DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/71

OFFICER BASIN DETAILED GRAVITY SURVEY, W.A., 1972

OPERATIONAL REPORT

by

I. Zadoroznyj

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ILLUSTRATIONS

SUMMARY

The Bureau of Mineral Resources made a detailed gravity survey in the southwest Officer Basin in Western Australia between August and November 1972. The survey provided gravity coverage at one-kilometre spacing along the Warburton Range Road from the vicinity of Lake Throssell for 214 kilometres towards the Warburton Mission, and on short traverses across the Warburton Range Road traverse, providing data supplementary to a concurrent seismic survey. The survey also provided detailed gravity coverage for 136 kilometres along the Emu Road between Lake Yeo and Neale Junction, near the southern boundary of the Officer Basin in Western Australia. Magnetic and radiometric measurements were made in addition to gravity observations at most stations.

The traverses were surveyed in an area covered recently by a Bureau of Mineral Resources reconnaissance helicopter gravity survey. The Bouguer anomaly profiles along the main traverses show departures of up to five milligals from profiles interpolated from the reconnaissance data. The most significant magnetic feature was a high-amplitude magnetic anomaly with a half-width of about 2 kilometres which was revealed in the northwest corner of the Westwood 1:250 000 Sheet area. This high coincided with one of two significant Bouguer anomaly highs.

This report describes the survey operations and presents survey statistics. The results of the detailed work along the Warburton Range Road and the 20-kilometre cross-traverses across it will be used with the seismic information to interpret the structure of this part of the Officer Basin.

1. INTRODUCTION

The Bureau of Mineral Resources (BMR) conducted a detailed gravity, magnetic, and radiometric survey in the southwest of the Officer Basin in Western Australia from August to November 1972. The Officer Basin covers a large area of Western Australia and South Australia. In the basin the thickest sedimentary pile is more than 6000 m. In the Western Australian part of the basin the sediments are mainly of Proterozoic age, largely overlain by a thin layer of Palaeozoic sediments. Hunt Oil Company carried out an active exploration program in the western part of the Officer Basin. 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 Geological Survey of Western Australia (GSWA) commenced a joint mapping project of the W.A. part of the Officer Basin. In addition to the joint mapping project and the work by Hunt Oil Company, other investigations completed have been a BMR seismic survey in the northern part of the basin and resistivity probing in the south for the W.A. Department of Public Works. A BMR reconnaissance helicopter gravity survey at a grid spacing of 11 km was recently completed.

The detailed gravity survey was carried out concurrently with a BMR seismic survey (Harrison, 1973) which shot several refraction and reflection probes along the Warburton Range Road. Gravity, magnetic, and radiometric observations were made at 188 shot-points. A total of 351 gravity observations were made at one-kilometre intervals along parts of the Warburton Range and Emu Roads. To obtain broader gravity coverage along the Warburton Range Road, 203 stations were established along cross-traverses which were generally 20 km long and 10 km apart. The locations of all stations are shown in Plates 1 and 2. The survey was integrated with previous gravity surveys, conducted by Hunt Oil Company from 1963 to 1965 and BMR in 1971-72, by tying to permanently marked gravity stations. All stations were optically levelled by surveyors from the Department of the Interior. Magnetic and radiometric observations were made at most gravity stations.

Sand plains with longitudinal dunes, commonly 10 to 15 m high, cover much of the area. Elsewhere the country is flat with occasional small hills and outcrop escarpments. The soft surface of Lake Throssell presented a severe obstacle to access. Vegetation is sparse and consists mainly of spinifex bushes, mallee, and mulga trees. The mulga often occurs in very thick patches.

This report describes the work done during the field survey and includes preliminary Bouguer anomaly, vertical magnetic intensity, and radiometric profiles along the main traverses. Detailed analysis of the data obtained, in relation to the reconnaissance gravity information and the

results of the seismic survey, will be required for an integrated interpretation. A discussion of the geology of the area and previous geophysical investigations may be found in the presurvey reports for the seismic and gravity surveys in the Officer Basin (Pinchin & Mathur, 1972; Zadoroznyj & Brown, 1972).

2. OBJECTIVES AND PROGRAM

Objectives

The primary objective of the survey was to obtain detailed gravity information, along parts of the Warburton Range and Emu Roads, which will help to define the structure of the southwest margin of the Officer Basin. The gravity work along the Warburton Range Road provided information complementary to a concurrent seismic survey, and the work along the Emu Road was to investigate two gravity minima west of Neale Junction. The magnetic and radiometric measurements were proposed to provide additional information.

