COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/139

BEACONSFIELD DEEP LEAD

GRAVITY SURVEY,

TASMANIA 1964

by

A.W. HOWLAND-ROSE

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CONTENTS

		Page
	SUMMARY	
1.	INTRODUCTION	1
2.	GEOLOGY	1
3.	METHODS AND EQUIPMENT	2
4.	REDUCTION	3
5.	INTERPRETATION	3
6.	CONCLUSIONS	5
7.	REFERENCES	6

ILLUSTRATIONS

Plate 1.	Locality map showing geology and layout of traverses	(Drawing No. K55/B7-93)
Plate 2.	Bouguer anomaly contours	(K55/B7-92)
Plate 3.	Bouguer anomaly profiles	(K55/B7-94)
Plate 4.	Comparison of observed and theoretical gravity profiles, Traverses D and L	(K55/B7-95)
Plate 5.	Comparison of observed and theoretical gravity profiles, Traverse C	(K55/B7-96)
Plate 6.	Comparison of observed and theoretical gravity profiles, Traverse G	(K55/B7-104)
Plate 7.	Comparison of observed and theoretical gravity profiles, Traverse H	(K55/B7-105)

Note. This Record supersedes Progress Report No. 1964/16.

1965/139

SUMMARY

A gravity survey was made over the gold-bearing deep lead at Beaconsfield, north-east Tasmania, in order to locate the lead and determine its vertical section.

All traverses showed gravity minima, which are approximately coincident with the deepest part of the lead or slightly displaced to the south-west. The shape of the anomaly indicates that the eastern bank of the lead is steeper than the western bank.

It appears that deep weathering, which may be associated with the continuation of the auriferous lead, is present north-west and south-east of the town.

1. INTRODUCTION

The past prosperity of the Beaconsfield gold field, in the north-east of Tasmania, was based on the Tasmania reef, which was discovered in 1877. Until work ceased in 1914, about 854,600 oz of gold were won from 1,067,556 tons of ore. In addition to the reef gold, alluvial gold was also worked down to a false bottom at 112 feet, but it appears that the quantity of alluvial gold recovered was of relatively minor importance. At the request of the Tasmanian Mines Department, the Bureau of Mineral Resources made a gravity survey, between 19th March and 10th April 1964, over the gold-bearing deep lead at Beaconsfield in an attempt to delineate the course of the lead.

The survey was made by the author and one field assistant, and the traverses were pegged and levelled by D.J. Sheaves and two chainmen from the Department of the Interior, Canberra.

2. GEOLOGY

The general geology of the area and the positions of the auriferous quartz reefs and the deep lead are shown in Plate 1.

The main feature of the area is Cabbage Tree Hill, along the south-western side of the town of Beaconsfield. It is composed of rocks of probably Ordovician age; the crest consists of coarse-grained grits or fine quartz conglomerate alternating with beds of hard metamorphic sandstone, known collectively as the Cabbage Tree Hill Conglomerate (Noldart, 1964), which is conformably overlain on the north-eastern flank of the hill by members of the Caroline Creek Sandstone.

To the north-east of Cabbage Tree Hill are the Tertiary deposits of the deep lead followed by Tertiary residual soils. Beneath these Tertiary deposits are rocks of Lower Silurian or Ordovician age, consisting of beds of Gordon Limestone, beneath the deep lead, and layers of slate, sandstone and limestone, which overlay the Gordon Limestone to the north-east (Montgomery, 1891). The exact positions and extents of these rocks are not known.

The Ordovician and Ordo-Silurian rocks form a conformable series, the Cabbage Tree Hill Series, striking approximately north-west and dipping to the north-east at between 45° and 65° (Hughes, 1953).

The auriferous quartz reefs at Beaconsfield are thought to consist of two distinct reefs: the Tasmania reef, which strikes at about N50°E, dips south-east, and lies within the Caroline Creek Sandstone; and the Moonlight-cum-Wonder reef, which strikes about N55°W, dips south-west, and lies within the Cabbage Tree Hill Conglomerate. The richer of the two reefs was the Tasmania reef, which caries from a few inches to about twenty-five feet in width, is about 1300 feet long, and was mined to a depth of 1500 feet. Both reefs were rich in the upper portions, but especially the Tasmania reef, where, from the 400-ft level to the surface, values averaged about 25 dwt per ton.

The deep lead is probably in an old river valley that was formed in Tertiary times when the area was at a higher elevation (relative to sea level) than it is today. From borings and old workings, unweathered bedrock is known to be at a depth greater than 270 feet below the present sea level. Where the positions and depths of bedrock are known, they have been marked in Plate 1. However, as many of the workings had long been abandoned even in 1891 (Mongomery, 1891), the actual sites are only inferred.

The channel was eroded through auriferous Ordo-Silurian rocks, and a large portion of the Tasmania reef has been eroded and sluiced into the old channel. As the Tasmania reef was being eroded, so were other reefs on Cabbage Tree Hill, and this gold also found its way into the old river. As more recent gravels derived from Cabbage Tree Hill have been found to be auriferous, it is thought that the lead must contain rich gravels as more sorting and concentration would have taken place (Montgomery, 1891).

