 1986) but it is perhaps significant that full economic development has occurred in the region where the thermal input of the Meredith Granite has been applied (near Savage River). No comparable oxide deposits have been recognised beyond this zone. Most other deposits, especially those involving tin, are undoubtedly granite-related (Collins and Williams, 1986).

The pattern and distribution of these deposits is wholly consistent with the interpreted form of the intrusion. Deposits around the south and south-east edge of the granite are very close to the margin, which dips very steeply, but are much more widespread to the north-east, indicating that the suggestions of a shelf roll with spines (e.g. fig. 80) are realistic. Collins and Williams (1986) infer a relationship between the Magnet and Waratah (Bischoff) mineralisation and a Devonian granite but note that the nearest granite (Meredith) is a considerable distance away. The association between mineralisation, quartz porphyries and granite can only be understood in the context supplied by this interpretation. The granite extends a spiny shelf north-east of Mt Ramsay, which is probably little more than two kilometres deep in the Waratah region, and may locally be a good deal shallower.

Formal definition of the granite roof is thus critical to exploration of further prospects. These would be principally rich in tin or tungsten, although there is scope for sulphide deposits further removed from the outer skin of the granite. Such a zonation can be inferred for other plutons (e.g. Dolcoath, Chapter 9; Heemskirk, Chapter 14). Such evaluation requires more extensive gravity coverage west of Waratah, full use of the aeromagnetic data base and resolution of basalt effects, and combined method assessment of the materials beneath the basalt.

SUMMARY

1. The Meredith Granite is a large Devonian pluton which is largely unroofed.
2. The margins are generally steeply dipping, except north-east of Mt Ramsay where a shelf extends toward Waratah and Guildford. Irregular roof forms are indicated but incompletely resolved at this stage.
3. The granite displays 'normal' physical properties. It is non-magnetic and of relatively low density (2.62 t/m^3).
4. The granite has affected older mineralisation and introduced an array of sulphide and Sn-W skarn and replacement deposits. These are clearly related to marginal irregularities.
5. The granite was intruded into a basin margin.
6. Further resolution of the shape of the granite and correlation with prospective host rocks, potential targets, and existing sites is feasible. Extension of the gravity coverage is required. Detailed evaluation might be most effectively concentrated north-east of Mt Ramsay.

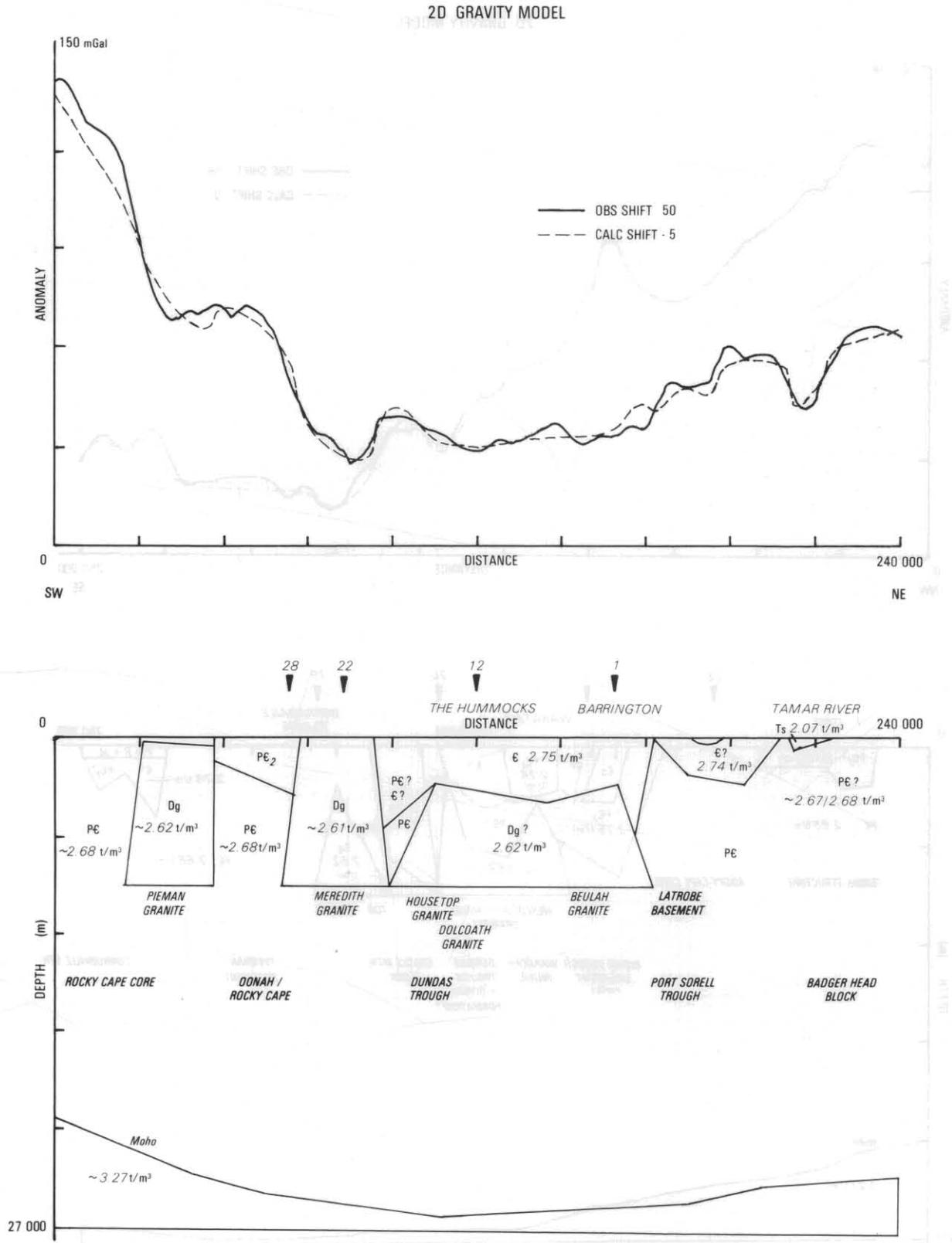


Figure 79. Regional interpretation: Line 8, Pieman Heads–Meredith–Weymouth.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

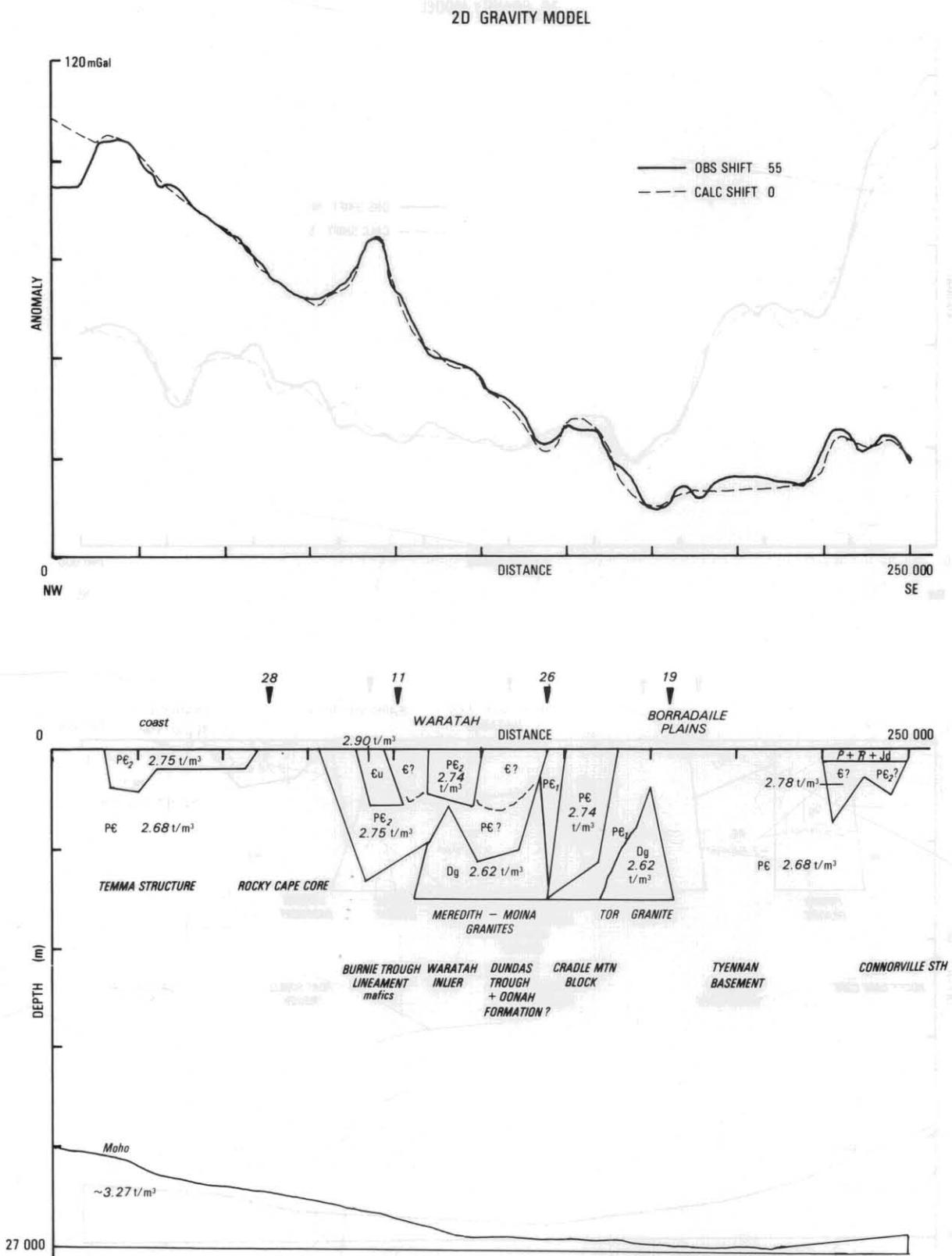


Figure 80. Regional interpretation: Line 16, Arthur River–Waratah–Arthurs Lake.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

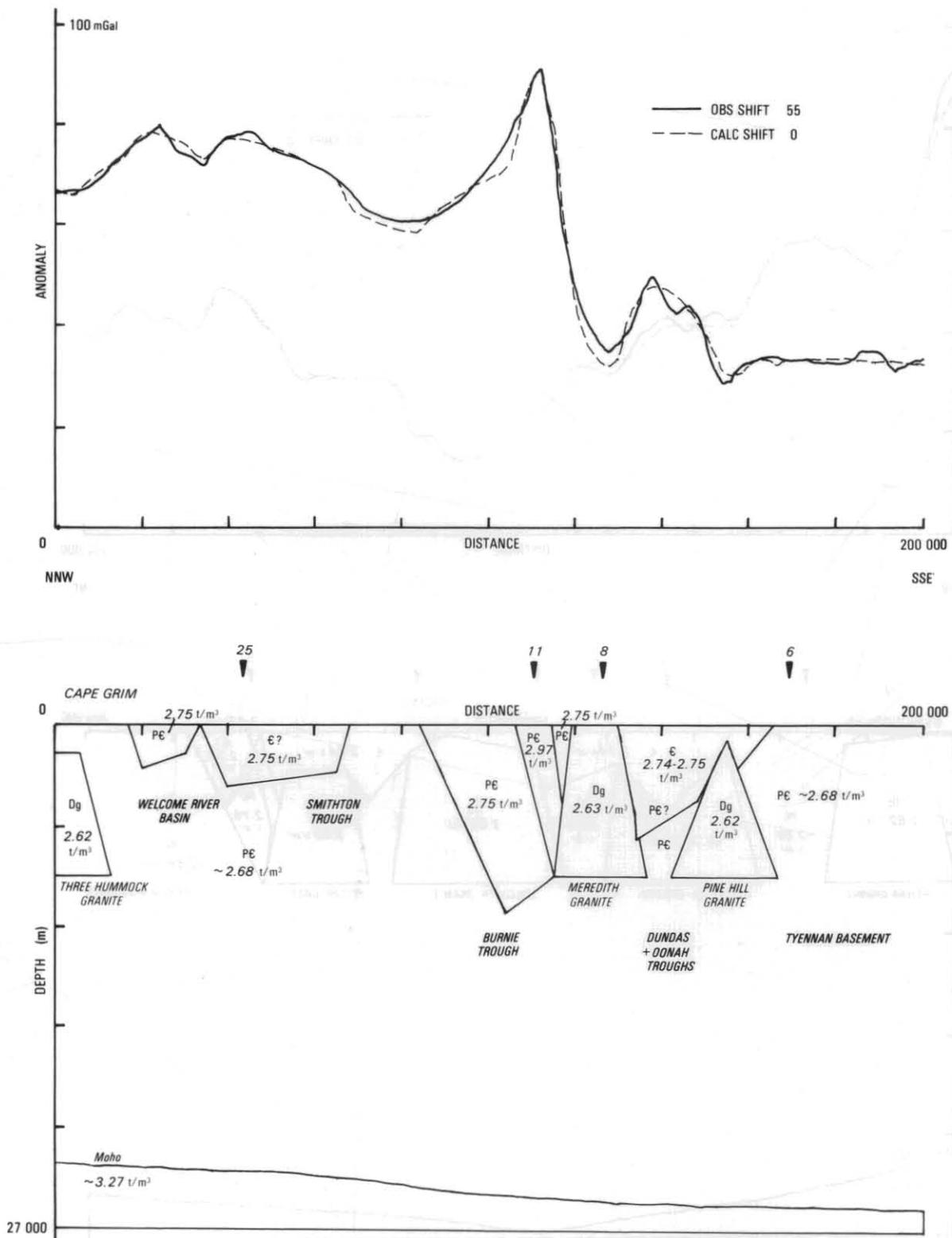


Figure 81. Regional interpretation: Line 22, Cape Grim-Heazlewood-Eldons.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

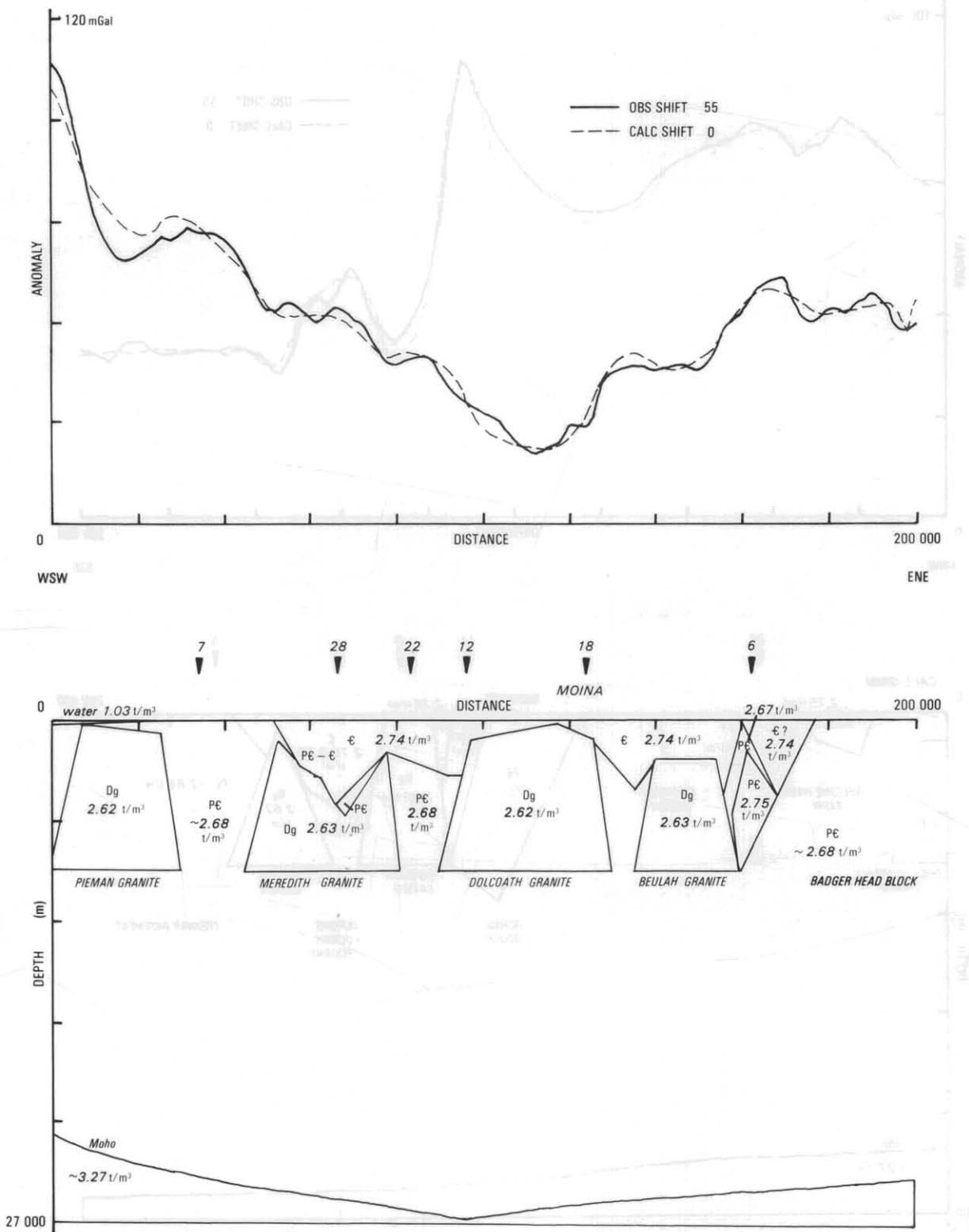


Figure 82. Regional interpretation: Line 26, Granville Harbour-Moina-Hillwood.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

