DEPARTMENT OF
MINERALS AND ENERGY

# BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS



Record 1973/85

# GRAVITY SURVEYS IN THE BILLYS CREEK/MIDDLE CREEK/ HAZELWOOD AREA, GIPPSLAND, VICTORIA, 1960

by

G.F. Lonsdale and L.M. Hastie

Record 1973/85

# GRAVITY SURVEYS IN THE BILLYS CREEK/MIDDLE CREEK/ HAZELWOOD AREA, GIPPSLAND, VICTORIA, 1960

by

G.F. Lonsdale and L.M. Hastie

## CONTENTS



## PLATES

## FOREWORD

The Bouguer anomaly maps in this Record are contoured at closer spacing than is strictly justified by the gravity measurements, and are thus somewhat subjective. It is not BMR policy to prepare contour maps in this way, but this report was written many years ago and is issued now to place the findings of the survey on record.

## SUMMARY

This Record describes the results of two gravity surveys carried out by the Bureau of Mineral Resources in the adjoining Billys Creek/Middle Creek and Hazelwood areas of Gippsland, Victoria during 1960.

The purpose of the Billys Creek/Middle Creek survey was to obtain more complete gravity coverage over a portion of the anomaly plan available from earlier gravity work, as an aid to the elucidation of local structure and suggested faulting.

The Hazelwood survey was carried out to investigate in more detail a domal structure partly delineated by drilling.

The gravity data have been interpreted in terms of the known geology and some conclusions are drawn concerning the thickness and structure of the Tertiary sediments in the survey areas.

# 1. INTRODUCTION

Gravity surveys have been carried out by the Bureau of Mineral Resources (BMR) in the Latrobe Valley of Gippsland, Victoria, since 1948 to investigate the structure of brown coal measures.

At the request of the State Electricity Commission of Victoria (SEC) a semi-detailed gravity survey was carried out south of Morwell in the Billy's Creek/Middle Creek area (Plates 1, 2) during January 1960 by G.F. Lonsdale and A. Douglas. The purpose of this survey was to provide more complete coverage on a gap in the anomaly plan available from earlier gravity work, and to establish in more detail Bouguer anomalies in relation to local structure and in particular in relation to suggested faulting.

The survey area extends east from Yinnar over a distance of 6 miles on either side of the two creeks. It is bounded to the north by Switchback Road, to the east by the Jeeralang West road, to the south by the Boolarra-Welshpool road, and to the west by the Boolarra-Morwell road.

147 new gravity stations were established at about 1/4-mile intervals along all available secondary roads and bush tracks. Ties were made to 3 stations read on previous surveys, to provide control for the results. The surveying, levelling, and preparation of base maps were done by the SEC's Brown Coal Investigation Branch, Traralgon.

In December 1960 a detailed gravity survey was carried out in the Hazelwood area (Plate 2), immediately north of the Billys Creek/ Middle Creek survey area, by G.F. Lonsdale assisted by A. Distel, a university vacation student. The purpose of this survey was to obtain gravity information over the Hazelwood Dome, a structure trending north east and partly delineated during the drilling program of the SEC and referred to in the statement: 'another structure of which there is little evidence on the gravity maps is the Hazelwood Dome' by Gloe (1960). At the time of this statement practically no gravity work had been done in that particular locality.

The Hazelwood survey area extends 3½ miles east from the Morwell-Yinnar Road and 1½ miles north and ½ mile south of Switchback Road. In view of the suggested northeasterly axial trend of the Hazelwood Dome a number of north-south traverses were planned to cross the suggested axis. These used roads and tracks wherever possible, but it was also necessary to site some traverses across paddocks in order to obtain a sufficient station density. Five of these traverses were made with a station interval of 300 ft, the traverses being about half a mile apart.

93 new stations were established during the survey, and ties were made for gravity control to 7 stations established along Switchback Road during the Billy's Creek/Middle Creek survey. The SEC's Brown Coal Investigation Branch again undertook the preparation of base maps. For further technical detail relating to the conduct of the field work, the equipment taken to the field, and the performance of the instruments used for taking gravity observations the reader is referred to Appendix 1.

## 2. TOPOGRAPHY, GEOLOGY, AND STRUCTURE

In the combined survey area (Plate 1) the topography shows an increase in elevation from the lowlands of the Morwell River in the northwest, with an average of about 200 ft, to timbered hills in the south and east, with an average of about 700 ft and rising to a maximum of over 1625 ft in the extreme southeast.

Two major topographic features are the valleys of Billys Creek and Middle Creek, both of which follow a general northwesterly course across the survey area with steep and narrow valleys in the southeast, becoming broader to the northwest.

The geology of the Latrobe Valley Tertiary basin has been recently described by Gloe (1960). A brief account of the geology of the Gippsland Basin as a whole with reference to the results obtained by recent deep drilling for petroleum and offshore geophysical exploration has been given by Neumann and Lonsdale (1973).

The major tectonics of the survey area and surroundings, based on geological and gravity data, are shown in Plate 1. This plate shows Tertiary terrestial sediments of the Latrobe Valley Tertiary basin (Gloe, 1960) cropping out to the northwest of a high-standing block of Jurassic rocks.

The Tertiary sediments are clay, sand, and thick brown coal seams. Beneath these brown coal measures the 'commercial basement' is formed by early Tertiary volcanics and/or Jurassic continental arkosic sandstone.

Beneath the Jurassic rocks, and exposed only in a small fault-controlled outcrop west of Boolarra in the southwest of the survey area, are Ordovician rocks (Plate 7). The structure in the area around Boolarra has been described in more detail by Thomas & Baragwanath (1951).

Geological mapping and drilling, together with the results of earlier gravity investigations, have indicated the presence of a number of structures aligned in a general northeasterly direction across the survey area (Plate 7). From the northwest, these structures are:

The Morwell Anticline, which follows the line of the Mirboo-Morwell railway near Hazelwood siding.

The Morwell Fault, which follows the Mirboo-Morwell road in the northern part of the survey area and lies ½ mile southeast of the Morwell Anticline. The fault has downthrow to the southeast.

The Traralgon Syncline, known to extend northeast from Eel Hole Creek to beyond the survey area.

The Hazelwood Dome, a small structure located by SEC's drilling southeast of the Traralgon Syncline in the north-central part of the survey area.

The Bennetts Creek Fault, a minor fault with downthrow to the northwest, situated southeast of the Hazelwood Dome and known only in the eastern part of the survey area.

The Jeeralang Fault, with downthrow to the northwest, situated southwest of the Bennetts Creek Fault and suggested from gravity data to occur in the eastern part of the survey area.

The Boolarra Fault, with downthrow to the northwest, situated southeast of the Morwell Fault in the western part of the survey area. This fault may form a continuation of the Jeeralang Fault.

An unnamed horst-like feature, known in the western part of the survey area and situated southeast of the Boolarra Fault. Ordovician rocks crop out on this structure.

The Budgeree Fault, with downthrow to the northwest, which forms the northwestern boundary of the Jurassic sandstone outcrop area. According to gravity data, this fault appears to be displaced by a cross-structure near its intersection with Middle Creek.

## 3. REDUCTION OF GRAVITY DATA

The over-all results of the two gravity surveys are presented in Plate 2 in the form of Bouguer anomaly contours over the Mirboo North One-mile Sheet area. The Bouguer values are based on the assumption of a near-surface rock density of 1.9 g/cm$^3$. In more detail the Bouguer anomalies of the Billy Creek /Middle Creek and Hazel Dome areas are shown at larger scale in Plates 3 and 4, respectively. Plates 2, 3, and 4 have been supplemented by the inclusion of gravity survey results obtained by BMR from 1948 to 1953.