The lowest alluvial workings were 112 feet below ground level, on a false bottom of black ligneous clay, which contained plant remains of Upper Tertiary age. It appears that no deeper workings in the deep lead were attempted, although the Ophir Company put down two drill holes, 286 feet and 375 feet to bedrock, and Montgomery (1891), commenting on evidence from the drill holes, concluded: "If these results are reliable the richness of the lead would be phenomenal". Montgomery also states that the false bottom contained "a good deal of gold", and the "high reef" (the bedrock forming the sloping sides of the old channel) were "fairly payable".

Unfortunately, no records are available now regarding later work on the alluvial deposits, and it seems likely that, as there were rumours about possible salting of the Ophir bores (Montgomery, 1891), little work was done after this time. Montgomery, however, concludes that "there are good a priori reasons for thinking that the lead ought to be richly auriferous".

3. METHOD AND EQUIPMENT

The gravity method detects variations in the Earth's gravitational field due to variations in density of the rocks at depth. Thus if the densities of the rocks are known, then their relative positions may be indicated provided the density contrasts are sufficiently great.

Because the unconsolidated material filling the lead channel is less dense than the unweathered bedrock, the position of the lead will be shown up by a gravity 'low', the extent and magnitude of which should indicate approximately the width and depth of the lead.

A Sharpe gravity meter, No. 145, having a sensitivity of 0.10637 milligals per scale division, was used in the field work.

4. REDUCTION

Gravity readings were corrected for drift in the usual manner, by taking readings at a base station at intervals of not more than one hour, and using the results to establish a drift curve.

The elevation correction corrects for natural decrease in gravity with increase in elevation above sea level. The correction is proportional to height above a given reference level (in this case mean sea level) and the density of the intervening material; the density chosen was $2.2 g/cm^3$.

The latitude correction takes into account the increase in gravity from the equator to the pole. The latitude correction was taken from the "International Tables" (Nettleton, 1940) and amounted to 1.295 milligals per mile. The base station used for latitude correction was zero grid position on Traverse D, where the latitude is approximately $41^\circ 12'$.

5. INTERPRETATION

Bouguer anomaly contours are shown in Plate 2 and Bouguer anomaly profiles in Plate 3.

The main feature of the results is a continuous gravity 'low', corresponding roughly in position with the Gordon Limestone. As this is the densest rock occurring in the area, the gravity 'low' must be due to a buried valley or zone of deep weathering. In general, the gravity minima correspond reasonably closely with the position of the lead as mined.

The Bouguer anomaly profiles for Traverses D and E, C, G, and H were compared with theoretical profiles (Plates 4-7), which were computed from assumed geological cross-sections. The sources of the geological information used in these assumed cross-sections were Montgomery (1891), Hughes (1953), and Noldart (1964).

The instrument used to compute the gravity profiles due to the assumed geological cross-sections was a vertical section integrator (Olbrich, in preparation). An average density was assumed for each group of strata. The densities used are as listed in Table 1, and are based on densities determined from samples collected in the field.

TABLE 1

Densities of rocks in the Beaconsfield area

Rock type	Density in g/cm^3
Cabbage Tree Hill Conglomerate	2.35
Caroline Creek Sandstone	2.25
Gordon Limestone	2.70
Shales	2.35
Weathered shales	1.95
Deep lead gravels, sands, clays, etc.	1.95

The dip of the strata was taken as 55°E and the width of the limestone was taken to be 300 to 400 feet.

The constructed gravity effects due to assumed geological cross-sections were compared with the observed gravity profile for each traverse and the geological configuration progressively adjusted until a reasonable conformity was obtained.

Traverses D and L

The first assumed geological section (Plate 4) was based on Montgomery's section across Cabbage Tree Hill (Montgomery, 1891). The bedrock at the deepest part of the lead was assumed to be approximately 370 feet below the surface. Of necessity, the section was simplified, but it can be seen that the eastern portion gives good agreement with the observed gravity profile.

Section 2 was constructed by changing the configuration of the western slope of the lead and also the width and position of the limestone. This gives better agreement, but the negative portion at 450W is still not explained completely; it may be due to a fault that is undetectable on the surface.

Traverse C

The maximum depth to bedrock assumed in this case was 400 ft. Progressive adjustments were made to the cross-section (Plate 5), and it will be seen that Section 3 gives a better conformity with the observed gravity profile than Sections 1 and 2.

Traverse G

On this traverse, there are no outcrops in the vicinity of the lead; therefore the positioning of the lead is rather more uncertain than for Traverses C and D. Two sections (Plate 6) were drawn up with maximum depths to bedrock of 420 and 490 feet. The anomalies indicate that the correct geological structure is probably somewhere between the two assumed sections. The negative anomaly between 1200W and 1400W could be explained by a depression in the bedrock as shown in Section 2.