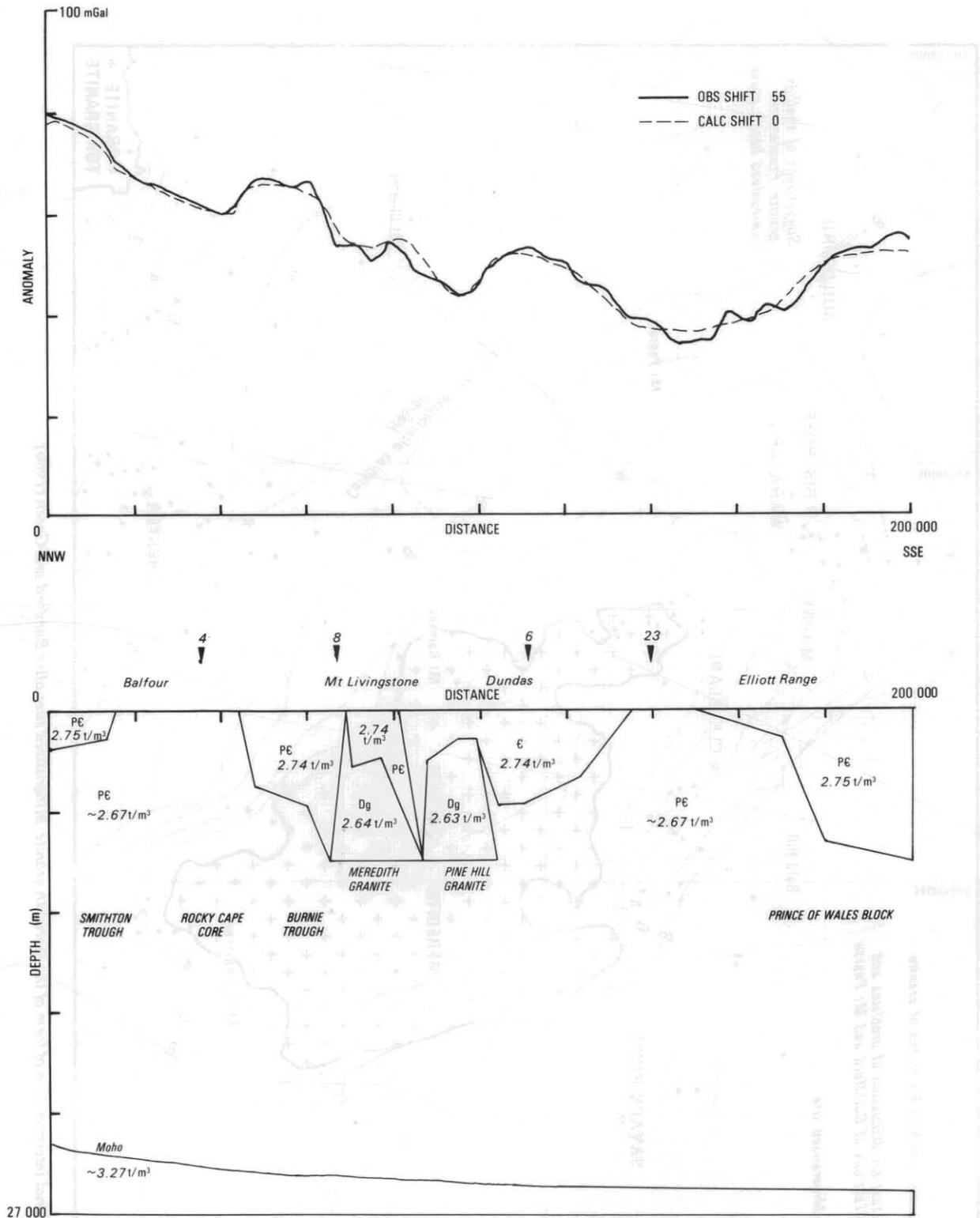


Figure 83. Regional interpretation: Line 28, Balfour–Zeehan–Hamilton Range.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

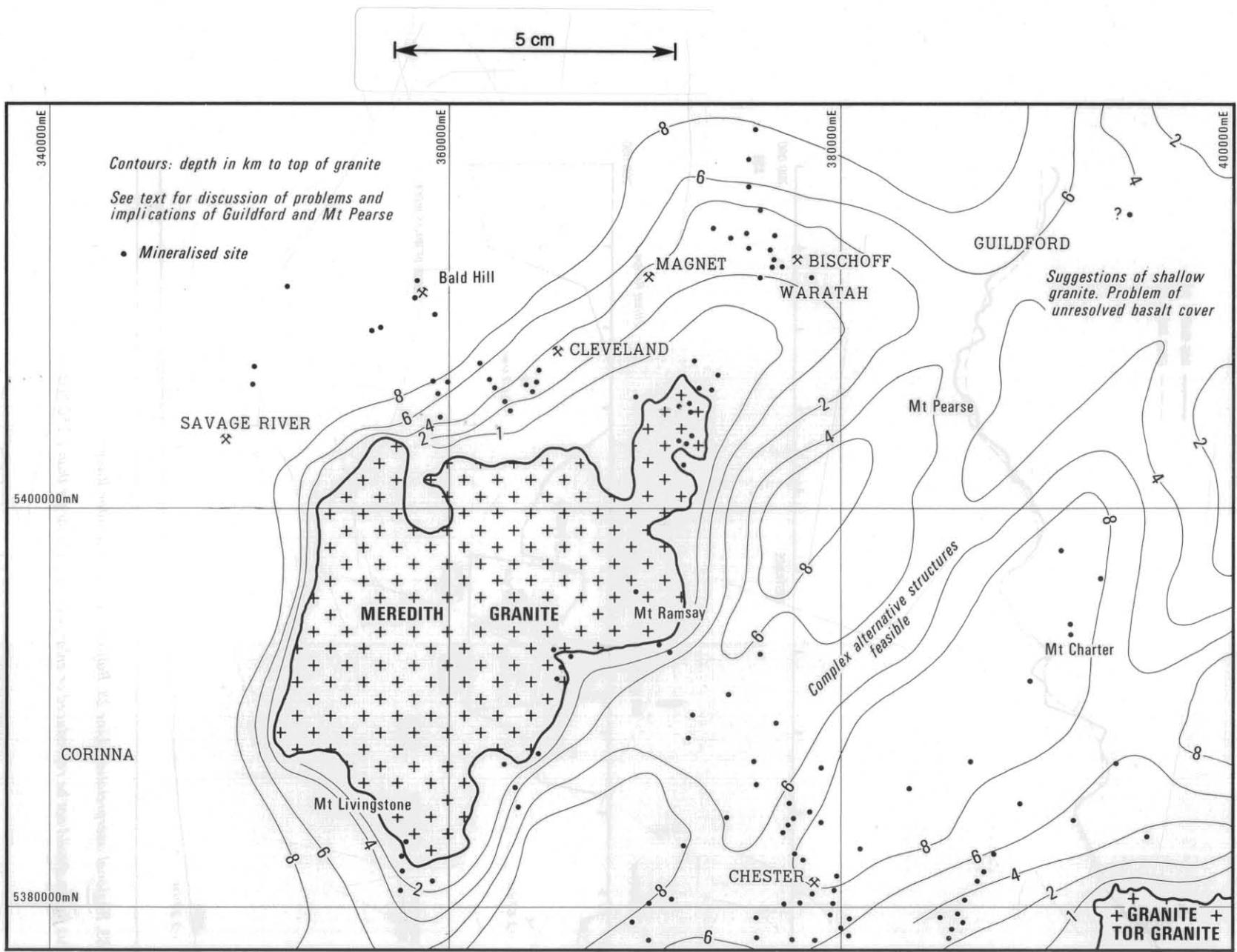


Figure 84. Provisional interpretation of form of the Meredith granite. Mineralised sites after Bamford and Green (1986).

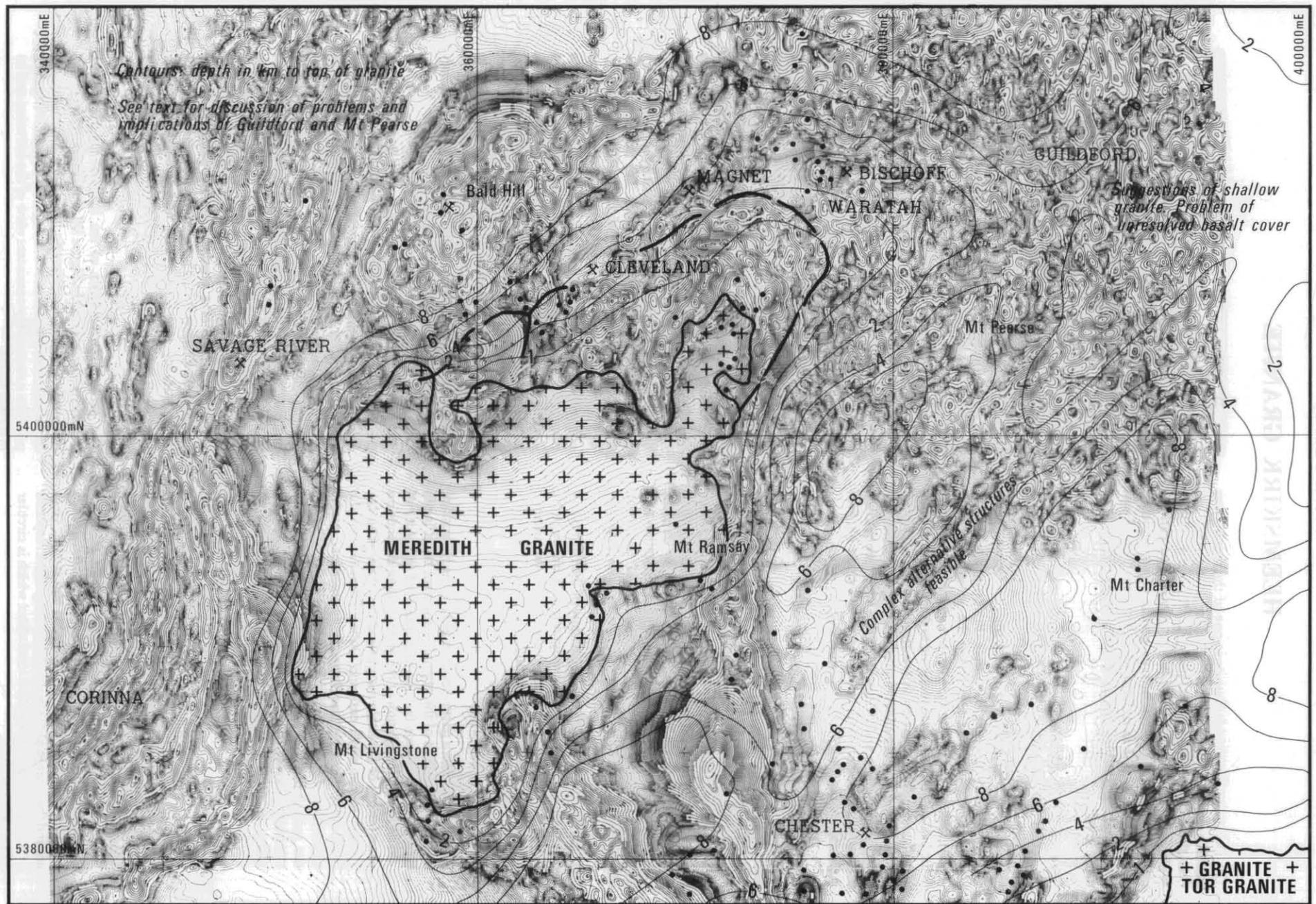
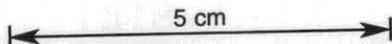


Figure 85. Department of Mines aeromagnetic coverage of the Meredith Granite. Contours from the provisional interpretation of the form of the intrusion are also shown. The heavy line indicates a qualitative judgement of the limit of thermal alteration responses.

5 cm

CHAPTER 14

HEEMSKIRK GRANITE



The Devonian Heemskirk Granite is one of the best known granites in western Tasmania (for location see fig. 1). It has been the subject of petrological study (e.g. Klominsky, 1972; Wells, 1978), and is a layered biotite granite (red variety) intruded by sheets (?) of muscovite granite (white variety). Tin mineralisation is associated with the white form. Apart from these relationships, relatively little is known of the form of the granite.

Leaman (1974), on the basis of a single coastal profile, suggested that the granite shelved shallowly south towards the Henty River. Leaman *et al.* (1980) incorporated the Heemskirk Granite into their super batholith concept based on very coarsely-spaced gravity data (inset, fig. 1). Leaman (1986a, c) supported and extended the view of Leaman (1974), and suggested that the granite surface dipped gently to the east of Zeehan before plunging to depths of six to eight kilometres. Irregularities on this surface were presumed to control much of the mineralisation in the Zeehan District (Sn, Pb-Ag etc). Collins and Williams (1986) have summarised other evidence in support of this concept but without any firm indication of the location of the mineralising granite.

INTERPRETATION

The analysis reported here is given in a form comparable to discussions provided for other granites in western Tasmania, even though this important pluton warrants very detailed study—at least between Mt Agnew and Zeehan. Such detailed work has been beyond the scope of the present project. As described by Leaman (1986a), any detailed appraisal of the west Zeehan area requires separation and simultaneous three-dimensional evaluation of the units, intrusions and structures between Zeehan and Trial Harbour.

This presentation provides a regional view of the Heemskirk Granite based on gravity and aeromagnetic data, although the magnetic data has not been extensively utilised. Its potential will be realised in any detailed study.

Line 7 (fig. 86)

This line presents a north-south section of the Heemskirk Granite. The effect of the granite is apparent but it is not immediately obvious that the response is of the order of -20 mGal. The resolution of the granite effect depends on examination of the basin margin and materials—Dundas Trough to the south-east and Oonah Formation to the north-west. The response is nearly symmetrical, as the orientation of the profile is sub-parallel to Moho strike and the granite intrudes a trough margin with rocks with a minimum density of 2.75 t/m³ on either side. Even so, some asymmetry of margin dips is implied, which is consistent with Leaman (1974).

Line 17 (fig. 87)

Line 17 offers the more common asymmetric granite-related response often observed in western Tasmania. This section is not biased by the thick Dundas Trough accumulation south of Zeehan or the units of the lineament north of Granville Harbour, and the granite is seen to intrude near normal basement types parallel to the lineament. This variability in contrasts and contact units around the margin of the body affects the general response of the granite, and produces a total effect which is circular and relatively small.



The present study cannot resolve the amount of north-eastward extension of the body towards the Meredith Granite. There are suggestions of granite source effects to at least 85 kilometres. These may be related to the spine of Pine Hill Granite a little south of the line (see Chapter 15). The confined, complex shape of the Heemskirk Granite is not adequately appraised by simple regional methods.

