COMMONWEALTH OF AUSTRALIA
MINISTRY OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORD 1951/10

ANALYSIS OF GRAVITY SURVEY OF THE YALLOURN - MORWELL - TRARALGON AREA, VICTORIA.

by

G. NEUMANN

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MEMORANDUM.

Re: Analysis of gravity survey of the Yallourn-Morwell-Traralgon area.

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SUMMARY.

For the purpose of obtaining further information as to favourable structural features in relation to brown coal seams within the Yallourn-Morwell-Traralgon area, a gravity survey is being carried out by the Bureau of Mineral Resources, Geology and Geophysics at the request of the State Electricity Commission of Victoria.

In the following a preliminary interpretation is given of the results obrained by this survey to date. This interpretation includes a detailed correlation of the gravitational disturbances with the geological structures so far known. Practical experience to be gathered from the work so far done has been outlined.

This analysis has been mainly based on the following sources of information:-

1. Results of gravity field measurements carried out by the Bureau of Mineral Resources in 1948-1950.

2. Data derived from bore-hole plans and drilling records, respectively cross-sections of the underground as worked out and supplied by the State Electricity Commission.

3. Description of geology and structural features of the area in question given by Messrs. Dr. D.E. Thomas and W. Baragwanath and published in Vol.3 No.6 of the "Mining and Geological Journal" September issued 1949, pp.28- 5, pt.1, entitled: "Geology of the Brown Coal of Victoria".

As to further sources of information, reference has been made in the following text whenever found necessary.

1. OUTLAY OF GRAVITY SURVEY.

A first gravity survey of the area in question was started by the Bureau of Mineral Resources in 1948, the practical field work and computing of field data placed under Mr. Williams who later prepared a report. This survey covered a territory on the eastern side of the Morwell River situated directly south of the townsite of Morwell and extending as far south as the township of Yinnar.

This first survey was a very detailed one - the average distance between stations ranges to about 500-600 feet only - and the total number of set -ups amounting to approximately 300.

Early in 1950 the gravitational surveying was continued on a more regional scale. The directions of the field work now placed under the responsibility of Mr. Waterlander He started his work at the beginning of January with a gravity-profile survey from the townsite of Morwell in N.W. direction towards Yallourn. The survey was extended later on as far to the east as Flynn's Creek. The actual field work ended by the beginning of June, 1950, and a total number of stations of approximately 250 (not counting the repeated stations) was read. The character of this section of the survey must be called a regional one since the distance between stations was roughly 0.5 mile, the profiles following the possible high-ways and country roads.

The territory covered by both sections of the gravity survey equals approximately 250 square miles. As to the outlay of profiles and stations reference is made to the station-plan, drawn on a scale of 1 mile to 2 inches (1 : 31,680), showing station numbers as well as data of gravitational disturbance and lines of equal gravity deviation, after corrections have been made for latitude, altitude (free-air corrections) and density of the upper layers (Bouguer corrections).

The instruments used in the field work were a Western gravimeter and a Humble-Truman gravimeter respectively, the latter being an old type instrument.

In general the loop-error of reduced gravity values obtained by the survey does not exceed 0.2 m.gal, the topography readings being accurate to approximately one foot.

2. GEOLOGY IN BRIEF.

The investigated area is part of the Latrobe Vall and forms the most western section of the East-Gippsland plains.

According to Messrs. Thomas and Baragwanath (s.a. the Great Valley in Gippsland can be sub-divided into three sect namely the West Gippsland Plains, or Koo-wee-rup Swamp, the Cent Gippsland section, including -

(a) Warrigal block
(b) Moe Swamp
(c) Haunted Hill block,

and finally the East Gippsland Plains, which begin at the Haunte Hill Fault Zone directly west of the town site of Yallourn and extend to the East as far as the Lakes Entrance district.

Extensive brown coal deposits occur under the East Gippsland Plains, where active mining has been under way for decades in the vicinity of Yallourn while the opening up of

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a new open cut south of the town-site of Morwell is in the initial stage at present.

Since mining activities have been preceded and still are accompanied by intensive drilling operations the younger formation of the area, i.e. Tertiary brown coal seams with interbedded clay layers and overburden, are very well known especially under the areas of commercial interest near Yallourn, Morwell and Loy Yang. Structural conditions of the layers encountered in drill holes could be worked out in detail as shown on various geological cross sections accompanying the abovementioned paper by Messrs. Thomas and Baragwanath.

Since, however, intensive drilling was restricted to certain areas only and shallow depths, great parts of the East Gippsland plains still remain rather unknown as to the information on detailed structural features. Therefore, the plan has been put forth, to explore this territory, which is of highest commercial value for the occurrence of coal deposits, by means of geophysical methods. These methods could be expected to indicate the strucure of the underlying deep stratas, i.e. the structural pattern of the very basement layers of the brown coal formations, which as a matter of fact never have been definitely reached by any of the exploration bores drilled to date The deepest hole which has been drilled in the area under consideration is the one put down by Australian Paper Manufacturers Ltd., located approximately 1 mile south of the river Latrobe and five miles west of the townsite of Traralgon. This bore has reached a total depth of 1,735' and ended in brown coal formations with a strong flow of artesian water at relatively high temperatures (158 deg. F).

So far as known up to today the general picture of the main structural features of the area covered by the gravity survey can be outlined as follows:

The underground of Latrobe Valley east of the Haunted Hill block is shaped in form of an easterly running and east gaping syncline, called Latrobe syncline. Its boundary to the north of Yallourn is marked by the Yallourn monocline, which passes into a fault (Yallourn fault) of north-easterly trend. On the north site of this fault we find only one coal seam of limited extent, the so-called Latrobe Seam, which is underlain by Jurassic rocks and has been mined in former years in the so-called Old Open Cut of Yallourn.

From just north of the power station, the Yallourn fault extends for about 3 miles to the N.E. and is then offset to the south for a distance of about half a mile. Thence it can be traced to just north of Toongabbie. No detailed information is available further to the east, since the northern flank zone of Latrobe syncline is still unexplored by drilling.

