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

RECORD 1950/37

GRAVITY SURVEY
WALLOWAY ARTESIAN BASIN,
SOUTH AUSTRALIA

by

C.H. van ERKELENS

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BUREAU OF MINERAL RESOURCES. GEOLOGY AND GEOPHYSICS.

RECORDS NO. 37.

GRAVITY SURVEY

WALLOWAY ARTESIAN BASIN, SOUTH AUSTRALIA

A. INTRODUCTION

The Walloway Artesian Basin is approximately 160 miles north of Adelaide and is traversed by the main road from Adelaide to Maree via Orreroo and Hawker. The town of Orreroo lies on its western margin in the south-western corner of the Hundred of Walloway and the village of Johnburgh is situated in its northern part.

The geophysical survey was carried out at the request of the Director of Mines for South Australia to assist his Department in the selection of sites for boring for artesian water and to delineate more precisely the limitations of the basin with regard to artesian flows. The gravity method was used as this method has proved successful elsewhere in determining the dimensions and form of sedimentary basins.

B. GEOLOGY.

The Geology of the area has been described by R.C. Sprigg (1949) and the following notes and quotations are drawn from his report.

The basin is relatively small and of the valley type. It exists in the broad plain which extends northwards from the Hundred of Black Rock Plain, through the Hundred of Walloway, where its width is greatest, and the Hundred of Oladdie.

The plain is flanked by outcrops of Upper-Pre-Cambrian rocks, (Adelaide System) comprising slates interbedded with quartzites, limestones and tillites which have been steeply folded and at a much later period subdued by erosion.

A deep valley has been eroded through the old rocks and fluvial deposits, consisting of sands, clay and lignitic matter, have been laid down along its course, probably in early Tertiary time.

The sands in these sediments have been found to carry water under pressure. The maximum proved depth of the basin is more than 600 feet.

With reference to the structure of the basin Sprigg writes as follows:-

"One major block fault almost certainly delimits much of the western perimeter of the basin and it may compound in part. The structure for the eastern border is more obscure and there is a suggestion that besides possible meridional faults, there may be others trending east of north producing the deep secondary valleys which lie in this direction".

It was hoped that the geophysical survey would indicate whether in fact these faults existed and if so where.

C. TECHNICAL MATTERS.

The instrument used for this survey was a Heiland type GSC-2 Gravity meter with a sensitivity of approximately one part in fifty million. This instrument is suitable for detecting anomalies expected from the sediments in the basin.

The basin was covered by 11 east-west traverses of an average length of 9 miles. Stations on these traverses were from a quarter to one third of a mile apart. In addition, three traverses running in a north-north-westerly direction were observed, the station intervals in the latter being approximately half a mile. The positions of the abovementioned traverses are shown on plate G81-2.

Several north-south runs were made along roads connecting stations at the ends and centres of the east-west traverses. This was done, firstly to connect the northern and southern parts of the survey and bring them to the same datum, and secondly to be able to apply loop closure corrections. The latter is necessary for judging the overall accuracy of the survey and localises mistakes if any. Owing to close settlement of the area it was possible to place all the traverses along public roads which generally speaking were in good condition.

The necessary surveying and levelling was done by a survey party of the Department of Mines, South Australia and levels and station numbers are shown on maps No. I49-23 and I49-24 dated 8-7-1949 of the South Australian Department of Mines.

The results were reduced by applying the latitude corrections and an elevation correction factor of 0.068 mg/ft, derived from some density profiles in the area.

Fieldwork was done in two parts. Firstly from 28-6-49 to 6-7-49 when the party consisted of one observer and the second part from 24-11-49 to 21-12-49 when the party was made up of one observer and two assistants.

D. RESULTS

After the necessary corrections for latitude and elevation had been applied to them, the observed gravity values were used in drawing the Observed Gravity Contour Plan plate G81-2. This plan also shows the positions of the gravity traverses and basement outcrops at places where the traverses cross them.

The pattern of the gravity contours includes three separated minima which, it can be assumed, correspond to three small sedimentary basins. The first of these is centred to the north of Orroroo; the second south of Orroroo between Dalton (Black Rock) and Yatina and the third which is smaller than either of the other two, approximately 7 miles east of Orroroo. These basins are joined by, and form part of, a buried valley structure which extends from north to south throughout the area investigated and which is known as the Walloway Artesian Basin.