These regional sections have been supported by reproductions of earlier interpretations. The magnetic model shown in Figure 88 at a northing of 5 363 000 mN (refer fig. 4) has not been revised, as the original discussion was comprehensive (Leaman, 1986a). The model suggests the manner in which the eastern face of the granite dips toward Zeehan and how it can be evaluated by considering the strongly magnetic features nearby. The gravity interpretation of the same line (fig. 89) is based on work reported by Leaman (1986c). The interpretation has been revised and recalculated to allow for observations and survey during the 1986/87 phase of the Mt Read Volcanics Project. These changes particularly affect the section west of Mt Agnew.

The gravity profile illustrates the curiously limited form of the Bouguer anomalies across the granite but modelling shows this to be due to the crustal gradient. Although the model parameters cannot be directly compared with other regional sections, the model provides for topography and other assumptions; it does include the newly-derived mantle-crust form used throughout all the regional analyses; and it can be used to recognise most structural features. Review of the basic requirements, and other models, shows that the gradients east of Zeehan are abnormal and consistent with the presence of a granite spine sub-parallel with the section (see Chapter 15). The section attempts to display a deep, glancing intersection with such a body but proper evaluation is not possible at this stage or with the methods used.

The general interpretation of the form of the Heemskirk Granite is summarised in Figure 90. Superimposition of this interpretation on the magnetic field, and the abnormal disturbed anomalies around the margin of the granite (fig. 91), provides a reasonably consistent view of the intrusion and its marginal forms.

Complete evaluation of the irregular, shelving zone east of Mt Agnew and the irregular magnetic pattern depends on use of the methods outlined by Leaman (1986a, c). Some critical points have been indicated in Figure 90, where present methods are quite inappropriate and the precise relationship between the Meredith and Pine Hill Granites has not been determined. There is no suggestion, in the current treatment, of granite occurring at depths of less than five or six kilometres in the region east of Zeehan and west of Melba Flats. This may be contrasted with the Dundas-Renison region, and near Zeehan itself.

MINERALISATION AND EXPLORATION

Mineralised sites in the Heemskirk region are also shown in Figure 90. Some peripheral mineralisation may be related to mafic Cambrian rocks but most of the tin and tungsten mineralisation west of Mt Agnew and near Zeehan is related to the white granite. Collins and Williams (1986) have discussed the problems of the Zeehan field. It is now believed that most of the lead-zinc-silver vein systems are genetically related to the Queen Hill-Severn cassiterite/sulphide replacement deposit, and that west to east zoning of pyritic ores is related to the thermal environment established by the granite. The present, rather crude resolution of the form of the Heemskirk Granite is consistent with such concepts derived from thermal and chemical inferences. It fully accounts for the general spread of tin mineralisation, including the occurrence within the Eureka 'cone sheet' (see also Leaman, 1986a).

The correlations summarised above show that the extent, proximity and structural control exerted by the granite was crucial to the siting of mineralisation in the arc from Granville

Harbour to Zeehan and Trial Harbour. Mineralisation of non-granite origin would appear to be minor and virtually non-existent.

Sufficient geological, gravity and magnetic data are available to resolve, in detail, the structural issues related to the form of the Heemskirk Granite, and assess those magnetic anomalies and features which are abnormal.

SUMMARY

1. The Devonian Heemskirk Granite is a relatively small body. It is isolated from other plutons but may be related to the Pieman and Pine Hill Granites.
2. The Heemskirk Granite is only partly unroofed, and the Zeehan Field is associated with marginal irregularities around the shelving east face.
3. The granite displays normal physical properties; it is non-magnetic and has a density estimated at 2.62 or 2.63 t/m³.
4. Significant mineralisation is associated.
5. The granite was intruded close to a basin margin.
6. Further detailing of the Agnew-Zeehan east face of the granite is feasible with the extant gravity and magnetic data bases. This is not a trivial exercise due to the complex structures in the arc from Trial Harbour to Zeehan, and resolution depends on three-dimensional whole geology methods.

2D GRAVITY MODEL

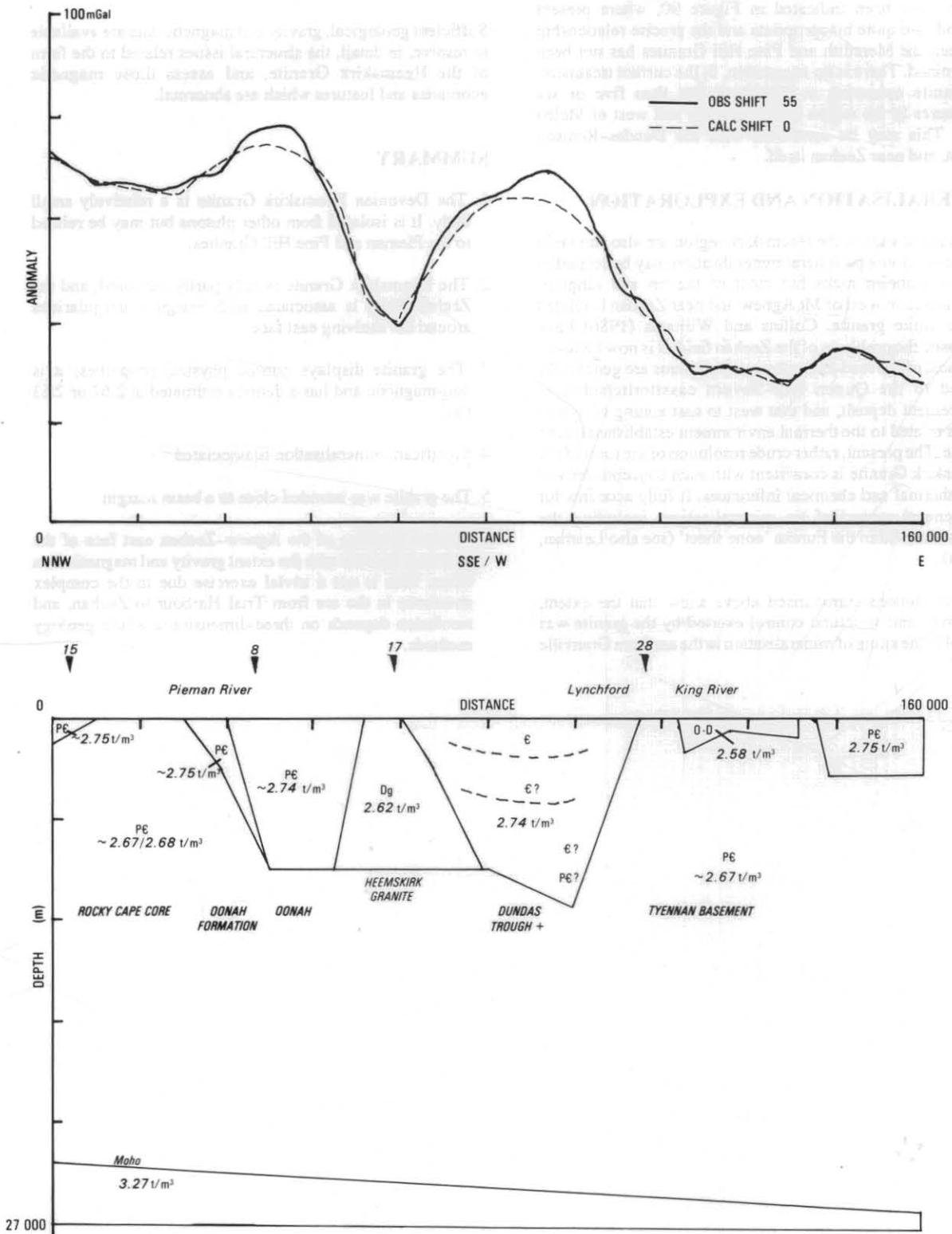


Figure 86. Regional interpretation: Line 7, Temma–Strahan–St Clair.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

2D GRAVITY MODEL

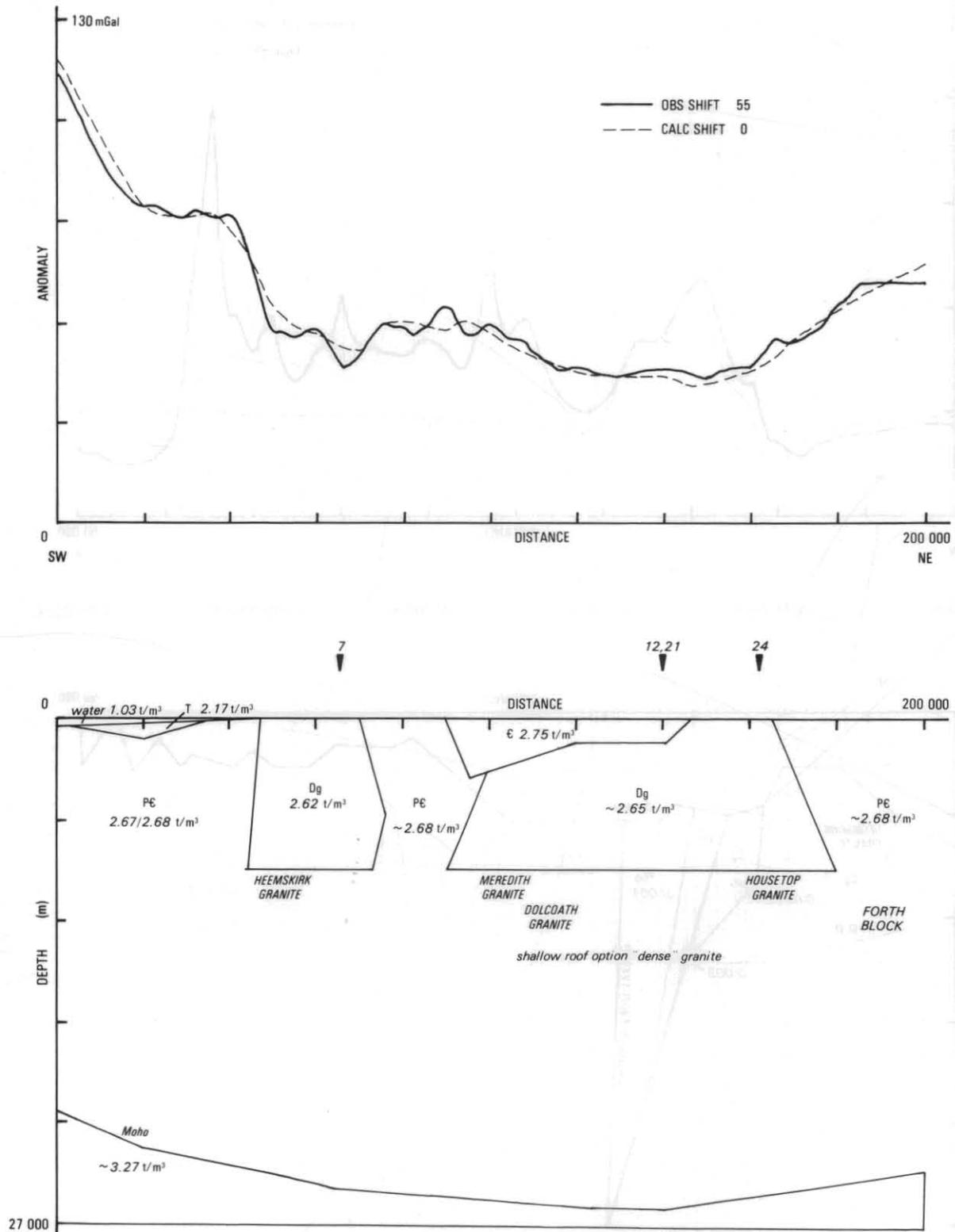
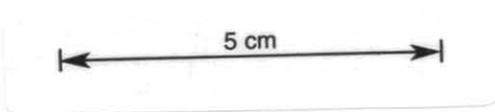


Figure 87. Regional interpretation: Line 17, Henty River–Penguin (dense granite option).

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D MAGNETICS MODEL

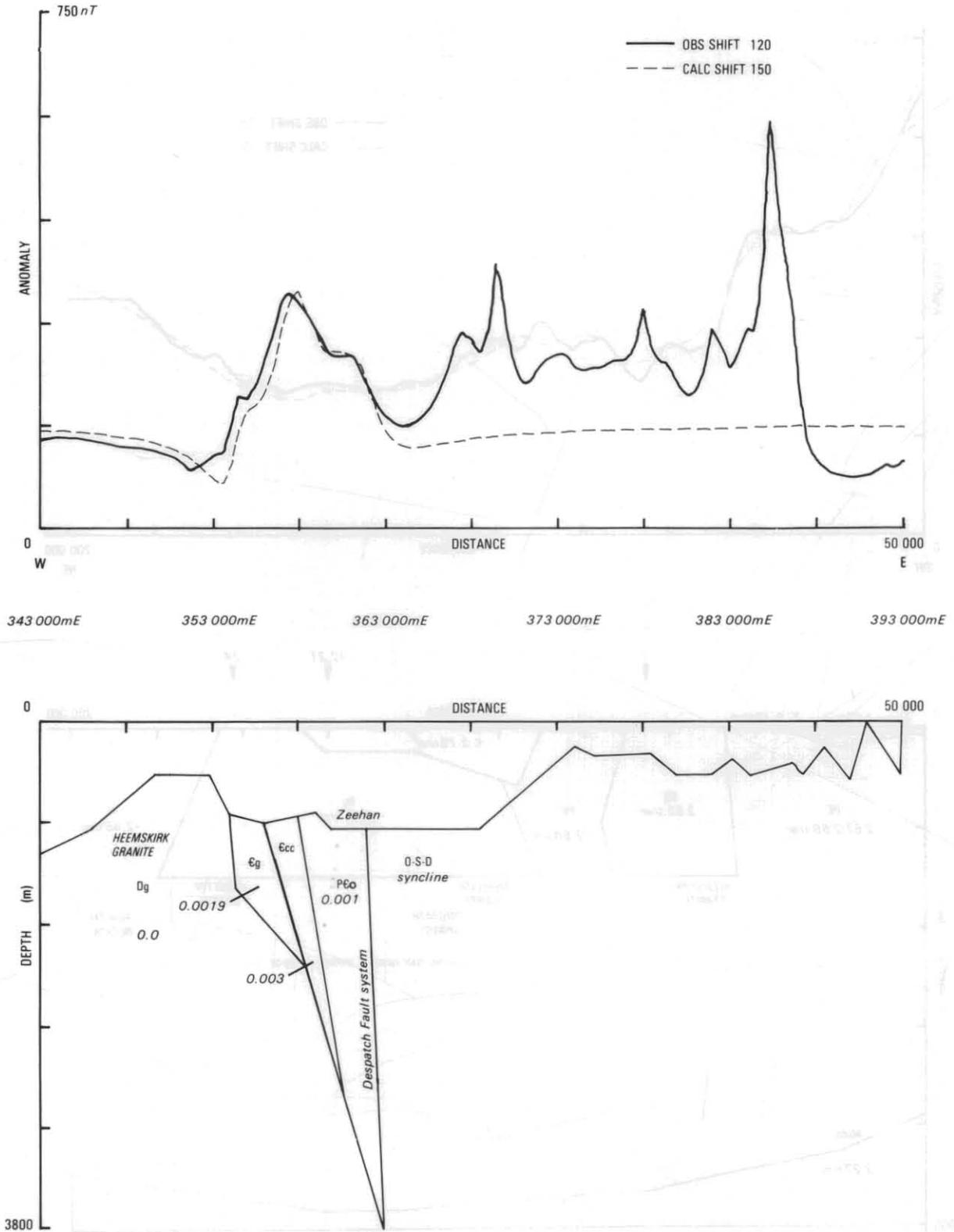


Figure 88. Magnetic interpretation: Heemskirk contact zone, Line 5363 [5363 000 mN, 343–393 000 mE] (magnetic line 1260).