Program

Two long gravity traverses were proposed: (a) one along the Warburton Range Road extending from astrofix T092 towards Laverton for 190 km, and (b) the other along the Emu Road for 136 km between bench marks X0118 and X087.

The station spacing along the roads was to be one kilometre. Cross-traverses 20 km long and 10 km apart along each road were also planned. In addition observations were to be made at seismic shot-points.

Apart from the cross-traverses, the program as proposed was carried out. Access problems on the cross-traverses slowed the rate of progress considerably. Many of the cross-traverses were relocated to make best use of open country, and a series of stations was also established on the north side of Lake Throssell because several of the cross-traverses were cut short on the southern edge of the lake. Time did not permit the establishment of cross-traverses along the Emu Road.

The locations of the gravity stations established are shown in Plates 1 and 2.

3. FIELD OPERATIONS

Surveying

Stations along the Warburton Range Road and the Emu Road were located by vehicle odometer and compass traversing, and were optically levelled. Elevation control was maintained by ties to benchmarks every 4 km along the road.

The six cross-traverses farthest from Laverton were pegged and levelled using a theodolite. Thereafter, chain and compass traversing was employed for pegging, and a spirit level for levelling, as this method was considered faster and without significant loss in accuracy.

Photo-identification of many stations was attempted, particularly those on the road traverses and at the ends of cross-traverses. Owing to the sparseness of easily identifiable features, however, only 14 stations could be pinpricked on the airphotos.

Surveying progress was severely hampered by difficult access to the cross-traverses, and much of the program would not have been completed with one surveying crew. Consequently a second surveying team was employed for the last eight weeks of the survey, and a bulldozer was used. In addition two field hands were employed to assist in line clearing. The surveyors were in the field for a total of twenty weeks. In the first twelve weeks 195 km of road traverse and 102 km of cross-traverse were surveyed. In the last eight weeks 155 km of road traverse and 410 km of cross traverse were surveyed. Use of the bulldozer increased the average surveying rate on cross-traverses by a factor of about three; in very thick mulga, the factor was as high as 10.

Stations were marked with wooden stakes except at the ends of each traverse and every 10 km along the traverses, where they were marked by a steel picket. Plastic flagging was used to help locate stations.

The overall rate of observing was tied to the rate of surveying. The gravity crew could easily observe along a traverse twice as fast as it could be surveyed, even with the magnetometer and scintillometer. There is thus a need for at least two surveying crews per gravity crew.

Gravity

Survey details and information on staff and equipment are given in Appendices 1 and 2. The gravity survey was tied to a previous Hunt Oil Company survey, to the BMR-1971-72 reconnaissance helicopter gravity survey, and to 'Isogal' stations at Warburton Range Mission and Lake Yeo.

Drift control was maintained by repeat readings at selected stations every one or two hours. Reading time was about two minutes. Transport-time between stations varied considerably depending on accessibility.

The meter behaved erratically at the start of the survey. Checks were conducted to determine the reason for a large drop in scale value but no major fault was apparent. The meter became stabilized and no further trouble was experienced. A report on the meter performance was submitted when the meter was returned to the BMR Regional Gravity Group.

Magnetic

Vertical magnetic intensity measurements were made at all but 15 gravity stations. Three readings about 10 metres apart were made at each station to eliminate bias due to the effect of any small surface concentrations of magnetic materials. The readings were made on range 3 of the magnetometer with a sensitivity specified to be about 30 gammas per division and a full-scale deflection of about 7500 gammas. The dial of the meter was such that it could be read to one division. Readings were made in the course of a gravity loop at gravity stations and usually took about two minutes. In areas of anomalous magnetic field readings, additional readings were made at closer spacing.

The meter was not sufficiently damped, for the dial needle oscillated considerably with minor variations from the vertical. Readings were particular difficult on windy days. Consequently the accuracy of any particular reading is estimated, on field experience, to be about $\pm$ 15 gammas at best. The BMR Geophysical Services Section is currently investigating this problem.

Radiometric

Radiometric observations were made at all but 46 gravity stations with the detecting head of the scintillometer about three centimetres above the ground.