The Observed Gravity Contour pattern however has certain features which suggest that it is not entirely due to the light sediments that fill the artesian basin. For example the gravity values on outcrops of basement rocks range from 10 milligals due west of Galloway to over 25 milligals east of Dalton (Black Rock). On each east-west gravity traverse there is a pronounced increase in gravity towards the east which must be attributed to a regional or basement effect. No attempt has been made to find an explanation for this easterly gradient nor does any such attempt appear worth while and it is attributed to an unspecified regional effect. A Regional Gravity Contour plan was prepared by interpolating linearly between the observed values measured on basement outcrops in the area. This plan is shown on plate G81-3 and it shows a practically linear increase in gravity values in an easterly direction.

The arithmetical differences between the Regional Gravity values and Observed values are called Residual Gravity values and they have been contoured on plate G81-1.

The Residual pattern is believed to represent the effect of the light sediments and serves to emphasise the valley and basin structures to which attention was drawn above when discussing the Observed Gravity pattern.

In the Residual Gravity pattern the steepest gradients occur on the western margin of the "valley" where geological evidence suggests that it is delimited by major faulting.

It can be shown with the aid of calculated gravity sections that the gravity gradients can be explained by light sediments resting on a basement which is dipping toward the centre of the valley at an relatively low angle and it seems unlikely that faulting alone delimits the valley.

Plan GS1-4 shows calculated gravity profiles for geological sections comprising 1800 feet of Tertiary Clays etc (density 2.1) overlapping or in faulted contact with Pre-Cambrian basement rocks (density 2.6). Calculations have been made for four different sections in which the angle between the Tertiary Sediments and basement rocks is respectively 90° , 25° , 17° & 13° . It will be seen that the gravity gradient varies with the basement slope, the gradient decreasing as the slope becomes flatter. Residual gravity values for Section A-B plate GS1-1 are superimposed on the calculated curves and it will be seen that their gradient matches that of the calculated curve for a basement slope of 17° . It seems likely that the actual density difference between the Tertiary Clays and the basement rocks will be greater than 0.5 and the total thickness of the sediments less than 1800 feet. Consequently it follows that the actual basement slope may be less than 17° . Slopes of this order may normally be expected on the flanks of buried valleys and it is probable that faulting where present has played a minor role in determining the shape of the valley.

The gravity results give some indication of total thickness of sediments in the Walloway Artesian Basin. They appear to be thickest about 2 miles west of Gallwey. Other deep depressions are centred about 7 miles east Orreroo and between Dalton (Black Rock) and Yatina. It is believed that the maximum thickness is of the order of 1000 to 1200 feet.