Gravity anomaly contours presented in Plates 2, 3, and 4 are based on relative values referred to an arbitrary gravity datum. The observed gravity value of the nearest BMR Pendulum Station located at Yarram in Southern Gippsland was determined during the course of the 1950-51 pendulum survey (Dooley et al., 1961). The observed gravity value at this station which as revised in 1962 is 980 022.4 mGal. From the Bouguer anomalies shown in Plates 2-4 approximately 5 mGal must be subtracted in order to obtain values referred to the international system.

For each gravity-meter station the readings were corrected for instrument drift by plotting a drift curve based on the results of repeated readings at a base station. The drift-corrected readings were then converted into milligals by using the instrument calibration factor.

In order to isolate anomalies due to near-surface structural features it is necessary to eliminate the deeper-seated gravity effects. The method used for the purpose of this report is fundamentally that described by Griffin (1949). This method defines the regional gravity anomaly at a given point in terms of the average value of gravity around a circle centred at that point. The regional value is subtracted from the actual value of gravity at the chosen point, thus leaving the value of residual gravity.

Naturally, the value of the regional gravity at any point depends on the radius of the circle used. With a small radius the residual pattern mainly includes very local anomalies. As the radius increases a greater part of the more widespread anomalies is included in the residual gravity pattern. With the radius suitably chosen, regional effects can be largely eliminated. The residual contour pattern then consists chiefly of such anomalies as are of interest in the elucidation of local geological structure.

Residual gravity values are determined for a number of points set on a square grid. The size of this grid must be chosen to approximate the station density in the survey area; e.g. in the Billys Creek/Middle Creek area the station density is about 1 station per 1/4 square mile. Accordingly a ½ mile grid of interpolating points was chosen.

For further detail concerning the Griffin reduction method, the reader is referred to Appendix 2.

## 4. INTERPRETATION OF GRAVITY RESULTS

### Bouguer anomaly picture

Past gravity experience in the Latrobe Valley of Gippsland suggests that in this area the gravity anomalies may be mainly interpreted as representing structural deformities on the base of Tertiary sediments of a density 1.9 $g/cm^3$ overlying a basement of approximately 2.5 $g/cm^3$ density (Neumann, 1951). The basement in this case is Jurassic arkosic sandstone and/or Eocene basalt. Consequently the structural deformities in the coal beds may be assumed to coincide with the topographic relief of this basement.

The narrow gravity ridge that trends northeast across the north-western portion of Plates 2-4 has been interpreted as the gravity expression of the Morwell Anticline, which is suggested to contain a core of relatively dense rocks, probably including some basalt underlain by Jurassic beds.

The steepest section of gradients bounds this gravity ridge to the southeast and can be interpreted as indicating the position of the Morwell Fault. The northeast-elongated gravity trough that follows the steepest gradients to the southeast has been interpreted as the expression of a syncline, which probably represents a southwesterly extension of the Traralgon Syncline (Plate 1).

The large area of low Bouguer anomaly values and little variation in the central to northeastern portion of Plates 2-4 will be discussed in more detail later. The Bouguer anomaly pattern suggests that this area is a shelf on which fairly thick Tertiary sediments are present with little structural relief.

The significant gradient trend in the area between Bennetts Creek and Middle Creek, which bounds the above gravity low to the southeast, has been interpreted as indicative of a fault with downthrow to the northwest. For this feature the name 'Jeeralang Fault' is proposed.

The Jeeralang Fault appears to be a southwesterly continuation of the Bennetts Creek Fault and a northeasterly continuation of the Boolarra Fault. The Jeeralang Fault deviates, according to gravity data, towards the northwest in the area between gravity stations 60-77 and 60-81 (Plate 2). It is suggested that this deviation is caused by two northwest-striking faults which form the boundaries of a sunken area parallel to the axis of Middle Creek Valley. This feature will also be discussed in more detail later.

Southwest of the deviation of the Jeeralang Fault between stations 60-77 and 60-81, steep gravity gradients indicate the position of the Boolarra Fault and step-faults parallel to the Boolarra Fault.

Residual anomalies

To further analyse the gravity data, the Griffin procedure has been used, as mentioned above, to separate the local anomaly features caused by smaller structures from larger gravity variations produced by major tectonics. The results of this analysis are shown in Plates 5 and 6.

In the Billys Creek/Middle Creek area a radius of 0.8 miles was chosen for the averaging circle in order to isolate anomalies up to about 1 3/4 miles in width. From the residual gravity values thus determined the contour plan, Plate 5, was drawn.

For the Hazelwood area, where the station density is approximately 16 stations per square mile, a 1/4 mile grid was used. The radius chosen for the averaging circle was 0.4 miles, in order to isolate anomalies up to about 7/8 mile in width. The residual gravity contours in this area are shown in Plate 6.

The effect of reducing the radius of the averaging circle is illustrated by the comparison of Plate 6 with the northern portion of Plate 5.

Because the density of stations over the Billys Creek/Middle Creek and Hazelwood areas is not consistent, a residual reliability diagram has been added to both Plates 5 and 6 showing the areas in which the density of gravity stations is greater or less than the optimum for residual calculations using the grid chosen for that particular area.

The main features of the residual anomaly map of the combined survey areas (Plate 5) are described below.

In the northwest portion of Plate 5 a northeast-elongated ridge of relatively high residual gravity values delineates more precisely the position of the Morwell Anticline or, more exactly, the core of denser rocks composed of basalt and Jurassic sandstone which have been suggested to occur under the coal measures. This gravity ridge is accompanied on either side by residual gravity lows. A linear trend of steepest gradients terminates this gravity ridge to the southeast. This trend extends northeast from near Yinnar into the area immediately west of the Mirboo to Morwell road. As on the Bouguer anomaly maps (Plate 2-4) this trend in the residual anomalies can be interpreted as indicating the Morwell Fault. Similarly, the elongate gravity trough of residual gravity anomalies (Plate 5) which accompanies the trend of steepest gradients to the southeast probably indicates a southwesterly extension of the Traralgon Syncline.

On the residual anomaly map (Plate 5) this trough terminates northwesterly a large area of little gravity variation, which, on the Bouguer anomaly plans, appears as a large gravity low. However, the map of residual anomalies discloses a closed gravity high immediately west of Middle Creek and also a gravity high, elongate north and northeast, which occurs on both sides of Eel Hole Creek in the area of the Hazelwood Dome. These gravity highs probably both indicate gentle doming in the denser basement rocks beneath the coal measures.

Southeast of these two high residual gravity anomalies a narrow strip of low residual gravity values occurs, which widens northeasterly. This low is probably related to a downwarp in the basement rocks. In turn this low is bounded by a continuous trend of relatively steep gravity gradients extending east and northeast from the western margin of the map area (Plate 5) near Belbrook Creek. The strike direction of this gradient trend is distinctly indicated by the zero-contour line. This trend in the gradients terminates to the northwest a large area of generally high but somewhat irregular anomaly features farther south. Considering this group of anomalies as a whole, it can be interpreted as the complex of residual gravity anomalies caused by the high-standing faulted block of Mesozoic rocks known from outcrops in the hilly areas of the Strzelecki Ranges in the northern portion of the map area (Plate 5).

The area of mainly high anomalies reviewed is intersected southeast of stations 60-81 and 60-62 by a major residual gravity low, which occurs in the hilly area along Middle Creek Valley. This feature is shown in Plate 5 as bounded by parallel contour lines on either side of the valley, and the residual anomaly picture supports in a more convincing manner than that of the Bouguer anomalies the suggested geological interpretation of this gravity low. This residual low anomaly can be interpreted as caused by a graben filled with sediments of lesser density and bounded along faults by higher-standing blocks of older and denser rocks.

The Budgeree Fault (Plate 7) which forms the northwestern and northern boundary of outcrops of Jurassic arkosic sandstone in the higher altitudes of the Strzelecki Hills is not distinctly discernible in the pattern of residual gravity anomaly contours. Perhaps the gravity high near the southern margin of the map area (Plate 5) south of Middle Creek Valley can be interpreted as caused by a block of denser rocks terminated to the northwest by a fault which may be related to the Budgeree Fault.