4. RESULTS

The preliminary Bouguer anomaly, vertical magnetic intensity, and radiometric profiles along the two main traverses are shown in Plates 3 and 4. The Bouguer anomaly profiles follow the general trend of the profile interpolated from the reconnaissance data but show departures of up to five milligals in places. These departures indicate local and possibly near-surface geological variations. A high-amplitude magnetic anomaly with a half-width of about 2 km was measured in the northwest corner of WESTWOOD 1:250 000 Sheet area. The character of the anomaly suggests that it arises from a vertical dyke of magnetic material. The anomaly coincides with the western side of a gravity ridge, which is about 8 km wide.

The results of this survey will be integrated with those from previous geological and geophysical results and the results of the seismic survey to give an integrated interpretation of the area.

5. REFERENCES

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

BARLOW, B.C., 1970 - National report on gravity in Australia, July 1965 to June 1970. Bur. Miner. Resour. Aust. Rec. 1970/62 (unpubl.).

HARRISON, P.L., 1973 - Officer Basin seismic survey, W.A. 1972 - Operational report. Bur. Miner. Resour. Aust. Rec. 1973/62 (unpubl.).

ZADOROZNYJ, I., & BROWN, F.W., 1972 - Presurvey report on detailed gravity survey, Officer Basin, W.A., 1972. Bur. Miner. Resour. Aust. Rec. 1972/107 (unpubl.).

APPENDIX 1

SURVEY DETAILS

1. The survey commenced on 21 August 1972 and was completed on 24 November 1972.

2. Observations

	Gravity	Magnetic	Radiometric
Number of stations occupied	830	889	830
Number of new stations	811	889	830

3. Ties to previous gravity surveys

Previous survey		Observed gravity (previous survey) (mGal)	Observed gravity (present survey) (mGal)	Difference (mGal)
Hunt Oil 1963-65	6361-0045			
" " "	6361-6001			
BMR 1971-72	7102-3939	979040.16	979040.06	-0.10
reconnaissance	7102-3942	979037.94	979037.89	-0.05
helicopter	7102-3945	979032.83	979032.92	+0.09
gravity	7102-3953	979021.17	979031.08	-0.09
survey	7102-3961	979002.28	979002.21	-0.07
	7102-3963	978993.90	978993.74	-0.16
	7102-3970	978986.27	978986.11	-0.16
	7102-3979	978966.49	978966.30	-0.19
	7102-4188	979057.64	979057.73	+0.09
	7102-4190	979065.72	979065.69	-0.03
	7102-4195	979071.59	979071.52	-0.07
	7102-4199	979065.87	979065.73	-0.14
	7102-4202	979061.72	979061.65	-0.07
	7102-4216	979051.45	979051.38	-0.07
	7102-4218	979055.29	979055.25	-0.04

4. The survey was tied to 'Isogal' stations (Barlow, 1970) at Warburton Range Mission (6491-9969) and at Lake Yeo (6792-9204).

5. The gravity meter used was Worden 169.

   A calibration factor of 0.1011(6) mGal/div was obtained at the Canberra range on 11 August 1972 and a value of 0.1010(3) mGal/div was obtained there on 7 December 1972. The former value was adopted for the preliminary calculations.

6. The stations were optically levelled. The levels were adjusted to a series of Department of the Interior benchmarks: numbers XN39 to XN87 on the Warburton Range Road, and X0118 to X087 on the Emu Road.

7. Stations were positioned by one of the following methods:

   (1) Compass and vehicle speedometer (road traverses)

   (2) Compass and chain (cross-traverses)

   (3) Theodolite and stadia (cross-traverses)

   To improve horizontal control, stations were pinpricked on airphotos where possible.

8. A density of 2.2 g/cm^3 was adopted to make Bouguer corrections. This is the value adopted for the Gravity Map of Australia.

9. The 'survey number' for the survey in BMR's Regional Gravity filing system is 7201.

APPENDIX 2

STAFF AND EQUIPMENT

A party of six began the survey - 1 geophysicist, 1 technical assistant, 1 field hand, 1 surveyor, and 2 surveying field assistants. The addition of a second surveying crew and 2 field assistants increased the number to 11 for the last eight weeks of the survey.