E. CONCLUSIONS.

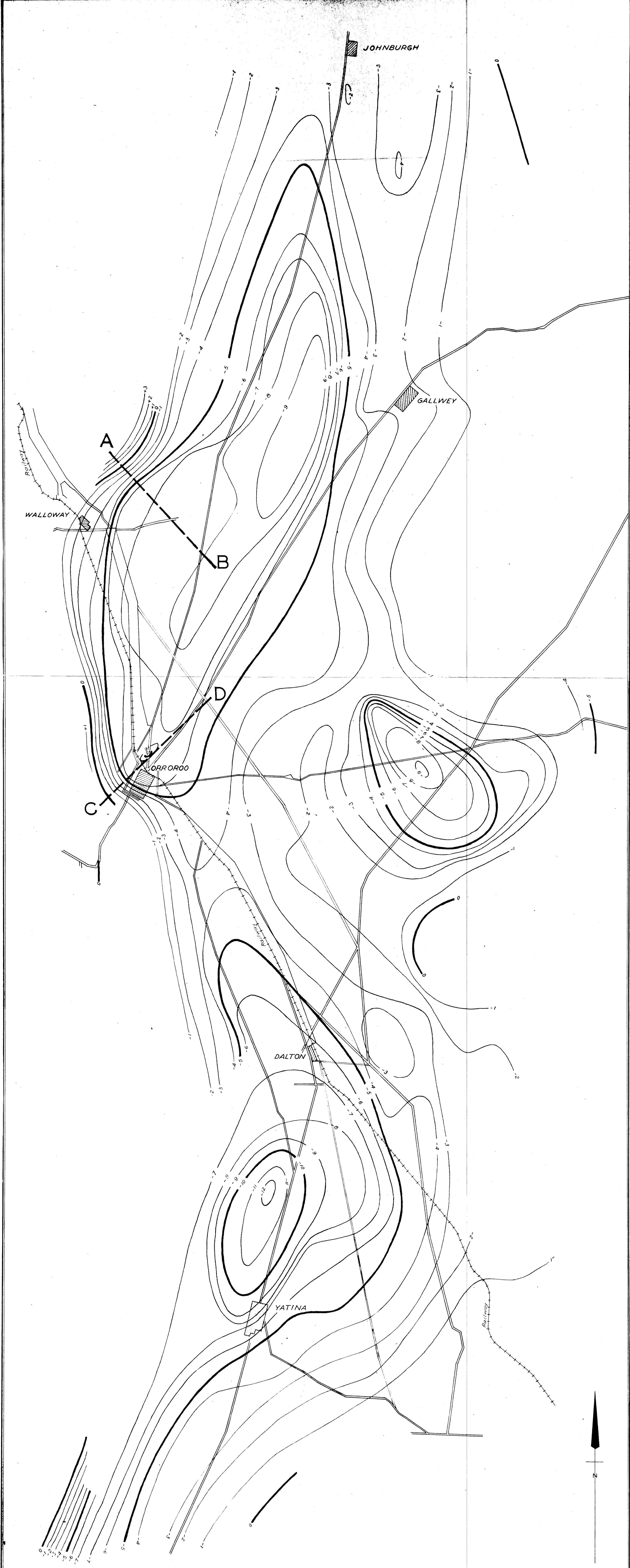
The survey has given what is believed to be a true representation of the shape and depth of the Walloway Artesian basin and this information when used in conjunction with the existing geological knowledge should provide a useful guide to the selection of further bore sites.

References

- Sprigg Reg. C. (1949) Senior Geologist S.A. Department of Mines -
"The Walloway Artesian Basin" unpublished notes May 1949.

(C.H. van Erkelens)
Geophysicist

Melbourne.
October, 1950.



GEOPHYSICAL SURVEY AT ORROROO, S.A.

WALLOWAY ARTESIAN BASIN

SHOWING

RESIDUAL GRAVITY CONTOURS

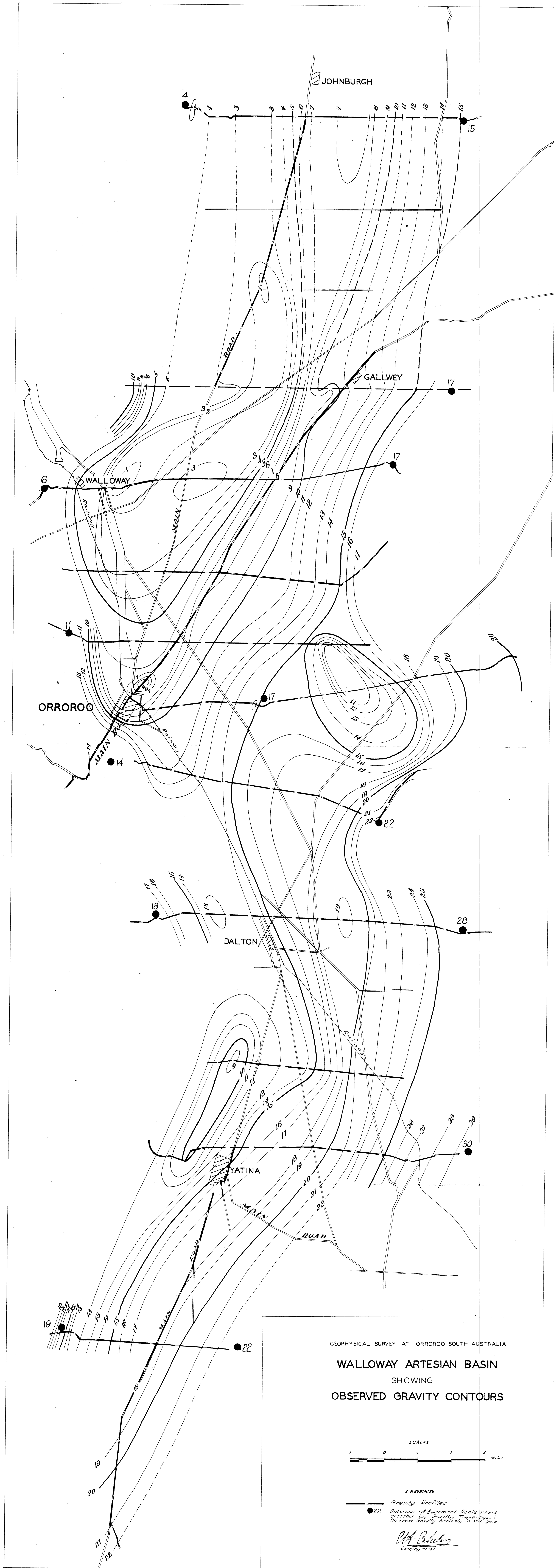
BASED ON REGIONAL VALUES SHOWN ON PLAN
G81-3