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

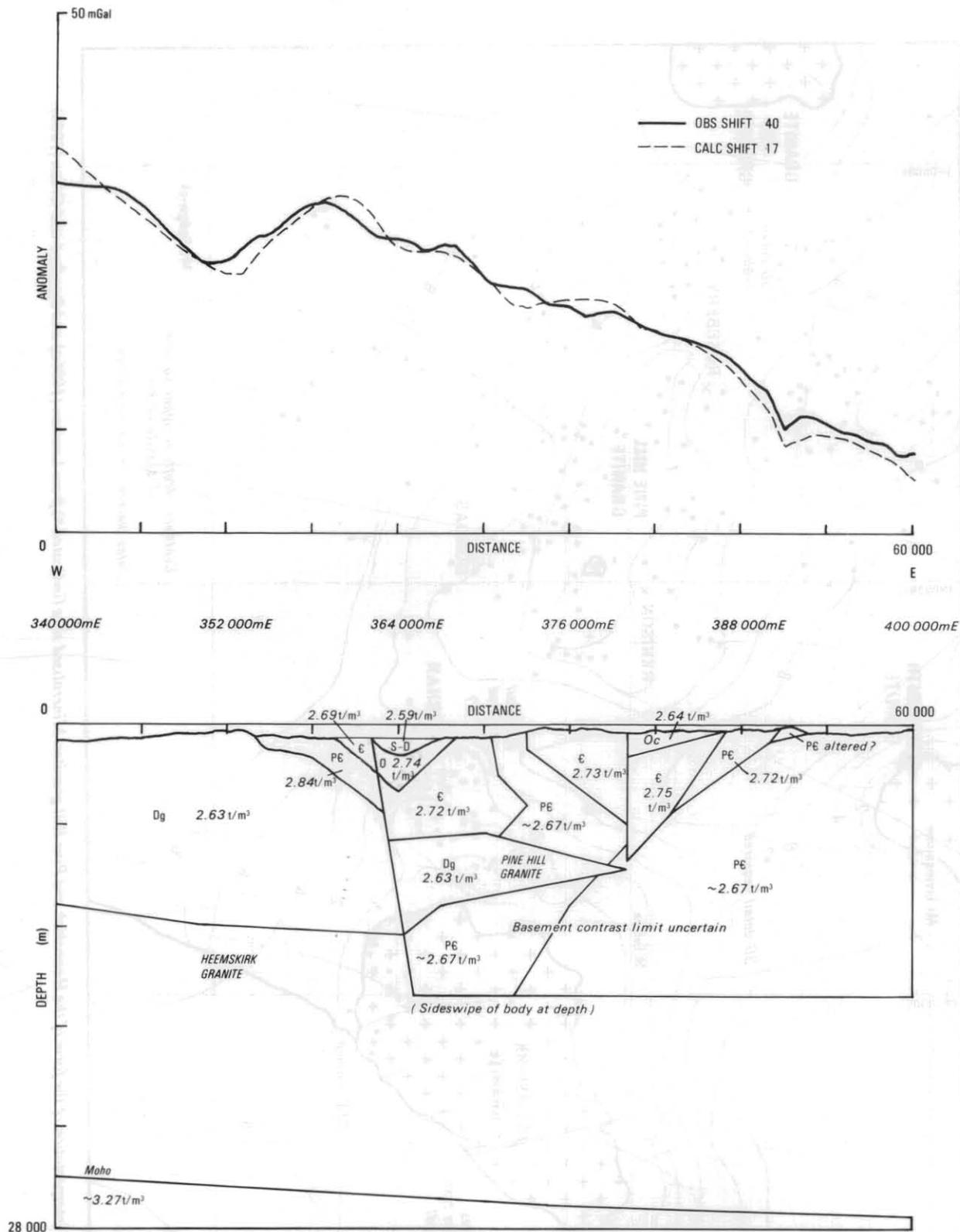


Figure 89. Semi-detailed gravity interpretation: Line 5363, Heemskirk-Zeehan cross-section [5363 000 mN, 340-400 000 mE)

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

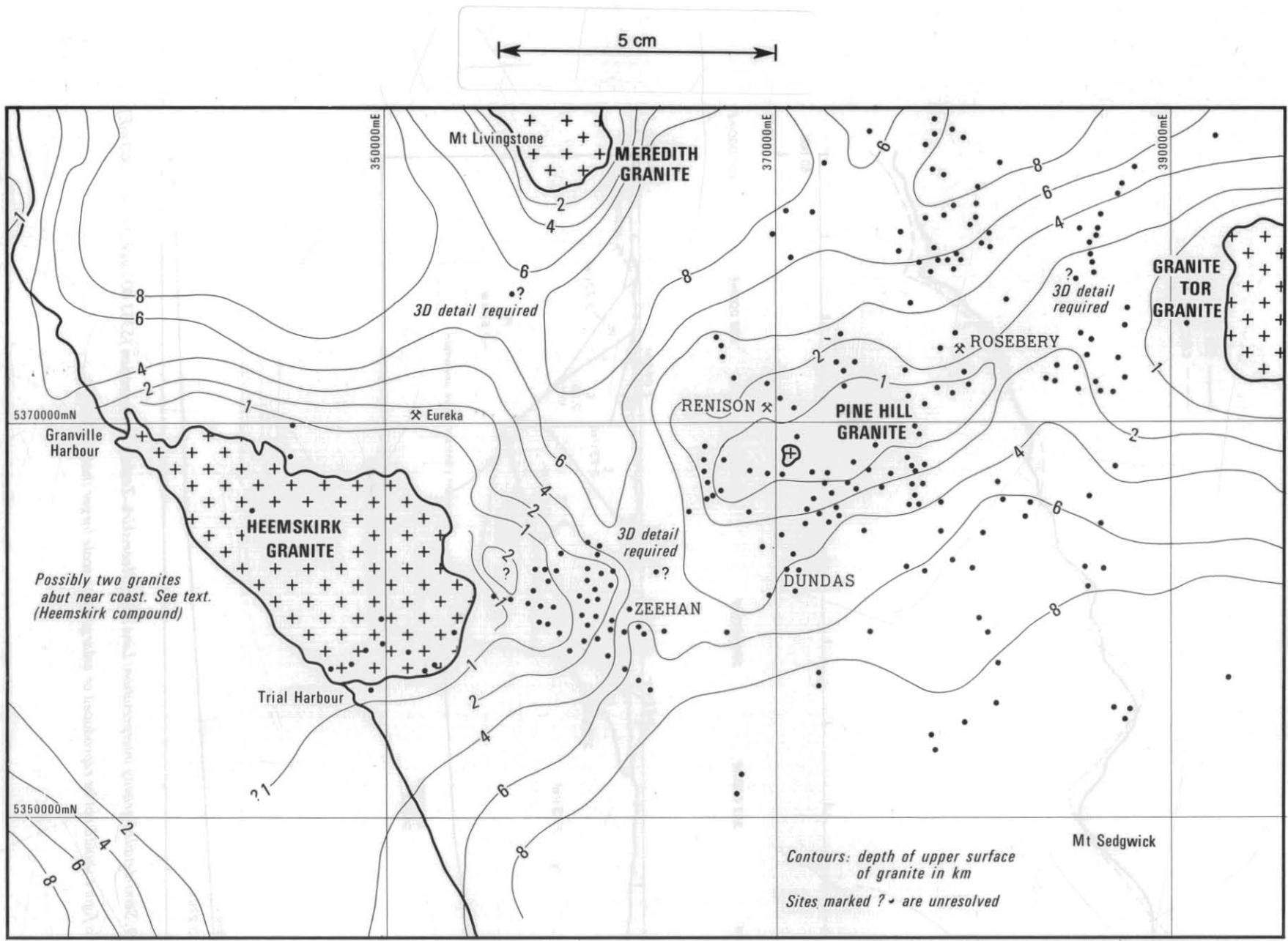


Figure 90. Provisional interpretation of the form of the Heemskirk and Pine Hill granites. Mineralised sites (indicated •) from Leaman (1986a) and Bamford and Green (1986).

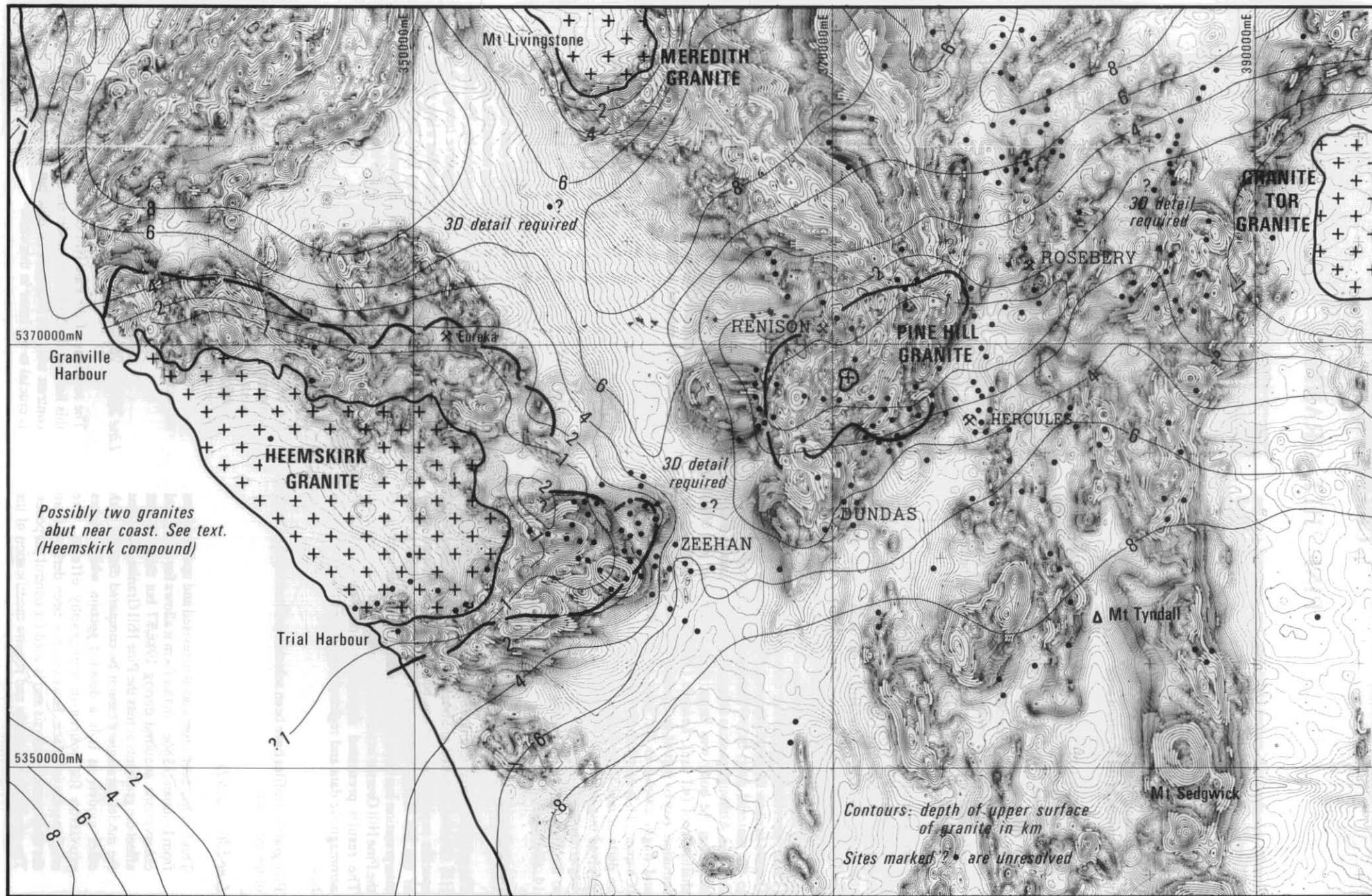
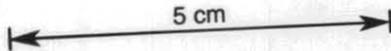


Figure 91. Department of Mines aeromagnetic coverage of the Heemskirk and Pine Hill granites. Contours from the provisional interpretation of the form of the intrusion are also shown.

CHAPTER 15

PINE HILL GRANITE



Granite blocks and quartz porphyry are exposed on the southern flanks of Commonwealth Hill south of Renison Bell (Blissett and Gulline, 1962). Granite occurs at depth within the Renison mine, and was also encountered in deep drilling at Colebrook Hill. These occurrences have been termed the Pine Hill Granite (see fig. 1). It will be observed that although the exposure is minimal there is no doubt of the existence of this intrusion or of its significance with respect to tin mineralisation in the Renison area.

In our opinion this granite is at least as important in overall economic terms as the Heemskirk Granite and its connection with the Zeehan Field. The Pine Hill Granite is exceptional in two respects, developed below; it has an east-west extension, and was intruded across the principal arc of Cambrian mineralised volcanic rocks. This has meant that mineralisation directly related to the granite can be confused with older and remobilised mineralisation.

The presence of the body was first mooted when regional gravity data were first compiled in 1975, and the concept was more fully developed by Leaman *et al.* (1980). Leaman *et al.* (1980) included the Pine Hill area within their western Tasmania super batholith, even though so little was exposed (inset fig. 1). It effectively formed the south-west face of that proposed mass. Leaman (1986a—section 4D) and Leaman (1986c) provided the first clear demonstration of the Pine Hill Granite to show that the Colebrook Hill encounter was related to the material deep below Renison and exposed south of Renison. Although precise forms were not established, it was clear that the body was large, with an irregular and often shallow roof (<1 km). Leaman (1986c) suggested that the intrusion may be part of the Granite Tor Granite (Chapter 1), and might extend as far west as the Heemskirk Granite (Chapter 14). It was directly implied that these bodies might be parts of one large intrusion. The present work has not resolved this issue; the Pine Hill Granite does seem to be a western spine from the Granite Tor Granite but no connection to the Heemskirk Granite has yet been proven (see Chapter 14, also fig. 97).

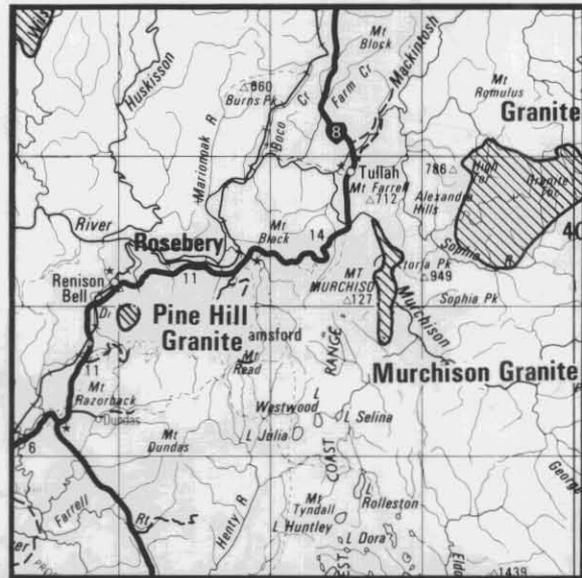
INTERPRETATION

The present interpretation provides a regional view of the Pine Hill Granite; detailed analysis of this intrusion amounts to specific exploration, and has been beyond the present scope of the Mt Read Volcanics Project. The object of this interpretation has been the provision of a basic description of the Pine Hill Granite in terms comparable with other granites. The results presented depend on complex analysis of aeromagnetic data and regional analysis of the gravity data base.

Five gravity profiles have been selected to illustrate the nature of the intrusion.

Line 5363 (fig. 92)

This line has been reproduced in revised and updated form from Leaman (1986c). In this form it allows for additional observations acquired during 1986/87 but these do not affect the gradients across the Pine Hill Granite. Note that the model parameters cannot be compared directly with other models as it is a detailed section which makes provision for source-in-topography effects. The crust-mantle interface, however, has been derived from the most recent analysis and is used for control purposes. The gradients are subtle and require modification of the



contribution from the Cambrian rocks by a negatively contrasted material—granite. In this section such material must occur at depth or off line, and the effect cannot be accurately modelled by two-dimensional methods.

Line 9 (fig. 93)

This line provides a clear demonstration of the attraction of the Pine Hill Granite. The response is comparable to that of the Meredith Granite, but is symmetrical as it is not affected by crustal effects or other granites. The interpretation is not dependent in any way on the composition or arrangement of the intruded rocks, although evaluation of the elevation of the intrusion requires detailed consideration of those materials.

Line 10 (fig. 94)

Line 10 presents a similar aspect (to Line 9) but much closer to the Granite Tor Granite. In this case the gravity field is affected by the form of the basin materials and the presence of the huge Granite Tor mass nearby. The effect of the Pine Hill spine is an abrupt negative trough. It is symmetrical and difficult to model, as either a low granite density is implied (perhaps as low as 2.60 t/m³) or the material is virtually exposed. In comparison, the deeper Waratah shoulder and cupola tip are less obvious.

Line 22 (fig. 95)

The effect due to the Pine Hill Granite is relatively minor for the reasons described for Line 10. It is a critical component of the model, and no other materials are present which could consistently explain the effect along its strike. Lines 9, 10 and 22 stress the apparent variability of the response due the Meredith Granite which reflects the surrounding materials, exposure and line position with respect to the body.

Line 28 (fig. 96)

The response of the Pine Hill Granite is more evident on this line but the body is at moderate depth. Again there is contrast with the Meredith Granite but the profile aspect is crucial to the latter in this case.

The interpretation has been summarised in Figure 97. Mineralised sites have been superimposed on this diagram. It must be stressed that the interpretation provided is coarse and regional, and serves only to show the general form and extent of the granite. The Pine Hill Granite is an irregular mass which is virtually fully roofed. The models, although crude, do indicate considerable roof relief. High points are implied near Renison and a little south-east of Rosebery. There are probably others.

Aeromagnetic data have been used to support and clarify the gravity interpretation. Much of this work was reported in Leaman (1986a, Section 4D). Figure 98 presents a sample of the magnetic field as observed and contoured. There is no obvious indication of the Pine Hill Granite, due to the effects of intense thermal alteration above the intrusion and the presence of many mafic rocks. A qualitative assessment of such alteration effects is also indicated in Figure 98. This was supported by comprehensive correction and normalisation of the survey as presented in Figure 99 (from Leaman, 1986a). Figure 99 shows that a magnetic source, which bears no obvious relationship to structural or unit trends, occurs a little east of Renison and centred beneath Colebrook Hill. Granite was encountered in a drill hole at approximately 1000 m in this zone.

Figure 100 suggests the style of the intrusion and the distribution of magnetic sources in the region. The asymmetry of the Bouguer anomaly shows that the granite has an irregular roof and, on this northing, shallows towards Renison. The magnetic data show that several magnetic sources are involved; most are unit-related but a skin effect sub-parallel to the granite surface is also present. This has a contrast of at least 0.005 cgs overall, and generally accounts for the highly disturbed nature of the field regionally.

MINERALISATION AND EXPLORATION

This Bulletin is hardly the place to attempt a description of all the mineralised sites in the region. Many are shown in Figure 97. It is not immediately apparent in this presentation that there is an abnormal concentration of mineralised sites along or near the axis of the Pine Hill Granite but this was clearly demonstrated by Leaman (1987). It is evident that the granite is an important factor in the mineralisation or concentration of mineralisation in this part of western Tasmania. This was recognised by Bamford and Green (1986).

All types of mineralisation are present, and many mineralised sites represent Cambrian volcanogenic deposits. It is also clear from the presence of tin (especially) and tungsten along the Pine Hill axis that the granite has introduced much mineralisation. Some Pb-Zn deposits may also be related. In such a complex environment there can be little doubt that the granite has remobilised and redeposited, in new vein or

replacement sites, much older mineralisation. This accounts for the complex chemical and thermal observations noted by many authors. The problems and issues have been summarised by Collins and Williams (1986). They quote, in particular, the enigma of the Mt Farrell mineralisation. This mineralisation is located midway between Rosebery and the Granite Tor Granite (refer fig. 97), and has many of the attributes of both Cambrian volcanogenic and Devonian mineralisation. Collins and Williams conclude a Devonian origin for this mineralisation, a view supported by the zinc number methods of Large and Huston (1986).

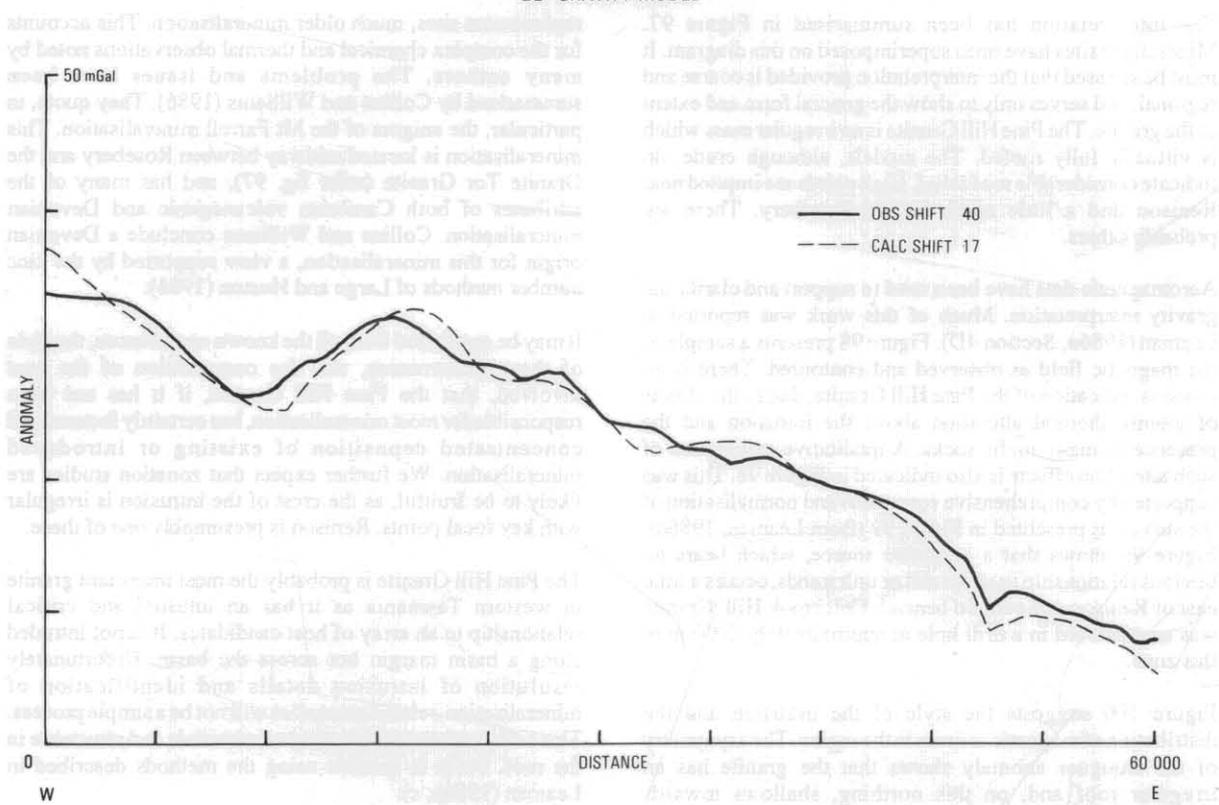
It may be concluded from all the known occurrences, the style of those occurrences, and the composition of the ores involved, that the Pine Hill Granite, if it has not been responsible for most mineralisation, has certainly focused and concentrated deposition of existing or introduced mineralisation. We further expect that zonation studies are likely to be fruitful, as the crest of the intrusion is irregular with key focal points. Renison is presumably one of these.

The Pine Hill Granite is probably the most important granite in western Tasmania as it has an unusual and critical relationship to an array of host candidates. It is not intruded along a basin margin but across the basin. Unfortunately resolution of intrusion details and identification of mineralisation-related anomalies will not be a simple process. This reflects the complex array of materials and structures in the roof, but it is feasible using the methods described in Leaman (1986a, c).

SUMMARY

1. The Pine Hill Granite is a significant body whose size is not reflected in exposures.
2. The composition and properties of this granite are normal but it has induced a substantial alteration halo in the roof rocks. This is recognisable magnetically.
3. The granite is intruded across, not along, the Dundas Trough. It has a high relief roof with several cupolas.
4. The granite is very important economically. It has introduced much mineralisation, and probably remobilised much older mineralisation. An abnormal concentration of mineralised sites lies along or near its east-west axis.
5. More detailed study can be recommended but this is probably the province of exploration licence holders. Such study will not be simple or straight-forward, and will require advanced and comprehensive three-dimensional methods. Any such study could reasonably be expected to yield useful information on the control and nature of the mineralised sites already known, and thus directly advance the scope and targeting of deep exploration.

2D GRAVITY MODEL



340 000mE 352 000mE 364 000mE 376 000mE 388 000mE 400 000mE

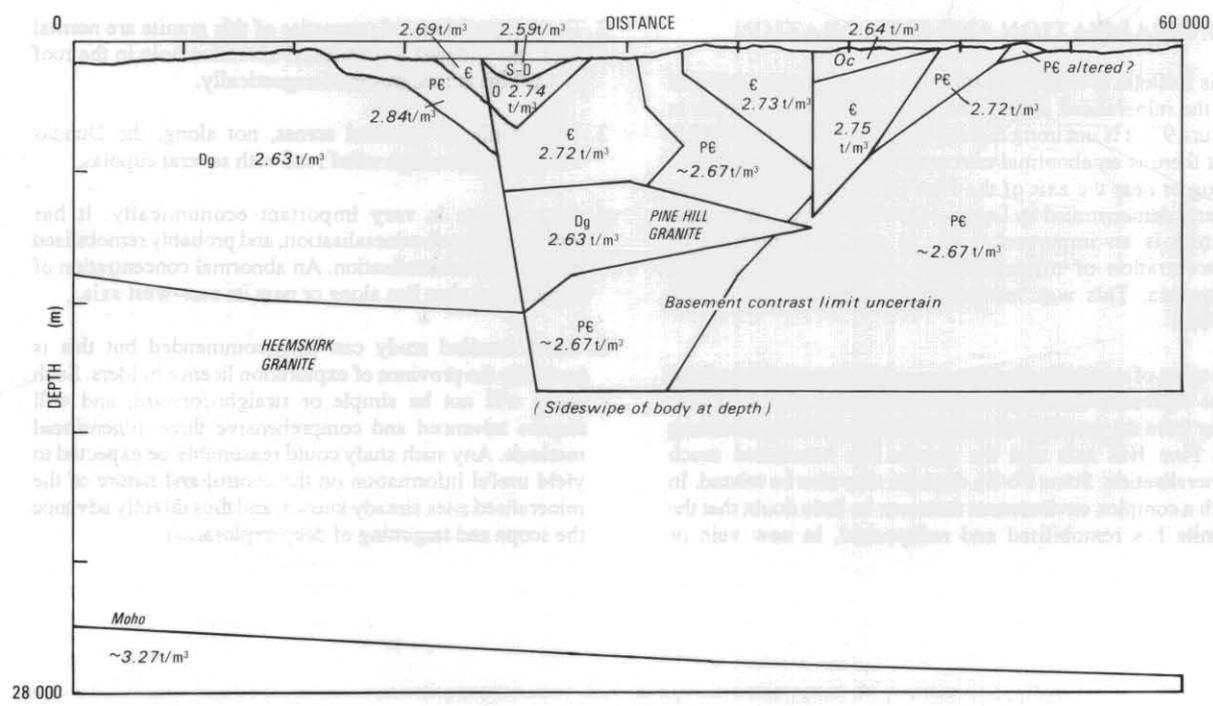
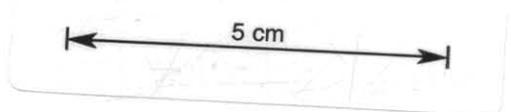


Figure 92. Semi-detailed gravity interpretation: Line 5363, Heemskirk-Zeehan cross-section [5363 000 mN, 340-400 000 mE]

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

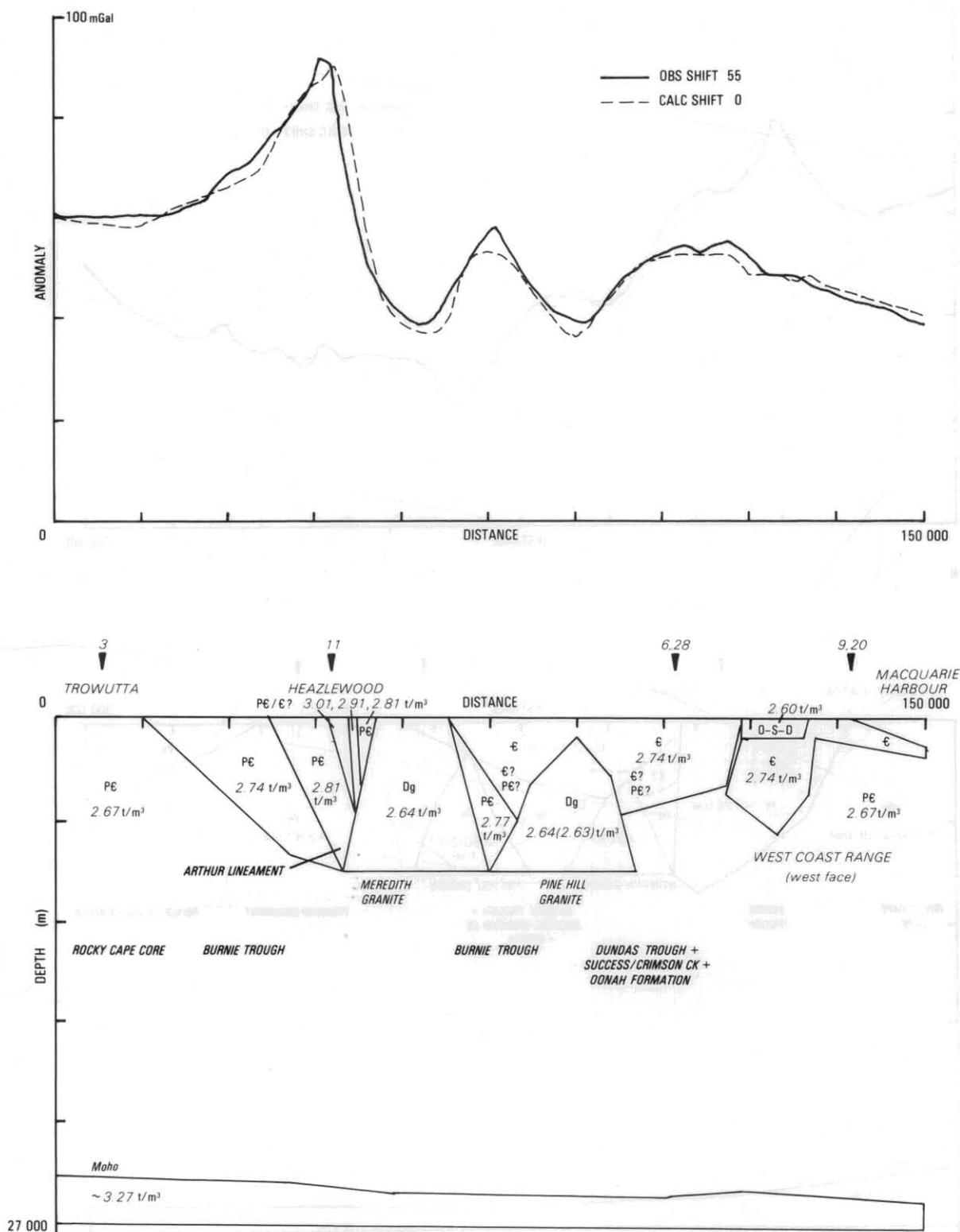
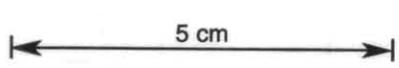


Figure 93. Regional interpretation: Line 9, Trowutta-Meredith-South Darwin.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.