Staff

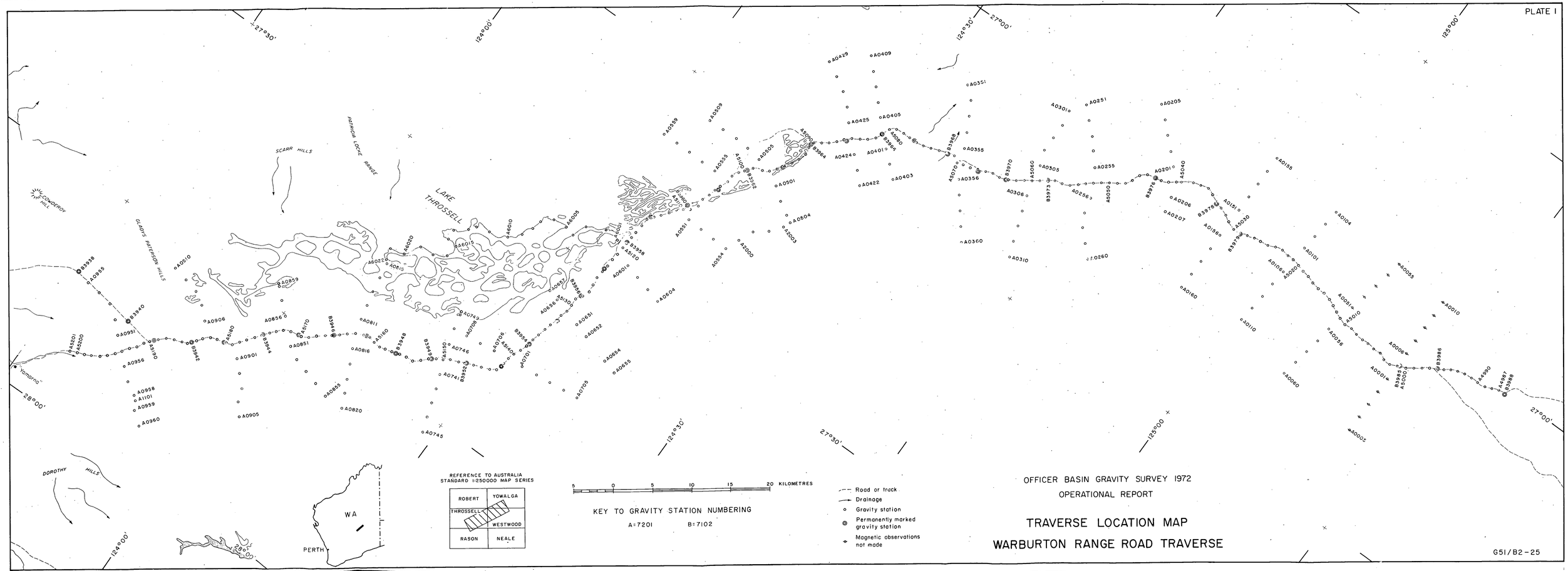
Geophysicist	I. Zadoroznyj
Technical Assistant	J.C. Allen
Surveyors	P. Douglas 10/7/72 - 27/8/72 A. Lyons 27/8/72 - 6/10/72 Dept of the P. Johnson 1/10/72 - 24/11/72 Interior W. Martyr 6/10/72 - 24/11/72
Surveying Field hands	I. Hunt 10/7/72 - 27/8/72 H. Powell " " D. Buckle 27/8/72 - 6/10/72 E. Cameron " " Dept of the P. Jones 1/10/72 - 24/11/72 Interior J. Oliver 27/10/72 - 24/11/72 J. Wheeler 1/10/72 - 24/11/72 D. Louis 6/10/72 - 24/11/72
Field Hands	P. West 6/10/72 - 24/11/72 A. Robinson 13/10/72 - 24/11/72 M. Leahy 1/9/72 - 20/9/72 P. Theilade 23/9/72 - 2/11/72
Bulldozer operator	G. Baker 23/10/72 - 2/11/72

Equipment

Gravity meter	Worden 169 (C.F. 0.10116 mGal/division)
Magnetometer	Jalander 7303

Scintillometer	Scintillation counter (crystals 5 cm diameter x 3.8 cm long) with portable ratemeter A.A.E.C. type 239
Barometers	3 Mechanisms barometers
Surveying equipment	
Camping equipment	
Transceivers	2 Traegers (1 BMR, 1 D. of I.)
Vehicles	3 LWB Landrovers (2 BMR, 1 D. of I.) 3 Toyota Landcruisers (D. of I.) 2 Caravans (accommodation, D. of I.) 2 x 150-gallon water trailers (D. of I.) 1 International TD8 bulldozer (equivalent to Caterpillar D4)