In the area west of Middle Creek and on both sides of Belbrook Creek is a sharp gravity ridge with high residual values. This anomaly is obviously caused by older and denser rocks of Ordovician age, which form a small horst west of Boolarra. This gravity ridge is terminated southeasterly by a relatively small gravity low elongated northeast. This low probably indicates a structural low of limited extent covered with younger sediments less dense than the higher standing blocks of Ordovician and Jurassic rocks in its immediate vicinity.

Plate 6 shows residual anomaly contours based on data obtained from the use of smaller grid and averaging circle radius than those used on Plate 5. Naturally the anomaly picture provides more detailed information on the major structure of the Morwell Anticline and also on the Hazelwood Dome of lesser structural relief. Generally in Plate 6 the pattern is more detailed than that in the central and northeastern portion of Plate 5.

The northeast-striking gravity ridge which has been related to the Morwell Anticline is shown in Plate 6 to have a number of small culminations along its axis. Similarly the gravity trough which bounds this ridge to the southeast is shown in Plate 6 to include a number of small gravity 'deeps'. There could be due to smaller cross-faults, perpendicular to and superimposed on the major features of the Morwell Anticline and Morwell Fault.

It has been suggested above that the large area of little gravity variation between the expected extension of the Traralgon Syncline and the Jeeralang Fault is a shelf area on which fairly thick Tertiary sediments are present with little structural relief. A more precise interpretation of local structures which occur in the Tertiary sediments can be attempted as a result of the more detailed residual anomalies of this particular area shown in Plate 6.

A section across the Hazelwood Dome is shown in Plate 8, in order to further illustrate the correlation of gravity data and the results obtained by drilling for coal. In this cross-section the Hazelwood structure reaches its highest point near bore 715H at a locality which is low in both Bouguer Anomaly and residual gravity.

It is suggested that the residual anomaly is directly related to the varying thickness of the Tertiary sediments, and it would seem probable that the gravity low at the highest point of the Hazelwood Dome is caused by the presence of thicker low-density coal measures. This increase in thickness in the coal beds could possibly be explained by warping in the upper coal beds rather than displacement by faulting. Consequently the Hazelwood Dome, according to gravity data, could be considered a superficial structure in the low-density Tertiary sediments rather than a structural deformity in the denser basement of older rocks. If this is correct, it could be postulated that the axis of the Hazelwood Dome is related to the axis of the residual gravity anomaly trough which elongates northeast and extends from near bore B114 to a point beyond station HO71 (Plate 6).

Northwest of this trough the gravity values disclose a northeast-elongated gravity ridge between stations 61-53 and station H30. A similar gravity ridge occurs southwest of the trough mentioned from the area north of Billy Creek to beyond station 193. Farther southeast a number of smaller northeast-striking ridges and troughs are shown on the residual gravity anomaly plan (Plate 6), which are probably related to folding and small faults in the Tertiary sediments.

## 5. CONCLUSIONS

From the interpretation of gravity data the presence of a number of structures has been suggested, generally with a northeastly trend.

Morwell Anticline and Morwell Fault are distinctly indicated on the Bouguer anomaly map and are more precisely delineated on the residual anomaly contour map.

Residual anomaly data obtained by the Griffin method provide more detailed information on the possible relation between gravity anomaly and local structure, mainly in the area of thick Tertiary sediments east of the Morwell Fault. One of these structures, the Hazelwood Dome, coincides with a gravity low elongated northeast. From the gravity results it is suggested that superficial warping in the sediments causes the doming in the upper beds under the Hazelwood Dome rather than faulting in the deeper basement rocks. Some warping in the basement complex under the coal measures is possible.

The gravity pattern suggests that the Jeeralang Fault is a southwesterly extension of the Bennetts Creek Fault and a northeasterly continuation of the Boolarra Fault.

A northeast-striking horst of denser Ordovician rocks in the area east of Boolarra produces high residual and Bouguer anomaly values, bounded by steep gradient trends.

Low residual gravity values extending southeast parallel to the axis of Middle Creek Valley suggest the existence of a sunken area with sediments of lesser density, terminated by southeast running faults. These faults intersect and partly displace the Boolarra-Jeeralang faults.

The Budgeree Fault, mapped from surface geology in the higher country south of the survey area, lacks gravity expression probably because of the absence of a significant density contrast between the Jurassic sandstone and Tertiary volcanics which occur along this fault.

## 6. REFERENCES

DOOLEY, J.C., McCARTHY, E., KEATING, W.D., MADDERN, C.A., & WILLIAMS, L.W., 1961 - Pendulum measurements of gravity in Australia 1950-51. Bur. Miner. Resour. Aust. Bull. 46.

GLOE, C.S., 1960 - The geology of the Latrobe Valley Coalfield. Proc. Aust. Inst. Min. Metall. 194.

GRIFFIN, W.R., 1949 - Residual gravity in theory and practice. Geophysics Vol. 14, p. 39.

NEUMANN, F.J.G., 1951 - Analysis of gravity survey of the Yalbrum-Morwell-Traralgon area. Bur. Miner. Resour. Aust. Rec. 1951/10 (unpubl.).

NEUMANN, F.J.G., & LONSDALE, G.F., 1973 - Gormandale gravity survey, Gippsland, Victoria, 1960-61. Bur. Miner. Resour. Aust. Rec. 1973/86.

THOMAS, D.E., & BARAGWANATH, W., 1951 - Geology of the brown coals of Victoria, p. 4. Min. geol. J. Vic. Dept Min., 4(3), 4, March 1951.

## APPENDIX 1

## STAFF, EQUIPMENT, AND SURVEY STATISTICS

### STAFF

BMR:

| | | |
|---|---|---|
| G.F. Lonsdale | - | Geophysicist, Party Leader |
| A. Douglas | - | Geophysicist |
| A. Distel | - | Field Assistant University vacation student |

SEC of Victoria:

| | | |
|---|---|---|
| L.C. Heron | - | Surveyor, in charge of surveying, pegging, and levelling of station positions, and preparation of topographic station plans. |

### EQUIPMENT

(a) Worden gravity meter No. 140

Used during the Hazelwood Survey.

Calibration factor : 0.11090 mGal per dial division

(b) Worden gravity meter No. 61

Used in the Billys Creek/Middle Creek survey area.

Calibration factor : 0.09050 mGal per dial division

Calibration. Both instrument were calibrated prior to the field work at BMR's Melbourne Calibration Range between Brenock Park and Kallista.

Comment on performance. A continuance drift check was maintained throughout the surveys by approximately hourly reoccupations of base stations. Additional drift information was derived by the reoccupation of other stations more than once during the day. The rate of the time-drift remained within reasonable limits. The daily drift curve was plotted each evening and remained within reasonable variations throughout the surveys with both instruments. At the most the hourly drift ranged from one to two scale divisions.

Worden No. 61 showed initially a rather steep increase in the readings, but settled down after a few days to an average steady upward drift of 4.4 scale divisions per 24 hours.

(c) Vehicles

Two Land-Rovers, C89824 and C89822, were used during the period of the field work. The performance of both vehicles was entirely satisfactory.

## SURVEY STATISTICS

(a) Billys Creek/Middle Creek Survey

| | |
|---|---|
| Commenced field work | 18.1.1960 |
| Completed field work | 25.1.1960 |
| Number of gravity stations occupied, including the reoccupation of 3 stations of the 1953 gravity survey | 150 |

(b) Hazelwood Survey

| | |
|---|---|
| Commenced field work | 8.12.1960 |
| Completed field work | 15.12.1960 |
| Number of gravity stations occupied, including the reoccupation of 7 stations of earlier survey for control purposes | 100 |

## APPENDIX 2

## DETERMINATION OF RESIDUAL GRAVITY ANOMALIES

Various procedures are used in removing the regional gravity gradient from local anomaly features.