However, a flattening of the formation's dip is reported from the area north of Sale and the fossiliferous limestones which overlie and overlap the brown coal are known to crop out against older rocks on the northern edge of Latrobe Syncline in this particular area. No geophysical information has been made available on this section yet.

The Yallourn fault, cited above, assumes to the southwest of the townsite of Yallourn a more southerly course after crossing Latrobe river and is finally intersected by the Haunted Hill fault. This rather impressive tectonical feature cuts off the Haunted Hill block at its edge to the east, thus de-limiting an area, which rises to nearly 600' above sea level, being covered up on the surface by sands, gravel and clays, underlain in turn by a little brown coal, Tertiary basalt and Jurassic rocks.

While intensive faulting prevails, as outlined above, on the eastern and northern edges of Latrobe Syncline, a large section of the southern flank zone of Latrobe Valley is formed by the so-called Carrajung monocline. It shows in general a gentle dip to the north or N.W. respectively, however, becomes faulted when traced further to the S.W. (Budgaree Fault) and is intersected by a number of cross-faults as Eel Hole fault Bennett's Creek fault and Traralgon fault.

Additional structural features of major importance interrupt the contours of the southern flank zone of Latrobe Syncline which thus may assume a very complicated tectonical pattern.

First to be mentioned is the Yallourn syncline shaped as a broad synclinal bowl, which is closed up to the west and to the north by the Haunted Hill and Yallourn Fault Zone and is limited to the east and south by the rather asymmetrical Morwell anticline, a very pronounced and dominating tectonical feature with a sharp dipping of formations to the south east, the dip steepening in south-westerly direction to the Tarwin faul and dying out gradually to the north east.

Morwell anticline is accompanied to the east by th so called Traralgon syncline which passes into a fault zone when traced towards Boolarra, and opens up in north-eastern direction into the broad open Latrobe syncline. It is known, that the Traralgon monocline, i.e. the southern limb of Traralgon syncline, continues further east as "Rosedale monocline" for a distance of approximately 15 miles, finally passing into the Rosedale fault and thus forming the northern flank zone of the Baragwanath anticline. However this particular area has not been covered by the gravity work under discussion.

3. PRINCIPLES OF GRAVITY INTERPRETATION.

The interpreting of gravity effects has been precisely described by L. L. Nettleton (Geophysical Prospecting for Oil, 1940, p.119) by the following statement:-

"The result of a gravity survey is nearly always a gravity contour map. The interpretation of such a map in terms of geology may be anything from a mere inspection of the map and outlining of trend lines or areas of structural disturbance to very elaborate and detailed calculations to find the size, shape and position of a mass anomaly that will account for the principa details of the observed effects.

"The variation in the degree of useful analysis an in the probable reality of the structural interpretation resultin depends -

(1) On the closeness and precision of data;

(2) On the degree to which the picture of the possible structure of interest is clouded by disturbing effects which may be shallow or deep; and

(3) On the amount of control, either actual or assumed, available to limit the inherent ambiguity in the determination of the mass distribution which can cause a given gravity distribution. No amount of detailed calculation to find a mass distribution to account for a given gravity distribution is justified unless the premises, other than the gravity data, on which such calculations are based are well founded."

The first aim of an analysis of the gravity survey of the Yallourn-Morwell-Traralgon area, therefore, has been to work out a map showing the contour lines of gravitational disturbance in connection with as much information as available on surface geology of the area, covered by the survey, and its surroundings (see plates G39-11, parts 1 and 2). Secondly, it had to be proved whether or not an obvious correlation between gravity and geology could be worked out, and, if so, to what details.

The next step to be taken was to carry on certain calculations under premises derived from boring data and geologically known facts and to try to work out certain details as to the distribution of heavy masses in the underground, i.d. as to the shape and depth of the basement rocks underlying the brown coal formations (see plates G39-12, and 13).

4. DISCUSSION OF GRAVITY CONTOUR MAP.

Reference is made to the map of gravity contour lines, already cited above, which represents the gravity differences between an arbitrary base or reference point and the rest of the stations set up within the investigated territory. Since these gravity anomalies shown on this map are corrected for gravity influences of latitude, altitude and density of upper most layers, they should represent a picture of gravitational effects, which are caused exclusively by subsurface conditions.

When working out the gravity lines, it soon appeared that some of the detailed structural features of the area under consideration should have been covered with quite a larger number of stations, in case one would intend to work out these features to the very limit of geophysical means. As to the wider edges of Latrobe basin, extending to rather mountainous areas, of course topography puts a natural obstacle to any sort of detailed geophysical work from the beginning.

Considering these facts the pattern of gravity contour lines had to be based principally and definitely on actual disturbances as have been found at every single station. However, in certain sections of the area investigated the designing of lines of equal gravity disturbance is more or less optional and in these cases it was considered correct to have the gravity lines following the direction predesigned by the trend of tectonical features or the formation's strike.

This comes especially true to certain sections of the Yallourn fault zone and of the Yallourn syncline as well as to parts of Traralgon trough zone.

The general pattern of the gravity map reveals a large minimum zone, beginning from the northern boundary line of Yinnar Parish and following a north-easterly trend until it passes into a more eastern direction in the vicinity of the townsite of Traralgon.

The total amplitude of gravity disturbance, i.e. the maximum gravity difference between two stations amounted to 39.8 milligals and is encountered between Station No. 447, set up on the eastern side of Bennett's Creek on Jurassic rocks more or less at the south-west corner of Traralgon Parish and Station No. 350, which has been placed near the townsite of Rosedale.

The general gravity picture, as outlined above, is differentiated by certain special features, for example, the very distinct arching of contour lines on the Morwell anticline and to the south-west of the townsite of Traralgon as a wide open bending of gravity contours, encircling an area of relatively high gravitational intensity on the eastern side of Traralgon Creek in the vicinity of bore No.12.

Proceeding further to the east the gravitational minimum zone of the Latrobe syncline appears to fall wide open, no complete geophysical information however is available yet, desirable as it might be though.