SCALE
0 1 2 miles

Contour Interval 1 milligal

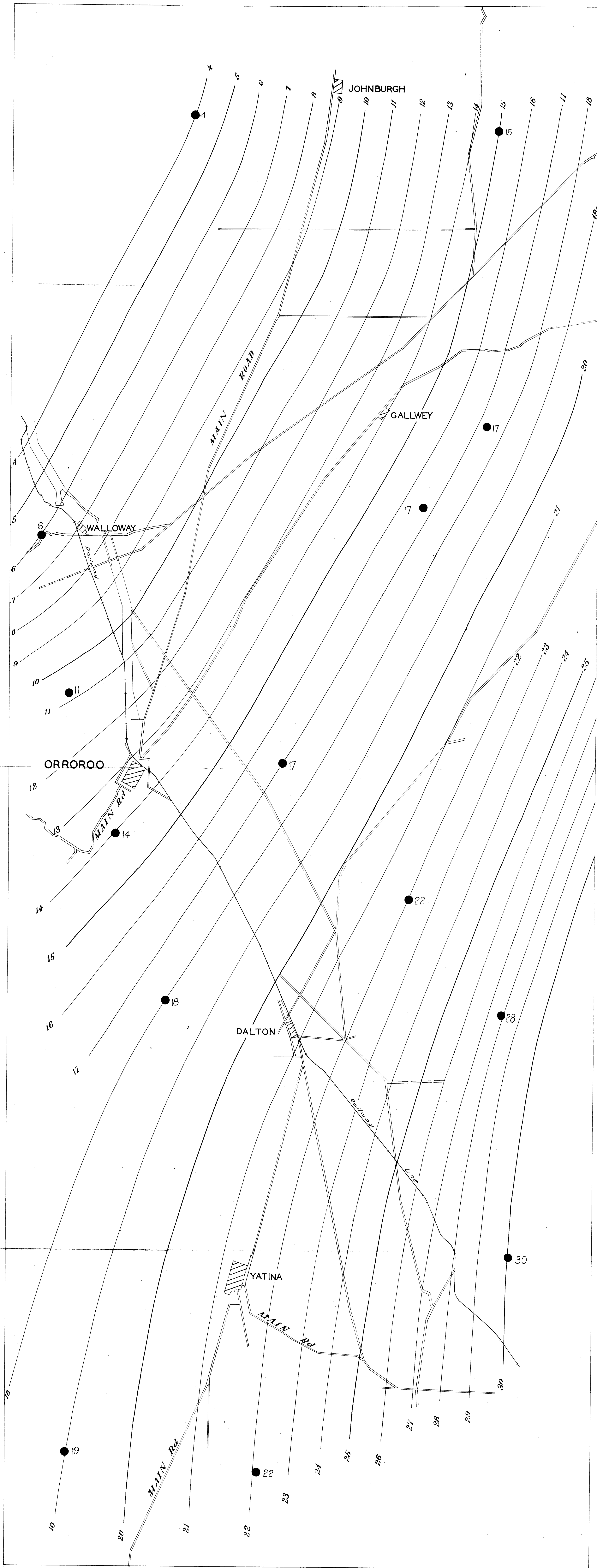
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G81/1



G81-2

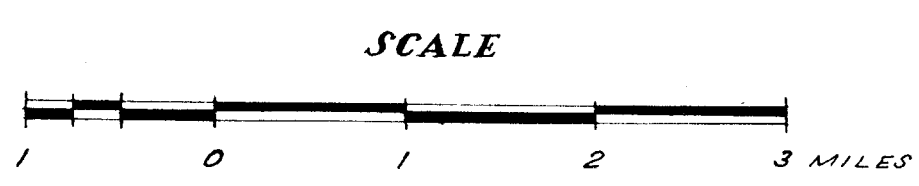
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GEOPHYSICAL SURVEY AT ORROROO, SOUTH AUSTRALIA.