It appears that the lead at this point has a more steeply dipping eastern bank, and is probably deeper than on Traverses C and D.

Traverse H

The positioning of the geological strata for this cross-section (Plate 7) is more uncertain. The lead channel probably occurs at about 1600W or 1800W. Caroline Creek Sandstones crop out at 2100W and conglomerate of density 2.6 g/cm^3 crops out at 2600W. It seems likely from the observed profile that there may be a slight depression in the bedrock between these two outcrops.

Section 2 gives reasonable agreement with the observed gravity, and it appears that the bedrock in the vicinity of this traverse is not so deep (about 250 feet), and the banks of the channel not so steep, as further south.

Traverses A, J, and K

These traverses were placed south-east of the town in an area where it was thought the Gordon Limestone would not be far below the surface, and where there was no previous evidence of the presence of the lead. However, the observed profiles over these traverses are similar to those in the town area. As the limestone has not actually been seen in outcrop on Traverses A and J, it seems likely that deep weathering has occurred in the limestone. This may be associated with an auriferous lead.

6. CONCLUSIONS

The gravity 'low' shown in the Bouguer anomaly contour map (Plate 2) agrees with the position of the deep lead as indicated by Montgomery (1891) and shown in Plate 1. Montgomery shows the lead to have its greatest width near Traverse F, whereas the gravity results indicate the greatest width of the channel to be at Traverse E.

From the comparison of observed and theoretical gravity profiles (Plates 4 to 7) and from drilling information on the Ophir bores on Traverse F (Plate 1), it appears that the deepest part of the bedrock is not quite coincident with the lowest value on the gravity profile, but is displaced slightly to the north-east, and that the lead has a steeper slope on its eastern bank than on its western bank.

In addition it appears probable that the lead continues to the north-north-west and south-south-east of the town as indicated in Plate 2.

Drilling to the lead gutter down-stream from the Tasmania reef (i.e. to the north-west) is recommended. Montgomery in 1891 thought further investigations for alluvial gold would prove successful, but there is no evidence of any further investigations having been made.

7. REFERENCES

HUGHES, T.D. 1953 The Beaconsfield and Lefroy Goldfields. In GEOLOGY OF AUSTRALIAN ORE DEPOSITS. Aust. Inst. Min. Metall.

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NOLDART, A.J. 1964 Notes on auriferous deposits, Beaconsfield Goldfield. Dep. Min. Tas. Tech. Rep. No. 8, 1963.

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PLATE 1
LOCALITY MAP
REFERENCE TO AUSTRALIA STANDARD MAP SERIES: LAUNCESTON
TASMANIA
LEGEND
Depth of bedrock below ground level
Known fault (approx. position)
Probable fault
Upper Tertiary
Alluvial gravel, clays and sands of the deep lead (after Montgomery, 1891)
Greywacke
Keratophyre
Ordo-Silurian
Slates and shale
Probable position of sub-surface limestone (Gordon Limestone)
Ordovician
Sandstones (Caroline Creek Sandstone)
Cabbage Tree Hill Conglomerate
Auriferous quartz reefs (after Montgomery, 1891)
Shaft
Quarry
Geophysical traverse with stations
GEOPHYSICAL SURVEY, BEACONSFIELD, TAS 1964
PLAN SHOWING TRAVERSES AND GEOLOGY
(AFTER MONTGOMERY, 1891 AND NOLDART, 1964)
FEET
TRAVERSE H
TRAVERSE G
TRAV. F
TRAVERSE E
TRAV. L
TRAV. D
TRAVERSE C
TRAVERSE B
TRAV. K
TRAVERSE A
TRAVERSE J
CABBAGE TREE HILL
Dense dark grits and conglomerates
Soft dark sandstones
Sandstones with conglomerates
Weathered Shale
Flooded limestone quarries
Swamp
To Launceston
From Beaconsfield
To Flower Gully
(Based on K55/B7-91)
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.
K55/B7-93
TO ACCOMPANY RECORD No. 1965/139

BOUGUER ANOMALY CONTOURS

(DATUM ARBITRARY)

(Based on K55/B7-91)

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K55/B7-92

TO ACCOMPANY RECORD No. 1965/159

PLATE 3

BOUGUER ANOMALY PROFILES AND SURFACE ELEVATIONS

(DATUM ARBITRARY)

FEET

400 0 400 800 1200

Vertical scales as shown
Density used in Bouguer correction = $2 \cdot 2\ g/cm^3$

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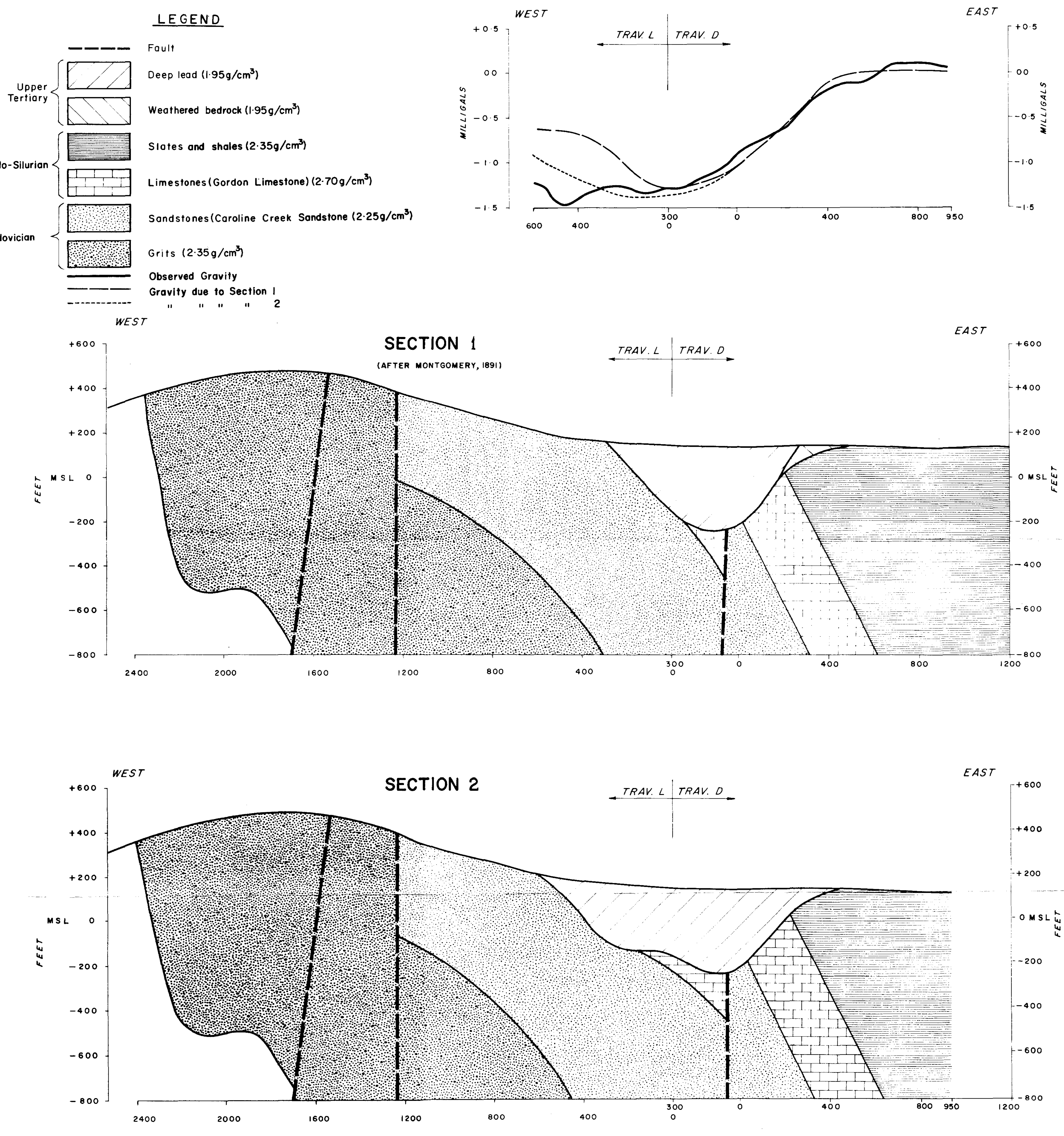
K 55/B7-94