PLATE I



REFERENCE TO AUSTRALIA STANDARD 1:250000 MAP SERIES

ROBERT	YOWALGA
THROSSELL	WESTWOOD
RASON	NEALE

5 0 5 10 15 20 KILOMETRES

KEY TO GRAVITY STATION NUMBERING

A=7201 B=7102

- Road or track
- Drainage
- Gravity station
- Permanently marked gravity station
- Magnetic observations not made

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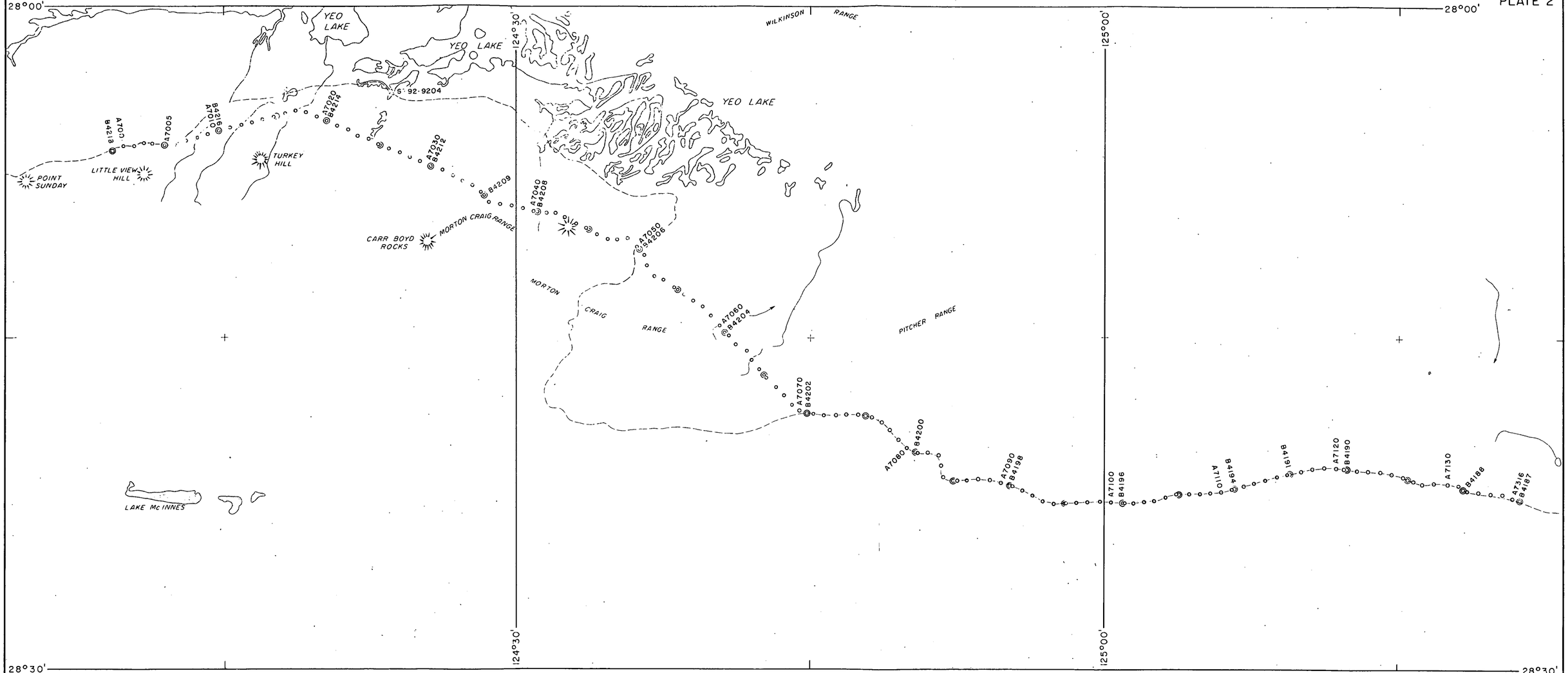
TRAVERSE LOCATION MAP

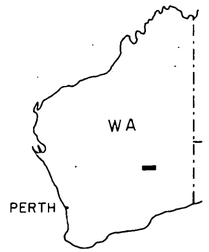
WARBURTON RANGE ROAD TRAVERSE

G51/B2-25

To accompany Record No 1973/71

PLATE 2





REFERENCE TO AUSTRALIA STANDARD 1:250000 MAP SERIES

THROSSELL	WESTWOOD
RASON	NEALE

5 0 5 10 15 20 KILOMETRES

KEY TO GRAVITY STATION NUMBERING

A=7201 B=7102

- Road or track
- Drainage
- Gravity station
- Permanently marked gravity station
- Secondary base station