> "Residual gravity is a term arising out of the fact that the conventional gravity map reflects the superposition of local gravity fields (anomalies) due to local geophysical structures upon regional gravity fields caused by regional geological structure."
>
> (W.R. Griffin, 1949)

The two main methods of residual gravity anomaly determination include:

(a) graphical and

(b) grid methods.

Graphical methods are carried out by drawing smooth anomaly contours on any particular gravity map submitted to residual gravity interpretation. The smoothed-out lines are suggested to represent the regional gravity anomaly contour pattern with local irregularities omitted. The departure of a contour based on actually measured gravity values from the smoothed-out lines is taken to indicate the amount of the residual gravity anomaly. The resulting values are then used to draw a residual anomaly contour map relating to local density variations only. The reliability of the graphical methods depends mainly on the judgement of the interpreter whereas the grid methods, being mechanical, will produce consistent results.

Grid methods for residual gravity determinations may be divided into three groups, namely:

(a) simple residual reduction methods (e.g. the Griffin method),

(b) second derivative methods,

(c) polynomial trend approximation methods.

For the purpose of the Billys Creek/Middle Creek and Hazelwood Report the Griffin Method was adopted in preference to the second derivative and polynomial approximation methods, as these methods require the use of more elaborate procedures. In the case of the second derivative method no appreciable advantage is gained from the extra complexity involved in the calculation procedure.

PLATE I


LOCATION


REFERENCE TO AUSTRALIA STANDARD 4 MILE MAP SERIES

SCALE

4 0 4 8 12 MILES

LEGEND

- Major Fault or Monocline geologically known
- Major Fault or Monocline geophysically indicated
- Smaller Fault or Monocline geophysically indicated
- Anticlinal Axis indicated by gravity
- Synclinal Axis indicated by gravity
- Structure Form Line, based on gravity
- Doming indicated by gravity High Residual Gravity Anomaly Feature
- MOE Reference to Australia Standard one-mile map series
- Direction of dipping in outcropping beds
- MOE Place name
- 5112' Deep Bore, with total depth in feet

GEOLOGICAL OUTCROPS:

- Recent and Tertiary Sediments
- Tertiary Basalt
- Jurassic, Arkosic Sandstone
- Palaeozoic

## STRUCTURAL PLAN OF STRZELECKI RANGES AND ADJOINING AREA

## BILLYS CK - MIDDLE CK AND HAZELWOOD GRAVITY SURVEYS, GIPPSLAND, VIC. 1960

TO ACCOMPANY RECORD NO. 1973/85 J55/B2-19

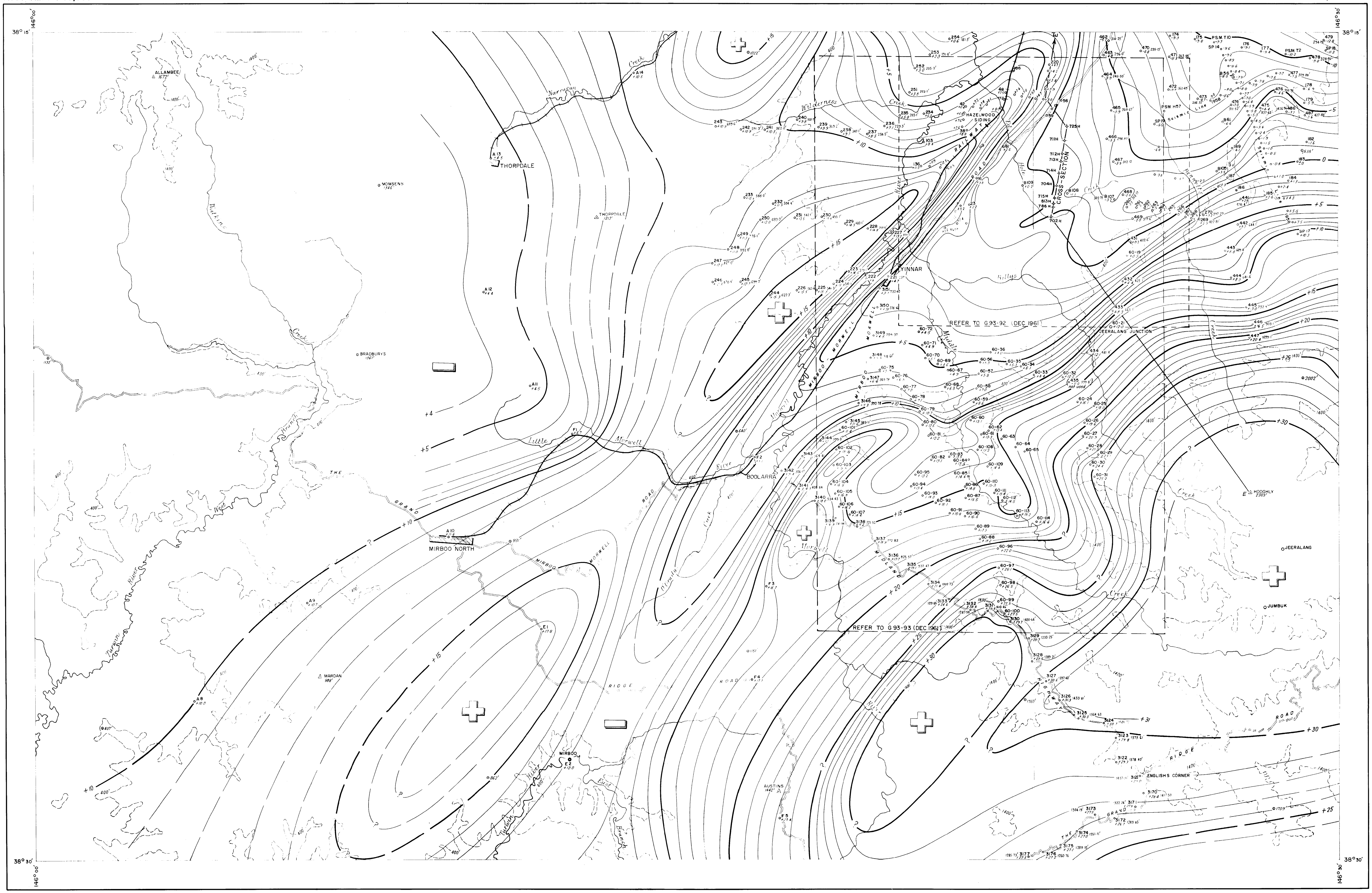
AUSTRALIA 1:63,360

# MIRBOO NORTH

VICTORIA

PLATE 2

J 55-10-870, ZONE 7




# BOUGUER ANOMALIES


INDEX

| | | |
|---|---|---|
| DROUIN | MOE | ROSEDALE |
| KORUMBURRA | MIRBOO NORTH | CARRAJUNG |
| WONTHAGGI | FOSTER | ALBERTON |

1-MILE MAP REFERENCE

Projection - Transverse Mercator, Australia Series, Zone 7

Control and planimetry after 1-mile military map with the same name and State Electricity Commission of Victoria field surveys

Geophysical data from B.M.R. surveys

Reliability – planimetric – accurate
gravimetric – ± 0·1 milligal

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 6 7 KILOMETRES

CONTOUR INTERVAL 1 MILLIGAL

TOPOGRAPHY

Built-up area
Drainage
Road
Railway

Horizontal control point
major
minor

GRAVITY

Gravity station
+28·7 Bouguer anomaly (milligals)
258·6' Elevation (feet)
702H Position of coal bore and Nº
Isogals
High anomaly
Low anomaly

