COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS
1959 NO. 6

GRAVITY EFFECT OF THE BURT RANGE LIMESTONE AND BASIN STRUCTURE IN THE BURT RANGE SUB-BASIN.

by

F.J.G. NEUMANN.

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ILLUSTRATIONS.

ABSTRACT.

An interpretation of gravity data in the Burt Range sub-basin of the Bonaparte Gulf Basin is described. The effect of the Burt Range limestone, the densest unit in the sedimentary section is eliminated and the residual anomaly, due mainly to the lighter sediments, correlates well with the basin structure postulated from seismic and geological data.

1. INTRODUCTION.

In a Record issued recently by the Bureau of Mineral Resources, Geology and Geophysics (Thyer, Stott and Neumann, 1959) the results of a gravity survey in the Bonaparte Gulf Basin are discussed. The present report deals with a further aspect of the interpretation of the gravity data obtained in the Burt Range sub-basin which occupies the extreme southern part of the Bonaparte Gulf Basin. The gravity effect of an assumed thickness of the Burt Range limestone, the densest unit of the sedimentary section, has been calculated and removed from the observed Bouguer anomalies. The residual anomalies, mainly due to the lighter sediments, gives a reasonable correlation with the basin structure postulated from seismic and geological data. The geology of the region and technical aspects of the survey are discussed in the earlier Record (Thyer, Stott and Neumann, 1959) and will not be repeated here

2. DISCUSSION.

The Burt Range Basin, as described by Utting (1957), may be considered to be -

(a) a southern embayment of the major Bonaparte Gulf Basin, with sediments steadily increasing in thickness towards the north, or

(b) a more or less closed, if relatively shallow, basin-type feature, which is separated from the Bonaparte Gulf Basin by some type of "buried ridge".

A relatively strong gravity "high" with southeasterly strike is indicated on the southern bank of the Keep River, roughly between the Weaber Range and Spirit Hill, with a maximum Bouguer anomaly value of +6.6 milligals (See Plate 2). This supports the possibility (b). From this "high", gravity anomaly values decrease rapidly in a northerly direction, towards the Legune-Carlton road between Sandy Creek and Keep River and in a southerly direction towards Milligan's Lagoon.

A possible reversal to southerly pitch within the bedding of sediments near "Spirit Hill" is mentioned by Utting (1957, p.3). This reversal in dip is, however, by no means certain, although it would agree with the trend of the gravity gradients.

Plate 2 of Utting's report presents several possible geological cross-sections, namely A-A' to G-G', as an interpretation of the observed geology, and of seismic reflection sections. Formation thicknesses along Section A-A' are difficult to assess, for the following reasons:-

(a) The base of the Burt Range Limestone can be alternatively placed either at 7,000 or at 4,000 feet (Utting, 1957 p.12).

(b) Reflections from 4,000 to 11,000 feet could represent -

(i) Burt Range Limestone

(ii) Cockatoo Sandstone

(iii) Lower Palaeozoic sediments such as the Ordovician-Cambrian succession which crops out within the Carlton Basin, or

(iv) Some upper Proterozoic sediments.

Sections A-A' and E-E' lend themselves to interpretation and hence to evaluation of the correlation between geology and gravity anomalies. This is important in determining which of the alternatives listed above is most likely to apply. An interpretation is attempted below using the following data:-

(a) Density values of samples obtained by testing, and listed in Table 1 of this report.

(b) Observed Bouguer anomaly values.

(c) Formation dips within the section, drawn from surface geology and seismic sections.

TABLE 1.

DENSITY DETERMINATIONS OF STRATA SAMPLES FROM BONAPARTE GULF BASIN.