TO ACCOMPANY RECORD No. 1965/139

Beaconsfield Tas. Study 1964



FEET
400 0 400 800 1200
Vertical scales as shown

COMPARISON BETWEEN OBSERVED AND THEORETICAL GRAVITY PROFILES ON TRAVERSES D AND L

PLATE 4

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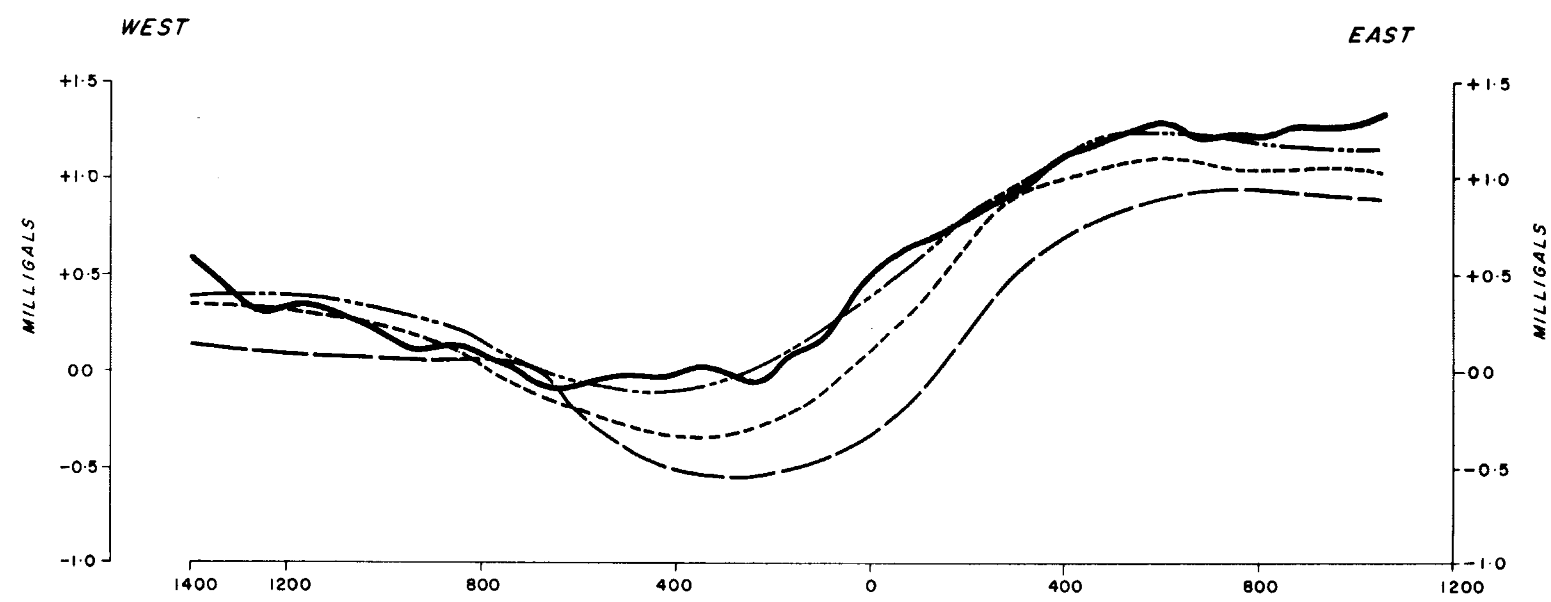
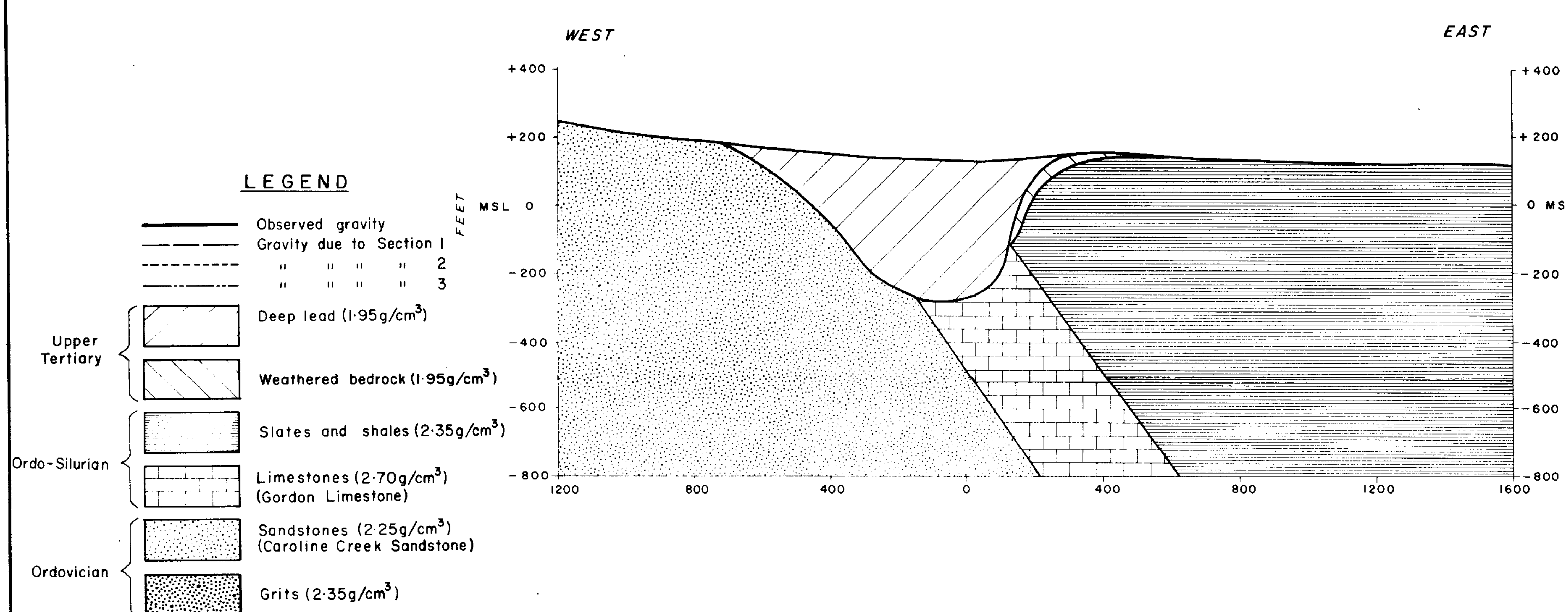
K 55/B 7-95