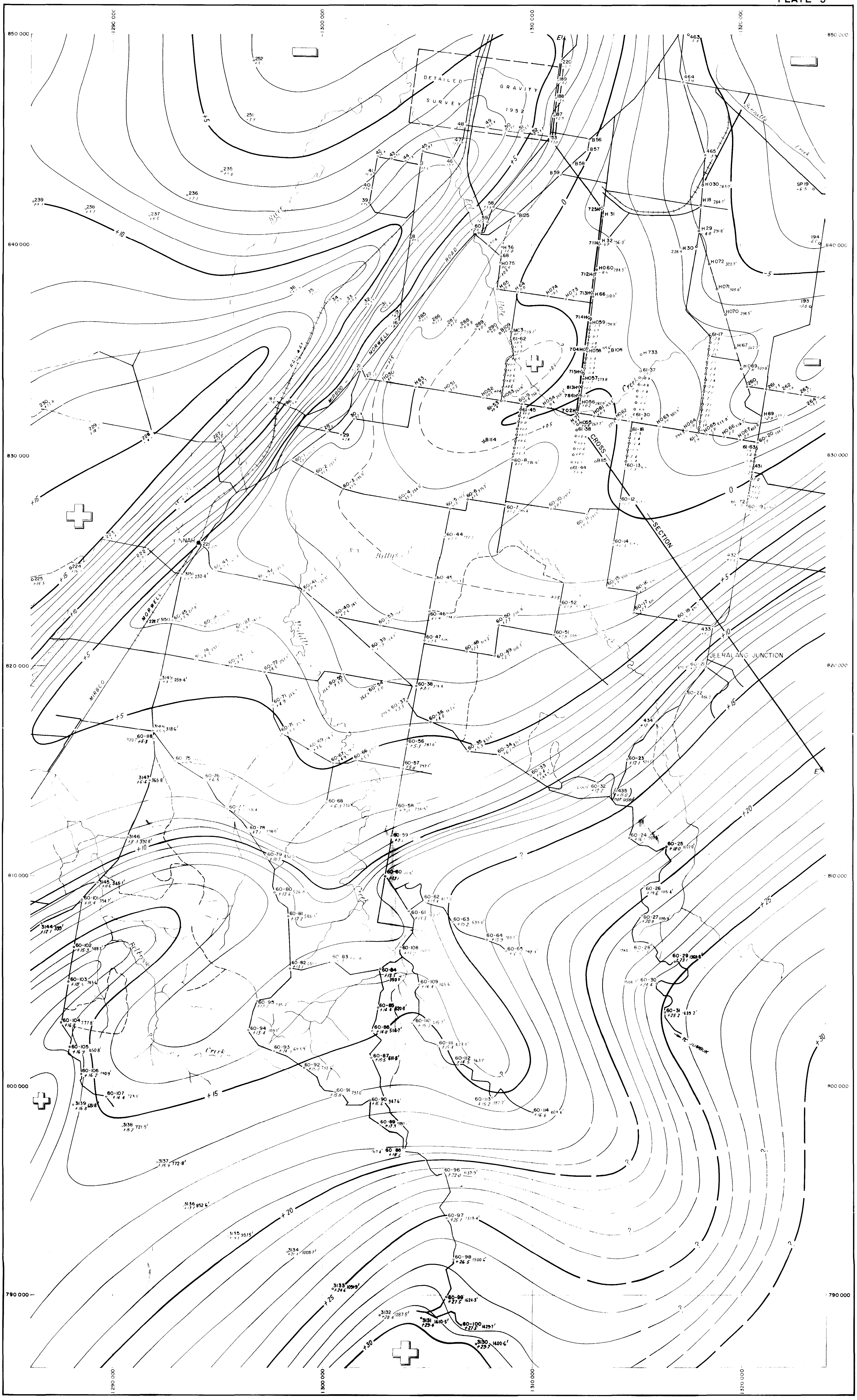
For the calculation of Bouguer anomalies 1·9 g/cm³ has been adopted as an average rock density

Elevation control – Low Water Mark, Williamstown and Low Water Mark Hobson's Bay for detailed surveys and M.S.L. for regional surveys
M.S.L. = (L.W.M. Williamstown + 1·583') or (L.W.M. Hobson's Bay + 2·2')

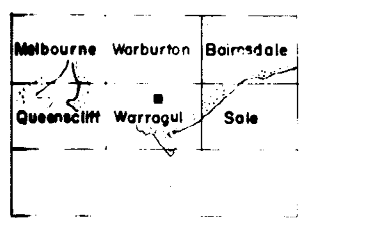

Department of National Development
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
Compiled and drawn in Geophysical Branch, Melbourne


G 93-24-1

TO ACCOMPANY RECORD NO. 1973/85 DECEMBER 1961








4-MILE MAP REFERENCE

# DETAILED GRAVITY SURVEY (1960)

## BILLYS CREEK-MIDDLE CREEK AREA, GIPPSLAND, VIC.

# BOUGUER ANOMALIES

½ 0 ½ 1 1½ 2 MILES

½ 0 ½ 1 1½ 2 2½ 3 KILOMETRES

CONTOUR INTERVAL I MILLIGAL

**TOPOGRAPHY**

- Road
- Railway
- Drainage

**GRAVITY**

- Station
- +27·5 Bouguer anomaly (milligals)
- 491·7′ Elevation (feet)
- 702H Position of coal bore and Nº
- Isogals
- High anomaly
- Low anomaly

Control and planimetry after State Electricity Commission and Department of Interior (1953) surveys

Geophysical data from B M R surveys

Transverse Mercator projection, Australia Series, Zone 7

Reliability – planimetric – accurate
gravimetric ± 0·1 milligal

Co-ordinates in feet corresponding with S E C of Victoria surveys

For the calculation of Bouguer anomalies 1·9 $g/cm^3$ has been adopted as an average rock density

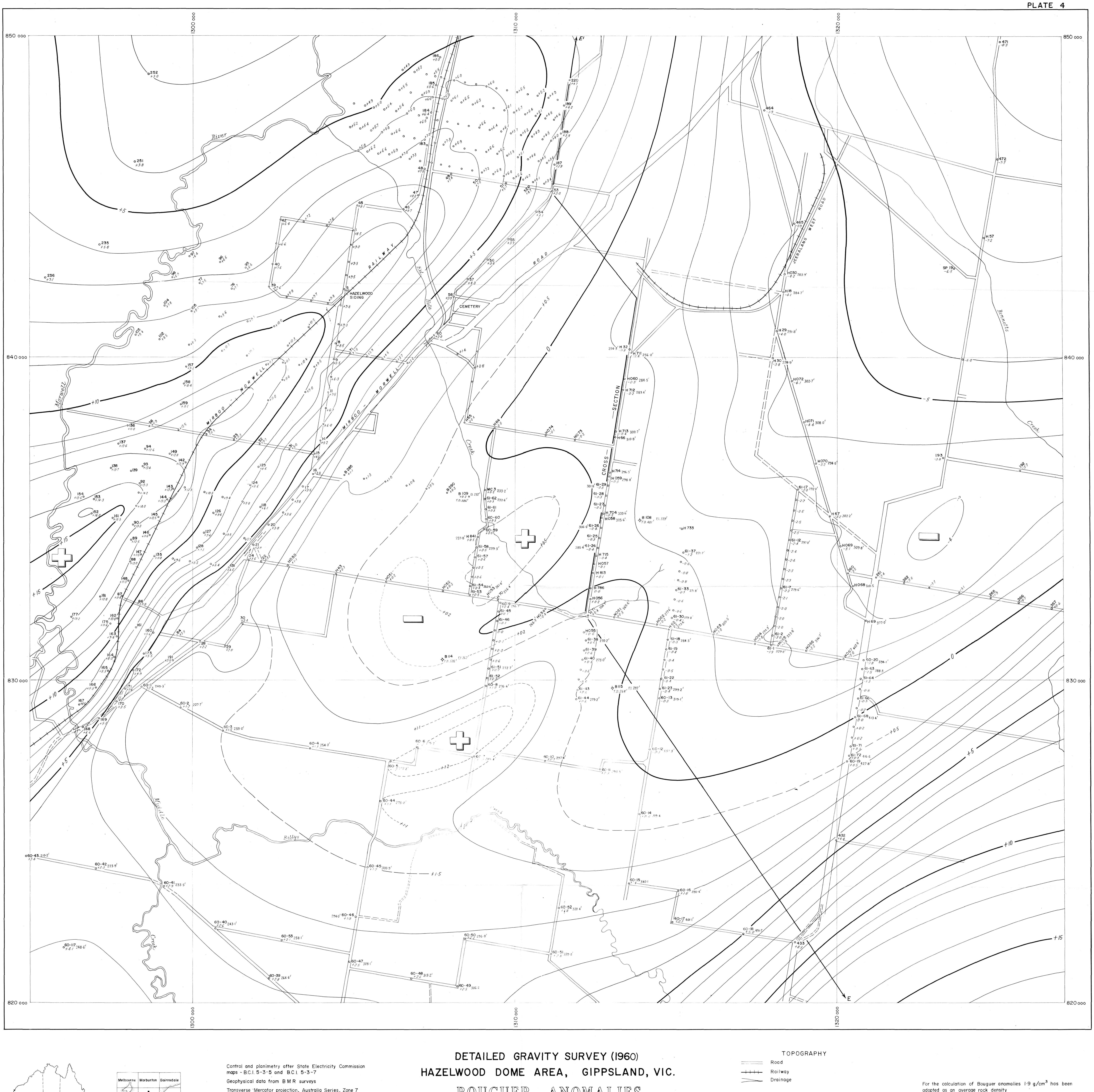
Elevation control – Victorian Railway Datum = L W M Williamstown