Sample No.	Type.	Locality.	Dry sample density.
AAD/KR/1	Upper Proterozoic	Pincombe Range	2.53
2	Antrim Plateau Volcanics	Ord River Crossing	2.80
3	Skewthorpe Formation	Skewthorpe Ridge	2 79
4	Hart Spring Sandstone	" "	2.22
5	Clark Sandstone	Clark Jump-up	2 13
6	Cockatoo Sandstone	Cockatoo Sands	2 00
7	Burt Range Limestone	Burt Range	2 62
8	Enga Sandstone	Enga Ridge	2.13
9	Septimus Limestone	Mt. Septimus	2.64
10	Spirit Hill Limestone	Spirit Hill	2.66
10A	" " "	" "	2.61
11	Sandstone overlying Spirit Hill Limestone	" "	2.05
12	Sandy Creek Limestone	Sandy Creek	2.63
13	Point Spring Sandstone	Point Springs	2.11

The assumed effect of variations in thickness of the Burt Range Limestone has been removed and a reasonable correlation between residual gravity anomaly and basin structure is apparent.

Results of this analysis and interpretation are shown on Plates 3 and 4. The analysed sections A-A' and E-E' are shown together with gravity profiles and main boundaries of outcropping geological formations. Relevant rock densities are as follows:-

(a)	Point Spring Sandstone	=	2.11
(b)	Burt Range Limestone	=	2.62
(c)	Cockatoo Sandstone	=	2.0
(d)	Pincombe Range Sandstone	=	2.53

These are "dry sample densities". Porosity of the tested sample of Cockatoo Sandstone was found to be very high, resulting in a relatively low density value, and it appears reasonable to accept a slightly higher figure (e.g. 2.2) as an average for the deeper sections of this formation.

The procedure followed is firstly to eliminate the gravity effect of the Burt Range Limestone according to probable thickness and then to evaluate the depth to the Proterozoic basement by using the resulting residual anomaly curve. Depth estimates to the probable Proterozoic basement along section line E-E', based on the residual gravity anomaly, agree reasonably well with the depth estimates based on the seismic section.

The analysis of section A-A' assumes that the bottom of the Burt Range Limestone is not much deeper than the 5,000 feet that Utting assumes as a probable depth. Because of the relatively high density of the Burt Range Limestone, the gravity "high" on the southern bank of the Keep River could be explained by an increase in thickness of the Burt Range Limestone towards the centre of the "high". This is a contradiction to the interpretation of the high as representing a buried basement ridge. However, an interpretation in terms of a thickening of the Burt Range Limestone would infer that the Burt Range Limestone dips towards the western margins of the Burt Range Basin, directly under the area of the gravity "high". There is no geological evidence to support this possibility. The presence of a buried basement ridge is considered more likely.

3. CONCLUSIONS.

The following conclusions can be drawn from the gravity analysis:-

1. A residual gravity map calculated by removing the effect of the Burt Range Limestone from the Bouguer anomaly values may give a more accurate representation of basin structure in the Burt Range Basin.

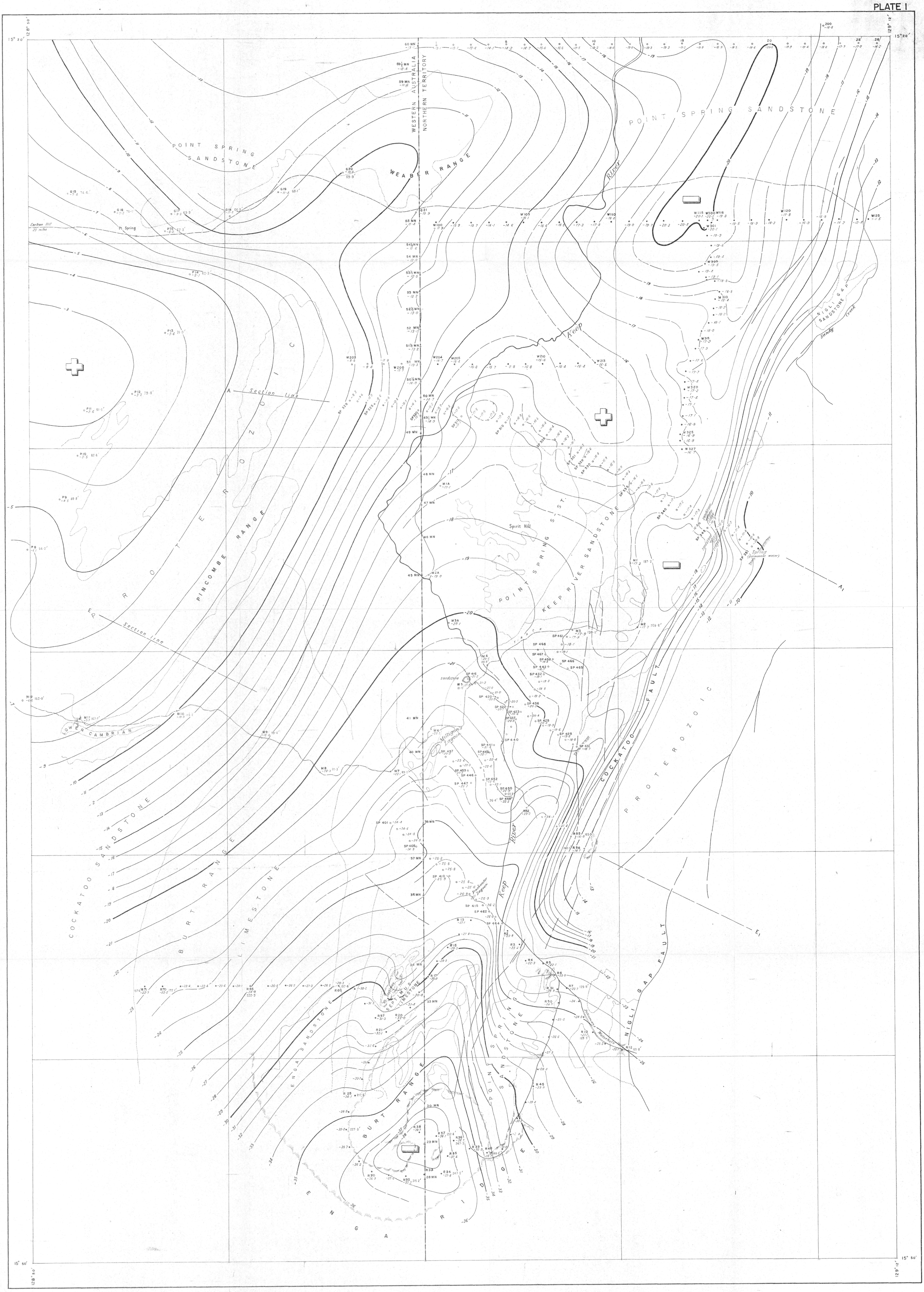
2. The assumption of a "buried ridge" of Proterozoic rocks offers a reasonable explanation for the high Bouguer anomaly values observed between Weaber Range and Spirit Hill.

4. REFERENCES.

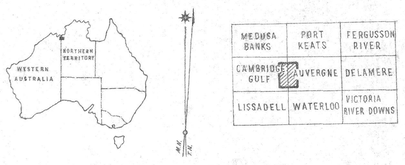
THYER, R.F., STOTT, P.M. and NEUMANN, F.J.G. 1959 - Report on a Gravity Survey in the Bonaparte Gulf Basin 1956-58. Bur.Min.Resour.Aust., Record No. 1959/20.

UTTING, E.P. 1957 - Report on Exploration within Permit No. 3 NT (1956). Westralian Oil Ltd., Perth, W.A. (Unpublished report).

PLATE I



LOCATION



REFERENCE TO AUSTRALIAN NATIONAL 4 MILE MAP SERIES

MAP DATA

PROJECTION: TRANSVERSE MERCATOR, AUSTRALIAN SERIES
CONTROL: DEPT. OF THE INTERIOR GRAVITY SURFACE CONTROL SURVEYS
DETAIL: B.M.R. 4 MILES TO 1 INCH GEOLOGICAL MAP, DEPT. OF THE INTERIOR SURVEYS OF GRAVITY AND SEISMIC TRAVERSES AND MINES ADMINISTRATION PTY. LTD. GRAVITY MAPS. GEOPHYSICAL AND GEOLOGICAL DATA FROM B.M.R. AND MINES ADMIN. FIELD SURVEYS
RELIABILITY: PLANIMETRIC - RELIABLE SKETCH
GEOPHYSICAL - SEMI - DETAILED GRAVITY

G. Neumann
GEOPHYSICIST

SEMI-DETAILED GRAVITY SURVEY (1957)
BONAPARTE GULF BASIN, BURT RANGE AREA,
BOUGUER ANOMALIES AND GEOLOGY

SCALE IN MILES
1 0 1 2 3 4

LEGEND

TOPOGRAPHY
ROAD
TRACK
WATERCOURSE
HOMESTEAD

GRAVITY
B.M.R. / MINES ADM. STATION
R 48 STATION NUMBER
+12·2 RELATIVE BOUGUER ANOMALY
120·4' ALTITUDE IN FEET
ANOMALY ISOGAMS IN MILLIGALS
HIGH ANOMALY
LOW "

EXPLANATION

RELATIVE BOUGUER ANOMALIES ARE BASED ON THE OBSERVED GRAVITY VALUE OF 978,415·9 MILLIGALS AT BMR No.30 PENDULUM STATION WYNDHAM.

AN AVERAGE DENSITY 2·1 HAS BEEN ASSUMED FOR ROCKS BETWEEN STATION SITE AND SEA LEVEL IN REDUCTION OF GRAVITY VALUES.

ELEVATION DATUM - LWM WYNDHAM
(LWM WYNDHAM - 11·5' = MSL)

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
(TO ACCOMPANY RECORDS 1959, No 6)

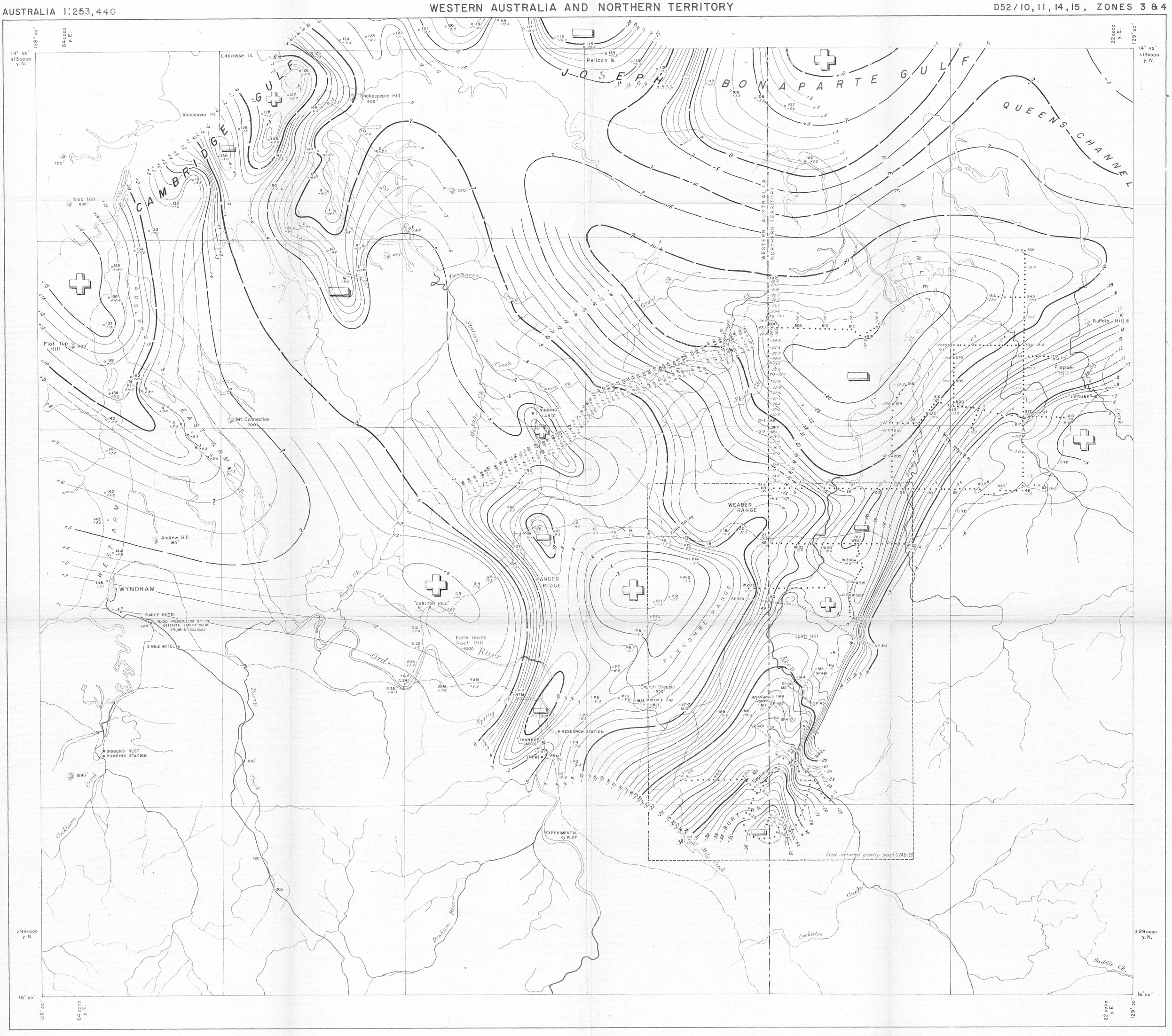
G 248-25

BONAPARTE GULF BASIN (SPECIAL)

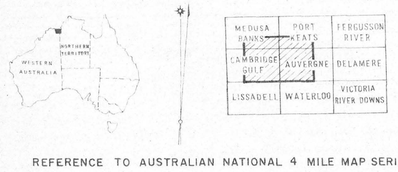
WESTERN AUSTRALIA AND NORTHERN TERRITORY

AUSTRALIA 1:253,440

D52/10, 11, 14, 15, ZONES 3 & 4



LOCATION



REFERENCE TO AUSTRALIAN NATIONAL 4 MILE MAP SERIES

MAP DATA

PROJECTION: TRANSVERSE MERCATOR, AUSTRALIAN SERIES

CONTROL: B.M.R. 4 MILES TO 1 INCH GEOLOGICAL MAP

DETAIL: PLANIMETRY FROM B.M.R. 4 MILES TO 1 INCH GEOLOGICAL MAP. GEOPHYSICAL DATA FROM B.M.R. AND MINES ADMINISTRATION PTY. LTD. FIELD SURVEYS AND B.M.R. UNDERWATER GRAVITY SURVEYS (N.W. AREA OF THIS SHEET)

RELIABILITY: PLANIMETRIC - RELIABLE SKETCH. GEOPHYSICAL - GRAVITY RECONNAISSANCE.

G Newman

GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1957-58)

BONAPARTE GULF BASIN, W.A./N.T.

BOUGUER ANOMALIES

SCALE IN MILES

4 0 4 8 12 20

LEGEND

TOPOGRAPHY

ROAD — TRACK — WATERCOURSE — HOMESTEAD

GRAVITY

R.M.R. / MINES ADM'N STATION

R 48 STATION NUMBER

+12·2 RELATIVE BOUGUER ANOMALY

120·4 ALTITUDE IN FEET

ANOMALY ISOGAMS IN MILLIGALS

HIGH ANOMALY

LOW ANOMALY

EXPLANATION

RELATIVE BOUGUER ANOMALIES ARE BASED ON THE OBSERVED GRAVITY VALUE OF 978,415·9 MILLIGALS AT B.M.R. No 30 PENDULUM STATION, WYNDHAM.

AN AVERAGE DENSITY 2·1 HAS BEEN ASSUMED FOR ROCKS BETWEEN STATION SITE AND SEA LEVEL IN REDUCTION OF GRAVITY VALUES.

ELEVATION DATUM - LWM WYNDHAM
(LWM WYNDHAM - 11·5' MSL)

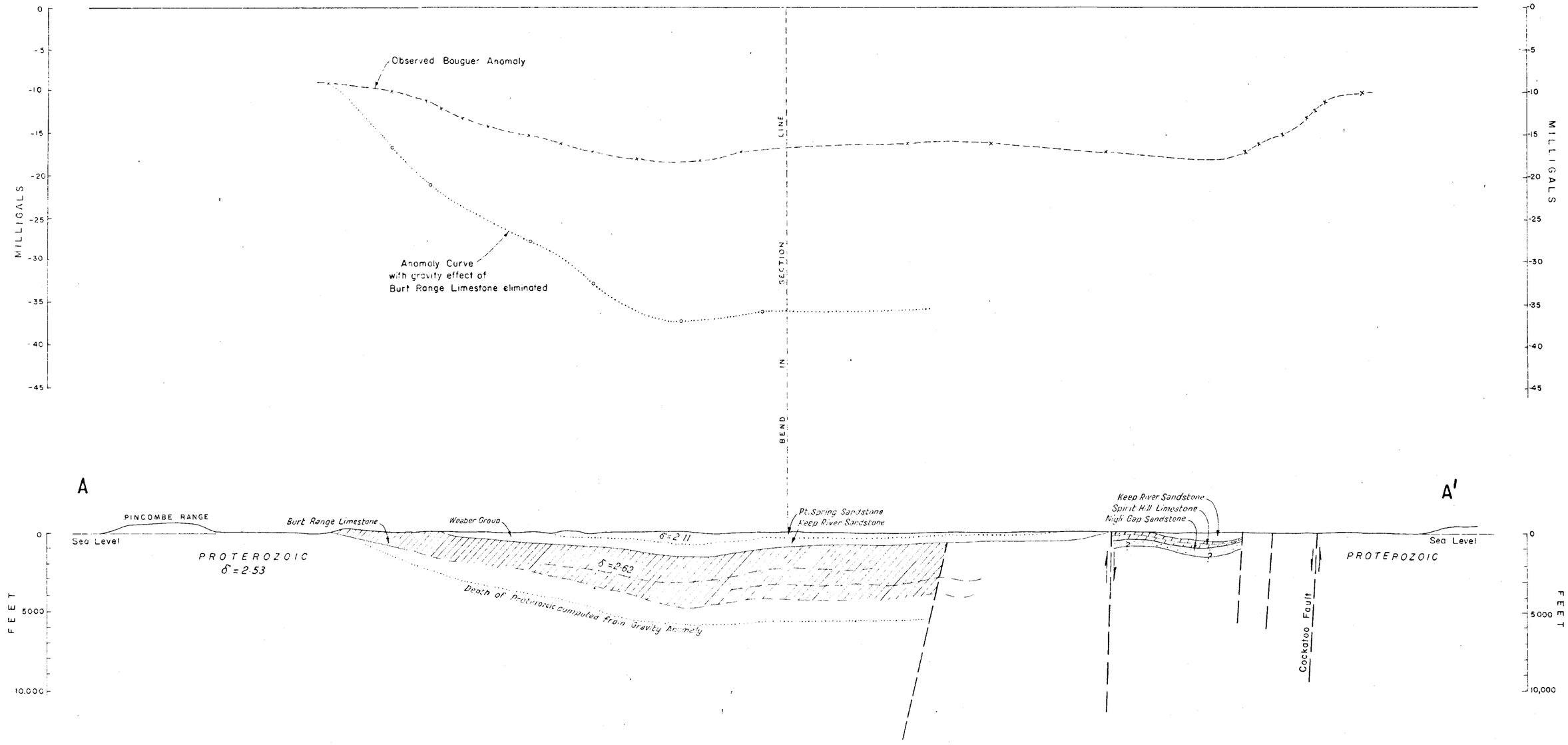
PLANIMETRIC DETAIL IS SHOWN ONLY TO LOCATE GEOPHYSICAL DATA.