TO ACCOMPANY RECORD No 1965/139

Beaconsfield, Tas. Gravity 1964



SECTION 1



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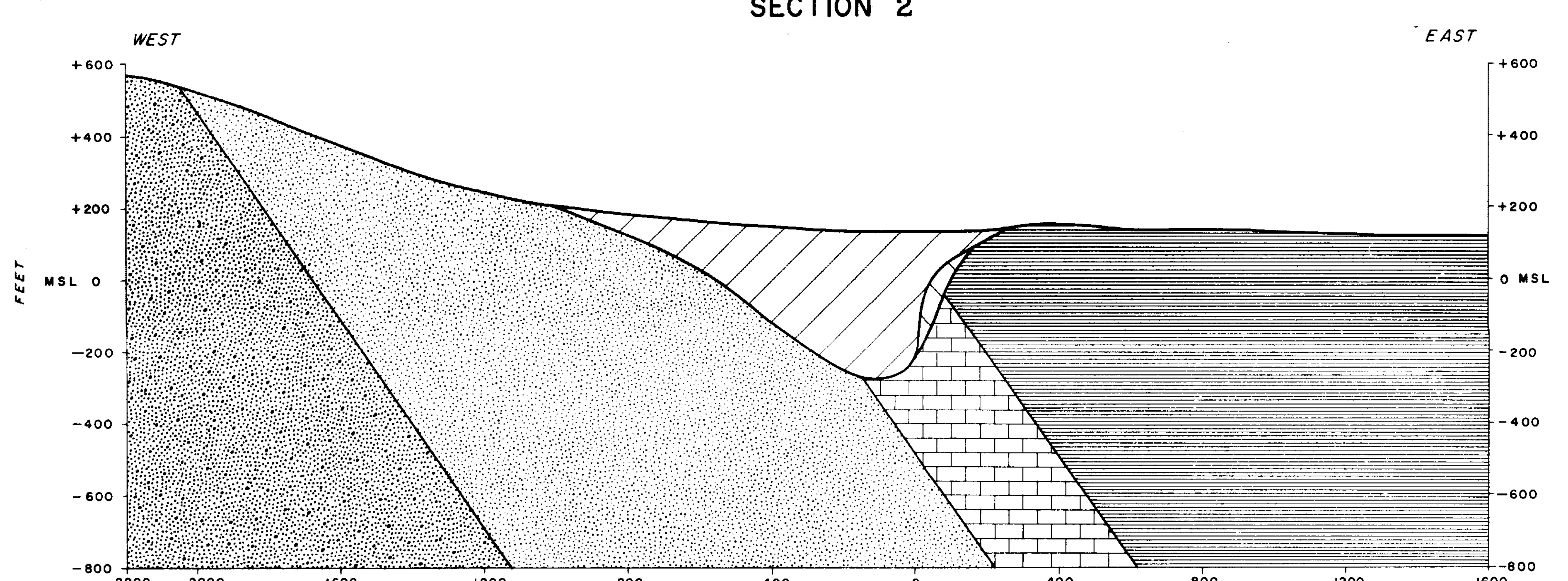

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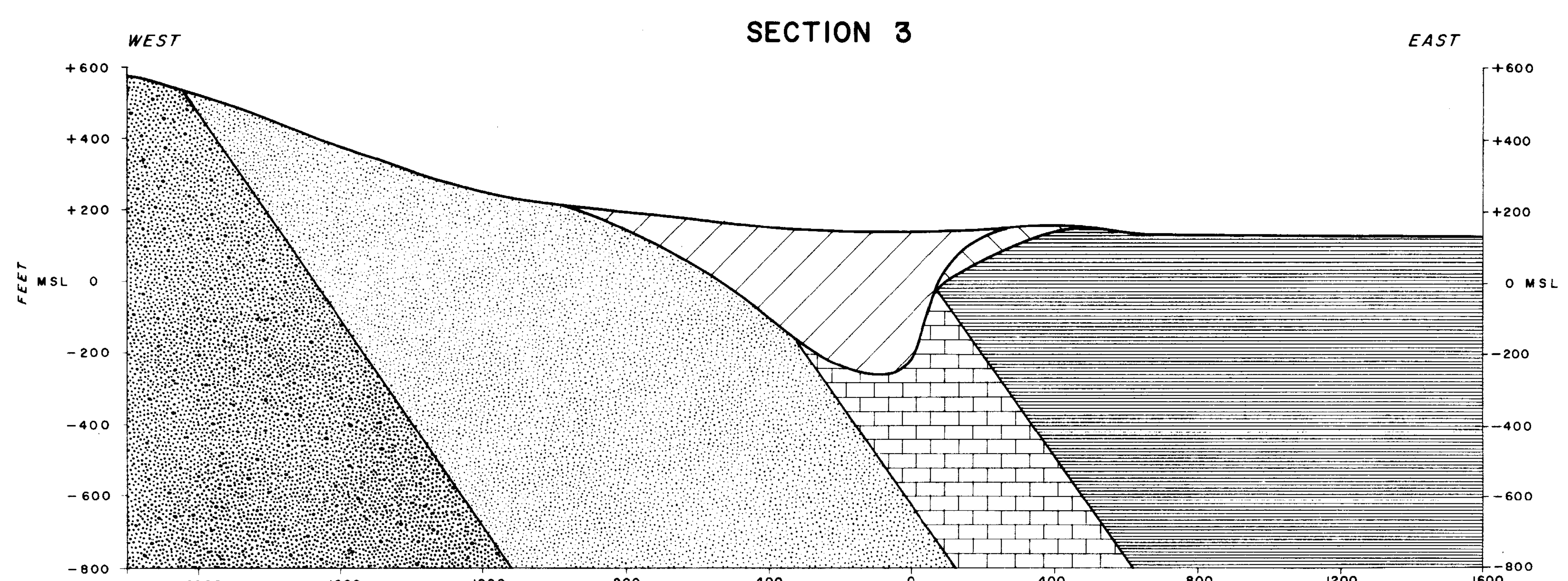