WALLOWAY ARTESIAN BASIN SHOWING REGIONAL GRAVITY CONTOURS

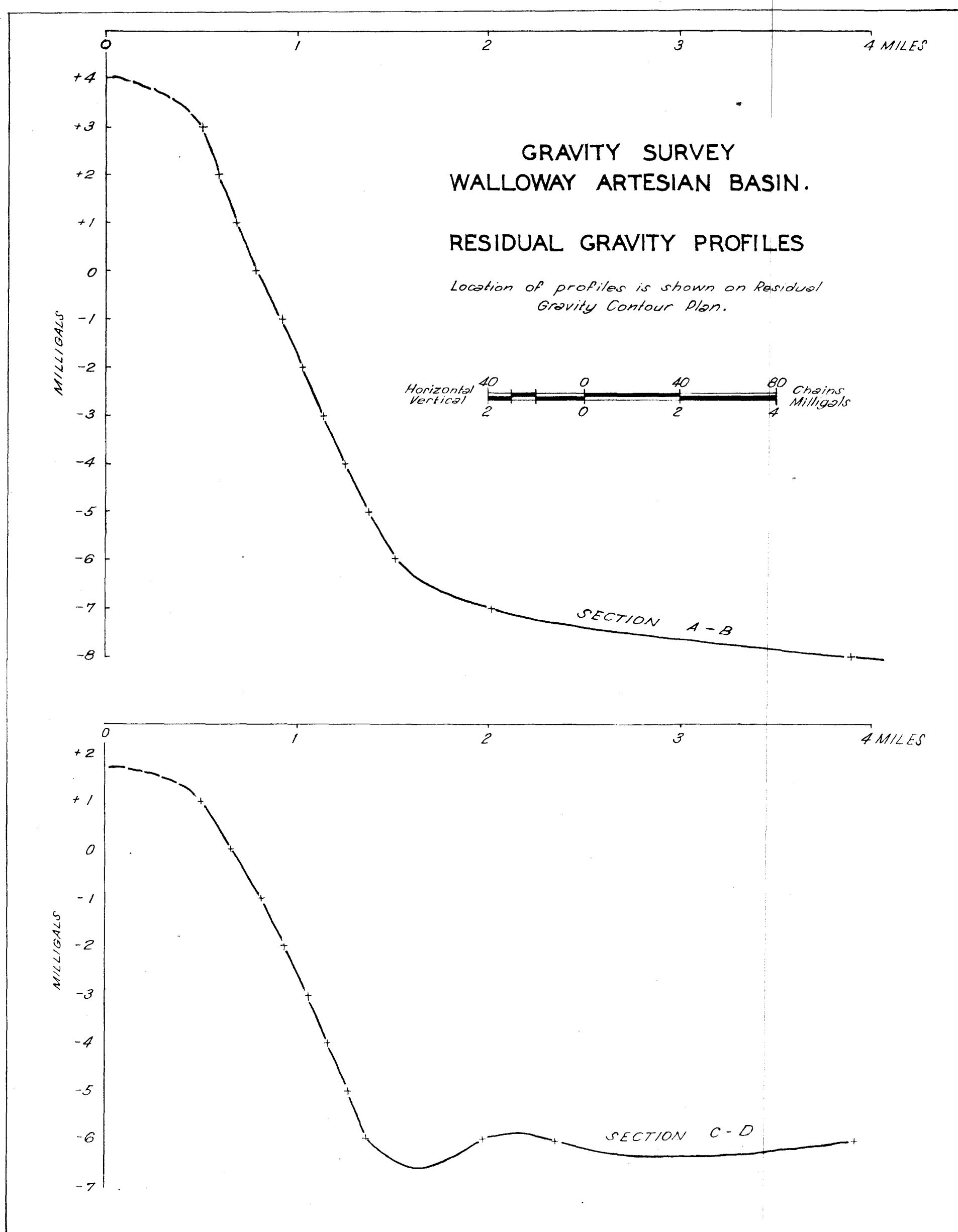
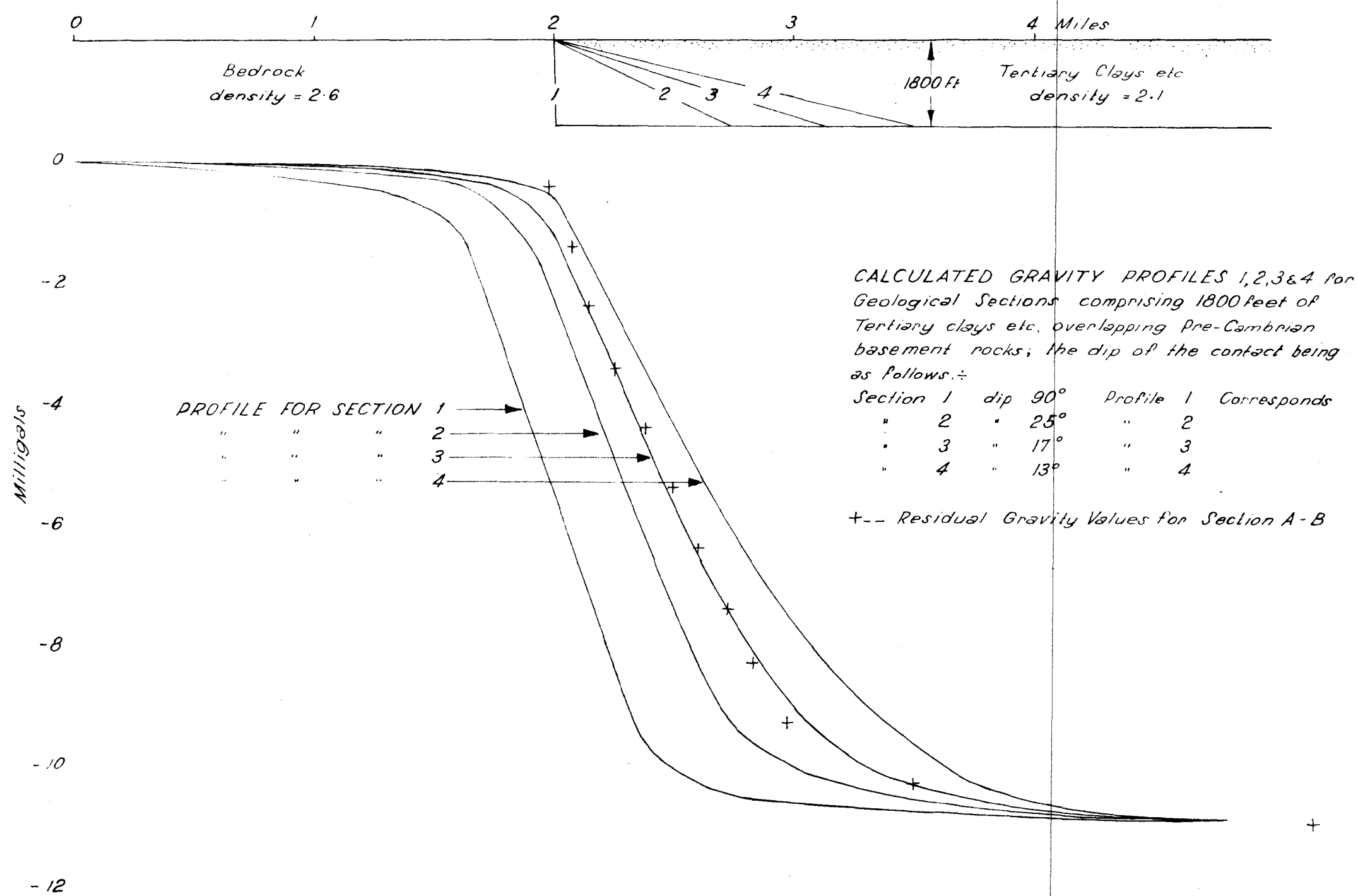
CONTOURS IN MILLIGALS



LEGEND
● 19 Outcrops of Basement Rocks where crossed by Gravity Traverses & observed gravity anomaly in milligals.

Chas. E. Baker
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GRAVITY SURVEY WALLOWAY ARTESIAN BASIN



GEOPHYSICAL SURVEY AT ORROROO, SOUTH AUSTRALIA

Ch. Erskine

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19-10-50

G 81-4

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics