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**BUREAU OF MINERAL
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Record 1972/107



**PRESURVEY REPORT ON DETAILED GRAVITY SURVEY,
OFFICER BASIN, W.A. 1972**

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by

I. Zadoroznyj and F.W. Brown

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SUMMARY

The Bureau of Mineral Resources (BMR) will carry out a detailed gravity survey in the southwest Officer Basin during a period of about three months beginning in August 1972. The survey will produce detailed gravity coverage along the Warburton Mission Road from the vicinity of Lake Throssel, for 190 km towards the mission, thereby providing data complementary to a current seismic survey. In addition, the survey will provide detailed gravity coverage along a road between Lake Yeo and Neale Junction, near the southern boundary of the Officer Basin, W.A. The area to be surveyed has recently been covered by a BMR contract helicopter gravity survey.

The results of the detailed work will be more precise than the reconnaissance results and should be of assistance in complementing the seismic information to provide an integrated interpretation of the structure along a line across the Officer Basin. The detailed gravity survey may also permit extrapolation of the results away from the seismic and detailed gravity traverses to provide a better interpretation of the reconnaissance gravity results in terms of basic structure and basement composition.

1. INTRODUCTION

The Officer Basin covers a large area of Western Australia and South Australia. In the basin the thickest sedimentary pile is more than 6 000 m. In the Western Australia part of the basin the sediments are mainly of Proterozoic age largely overlain by a thin layer of Palaeozoic sediments (Plate 1). In the western part of the Officer Basin only the Hunt Oil Company has carried out an active exploration program. That company drilled four shallow exploration wells after extensive geological and geophysical investigation before relinquishing its exploration permit in 1966. In 1970 BMR and the Western Australian Department of Mines commenced a joint mapping project of the West Australian part of the Officer Basin. In addition to the joint mapping project and the Hunt work, other major investigations completed have been a BMR seismic survey near the northwest limit of the basin and resistivity probing for the W.A. Department of Public Works. A reconnaissance helicopter gravity survey at a grid spacing of 11 km is currently being completed.

The BMR is carrying out a program of stratigraphic drilling, mainly around the periphery of the basin to investigate marginal sedimentary facies and basement composition and depth, and also a seismic survey intended to define some of the basin's broad characteristics.

A detailed gravity survey will be carried out along the Warburton Mission Road from the vicinity of Lake Throssel, for 200 km towards the mission, providing data complementary to the seismic survey. The seismic party will provide logistic support for the gravity party. The Presurvey Report on the seismic survey (Pinchin & Mathur, 1972) describes the geological setting and gives a comprehensive summary of previous geophysics, indicated in this report by seismic line locations in Plate 1, the magnetic basement contour map (Plate 2) and Bouguer anomaly contours in Plate 3. A detailed bibliography and references for work carried out in the southwest Officer Basin are included also in the seismic presurvey report. The present report complements that report and discusses, particularly, aspects of the previous gravity work relevant to the proposed gravity survey.

2. PREVIOUS GRAVITY RESULTS AND INTERPRETATION

The Officer Basin in Western Australia has been covered by three gravity surveys: two BMR reconnaissance surveys, using helicopter transportation, in 1962 and 1971-2, and a detailed land survey by Hunt Oil Company from 1963 to 1965. The barometrically levelled BMR stations are on an 11 km grid while the optically levelled Hunt Oil Company stations are at half-mile intervals on a 4 x 4 or 6 x 2 mile grid. The results are shown as Bouguer anomaly contours in Plate 3. Slight mismatch occurs at the common boundary

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because rock densities of 1.82 g/cm^3 and 2.2 g/cm^3 were used by Hunt Oil and BMR respectively to compute the Bouguer correction. The BMR value is the common one used in preparing the gravity map of Australia while Hunt Oil considered their value was close to the average surface rock density of the area. The Hunt Oil detailed work was intended to assist in defining prospective structures for seismic and drilling but was largely unsuccessful as the data seemed to reflect basement variations rather than sedimentary structure.

The results of aeromagnetic and seismic work carried out in the western Officer Basin may be examined in relation to the gravity results. The aeromagnetic interpretation of basement structure (Plate 2) shows the western Officer Basin as a large, oval area within, say, the $-13\ 000 \text{ ft}$ ($4\ 000 \text{ m}$) basement contour, extending from southern BROWNE through YOWALGA into TALBOT, LENNIS, and northeastern WESTWOOD. (In this report the names of 1:250 000 sheet areas are shown in capital letters to distinguish them from ordinary place names). There are two deeper lobes, and the more northerly of these, centred near the northeast corner of YOWALGA, has been shown by seismic refraction probes to be about $6\ 000 \text{ m}$ deep, thus confirming the aeromagnetic interpretation. This lobe is also represented by a gravity low from which it is possible to estimate a density contrast of about 0.1 g/cm^3 between the basement rock and overlying Proterozoic sediments.

Except in the east and southeast, the limits of the basin as judged from the aeromagnetic work are fairly clearly defined by a sharp basement rise which tends to reach about $2\ 000 \text{ m}$. On the western side the basement continues to rise gently westward towards the surface. Outcropping crystalline or metamorphic basement is revealed by geological mapping in the southwest, mainly in THROSSEL and RASON and a little in NEALE, and in the northeast in the Musgrave Block beginning in TALBOT and BENTLEY. A line of resistivity probes in RASON and NEALE indicated very shallow basement, even where there is a sudden, sharp drop in the aeromagnetic basement near Rason Lake.

The Bouguer anomaly gravity contours (Plate 3) may be considered in the light of these results. In the northeast and east the pattern extending southward from BENTLEY through TALBOT into LENNIS corresponds fairly well in general form with the basement surface interpreted from the aeromagnetic data, especially considering the latter's very wide flight-line spacing. In this area, therefore, the gravity may suggest that the basement surface rises sharply northeastward in BENTLEY and northeast TALBOT, gently northeastward in central TALBOT, and gently eastward in central LENNIS.

Whereas the sharp basement rise culminates in outcropping of the Musgrave Block, the gentle rise does not (Plate 1). It appears to reach a uniform level in the eastern half of LENNIS. In this vicinity, seismic horizon B on Hunt Oil Company's seismic line 67A rises gently eastward to a minimum reflection time of 0.7 seconds, equivalent to a minimum depth of 1 200 metres from the time/depth velocity relation established by Hunt. This horizon may be related to the basement surface interpreted from their gravity data.

In the southern part of the area, on NEALE and RASON, the gravity results suggest that the basin edge lies in an east-west direction and the basin deepens steeply northward.

Towards the western margin of the basin, the gravity contour pattern shows a similar, but more gentle, gradient than on the east. In this area the aeromagnetic interpretation (Plate 2) shows a sharp basement rise to an intermediate depth of about 2 500 m trending northwest through WESTWOOD and YOWALGA. This is followed by a very gentle rise to the zero contour along the western boundary of these map sheets. Farther west the aeromagnetic depths are small, in places approaching ground level. The gravity contours show no evidence of the intermediate steep gradient, nor its northwesterly trend. They suggest that the western flank of the Officer Basin rises very gently to a depth of some 1 000 m to 1 500 m, close to the west boundary of WESTWOOD and YOWALGA. The basement west of this may undulate near surface, particularly at a prominent local gravity high in ROBERT; there also the Proterozoic rocks crop out, giving further evidence that the underlying basement may be shallow.

The tongue of low gravity extending southwestward through NEALE may indicate a triangle of sediments extending from the main basin region.

The part of the Warburton Mission Road between Lake Throssel and the edge of the area surveyed by Hunt Oil crosses a ridge-like gravity maximum and part of a gravity gradient dipping gently eastward (Plate 3). Detailed gravity work along this part of the road will permit interpretation which will help to resolve geological basement structure and composition. The road between Lake Yeo and Neale Junction crosses two gravity lows separated by a slight gravity ridge. Detailed work along the road will permit interpretation of the lows, which will help to resolve the basement configuration and structure in NEALE. This interpretation will be strengthened by the interpretation of the work along the Warburton Mission Road, where seismic data will be available.

3. OBJECTIVES AND PROGRAM

The objective is to carry out a detailed gravity survey along the part of the Warburton Mission Road between Lake Throssell and the edge of the Hunt Oil gravity survey and also along part of the road between Lake Yeo and Neale Junction. Particular objectives are:

1. To interpret the gravity data along the Warburton Mission Road in a manner consistent with all the other information that will be available.
2. To investigate and interpret gravity minima west of Neale Junction.
3. To extend the knowledge so obtained to define the regional structure of the western Officer Basin.
4. To measure rock density from surface and borehole specimens from the survey region.

The main gravity traverse will follow the Warburton Mission Road from astrofix T092, about 200 km southwest of Warburton Mission, for a distance of about 190 km towards the southwest. It will end about 9 km northeast of "Yamarna" homestead. The gravity station interval will be 1 km. A grid of lateral stations will be established from the main traverse to produce a band of detailed gravity about 20 km wide along the length of the main traverse. Every station will be marked by a wooden stake except at the ends of each traverse and every 10 km, where they will be marked by a steel stake. Plastic flagging will be used for ease of location of stations. Optical levelling will be carried out by a party from the Department of the Interior Survey Branch which will mark station positions on aerial photographs.

A traverse will be established across the area of low gravity in NEALE from the westward end of the Hunt Oil Company work to Lake Yeo, using the same station spacing, disposition, and levelling technique.

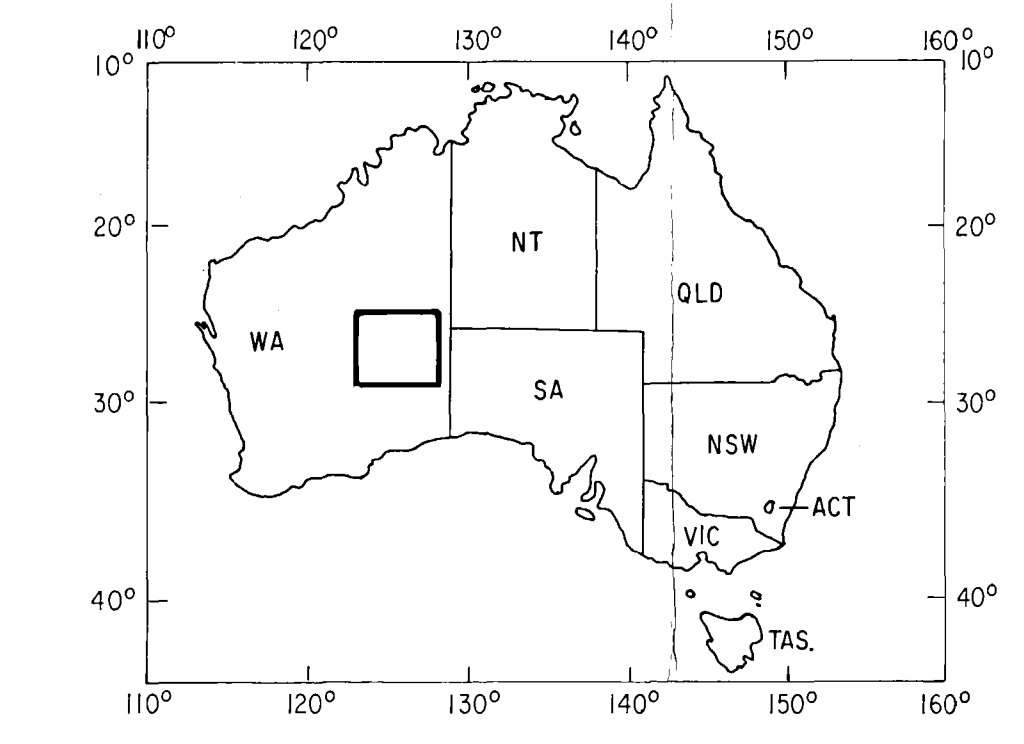
The program may be modified as the work progresses if new information from the gravity work, the seismic survey, or stratigraphic drilling suggests other, specific areas where detailed gravity data should permit a better integrated interpretation.

Total magnetic intensity measurements will be made at gravity stations to permit a more comprehensive integrated interpretation of geophysical results.

4. REFERENCE

Reference material relevant to this report is included in the presurvey report on the seismic survey to be conducted in the same area:

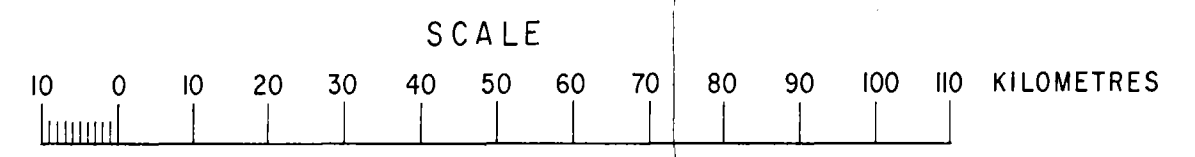
PINCHIN, J., & MATHUR, S.P., 1972 - Presurvey Report on Officer Basin seismic survey, W.A. 1972. Bur. Miner. Resour. Aust. Rec. 1972/95 (unpubl.).



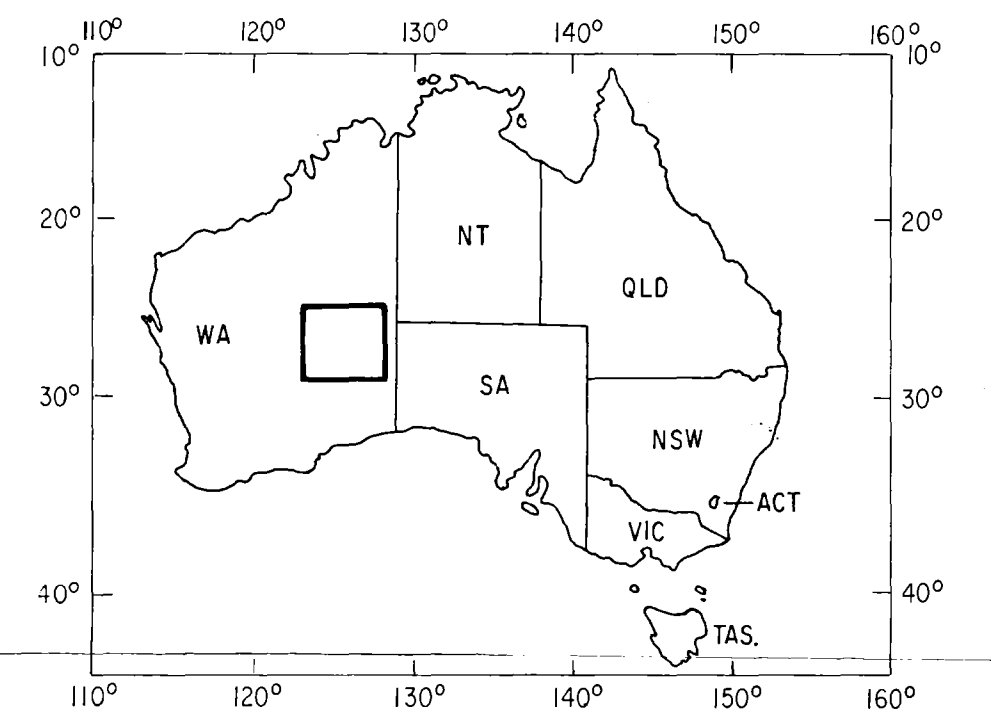
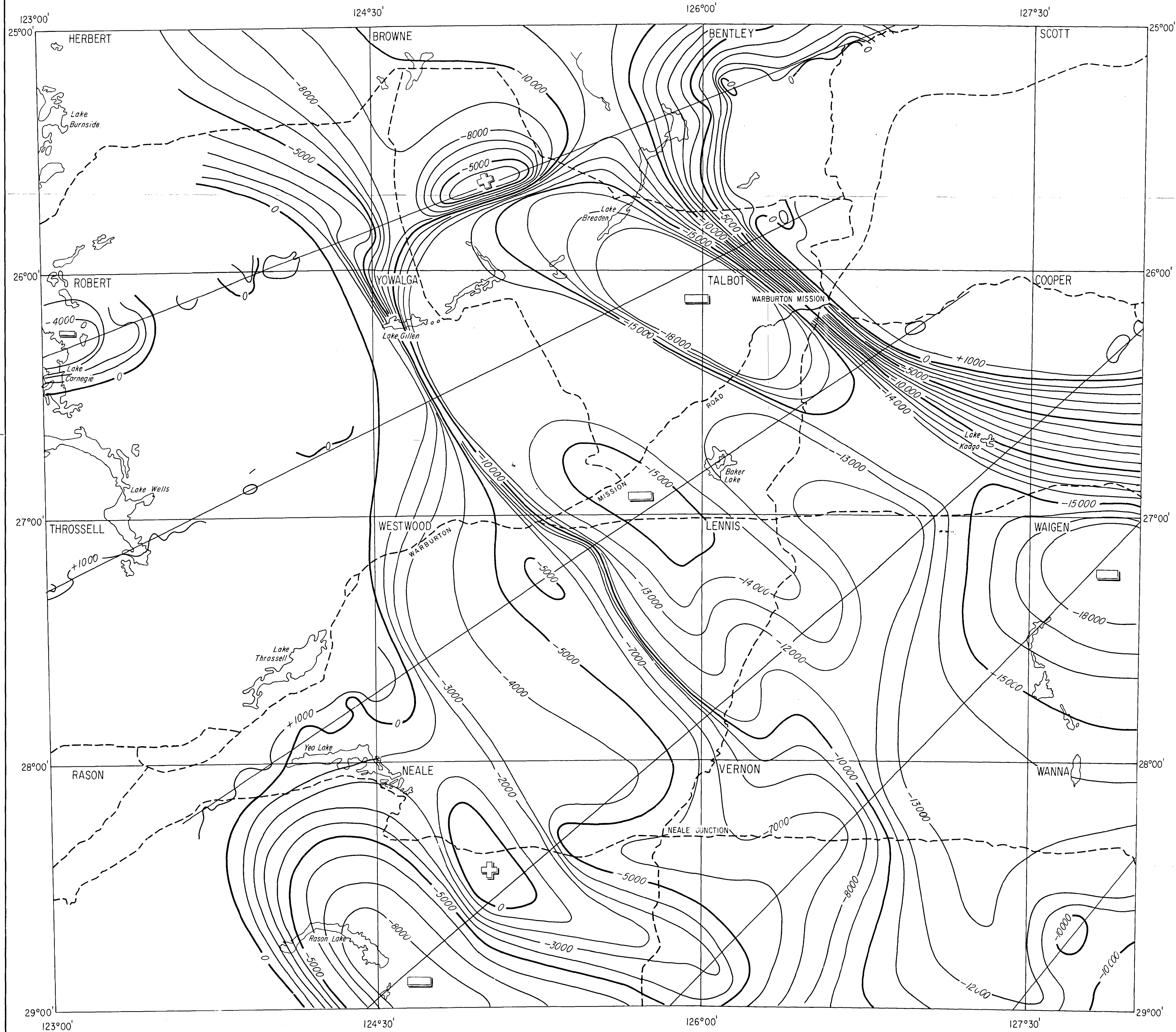
LEGEND

- | | | | |
|--|--|------------|--|
| | Plumridge Beds | MIOCENE | TERTIARY |
| | Bejah claystone and Samuel Formation | CRETACEOUS | |
| | Paterson Formation | PERMIAN | MESOZOIC |
| | Wanna Beds | | |
| | Lennis Sandstone | | PALAEOZOIC |
| | Table Hill Volcanics and Kulyong Volcanics | ORDOVICIAN | |
| | Undivided | | PROTEROZOIC |
| | Lupton Beds and Lefroy Beds | | |
| | Townsend quartzite | | PRE-CAMBRIAN |
| | Geology uncertain | | |
| | Igneous and metamorphic rocks | | |
| | Geological boundary (position approximate) | | |
| | Inferred subsurface continuation of boundary | | |
| | Fault | | |
| | Well (dry) | | |
| | Road or track | | |
| | Line of geological cross-section adjacent to proposed survey | | |
| | BMR reflection line 1961-62 | | BMR proposed seismic traverses 1972 |
| | BMR refraction line 1961-62 | | BMR proposed detailed gravity survey, 1972 |
| | Hunt Oil Co. reflection line | | |
| | Hunt Oil Co. refraction line | | |

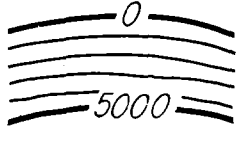




Source of geological information : LOWRY et al 1972



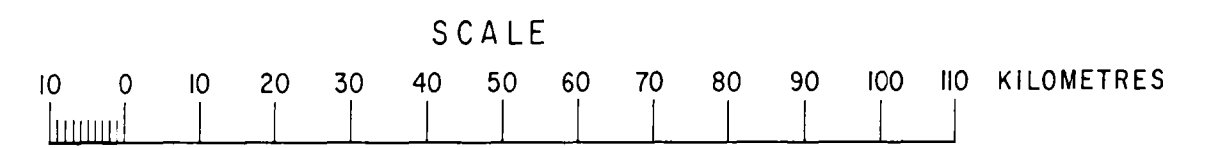
SURFACE GEOLOGY AND LOCATION MAP

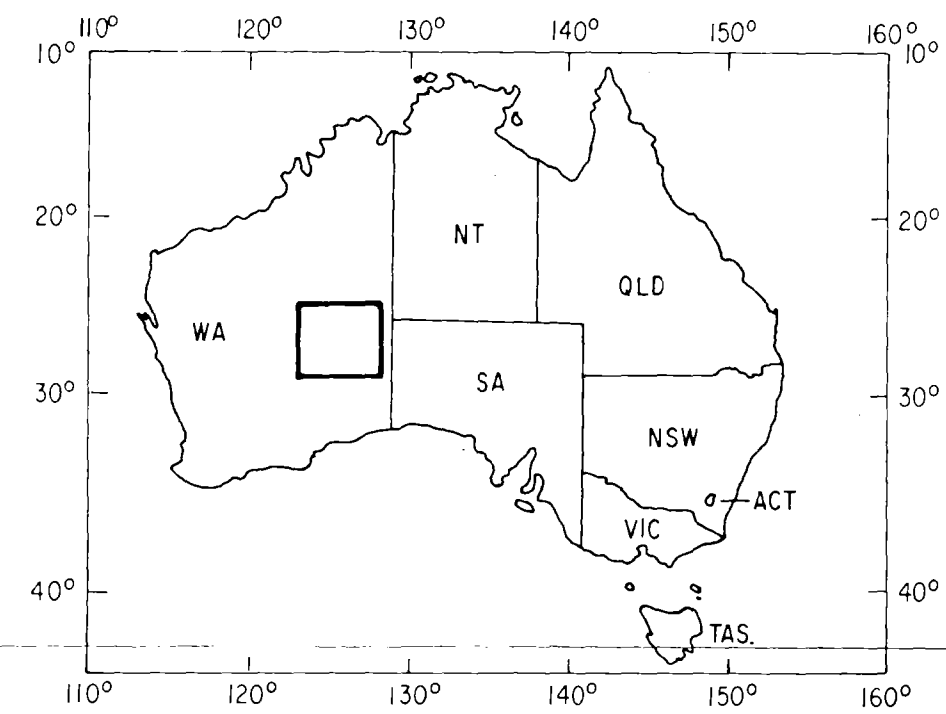
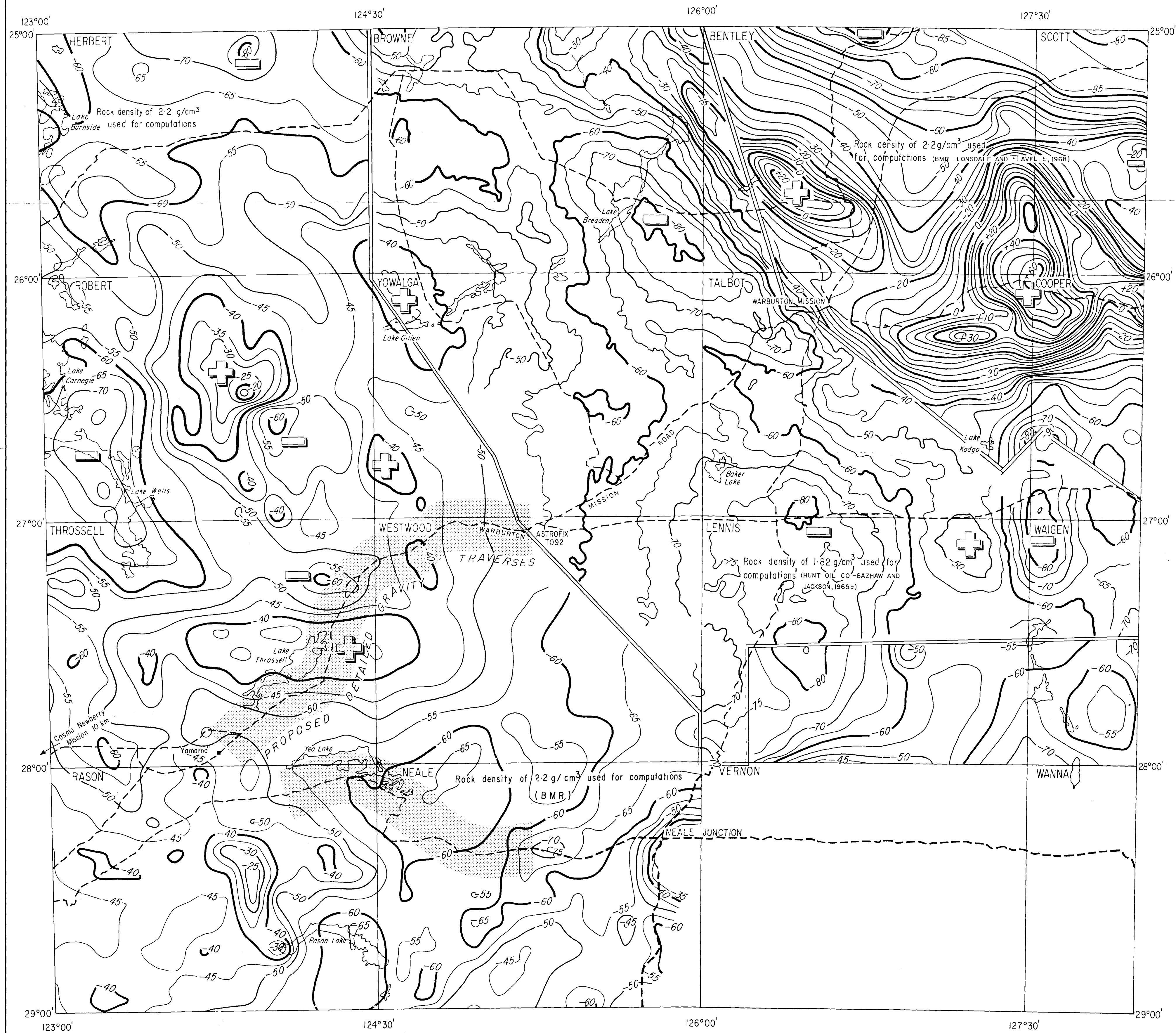


LEGEND

-  MAGNETIC BASEMENT CONTOURS (interval 1000ft)
(Datum: sea level) from Hunt Oil Company (Jackson, 1966b)
-  ROAD OR TRACK
-  FLIGHT LINE
-  BASEMENT 'HIGH'
-  BASEMENT 'LOW'

MAGNETIC BASEMENT CONTOUR MAP





LEGEND

- BOUGUER ANOMALY CONTOURS (interval 5 mgal)
- DENSITY CHANGE BOUNDARY
- GRAVITY 'HIGH'
- GRAVITY 'LOW'
- HUNT OIL Co. GRAVITY TRAVERSE
- BMR PROPOSED DETAILED GRAVITY SURVEY, 1972

BOUGUER ANOMALY CONTOUR MAP