East of the townsite of Morwell a zone more or less trending south-worth occurs, which runs as far north as Latrobe River, where gravitational lines indicate a decrease of gravity intensity to the east at a rate of approximately five milligals per mile.

From the foregoing it is quite obvious that the gravity map in general reflects the tectonical pattern of the area investigated, viz. the broad and wide open shape of Latrobe syncline as well as the very accentuated uplift of the Morwell anticline, the more or less steeply dipping of formations, which form the Traralgon and Yallourn monoclines and last but not least the occurrence of distinctive fault zones as Yallourn and Haunted Hill faults.

Furthermore it could be derived from the gravitation picture that Latrobe syncline appears to develop to an even wider and deeper basin when proceeding to the east.

Coming back to the very cause of gravity effects measured on the earth's surface it has to be kept in mind, that the data obtained might well include effects originating from various depths and having various geological reasons, to be accounted for.

However, in the area under consideration it is a well known fact from intensive drilling that Tertiary beds of comparatively small specific density are underlain by lava flows of basalt and by Jurassic rocks such as sandstones, which show a considerably higher density than the brown coal seams of great thickness and associated layers of sand and clay.

These prevailing circumstances lead to the conclusion that the greatest part of the gravitational underground effect is most probably due to a definite and sudden change of physical properties, which are encountered between the brown coal formations and the underlying beds.

If there is an additional effect caused by deeper rocks it apparently cannot be of a very great influence on the gravity picture. However, the area under consideration is still too small in order to come to any final decision and a regional map on a much larger scale, e.g. of all of the State of Victoria, could possibly reveal some more facts on the gravitational character of the deeper basement complex and its probable tectonica pattern.

5. DATA AVAILABLE AND ASSUMPTIONS MADE ON UNDERGROUND DENSITY FOR DETAILED ANALYSIS.

The process of a detailed analysis of certain cross-sections, which have been partly selected in accordance with those described by Messrs. Thomas and Baragwanath in their aforementioned paper can be based on data available as follows:-

1. Petrographical character of strata encountered in drill holes as brown coal seams, interbedded with clays and sands, and overburden.

2. Information available or to be assumed on density of these data.

3. Dip data on the various layers as revealed by drilling records.

4. Depths data derived from drill holes as to the maximum thickness of the brown coal formation or minimum depth of underlying basement rocks.

5. Data on the outcropping at the surface of coal seams and formations such as basalts and Jurassic rocks.

6. Data on the dipping of formation as revealed at the surface.

7. Data on faulting of beds as found by geological mapping of the investigated area.

8. Topographic information on elevation of surface above sea level.

In addition to the sources of information enumerated above it has to be stated that the topographic maps prepared by the Australian Section Imperial General Staff have been found to be very helpful to work out profiles on a natural scale, i.e. showing underground formations and tectonical features as well as the topography of the surface according to their natural relations.

Using these data a distribution of heavy masses in the concealed underground, i.d. the pattern of the basement rocks, had to be found by calculations from the gravity results, simultaneously fitting in geological facts as well as drilling records, geophysical data, this way obtaining a reasonable picture of satisfying nature.

According to Reich and Von Zwerger (Taschenbuch der angewandten Geophysik 1943, p.126) dipping of an inclined surface of a density different from its surroundings can be approximately derived from the gravitational effect by using a gravity formula of the following form:-

$$\Delta g = (U_z)_a - (U_z)_b = 2G \sigma \pi h$$

$$h = \frac{\Delta g}{2G \sigma \pi}$$

g : Difference in gravity

h : " " depth.

σ : " " density.

G : Gravitational constant.

$= 66.7 \times 10^{-9}$ CGS.

Generally speaking this formula reflects the well known fact, that at a given difference in gravity the disturbing mass might be placed at a relatively shallow depth-range on the assumption of relatively great difference of density or on the other hand might be put at a deeper level if an allowance is made for a smaller divergence of specific densities.

On the other hand the amount of slope or inclination of the surface of a heavy mass interface concealed in the underground may be calculated approximately if reasonable assumptions are at hand concerning specific density of the beds under consideration.

Starting from the assumption, as outlined above, that the greatest part of gravitational effect is probably caused by variation in density between the brown coal formation on the one hand and the underlying basalts or jurassic rocks on the other, we are facing the following situation:

Tertiary Brown Coal	spec. density appr.	1.3
Tertiary clay	"	1.9
" sand	"	2.0

Jurassic sandstone	spec. density appr.	2.5
Basalt	"	2.9
Vesicular Basalt	"	2.3

Average density values for series of beds occurring in the Yallourn-Morwell-Traralgon area are not at hand, however any difference in density in the range of 0.8 - 1.2 in the relation of brown coal formations and basement rocks seems to be reasonable.

Using equation 2 above and figuring it out on the basis of: $\Delta\sigma = 1.2$
" $= 1.0$
" $= 0.8$

a difference of gravity of 1 milligal corresponds to a difference in depth of the basement layer respectively of 65ft, 80ft, 100ft.

As shown later on by detailed sections, which combine topography, geology, i.e. outcrop of formations and beds encountered by drill holes, as well as structural conditions of the underground, the assumption of a density difference equal to 1,0 matches appropriately with known dip data.

To make the situation entirely clear these sections of course had to be placed on a natural scale, horizontal and vertical scale both equalling 1 mile to two inches.

From certain portions of sections, however, it is known that no thick coal seams are included in the brown coal formation. This comes especially true on Traralgon monocline, where series of the so-called Yinnar group occur, described by Messrs. Thomas & Baragwanath as follows:-

"Beds of variable thickness composed mostly of clays with seams of brown coal of variable thickness, lying between Morwell No.2 seam and the top of the Thorpdale volcanic suite."

Apparently these beds must have a higher density than those including thick coal seams. Hence it was found appropriate to have the density difference placed at 0.8 in case series of the Yinnar group only are overlying basement rocks.

From intensive drilling it is well known that a pronounced thickening of overburden occurs in certain parts of the area covered by the gravity survey. This becomes particularly true when proceeding east from the crest of the Morwell anticline and when advancing north in the Loy Yang area, i.e. when approaching Princes Highway and eastern railway line.