Department of National Development
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
Compiled and drawn in Geophysical Branch, Melbourne

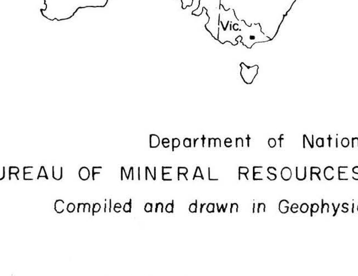
TO ACCOMPANY RECORD NO. 1973/85

G93-93

DECEMBER 1961




# DETAILED GRAVITY SURVEY (1960)
# HAZELWOOD DOME AREA, GIPPSLAND, VIC.
## BOUGUER ANOMALIES




4-MILE MAP REFERENCE

Control and planimetry after State Electricity Commission maps - B.C.I. 5-3-5 and B.C.I. 5-3-7

Geophysical data from B.M.R. surveys

Transverse Mercator projection, Australia Series, Zone 7

Reliability - planimetric-accurate
gravimetric ± 0·1 milligal

Co-ordinates in feet corresponding with S.E.C. of Victoria surveys

¼ 0 ¼ ½ ¾ 1 MILES

¼ 0 ¼ ½ ¾ 1 1¼ 1½ KILOMETRES

CONTOUR INTERVAL 1 MILLIGAL

TOPOGRAPHY

Road

Railway

Drainage

GRAVITY

Station

+2·7 Bouguer anomaly (milligals)

Elevation (feet)

Isogals

High anomaly

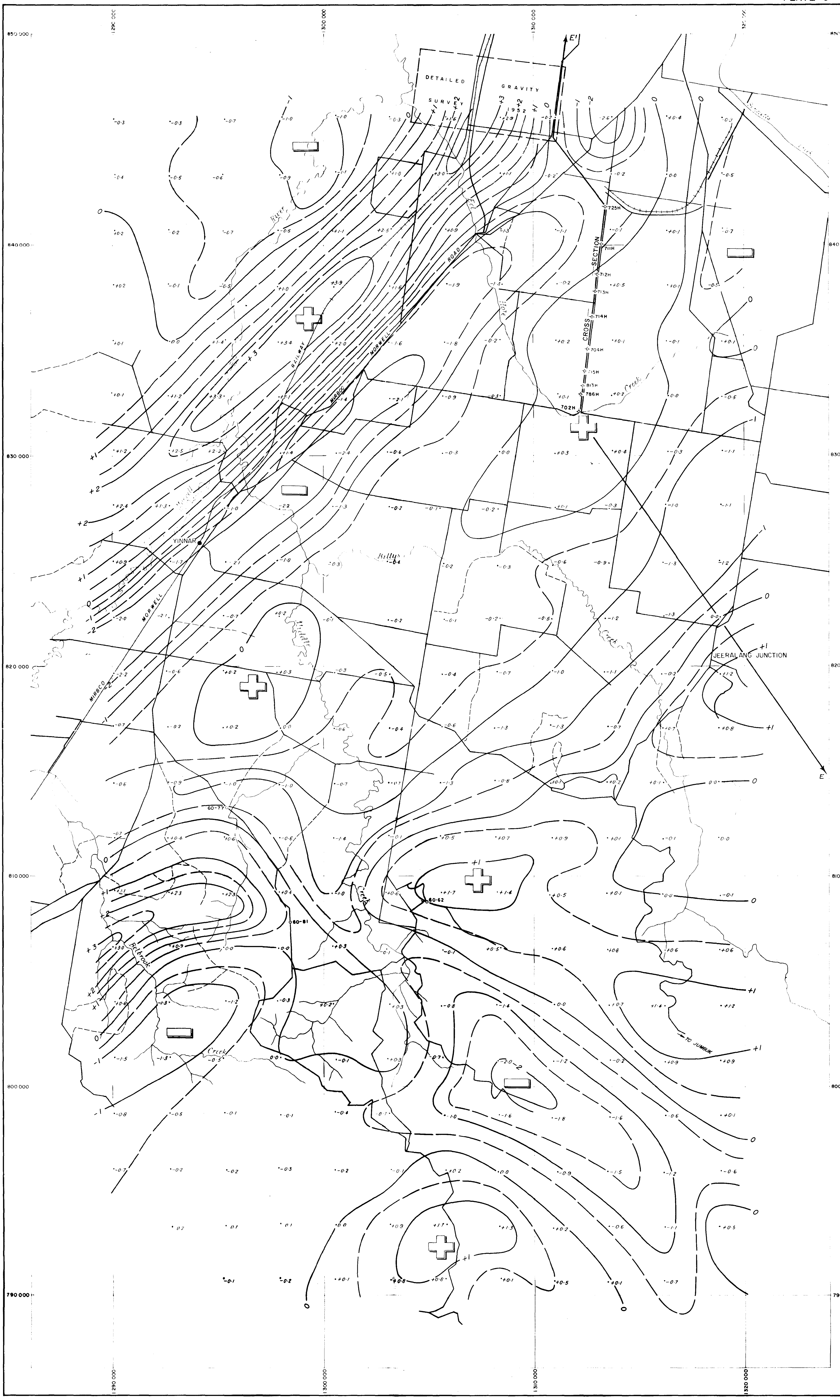
Low anomaly

For the calculation of Bouguer anomalies 1·9 g/cm³ has been adopted as an average rock density

Elevation control - Victorian Railway Datum = L.W.M. Williamstown

Department of National Development
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
Compiled and drawn in Geophysical Branch, Melbourne

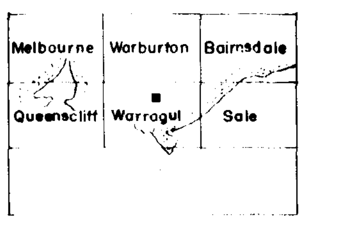
G 93-92
TO ACCOMPANY RECORD NO. 1973/85
DECEMBER 1961