FEET

400 0 400 800 1200

Vertical scales as shown

COMPARISON BETWEEN OBSERVED AND THEORETICAL GRAVITY PROFILES ON TRAVERSE C

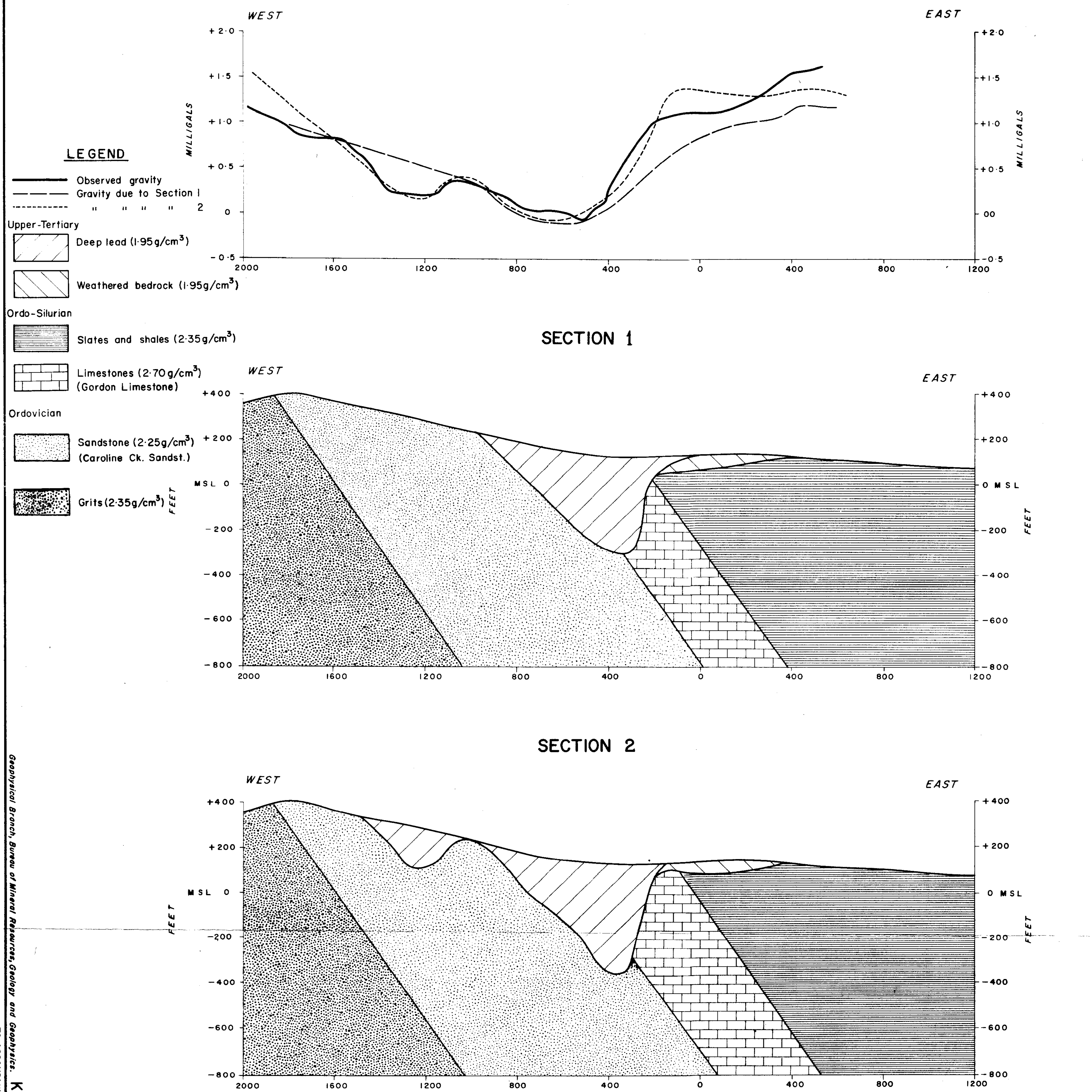
PLATE 5

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

K55/B7-96

TO ACCOMPANY RECORD No. 1965/139

Beaconsfield Tas. Gravity 1964



COMPARISON BETWEEN OBSERVED AND THEORETICAL GRAVITY PROFILES ON TRAVERSE G

FEET

400 0 400 800 1200

Vertical scales as shown