Considerable erosion of brown coal seams is known to be present in Latrobe syncline, i.d. west of the townsite of Traralgon and east of Morwell, coal being replaced by gravel beds to a thickness of at least 497' as proved by bore No.2 in this particular section.

It soon appeared when analysing gravity effects of overburden layers of considerable thickness that corrections had to be made to eliminate the influence of relatively heavy uppermost stratas occuring in certain sections of the investigated area.

Since the maximum thickness of those layers in a number of holes has not been entirely tested, since some of the bores are too shallow to penetrate the overburden, the total thickness of it had to be estimated when analysing certain sections.

The unknown conditions of upper-most layers of higher density of course must cloud in a certain way the picture which can be derived from gravity results concerning the deeper underground. The gravity effect of a plain layer can be computed according to formula 1 above. Density difference in the relation of an overburden layer of gravel beds overlying a series of brown coal seams with interbedded thin stratas of clay may be reasonably placed at 0.6 thus assuming a specific density of 2.0 for the overburden and 1.4 for the brown coal formation.

Computing the gravity effect on such a basis the influence of an overburden of a thickness of 100 m = 328 feet results in a gravity increase of 2.5 milligals. By checking a number of sections it could be found, that the assumption of 0.6 as density difference between overburden and coal formation eliminates sufficiently the gravity effect of the overburden.

6. DISCUSSIONS OF ANALYSED CROSS SECTIONS.

(a) Profile A - A'.

Profile A-A' follows a NW-SE direction and crosses the Morwell anticline in a distance of 4 miles south of the townsite of Morwell. It is shown on plates G39-11 and G39-13. The computing of the profile in question was started from two different fixed points, one of them being the estimated top of basalt under bore site No.329 where the basalt top can most reasonably be placed at Sea-Level resulting from the known point of outcrop and rate of dipping in north-easterly direction.

Bores Nos.	1002.	769.	766.	767.	735.	374.	359.
	344.	329.	314.	310.	289.	109.	108.
	116.	117.	119.	118.			

were plotted on the course of the profile A-A' and the dipping of the basement basalt was computed on the basis of   = 1.0, i.e. difference in density between brown coal formations and basement. An allowance had to be made for the density of overburden at Bores Nos.310, 289 and 109, resulting in an overburden correction up to 2 milligals.

The second fixed point from which calculating could be started on Section A-A' is the known outcrop of basalt rocks app. ½ m. SE of Bore 118 along the trend of the southern wing of Carrajun monocline. This wing shows strata of the Yinnar group overlying basalt and Jurassic rocks respectively. Accordingly computing was based on a density difference of 0.8 = 2.6 - 1.8 between brown coal formation and basement. Both parts of the profile A-A' had to be connected of course in some way in the very deepest part of the syncline, as shown by a dotted line on the profile.

(b) Profile D-D' (see plates G39-11 and G39-13.

The next profile approximately 3 miles north of A-A' has been placed exactly the same as section D-D' which is shown in Messrs. Thomas and Baragwanath's paper page 44. Information on the upper layer was derived and used for plotting from the following bores:

265.	675.	702.	750.	716.	685.	673.	686.
419.	58.	385.	159.	109.	147.	143.	153.
45.	102.	103.	105.				

Computing from difference in gravity between the two crest points on top of Morwell anticline, a difference in depth between profiles A-A' and D-D' can be derived. The maximum of gravity on profile A-A' amounts to 11 milligals and 2.5 milligals on profile D-D', correspondingly a difference of 11 - 2.5 = 8.5 milligals appears to be present. Figuring on the basis outlined above we have 8.5 x 80 = 680' depth-difference of the basement layers and therefore the basalt-top under bore No. 147 has been placed at -700' beneath sea-level.

The southern wing of profile D-D' had to be computed in accordance with the same principle as used on profile A-A', i.e. assuming a density difference of 0.8. The point to start the computing from was naturally the outcropping of basalt at a height of approximately 800' above sea level on Carrajung monocline.

As will be noticed from both profiles A-A' and D-D' no fault on the east side of Morwell anticline has been derived from the gravity data, though it is known that the south-eastern wing of Morwell Dome is passing into a fault (Tarwin-fault) in south-western direction. As to the exact locating of fault zones gravity data resulting from Torsion Balance surveying might be more helpful than those obtained by the gravity meter. Theoretically it might seem possible to proceed to the same conclusions by calculating, e.g. by deriving the potential of gravity both ways from gravity meter or T.B. data. Practical experience, however, has proved that the precision and sensitivity of a gravity gradient directly measured by the T.B. cannot be substituted by an indirect calculating from gravity meter results, if near-surface fault zones are to be worked out.

However, there still might be actual faulting occurrin in deeper layers than those plotted on the profile A-A' and D-D'.

<u>C. PROFILE F-F'</u> (see plates G39-11 and G39-12).

A third profile, F-F' was placed by proceeding further east from profile D-D', again following exactly the same line as the profile F-F', shown on page 44 of Messrs. Thomas and Baragwanath's paper. Profile F-F' starts approximately at Tyers river junction and runs N.E.-S.E. towards the N.W. corner of Callignee Parish; thus crossing Latrobe River basin for a distance of approximately 7 miles.

The southern wing of Profile F-F' had to be connected with the outcropping of basalt rocks, known from Callignee hills. For a description of the geology of the area, reference is made to the paper of Messrs. Thomas & Baragwanath, which reads on pp.51-52, as follows:-

> "On top of these hills there is from 300-400' of basalt overlying siliceous sandstones, conglomerates and lignites. The basalt then dips to the north on the Currajung monocline and becomes covered with overburden. This basalt is brought to the surface by an east-west fault along Shingle Creek on the south side of Loy Yang foothills.
>
> The basalt outcrops on the north side of Shingle Creek, but beyond this is covered by the Haunted Hill gravels. The basalt, however, can be traced northwards in bores where the surface of the basalt has a fall of 100' in two miles, considerably flatter than the slope of the Currajung monocline on the northern slope of the Callignee Hills".