2D GRAVITY MODEL

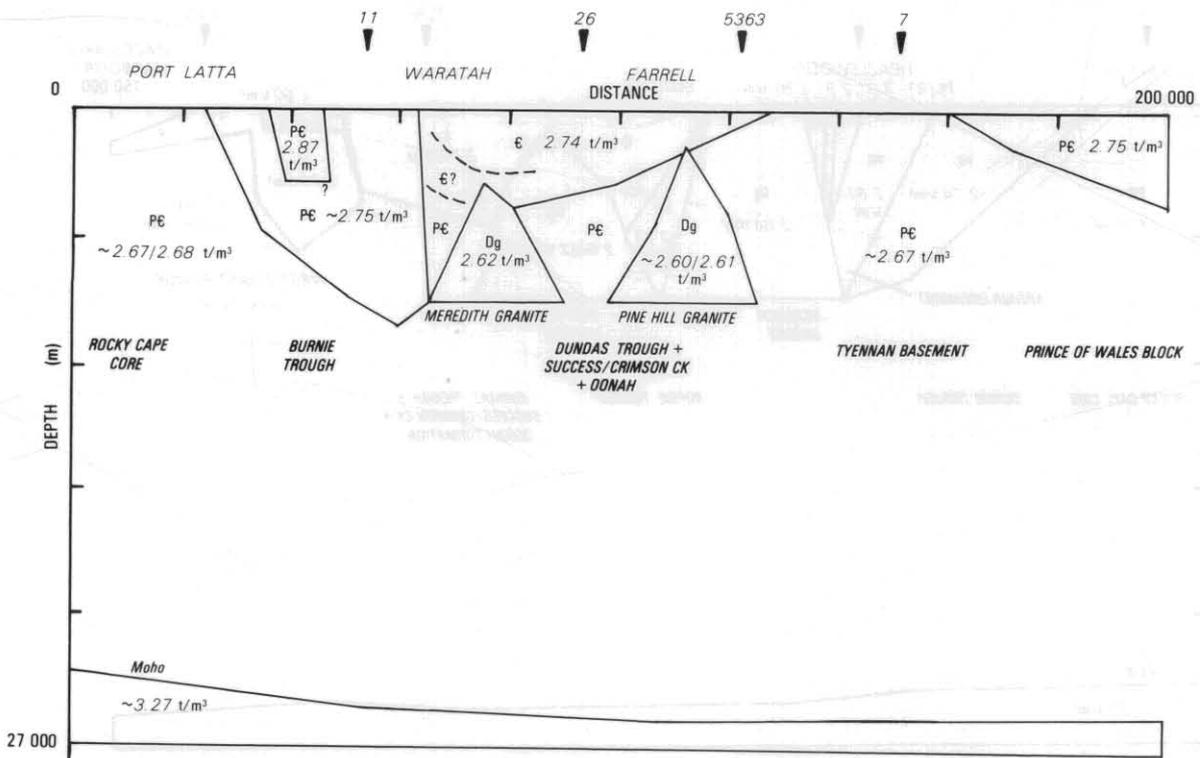
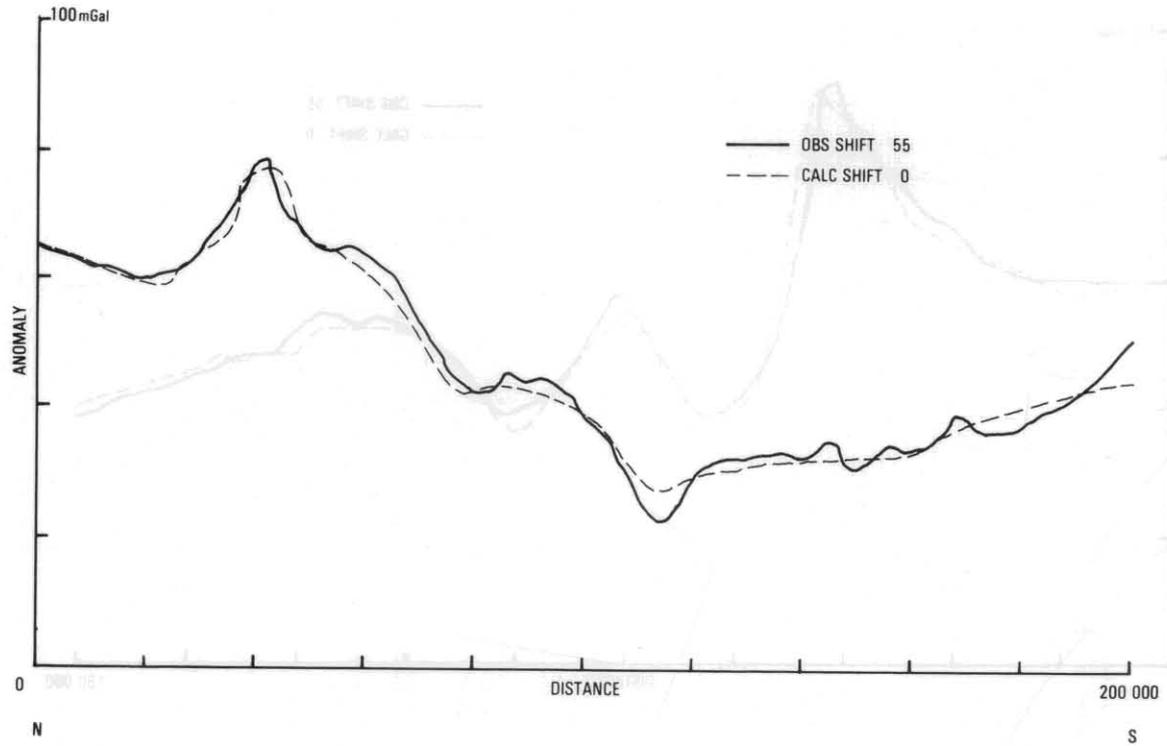


Figure 94. Regional interpretation: Line 10, Port Latta–Waratah–Frenchmans Cap.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

2D GRAVITY MODEL

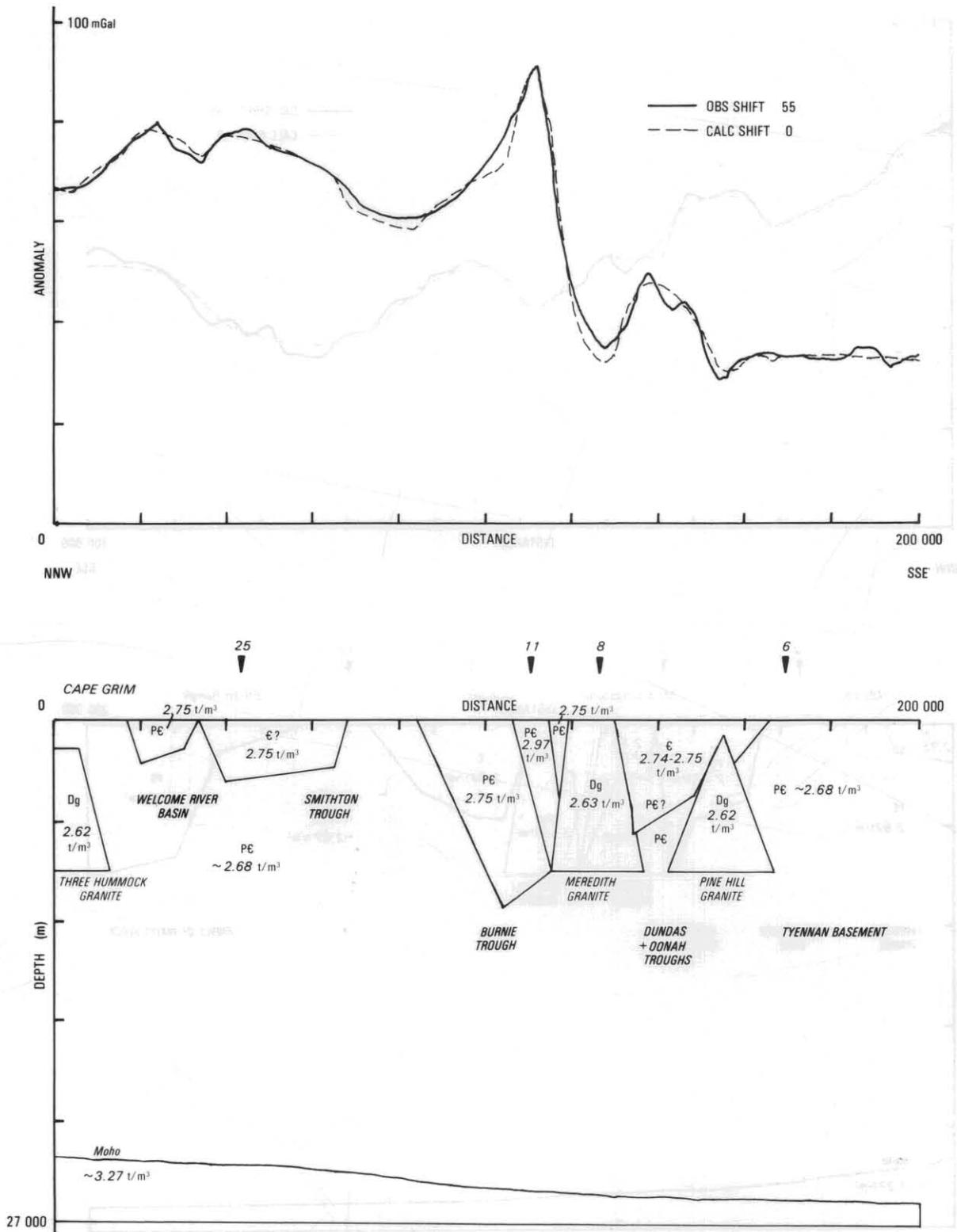


Figure 95. Regional interpretation: Line 22, Cape Grim–Heazlewood–Eldons.

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

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2D GRAVITY MODEL

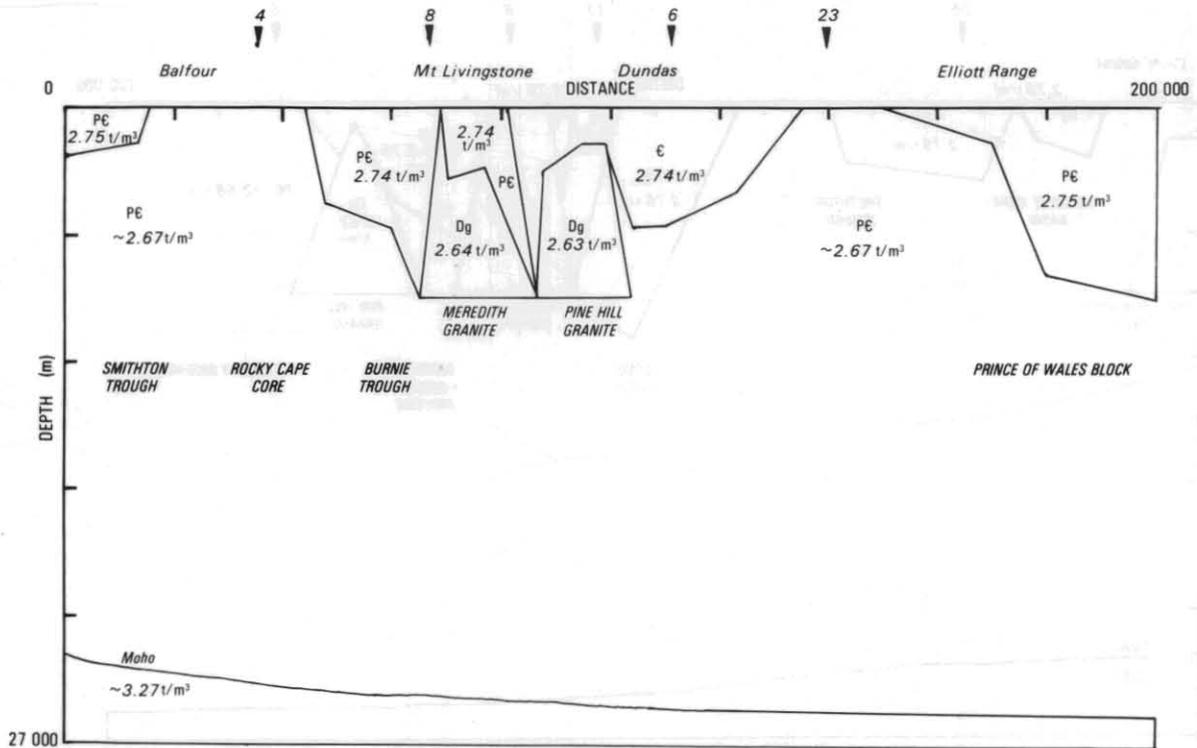
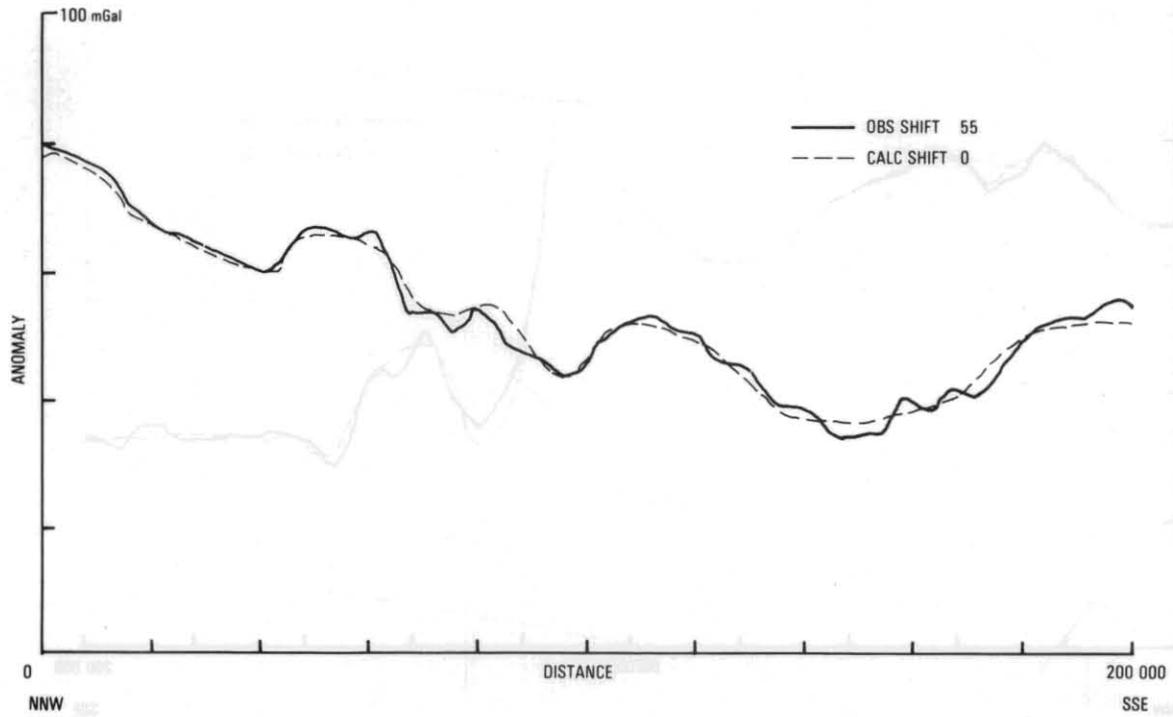


Figure 96. Regional interpretation: Line 28, Balfour-Zeehan-Hamilton Range.