# DETAILED GRAVITY SURVEY (1960)

## BILLYS CREEK-MIDDLE CREEK AREA, GIPPSLAND, VIC.

## RESIDUAL ANOMALIES




4-MILE MAP REFERENCE

½ 0 ½ 1 1½ 2 MILES

½ 0 ½ 1 1½ 2 2½ 3 KILOMETRES

CONTOUR INTERVAL ·5 MILLIGAL

**TOPOGRAPHY**

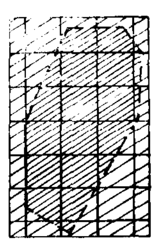
- Road
- Railway
- Drainage

**GRAVITY**

- Interpolation point
- Residual anomaly (milligals)
- Gravity Peg
- Isogals
- High anomaly
- Low anomaly
- 702H Position of coal bore and No

Residual anomalies derived from Bouguer anomalies shown on Plan G93-93

Residual Reliability Diagram



Area in which gravity station density is greater than optimum for residual calculation

Area in which gravity station density is less than optimum for residual calculation

Control and planimetry after State Electricity Commission and Department of Interior (1953) surveys

Geophysical data from B.M.R. surveys

Transverse Mercator projection, Australia Series, Zone 7

Reliability – planimetric – accurate
gravimetric ± 0·1 milligal

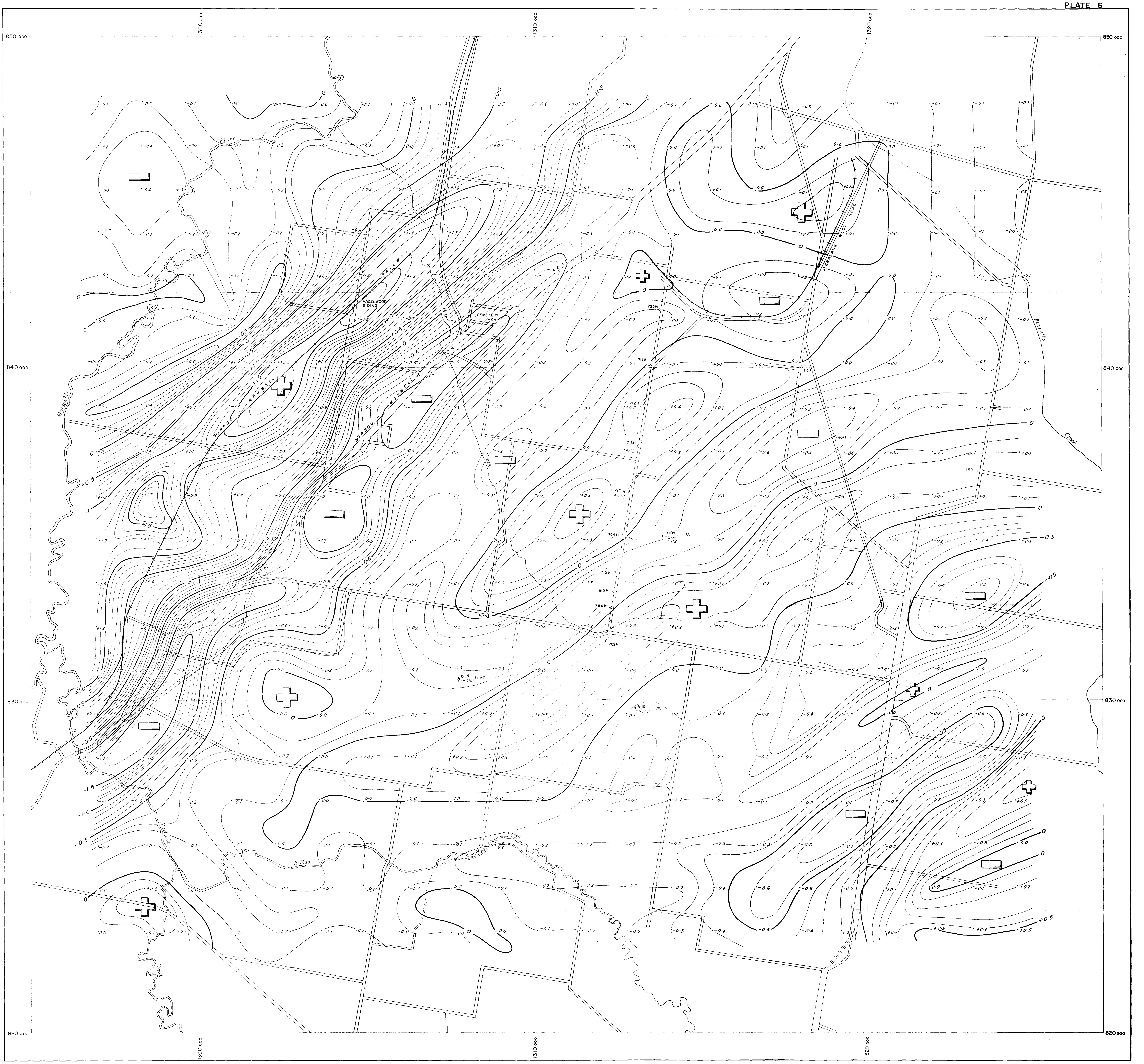
Co ordinates in feet corresponding with S.E.C. of Victoria surveys

Department of National Development
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
Compiled and drawn in Geophysical Branch, Melbourne

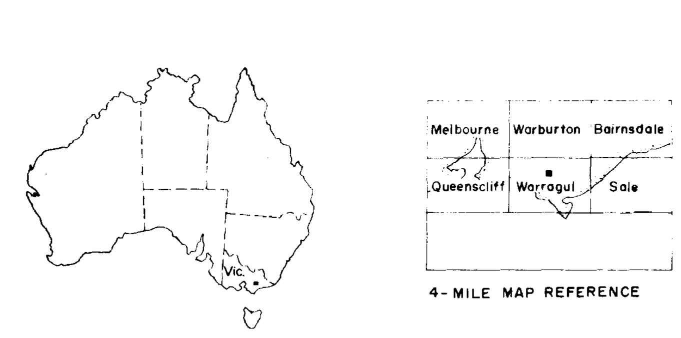
TO ACCOMPANY RECORD NO. 1973/85

G93-93-2

PLATE 6




# DETAILED GRAVITY SURVEY (1960)
## HAZELWOOD DOME AREA, GIPPSLAND, VIC.
## RESIDUAL ANOMALIES




4-MILE MAP REFERENCE

Control and planimetry after State Electricity Commission maps - B.C.I. 5-3-5 and B.C.I. 5-3-7

Geophysical data from B M R surveys

Transverse Mercator projection, Australia Series, Zone 7

Reliability - planimetric-accurate
gravimetric ± 0·1 milligal

Co-ordinates in feet corresponding with S.E.C. of Victoria surveys

¼ 0 ¼ ½ ¾ 1 MILES

¼ 0 ¼ ½ ¾ 1 1¼ 1½ KILOMETRES

CONTOUR INTERVAL 0·1 MILLIGAL

TOPOGRAPHY

Road
Railway
Drainage

GRAVITY

Interpolation point
Isogals
+0·2 Residual anomaly (milligals)
High anomaly
491·7′ Elevation (feet)
Low anomaly
702H Position of coal bore and Nº
Gravity peg