From the southern most end of profile F-F' it will be noted, that the very gentle change of gravity corresponds exactly to the flat dipping of the surface of the basalt as described by Messrs. Thomas and Baragwanath for this particular area

The calculating of the basalt top of the southern wing of Profile F-F' has been placed on a density difference of 0.8 since there is still the Yinnar Group (mostly clays with seams of coal of variable thickness) to account for as it was on profiles A-A' and D-D'.

For computing of the northern wing of Profile F-F' the drilling records of the deep test-hole put down by the Australia Paper Manufacturers Ltd. had to be taken into consideration. As cited before (page 2) this deepest bore of Latrobe syncline has been completed at a total depth of 1735' ending in brown coal formation, however, with a steady flow of artesian water at high temperature. Since the location of this Bore is at a R.L. of 140', the total depth is at 1595' below sea level and the top of basement rocks therefore must be placed well under this figure. The depth of basement as shown by the Profile F-f' was assumed at 1700' below sea level which, of course, must be considered as a minimum figure. From this meference point the rest of the northern wing of profile F-F' has been computed on the base of a density difference of 1.0.

An overburden correction amounting to a maximum of 4 milligals had to be made on account of the thickness of overburden found to be as much as 492' at Bore No.2, however, not penetrated by the following Bores Nos. 36, 41 and 42.

(d) PROFILE H-H' (see plates G39-11 and G39-13)

A fourth cross-section, H-H', corresponding to profile H-H' described in Messrs. Thomas & Baragwanath's paper (p.44), runs approximately 2½ miles east of the town site of Traralgon, crossing the Loy Yang area in a north-south direction.

The geology on the southern end of the profile is similar to that at the southern end of Profile F-F'. A gradual thickening of the coal is to be noted along the profile northwards towards the centre of the Latrobe syncline (Thomas and Baragwanath, p.53). Between the thick coal seams and the underlying basalt are beds with relatively thin coals which are characteristic of the Yinnar Group. The dip of coal increases but slightly on the Traralgon monocline, but there is a much greater thickness of overburden.

A number of bores to the north and south of the Eastern Railway line did not penetrate the overburden, though drilled to a depth of 300'.

Computing of profile H-H' was started from the outcrop of basalt at the southern most end of the cross-section and it was found necessary to have all of the cross-section calculated on the basis of 1.0 density-difference, to match the depth of the basin as revealed by profile F-F'. Bore records used for the plotting of the formations were those of Nos.167, 121, 102, 93, 110, 332, 12 and 55.

(e) PROFILE B-B' (see plates G39-11 and G39-12)

Finally it was found desirable to have a fifth profile worked out, in order to have an east-west cross-connection between profiles H-H' and F-F' made and to find out further details about Yallourn syncline and the most northerly end of Morwell anticline. Thus profile B-B' was placed approximately 3 miles north of Morwell, generally following an E-W trend, however turned into a N.W. direction at the most westerly end to cross Yallourn Fault.

Bores which have been used for putting down the structural features of the upper stratas show the following Nos.

631	346	388	197	198	205	206	76	275
64	276	61	1008	633	644	653	1009	665
672	1010	2	36	37	38	39	40	179
	98	100	213	102	80.			

An allowance for a considerable overburden correction had to be made, which runs up to more but 4 milligals and had to be derived from the thickness of overburden as revealed by bores Nos. 672, 1010, 2 36, 37, 38, 39, all of which except No. 2 did not penetrate the upper layers and did not strike coal.

Intersections of Profile B-B' with Profile F-F' and H-H' respectively have been used as fixed points to start the computing, which had to be based of course on 1.0 density-difference. On account of the heavy overburden which occurs in the central section of the profile, and naturally clouds the gravity picture of the deeper underground, no precise figure can be expected as to the very deepest part of the basement rocks. However it appears to be reasonable and natural to have both wings of the profile connected the way as it is shown by the dotted line.

7. DEPTH CONTOUR LINES OF BASEMENT ROCKS AS DERIVED FROM GRAVITY RESULTS.

The final depths to the surface of basement rocks as worked out from the five cross-sections have been combined in one basement contour map drawn on a scale of 1 mile to two inches.

The contour lines shown by this map reflect trends as well as depths and dipping data on the basement layers and must be looked at as the nearest approach to the actual conditions of the basement complex, i.e. basalt lava flows and Jurassic rocks, as can so far be derived from the gravity picture.

As to the depth data shown on this map, the fact must be stressed that they represent rather minimum figures and that especially the relatively deepest parts of the synclinal features might be well deeper than represented by the map prepared.

Furthermore the structural pattern shown must be considered as mainly a generalised one, since it would take many more and rather close set-up stations, to work out more details of the individual features, e.g. certain parts of Yallourn syncline, Morwell anticline and Traralgon trough zone. The same comes true with reference to faulted areas, as Yallourn and Haunted Hill faulting and the very edges of Latrobe basin, which have been so far covered only partly. A more or less complete gravity picture is at hand on Traralgon monocline only, but even in this particular area more detailed work would be necessary to elucidate some of the minor north-south running cross faults.

The basement contour map shows Yallourn syncline as an oval-like feature of bowl-shaped character, the great axis trending more or less parallel to Morwell River, however, diverted a little into a N.N.E. direction. The maximum depth of the basement layer might be placed well over 1100 feet below sea level.

The crest of Morwell anticline follows a strictly N.E. trend, dying out to the N.E. where it is possibly terminated by the fault, which causes the known off-set of the Yallourn fault zone to the south by about one half mile. According to the depth contour lines, the trend of it is N.N.W. - S.S.E.; it separates part of Traralgon trough which forms this way a special annex or somewhat shallower basin to the S.E. of Morwell, from the deeper part of Traralgon syncline.

In connection herewith reference is made to the map prepared by the S.E.C. which shows the occurrence of thick brown coal seams in the Yallourn-Morwell area under a cover of less than 200' overburden.