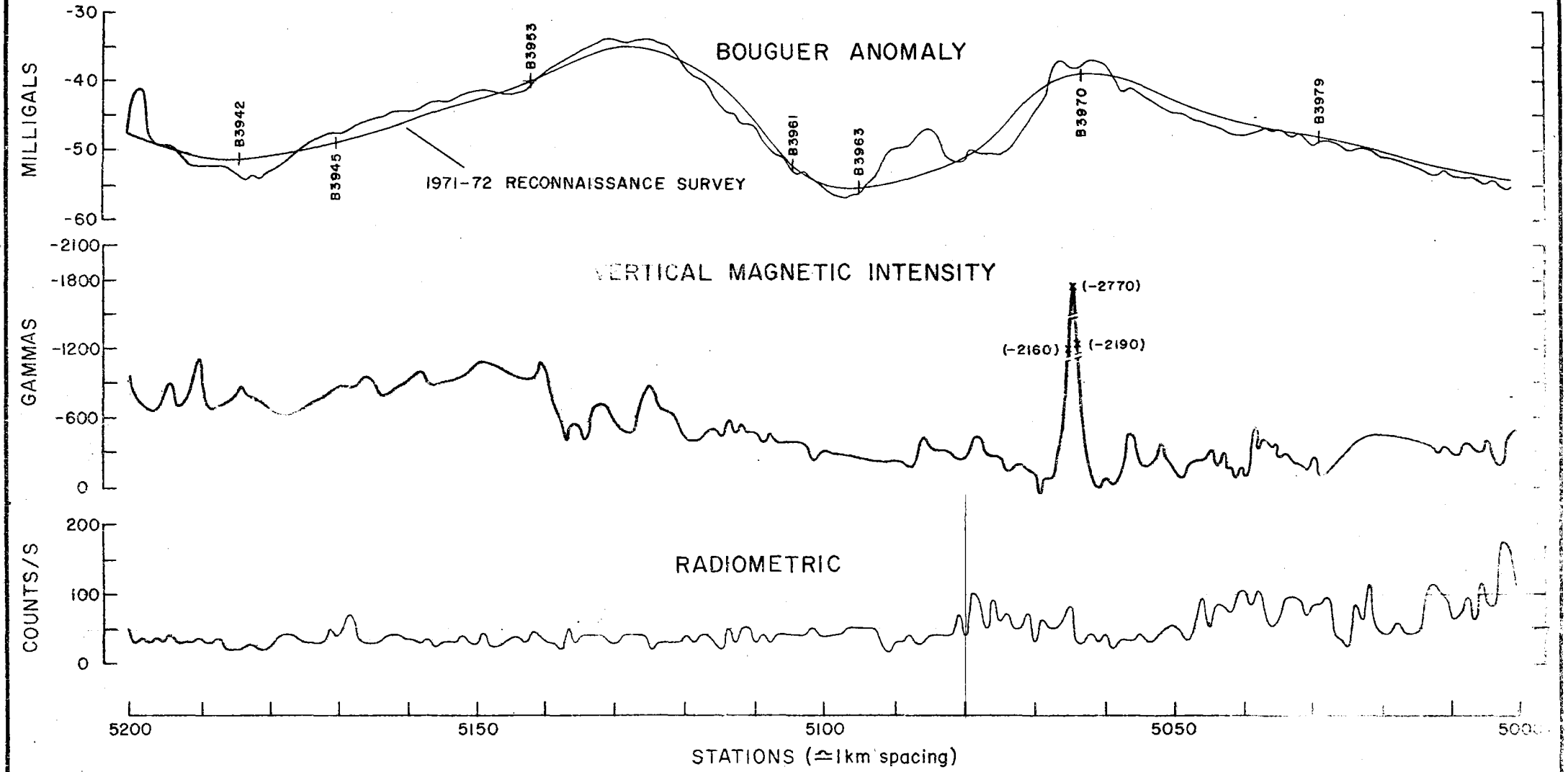
Station positions between B4202 and B4218 are doubtful