PLATE 6

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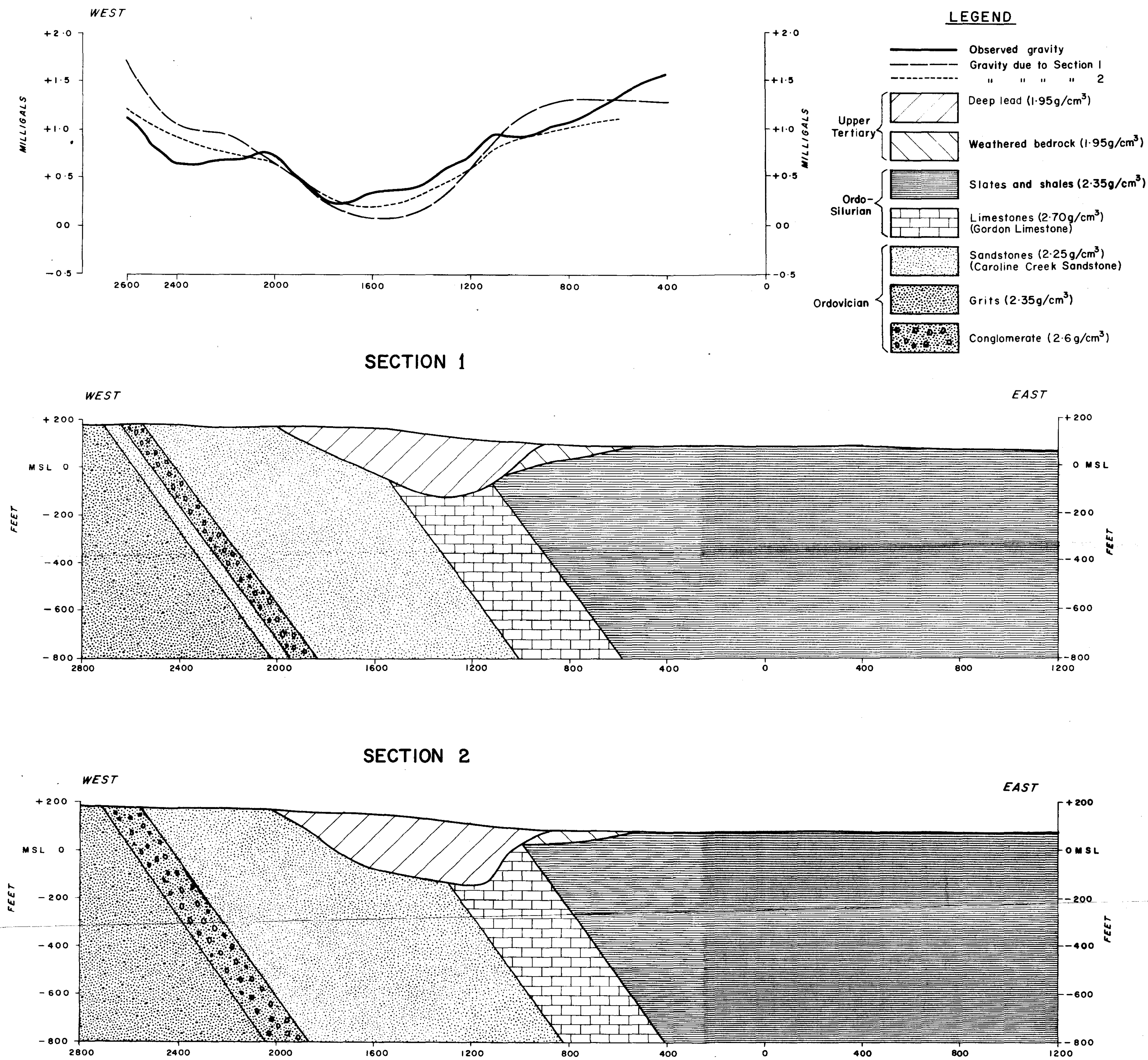
K55/B7-104

TO ACCOMPANY RECORD No.1965/139

Beaconsfield Tas. Survey 1964



COMPARISON BETWEEN OBSERVED AND THEORETICAL
GRAVITY PROFILES ON TRAVERSE H

FEET
400 0 400 800 1200
Vertical scales as shown

PLATE 7

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. K55/B7-105

TO ACCOMPANY RECORD No. 1965/139