It well appears from a comparison of the S.E.C. map with special features shown on the basement contour map that the eastern boundary line of the area favourable to coal deposit follows the structural trends indicated by the basement contour map as described above. No favourable coal to overburden ratio has been found to the east of the steep dipping eastern wing of Morwell anticline and its N.N.W. trending extension up to Latrob river.

The contour map shows the deepest part of the basin area somewhat north of the Eastern Railway line and half-way between Traralgon and Morwell at a minimum depth of 1900'. On account of the thickness of the overburden, as outlined above no definite statement can be made, however, either as to the total depth nor to the potential extension of the east of this particular deep area.

A relatively shallow depth of basement rocks underlying brown coal seams is well indicated within an area between Traralgon and Flynn's Creek to the north of Bore Nos. 55 or 190 respectively reaching probably a depth of 500 feet.

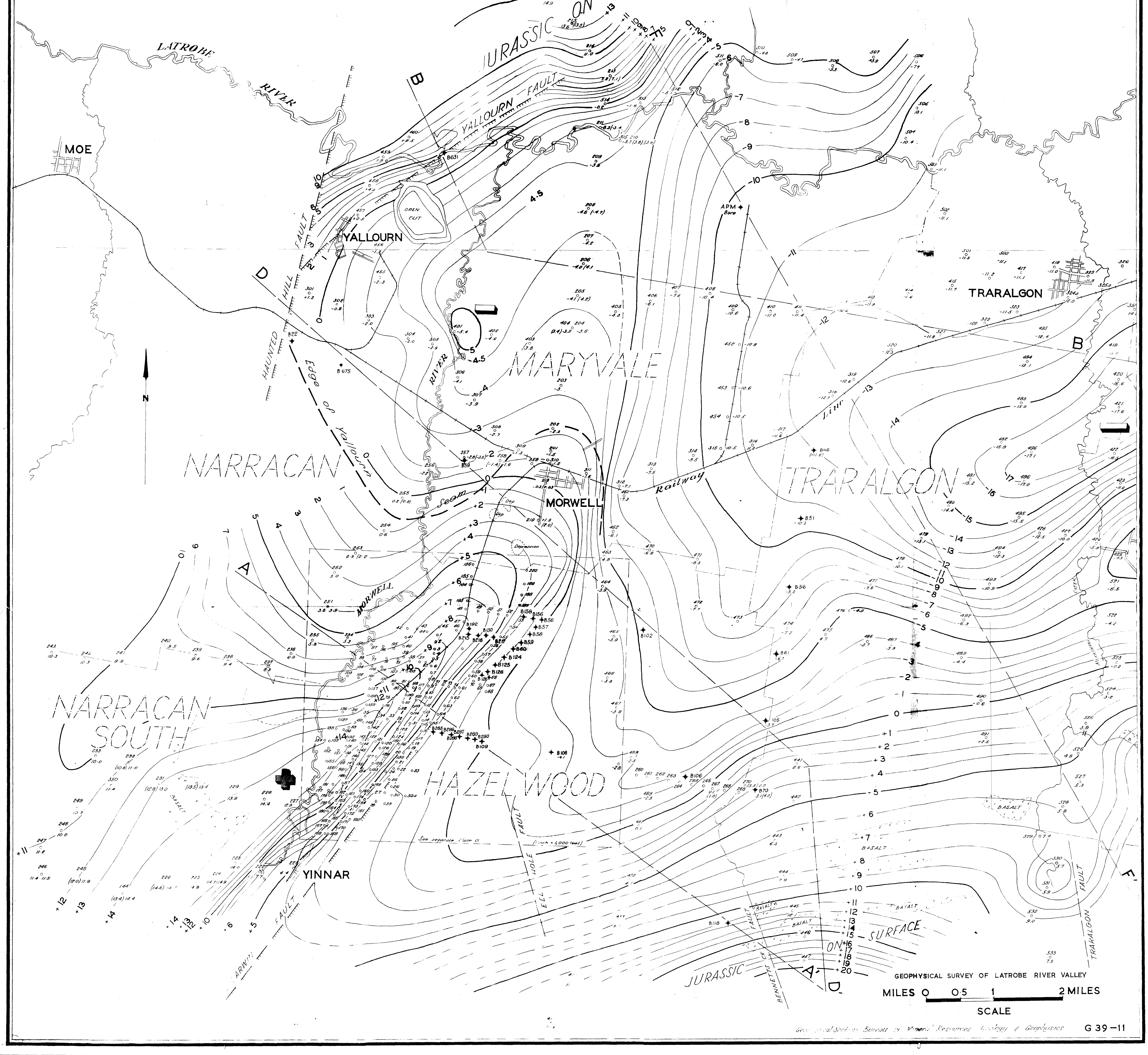
On account of lacking gravity information nothing definite can be said yet as to the final trend of contour lines within this particular area, the design shown being of a preliminary character. However, the distribution of thick brown coal seams in the Loy Yang area as shown on the map prepared by S.E.C. well indicates a similar outlining and strike of the formations found by drilling.

(G. NEUMANN)