TRAVERSE LOCATION MAP

EMU ROAD TRAVERSE

H51/B2-26

To accompany Record No 1973/71

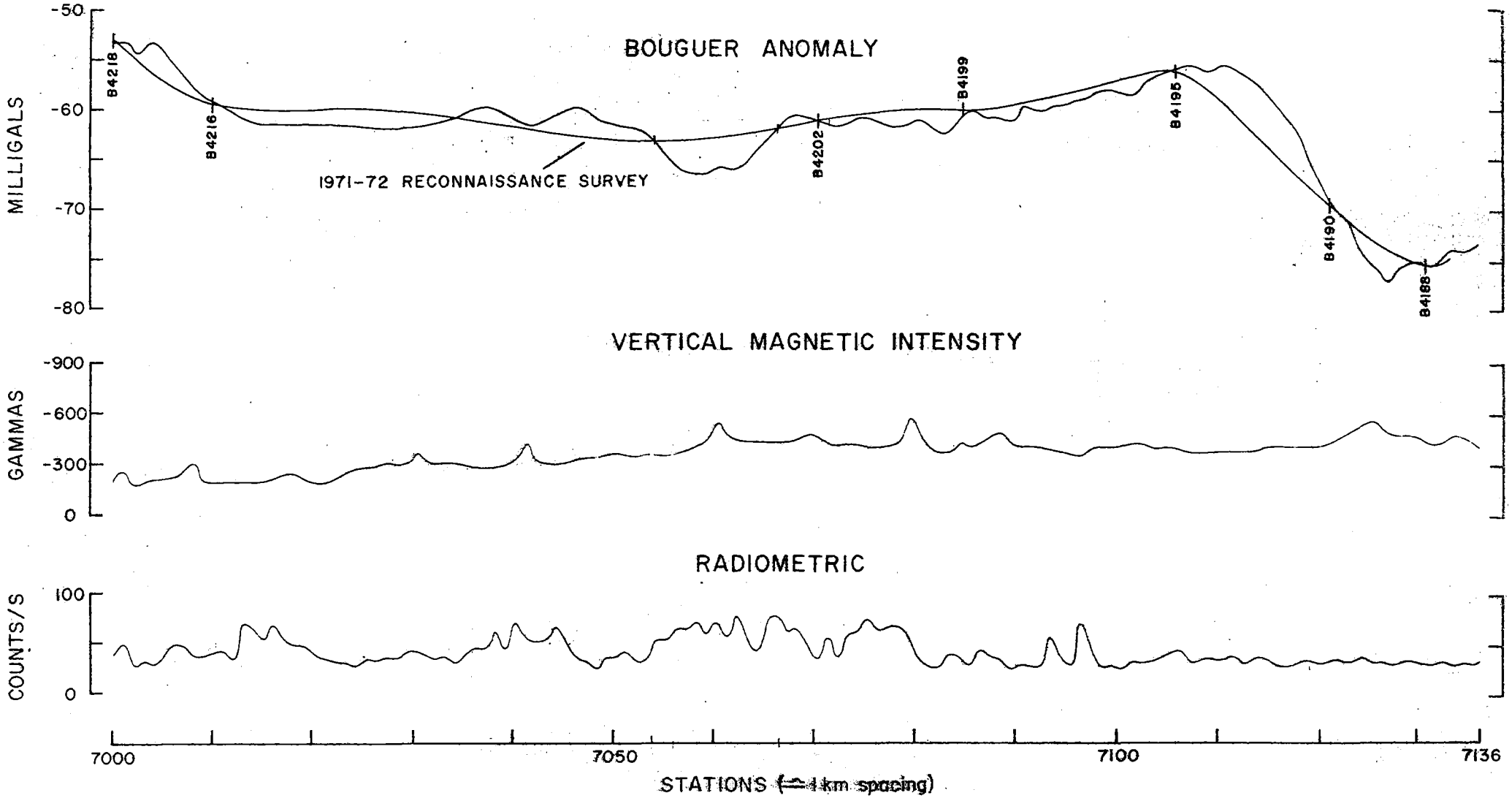


WARBURTON RANGE ROAD TRAVERSE

PRELIMINARY GRAVITY, MAGNETIC, AND RADIOMETRIC PROFILES

G51/B2-24A

PLATE 3



THE EMU ROAD TRAVERSE

PRELIMINARY GRAVITY, MAGNETIC, AND RADIOMETRIC PROFILES

H51/B2-25A

PLATE 4