WATER DENSITY FOR UNDERWATER GRAVITY VALUE REDUCTIONS = 1·03

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS G 248-26

TO ACCOMPANY RECORDS 1959. NO. 6

PLATE 3



HORIZONTAL AND VERTICAL SCALES IN MILES

0 1 2 3 4

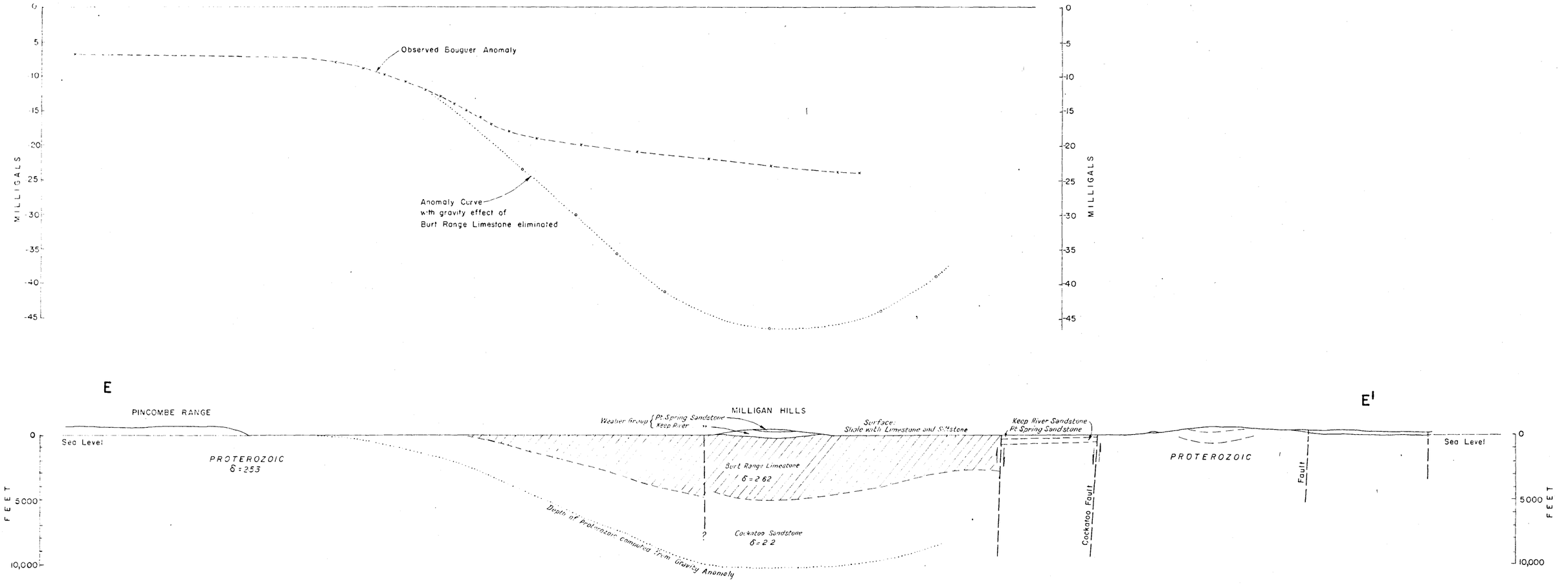
G. Keunnum
GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1956)
BONAPARTE GULF BASIN, W. A.

SECTION ALONG A - A', BURT RANGE BASIN

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G 248-22

(TO ACCOMPANY RECORDS 1959, N°6)



HORIZONTAL AND VERTICAL SCALES IN MILES

1 0 1 2 3 4

G. Neumann
GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1956)
BONAPARTE GULF BASIN, W. A.

SECTION ALONG E-E', BURT RANGE BASIN

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G 248-23