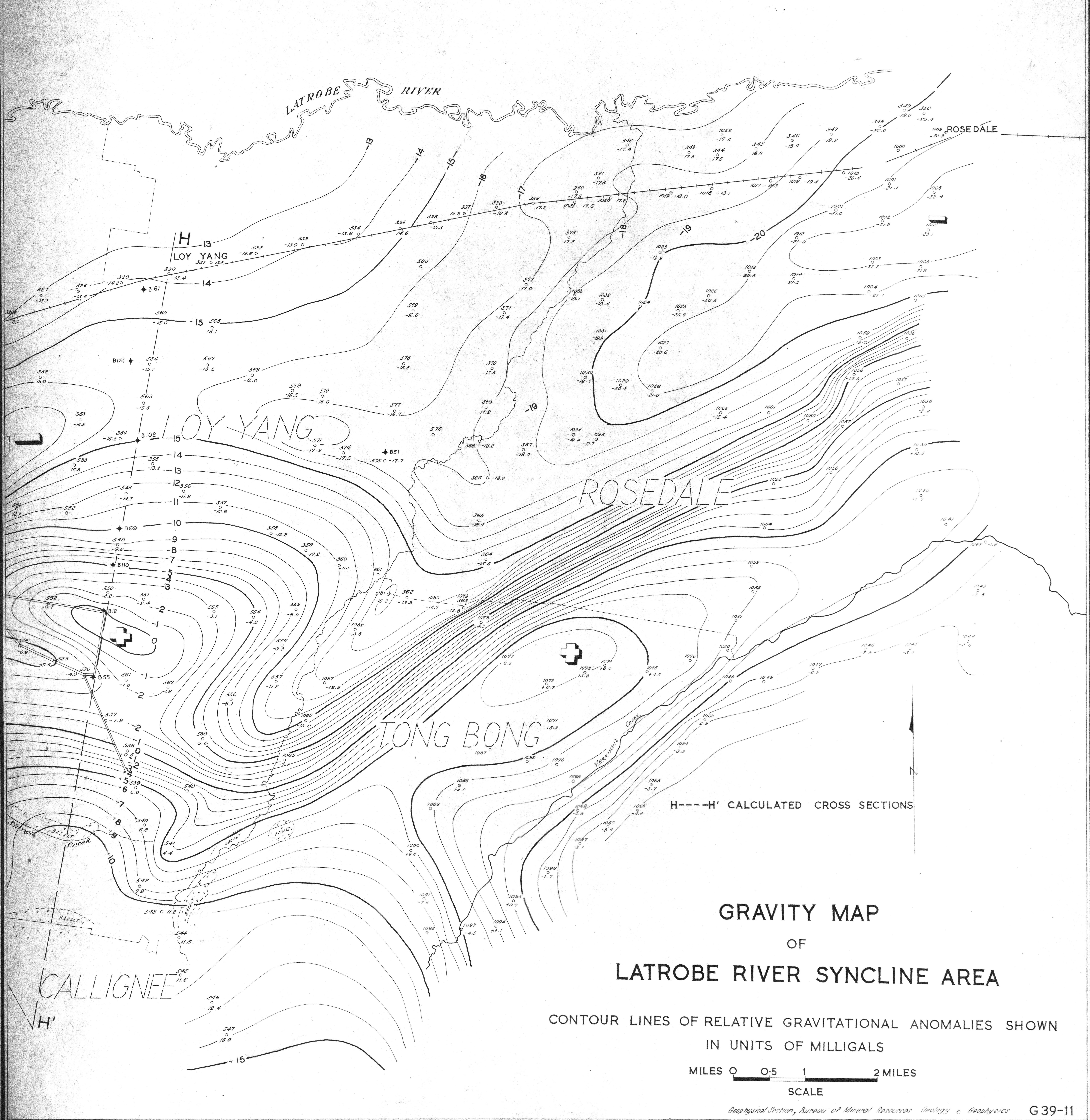
DEPTH CONTOUR LINES BASED ON TOP OF BASALT
AS COMPUTED FROM GRAVITY DATA
LATROBE RIVER SYNCLINE AREA.
MILES 0 0·5 1 2 MILES
SCALE
H----H' CALCULATED CROSS SECTIONS
GEOPHYSICAL SURVEY OF LATROBE RIVER VALLEY
Geophysical section, Bureau of Mineral Resources, Geology & Geophysics
G 39-9
JURASSIC ON SURFACE
FAULT
YALLOURN
HAUNTED HILL FAULT
OPEN CUT
YALLOURN SYNCLINE
MORWELL RIVER
MORWELL
MORWELL ANTICLINE
MORWELL MONOCLINE
Railway Line
SYNCLINE
TRARALGON
TRARALGON MONOCLINE
TRARALGON SYNCLINE
Traralgon Creek
CARRAJUNG MONOCLINE
Basalt at sea level
LATROBE RIVER
FLINN
Flinns Creek
Shingle Creek
BASALT AT SURFACE
Subsurface Boundary of Basalt
YINNAR
TARWIN FAULT
BENNETTS CK FAULT
TRARALGON FAULT
JURASSIC ON SURFACE
BASALT
A.P.M. Bore
A A' B B' D D' F F' H H'