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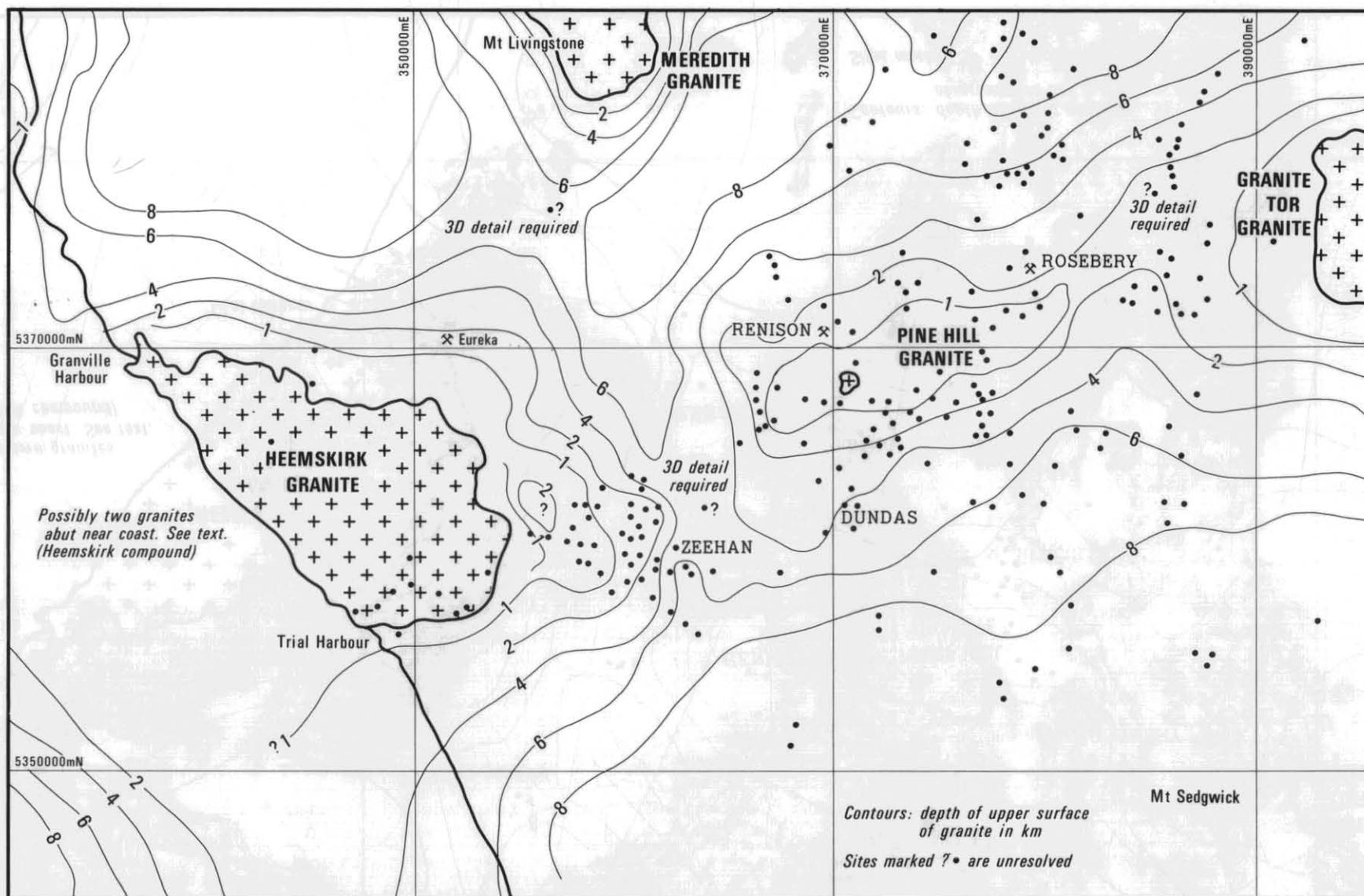
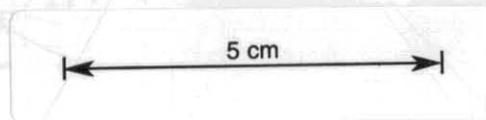


Figure 97. Provisional interpretation of the form of the Heemskirk and Pine Hill granites. Mineralised sites (indicated •) from Leaman (1986a) and Bamford and Green (1986).



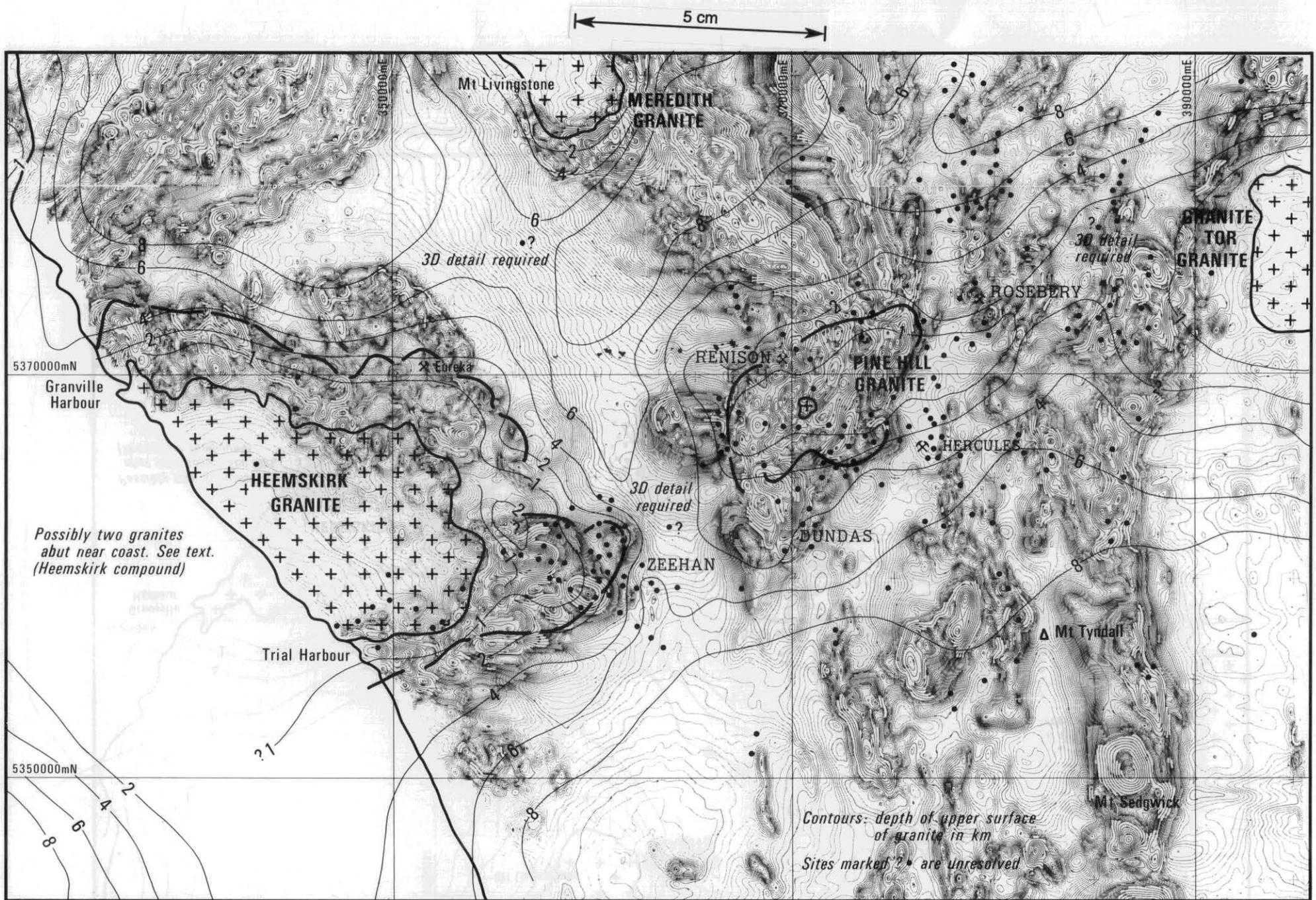


Figure 98. Department of Mines aeromagnetic coverage of the Heemskirk and Pine Hill granites. Contours from the provisional interpretation of the form of the intrusion are also shown.

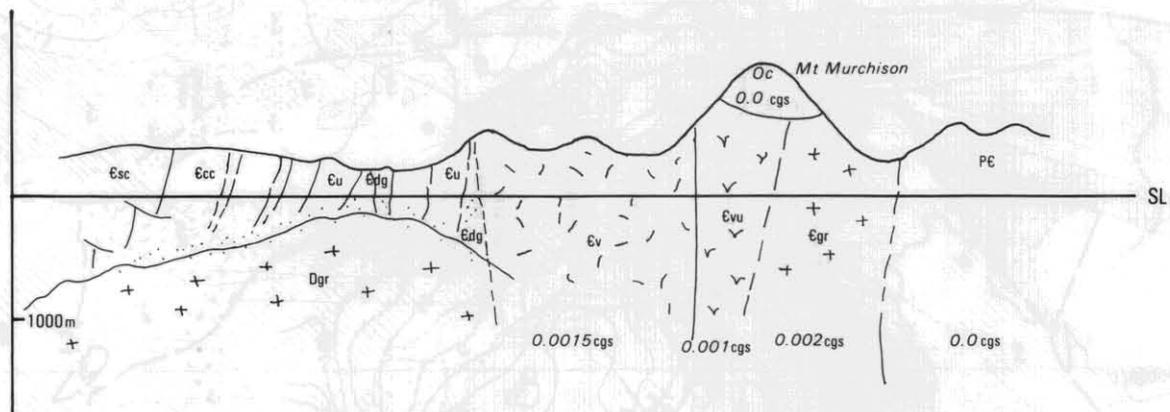
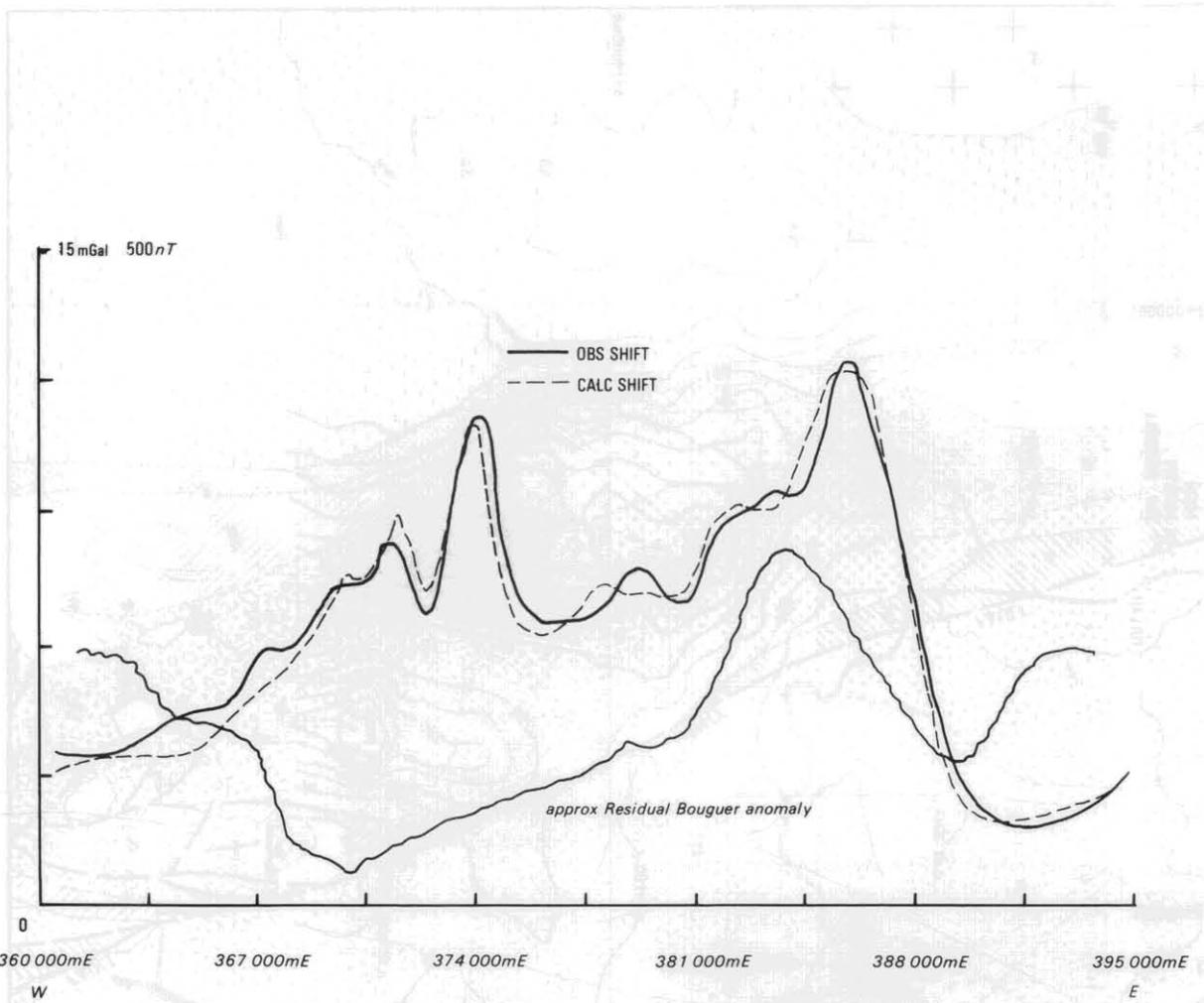


Figure 100. Introductory magnetic interpretation: Line 1411 [5369 500 mN, 360-395 000 mE].

Note: This figure should not be reproduced or enlarged to a scale larger than 1:250 000.

5 cm

CHAPTER 16

SUMMARY

Fifteen granite bodies in west and north-western Tasmania have been reviewed individually in this Bulletin. A number of common denominators and surprises were revealed. This chapter summarises the general findings of the regional studies, which remain provisional due to data restrictions, limited objectives, and the form of data used. There is scope, in many cases, for revision and fine detailing which will be of direct exploration benefit. Such locations and possibilities are discussed below.

SUMMARY OF RESULTS

This outline notes only those aspects which may be of general or economic interest. All justification and discussion of conclusions or intrusion forms (including explanatory sections) appears in the earlier chapters.

#1. GRANITE TOR GRANITE

This is a very large, almost fully-roofed pluton south of Cradle Mountain (fig. 9), and includes the isolated exposures known as the Granite Tor, Birthday and Lone Pine Granites. It was a mineralising granite and its intrusion was structure controlled. The upper surface of the granite is very irregular and of high relief. There is scope for further exploration but the geophysical and property data bases are currently limited.

#2. PIEMAN GRANITE

A large elongate (NNW-SSE) body, with most of the roof removed. Some limited mineralisation is associated with cross structures (fig. 14).

#3. GRANDFATHERS GRANITE

This intrusion was defined by the present work, there being little surface expression (fig. 18). Its economic significance is unknown but its presence may alter the exploration rating of the Cape Sorell peninsula.

#4. TIMBERTOPS GRANITE

A small, potentially distinctive intrusion with affinities to the Darwin Granite. It may be economically significant but improved base mapping, gravity survey, and property data are required.

#5. ELLIOTT BAY GRANITE

A group of small, physically indistinct bodies whose economic significance is not known. Property data required.

#6. DARWIN GRANITE

A small, distinctive plug intrusion (see fig. 33). The economic significance of this intrusion has yet to be established but its associations are tantalising. Future analysis should be supported by property study and more detailed work, as the implications of its association with the volcanic rocks, and possible thermal or fluid controls, are far reaching. Other comparable bodies may exist within the West Coast Range. Such bodies can be resolved magnetically.

#7. MURCHISON GRANITE

This larger, plug-like intrusion has properties and associations similar to those inferred for the Darwin Granite

but in this case the property and data control is extant (see fig. 39). The implications affect exploration of the entire West Coast Range south of Mt Murchison.

#8. DOVE GRANITE

Three small, enigmatic bodies of variable properties. There is arguably no economic association (see Chapter 9).

#9. DOLCOATH GRANITE

This granite is a large, virtually fully-roofed body (fig. 49). Much of the irregular roof is within 1500 m of the surface. A mineralising granite, it is possible to correlate deposit styles, zonation and composition with distance from granite. The western half of this large body appears under-explored due to difficult access and Ordovician roof rocks. Adequate geological and geophysical data exist to refine the interpretation.

#10. BEULAH GRANITE

The Beulah Granite is a large, possibly compound intrusion which is almost fully roofed (fig. 60). Much more analysis is required, but only a granodiorite phase is exposed. The interpreted form of the intrusion accounts for most of the isolated prospects in north and north-western Tasmania east of the Dial Range. The region may be more prospective for deeper targets.

#11. HOUSETOP GRANITE

The Housetop Granite is a large pluton with a high proportion of exposure (fig. 72). Economically significant, it possesses abnormal density and magnetic properties. Property ambiguities and basalt cover limit regional resolution south of the Kara deposits. Improvements in definition are feasible but require compound analysis (available data coverage is excellent) and treatment of the basalt problem (e.g. methods of Leaman, 1986a). More detailed examination of raw data in the Dial Range region has shown that the body has dispersed spines and cupolas which can be correlated with mineralisation and anomalous tin content.

#12. THREE HUMMOCK GRANITE

This granite is a large pluton (fig. 78) and a large proportion is unroofed. Its economic significance is not known.