Residual anomalies derived from Bouguer anomalies shown on Plan G93-92

Elevation control - Victorian Railway Datum = L.W.M. Williamstown

Residual Reliability Diagram

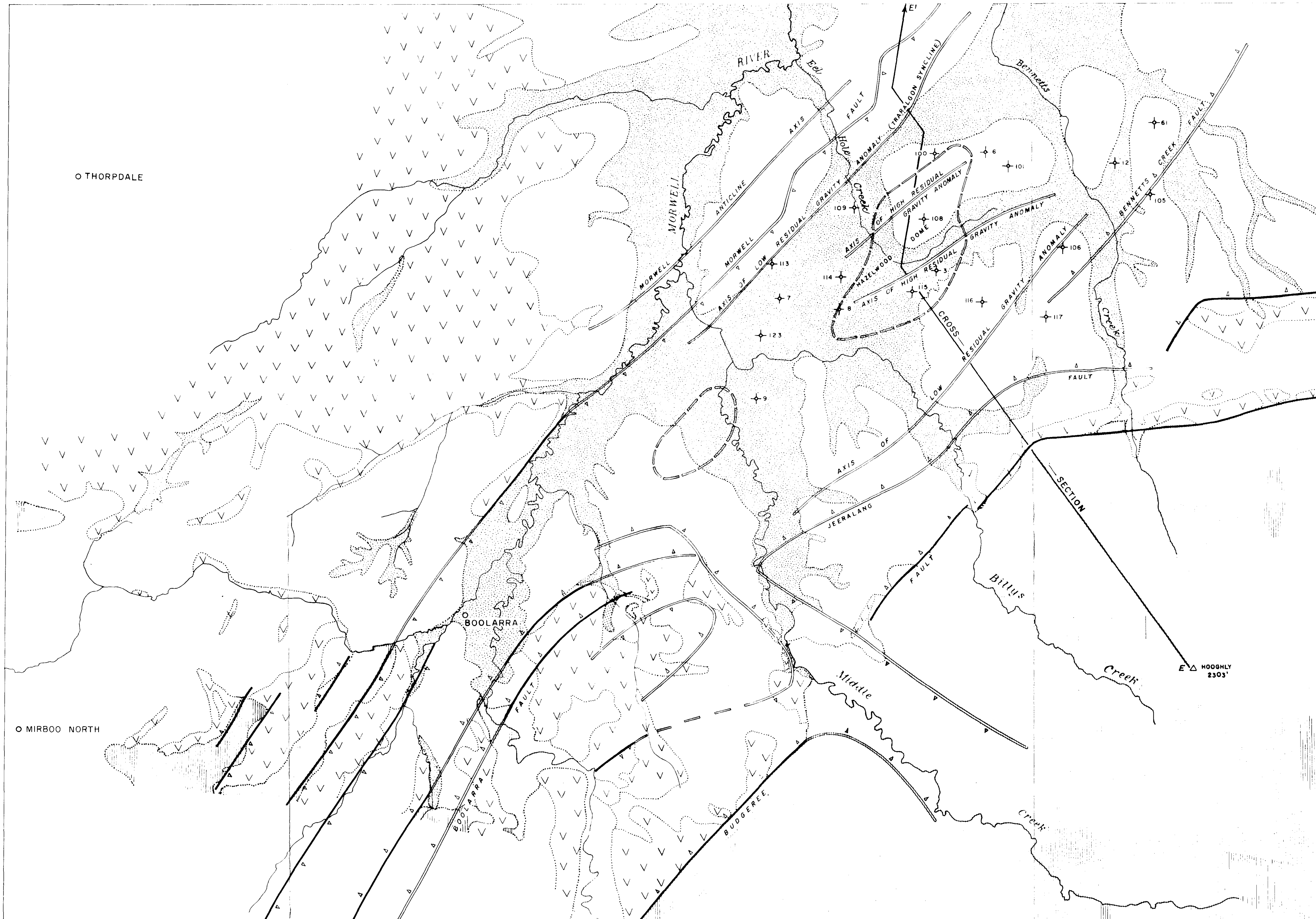
Area in which gravity station density is greater than optimum for residual calculation

Area in which gravity station density is less than optimum for residual calculation


Department of National Development
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
Compiled and drawn in Geophysical Branch, Melbourne


TO ACCOMPANY RECORD NO. 1973/85

G93-92-1




TERTIARY, POST VOLCANIC

TERTIARY, VOLCANIC

JURASSIC

ORDOVICIAN

RECENT

FAULT, GEOLOGICALLY KNOWN

FAULT, MONOCLINE, GRAVITATIONALLY INDICATED

AXIS OF HIGH OR LOW RESIDUAL GRAVITY ANOMALY

HIGH RESIDUAL GRAVITY ANOMALY FEATURE

COAL BORE

GEOLOGICAL REFERENCE:— THOMAS AND BARAGWANATH MIN. GEOL. J VIC. MARCH 1951

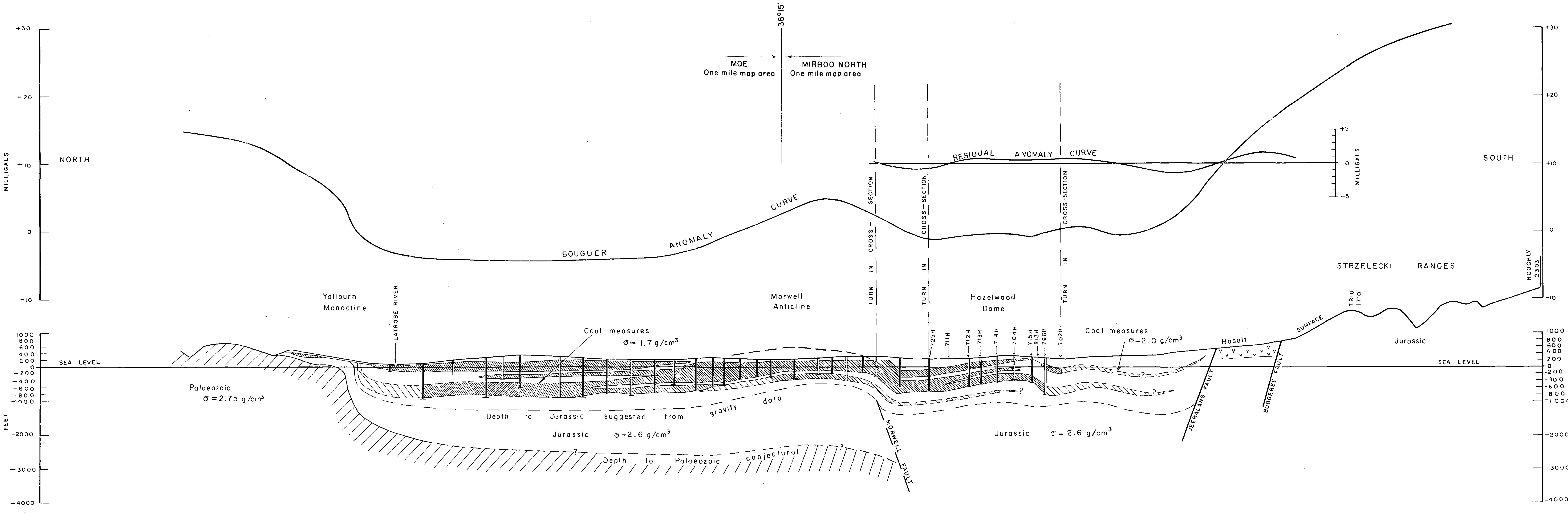
# BILLYS CK – MIDDLE CK AND HAZELWOOD AREA GIPPSLAND VICTORIA

## GEOLOGY AND STRUCTURE

SCALE

1 0 1 2 3 4 MILES

TO ACCOMPANY RECORD NO. 1973/85 J55/B2-34




# CROSS-SECTION E-E'
# YALLOURN MONOCLINE - MOORWELL ANTICLINE AND HAZELWOOD DOME

## CORRELATION OF GRAVITY AND DRILLING DATA

Coal seams (certain / uncertain)

Drilling data reference :— C.S. Gloe, Proc. No 194
The Aust. I.M.M. 1960

HORIZONTAL SCALE
1 0 1 2 3 4 MILES
VERTICAL SCALES AS SHOWN

TO ACCOMPANY RECORD NO. 1973/85

J 55/B2-35