WESTERN SECTION OF LATROBE SYNCLINE GRAVITY SURVEY

B---B' CALCULATED CROSS SECTIONS



EASTERN SECTION OF LATROBE SYNCLINE GRAVITY SURVEY

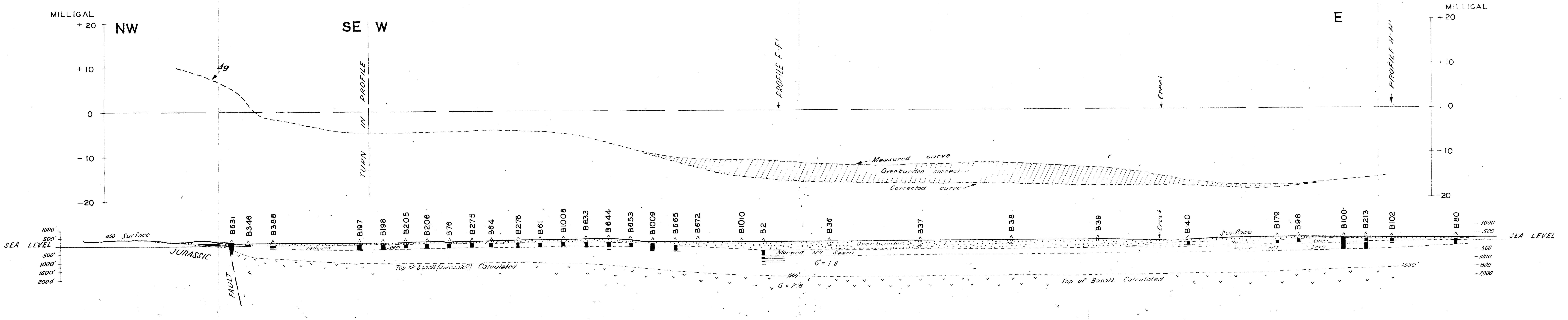


GRAVITY MAP
OF
LATROBE RIVER SYNCLINE AREA

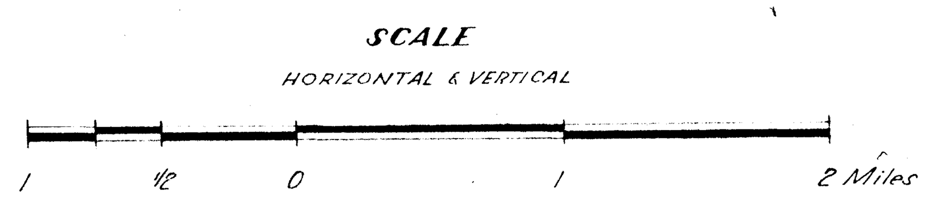
CONTOUR LINES OF RELATIVE GRAVITATIONAL ANOMALIES SHOWN IN UNITS OF MILLIGALS

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics G 39-11

CROSS SECTION B - B'
YALLOURN – TRARALGON



CROSS SECTION F-F'
TRARALGON



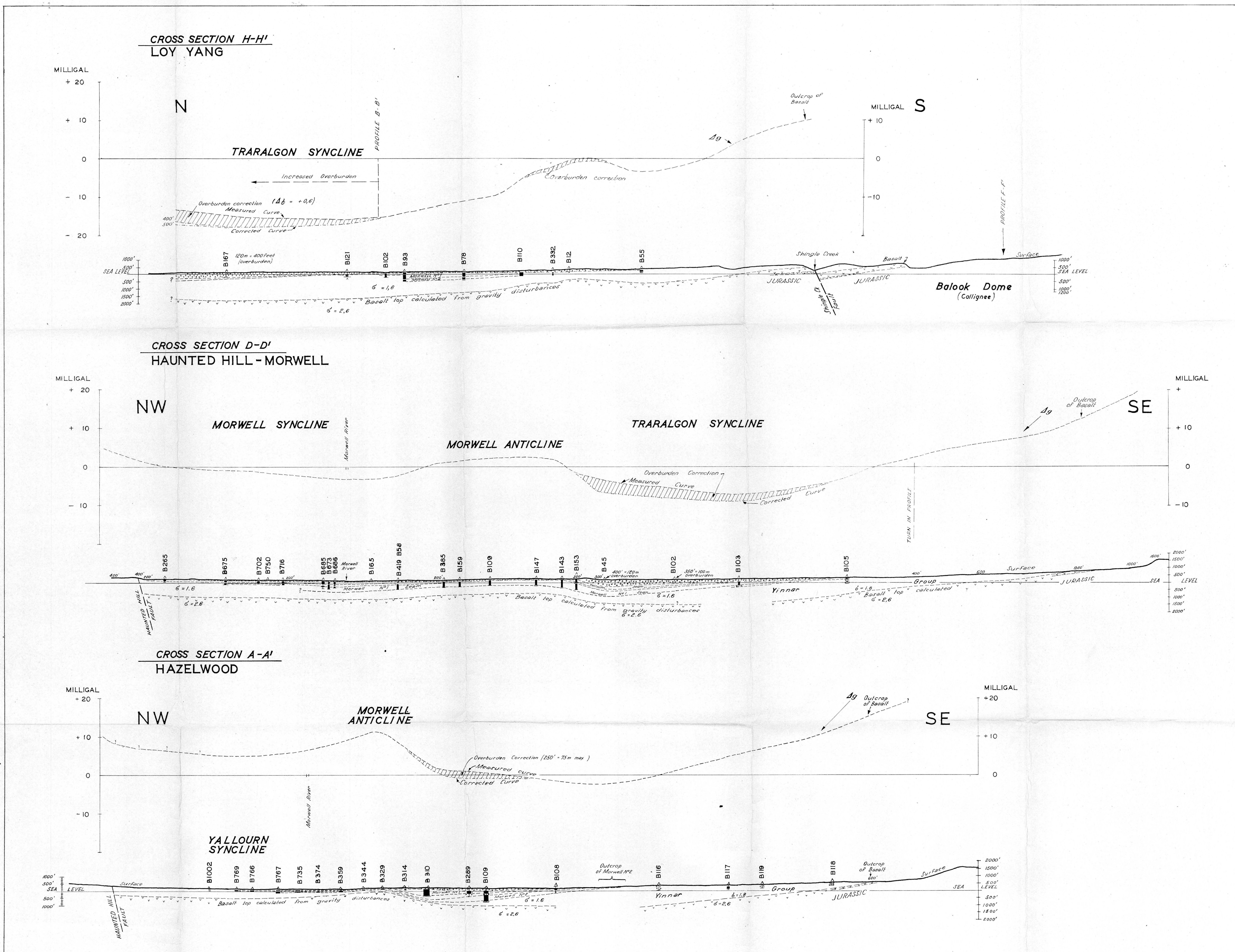
LATROBE RIVER SYNCLINE AREA

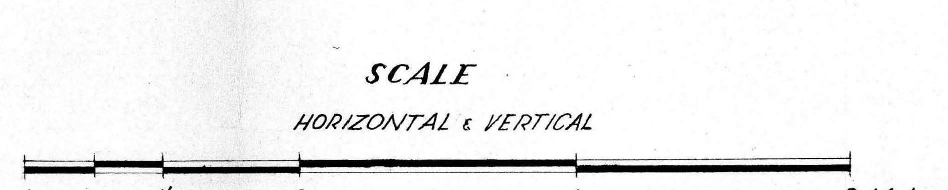
SHOWING GEOLOGICAL AND GRAVITATIONAL CORRELATION OF CROSS SECTIONS

GEOPHYSICAL SURVEY OF LATROBE RIVER VALLEY

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics.

G 39–12





LATROBE RIVER SYNCLINE AREA

SHOWING GEOLOGICAL AND GRAVITATIONAL CORRELATION OF CROSS SECTIONS

GEOPHYSICAL SURVEY OF LATROBE RIVER VALLEY

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics.

G 39-13