#13. MEREDITH GRANITE

A large, virtually unroofed granite (fig. 84) with steeply-dipping margins. Shelving margins and irregularities occur north-east of Mt Ramsay but present data do not allow detailed resolution. There is a clear association between intrusion form and mineralisation. Extension of the 1 km gravity survey, acquisition of property data and geological control, coupled with magnetic analysis of the basalt cover, should clarify exploration potential in the Magnet-Waratah-Guildford region.

#14. HEEMSKIRK GRANITE

This is a relatively small body which may abut or join the Pieman, Pine Hill or Grandfathers Granites (fig. 90). It is economically significant, and the shelving east-wall near Zeehan is irregular and spiny. Detailed analysis is feasible

using extant data but requires comprehensive evaluation of the complex structures and materials around the margin west of Zeehan.

#15. PINE HILL GRANITE

We have argued that this is the most important of all the granites. This granite has introduced an array of mineralisation styles, as well as remobilisation of older volcanogenic material. Its transverse relationship to the Dundas Trough is probably the critical element (fig. 97). It is almost fully roofed. The roof is irregular and could be defined in detail with extant data. Such analysis would require simultaneous review of features preserved in the roof and any thermal metamorphic halo. Mineralisation can be directly correlated to roof form and body distribution.

DISCUSSION

THE CAMBRIAN GRANITES

Five Cambrian granites were included in this study. None were found to be of regional significance gravimetrically, although all but the Dove (#8) and Timbertops (#4) are covered by the one kilometre-spaced gravity survey. This suggests that the intrusions present a negligible density contrast with the country rocks, or that they are very small masses. Several are magnetically distinct. Magnetic properties are variable but often of high contrast.

Although the bodies differ in surface expression and apparent size, all appear to have the intrusion style of pipe-plugs with a depth taper (see fig. 33 and 39). All were intruded close to the siliceous basement at the edge of the Palaeozoic basin. With the exception of the Dove Granite, all intrude volcanic pile remnants which are now relatively thin. As several of these granites have been exposed more than once in their history, the original thickness of the intruded pile may have been much greater.

There is evidence, especially for the Darwin, Murchison, Timbertops and possibly Dove Granites, of intrusion in local basement-high axes. The Dove Granites may be residual pipe remnants in the marginal basement from which the Palaeozoic onlap has been removed. The entire West Coast Range may have been built on an original basement high, as many units wedge or thin onto the basement within it. Similar constructions can be inferred for the Elliott Bay and Timbertops regions.

All the granites are lithologically variable or include granodiorites. Relatively few measured densities are available (Murchison, #7) but these, and implied densities, lie in the range 2.64 to 2.70 t/m³, with an average of 2.68 t/m³. This is a distinctive result, as most of the more bulky Devonian granitoids are less dense (2.62–2.64 t/m³). Susceptibilities are also abnormal and relatively high. Typical values for the Murchison (#7) and Timbertops (#4) Granites are of the order of 0.001 to 0.003 cgs, and remanence effects (not yet measured) may increase this by at least 50%. The Darwin Granite (#6) may be inferred to possess similar properties in bulk but the two available samples are less magnetic. The Dove Granite (#8) is more variable and less magnetic, but certainly within the same family of responses, whereas the Elliott Bay Granite (#5) is virtually non-magnetic. Given its unusual dating, not yet adequately explained, the Elliott Bay Granite may not belong to this granite group.

The association with mineralisation may be coincidental but is worthy of further study. Copper–gold deposits may be the relevant targets.

This study, coupled with Leaman (1986a especially, and 1986c), indicates that other Darwin–Murchison-like bodies are embedded in the Mt Read Volcanics south of Mt Murchison, and may be associated with important mineralisation—including that at Mt Lyell.

A better understanding of these bodies, their properties, forms and locations, may be crucial to future exploration along the volcanic axis, whether the bodies are simply feeders for acid volcanic rocks, intermediate magma chambers, or controls for convection cells. Further evaluation by gravity methods is unlikely to be productive unless the station spacing is about 200–250 m, which could not be recommended on a regional basis. This may be effective and practical at Elliott Bay. Resolution and definition by magnetic methods is feasible in most cases after terrain correction and flight compensation. The determination of properties of the known bodies is advised prior to any large-scale evaluation or search for concealed relatives.

THE DEVONIAN GRANITES

Ten Devonian granites were examined. Only two intrusions could be considered compositionally or physically unusual. The Beulah Granite (#10), as exposed, has been described as a granodiorite but it is not especially magnetic and although local positive anomalies occur near its outcrop they are not universal. We have implied the presence of a compound granodiorite–adamellite mass for the Beulah Granite. The Housetop Granite (#11) has previously been noted as unusual (e.g. Collins *et al.*, 1981), and it is the only magnetic Devonian granite. Its bulk density is not known at the time of writing but the present work would indicate a value at the upper end of the normal granite–adamellite range (say 2.65 or 2.66 t/m³). This variation must be confirmed, as the interpretation of shelving or cupola roof forms so clearly related to mineralisation cannot be reliably assessed pending some confirmation of implied contrasts.

The other eight intrusions, and probably much of the Beulah mass, are comparable in form, composition and physical properties. Typical densities would appear to be of the order of 2.62–2.64 t/m³, although lighter phases (2.60–2.61 t/m³) are occasionally implied. Detailed work may show these to be related to cupolas or quartz-porphyry dyke swarms.

A previous interpretation by Leaman *et al.* (1980) (inset on fig. 1), based on a very coarse (7 km spacing) gravity coverage, suggested that the various plutons might be related or merge to form, in effect, a super batholith. This is definitely not the case. Other authors (e.g. Collins *et al.*, 1981; Collins and Williams, 1986) have expressed doubts. Although some bodies may abut locally, a condition not always resolved with certainty in the present analysis, it is clear that most are discrete plutons.

The granites retain variable roof proportions. Some, such as the Pieman (#2), Meredith (#13) and Housetop (#11) Granites have lost more than half their roof cover cross-section but others, such as the Granite Tor (#1), Beulah (#10) and Pine Hill (#15) Granites are virtually fully roofed. Although the present analysis was never intended as a specific granite study (see Appendix 1), and consequently was not extended to a detailed review of roof forms (the available data does not permit it in many cases in any event), it has become clear that roofs are irregular and of high relief, and some of the irregularities can be directly correlated with mineralisation or particular deposit styles and content. The roofs of the Pine Hill, Granite Tor, Dolcoath (#9), Housetop, Meredith and Heemskirk (#14) Granites—where preserved—may have relief in excess of 1.0 to 1.5 km, and the pinnacles form loci for mineralisation. Examples occur near Lone Pine (part of #1 in the Forth River), Moina (#9), Dial Range (#11), Waratah

(#13), Queen Hill (#14) and Renison (#15). Only the most major of these features has so far been defined, except where the data set has been more closely inspected (parts of #11, #15). Wall irregularities or corners may also harbour or control mineralisation. This is particularly evident around the Meredith Granite, where the southern and eastern faces are steeply dipping but side-stepped. Other examples included the central, mineralised offset across the Granite Tor Granite.

The composition or arrangement of the materials in the roof rocks is certainly crucial to formation of worthwhile deposits, whether by veining, skarns or replacement. The content of a deposit may also be related to the distance from granite. Zonation with respect to granite roof foci has been established within the precision of this interpretation for the East Heemskirk rise (#14), Moina-Cethana (#9), South Housetop (#11), and possibly even Beulah (#10) areas.

The present provisional interpretation should be considered a guide to intrusion form and critical areas (for both interpretation and exploration), and it is left to the reader to draw detailed conclusions on intrusion-prospect relationships. There would seem to be several broad aspects. Sn-W mineralisation occurs within or close to intrusion margins—less than 1000 m. Some deposits related to quartz porphyries may also lie within this range of the main intrusion. Further detailed coverage or analysis may be needed in such cases (e.g. Mt Bischoff). There is evidence that gold deposits occur in the 500 m to 1500 m range (e.g. Dolcoath, Beulah). Sulphide deposits are further removed. Several barytes occurrences may also be related (e.g. The Hummocks—#11, Beulah—#10).

There are few anomalous or unaccounted occurrences if the present interpretation is accepted as guide but a prime example exists at Balfour. No granite has been inferred closer than the Pieman Granite (#2), even though the presence of tin and porphyries suggest that granite must be nearby. This should not be regarded as a final conclusion in this case, as the local station spacing is 7 km and an isolated stock may have been overlooked or unrepresented in the current gravity compilation. There is some evidence of a negative distortion in the gradient south-east of Bluff Hill Point in the vicinity of Balfour but much more data is required to establish its reality. Trial use of mantle concept MANTLE88, developed subsequent to this study, using the extant coarse coverage and generation of residuals, suggests that the negative distortion reflects a spine form the Pieman Granite.

The interpretation also suggests that the Devonian granites have dominated mineralisation. Inspection of the figures and the relationships between prospects and granites indicates, irrespective of host types and styles, that the granites are primary contributors to the mineralisation in west and north-western Tasmania. East of Zeehan, around the Mt Read Volcanic arc, much the same is true. In the vicinity of the Pine Hill Granite it is likely that up to two-thirds of all mineralised sites are related to the granite outright, and some others may represent remobilised Cambrian mineralisation. This can be inferred from the localisation and orientation of the mineralised sites (see Leaman, 1987, fig. Lineament 1), with a particular bias toward Sn, W, Pb-Zn and Pb-Ag deposits. Cu and Cu-Au mineralisation is more likely related to Cambrian granites or volcanic rocks. The larger Pb-Zn deposits are certainly volcanogenic. In many areas the use of post-Cambrian host rocks establishes the position but in central western Tasmania thermal and isotopic overprinting is inevitable in the region of the Pine Hill Granite.

CONCLUSIONS AND RECOMMENDATIONS

The present work is of considerable exploration value. It accounts for a range of occurrences and resolves many

problems related to the genesis of some mineralisation or compound isotopic properties. It suggests where detailed evaluation would be of greatest use. Provision of such detail has been beyond the resources and goals of the Mt Read Volcanics Project.

Some areas require additional data coverage: across the Meredith Granite and surrounds; Beulah and surrounds; around Balfour; and along the eastern spine of the Granite Tor Granite.

Some areas of undoubted prospectivity would justify detailed definition of the granite forms and relationships within the roof rocks. These include the eastern side and south-west extension of the Housetop Granite; the north-east shelf of the Meredith Granite; the south and east faces of the Heemskirk Granite; the relationship between the Pine Hill and Heemskirk Granites; the crest of the Beulah Granite; the nose and western half of the Dolcoath Granite; and the entirety of the Pine Hill Granite.

Gravity data must carry the bulk of any exploration load, although some related issues which complicate interpretation can be assessed or controlled magnetically. These include metamorphic skin effects and the Tertiary basalt cover, which bedevils exploration between the Housetop and Meredith Granites. Future interpretations should be based on a study of residuals generated from use of MANTLE88 as a regional guide.

Further work should also be supported by definitive property surveys rather than the inferential conclusions demanded or drawn from this and all previous interpretations.

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APPENDIX 1

INTERPRETATION ISSUES

1: The interpretation has utilised smoothed regional aeromagnetic and gravity data. Aeromagnetic data has been used in an accessory capacity to support predominantly gravity-based structural analysis. Magnetic data are not of immediate application to granite studies, other than to review metamorphic haloes. Magnetic data must be consistently corrected and continued to yield a data base free of terrain effects and shallow sources. Both data bases, compensated but unsmoothed, must be used in any detailed study.

2: Interpretation of granite forms was undertaken as part of basin and basement property studies in western Tasmania. The granite evaluation reported in this Bulletin is thus a by-product, as no regional study of basins, troughs, margins or basement characteristics (Precambrian) can be undertaken without comparable simultaneous evaluation of all large features. As the granite study evolved from a large-scale regional evaluation it will be understood that, in many cases, only gross forms have been described. There are exceptions. All the Cambrian granites have been specially included, as they may be of economic significance; they are of little structural consequence. Certain aspects of some Devonian granites have also been reviewed in more detail, for example parts of the Heemskirk, Meredith, Housetop and Pine Hill Granites, because of their significance.

In every case the presentation provides the first, if coarse, step toward an adequate description. This has been defined as one suitable for direct economic or exploration usage on a moderate regional rather than specific site basis.

3: Interpretation of any upper crustal feature is neither feasible, nor reliable, in many parts of western Tasmania without some satisfactory presumption concerning the shape of the crust-mantle interface. The concept developed and used throughout is reported elsewhere (Leaman, 1988a). The general shape of this surface was deduced from an array of more than 50 sections covering much of west, north-west and, to a lesser extent central, south and south-west Tasmania. More than 30 sections were reproduced in the chapters of this Bulletin.

Only when the density-contrast parameters demanded by various orientations and samplings of substantial chunks of the geology — including the obvious large granites — were consistent was the concept accepted. The sections were then reworked to add second-order detail of direct relevance to the project (basin study, basement margins and relationships). The alternative to this procedure is to grossly smooth the potential field by averaging or continuation, and to accept the long wavelength result as the equivalent to crustal definition. It can be easily demonstrated on many transects that this process is unsatisfactory, as too many components of the geology generate overlapping wavelengths.

It is also unusual to recognise pure regional trends in any profiles drawn across this region. Where trend fragments are identifiable no assurance of mantle sourcing is possible. The crustal model, once developed, was applied whatever peculiarities seemed to be posed by particular profiles. This seemingly arbitrary process frees the interpretation from multiple source uncertainty, as the concept is based on a random orientation array and is not, in itself, arbitrary. Coastal issues, at the level of the present treatment, can only be resolved in this manner.

The mantle concept implied from the total analysis, and incorporated in profile sections, was subsequently integrated,

checked, and tested. Some minor revisions were made after application of three-dimension tests. The result, titled MANTLE88, although subject to future revision is available (Leaman, 1988a). Application and recycling of the concept will enable generation of realistic residuals and more detailed, localised interpretation.

4: Other problems relate to the offshore data used. All offshore data were derived from the BMR data base, and are not part of TASGRAV. None has been fully corrected for terrain effects offshore, although most of the inshore corrections are not significant in terms of the present work. The coverage itself is variable, with coarse line spacings. It has been treated as indicative only and has not been over-interpreted.

5: A slightly smoothed version of the gravity data base has been used throughout, with some exceptions (e.g. Dial Range area). This version of the gravity field was produced as a 1:250 000 contour presentation of the data base, and explains the use of the scale in model titles. Most exceptions relate to the Cambrian granites, where the actual data set was consulted and locally contoured. Detailed inspection, with respect to the Devonian granites, has shown that the one kilometre station spacing data, where it exists, will allow a detailing improvement of up to an order of magnitude. This is particularly relevant to cupola or roof irregularity studies. Similar comments apply to the essentially under-utilised magnetics data base.

6: Because the project objectives were coarse and essentially crustal, relatively direct simple methods have been used. Models are two-dimensional and do not include subtle corrections for sources in an irregular terrain. Some more refined interpretations in Leaman (1986a, c), which have allowed for such factors, have been upgraded as part of this study with respect to the mantle model and property control. The present work, however, is approaching the usable limits of such methods. All refinement, with or without topographic source considerations, must use three-dimensional methods based on the initial model now established.

It cannot be overstressed; the model now provided is comprehensive and consistent but it is crude and merely the basic feedstock for the three-dimensional procedures which can refine it but not generate it efficiently in the first case.

7: The granites have formed an important element in the entire regional analysis. Although the present granite study is a by-product, the overall study would have been more complicated by the absence of such material. This comment reflects the volume of any granite pluton, its bulk uniformity in composition and density, and the very limited range of possible pluton densities. For example; the range covering true granites to granodiorites is only of the order of 2.59–2.71 t/m³, and most siliceous granitoids are in the range 2.59–2.64 t/m³. This means that granites can establish the contrast pattern for an entire section, or major abutting units, within ±0.02 or 0.03 t/m³. Assumption of a mean density of 2.62–2.64 t/m³ for the average western Tasmanian granite leads to a density valuation of 2.65–2.68 t/m³ for the siliceous Precambrian basement rocks, and 2.75–2.80 t/m³ for the argillaceous or dolomitic basement rocks. These are consistent, supportable, and believable values.

8: Very long model profiles have been used throughout. These allow appraisal of the interaction and influence of the large masses or volumes involved, as well as satisfying the

