DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record of 1975/15

GOULBURN VALLEY GRAVITY SURVEY

OPERATIONAL REPORT,

VICTORIA, 1973

by

G.R. Pettifer & L. Kerec

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SUMMARY

The Engineering Geophysics group of the Bureau of Mineral Resources is conducting a systematic geophysical investigation of the Goulburn River valley system for the Mines Department of Victoria and the State Rivers and Water Supply Commission. As part of this investigation a gravity survey of 684 stations, covering 2400 square kilometres, was carried out around Rochester in January 1973, tying in to and extending a previous gravity survey in the same area. This report gives an account of the operations of the 1973 gravity survey and presents a preliminary Bouguer anomaly map. The interpretation of the gravity survey results together with an interpretation of the aeromagnetic results in the area will be presented in a later report.

1. INTRODUCTION

The Bureau of Mineral Resources (BMR) is conducting a geophysical study of the Goulburn River valley system using seismic, resistivity, and gravity methods in conjunction with the Mines Department of Victoria and the State Rivers and Water Supply Commission (SRWSC). The objectives of the survey are to determine bedrock geology and to delineate aquifer systems within the Tertiary sediments of the river valley. This report gives an operational account of the regional gravity survey in 1973 by the Engineering Geophysics group of the BMR, which was carried out to extend the 1971 and 1972 gravity surveys (Taylor et al. (in prep.) ; Pettifer, 1973), west across the Heathcote-Colbinabbin greenstone axis to the Campaspe River valley and south to the Siluro-Devonian bedrock. No interpretation will be attempted at present as the gravity results will be combined with aeromagnetic results and further geophysical control from a proposed seismic survey in 1974 (Taylor and McDowell, in prep.), to present an overall interpretation of the gravity field in the Goulburn valley area. A preliminary Bouguer anomaly map (Plate 2) and loop closure map (Plate 1) are presented.

The area covered by the 1973 survey is 2400 km^2. Over this area 684 new stations were established, bringing the total area of the 1971-73 survey to 7000 km^2 covered by 1949 stations. This represents a station density of one station per 3.6 km^2 or an equivalent survey grid of 1.89 km; 81 stations were barometrically levelled using Mechanism microbarometers, in the higher parts of the Colbinabbin ranges above the irrigation area. The field work was completed in January 1973 by G.R. Pettifer (geophysicist) and L. Kerec (draftsman).

The assistance of Mr Arnold Windsor and the staff of the SRWSC's survey office at Rochester in supplying level information for the survey area is gratefully acknowledged. A. Murray of Regional Gravity group at BMR kindly assisted in computer reduction of the gravity and barometric field data.

2. SURVEY AND COMPUTATION METHOD

The Goulburn Valley survey was conducted using two vehicles and two gravity meters, and the 1971-72 survey station network was extended farther east and south using the standard techniques of BMR helicopter gravity surveys (Hastie & Walker, 1962) as applied to a square grid of gravity stations. The 1973 survey was tied to the 1971-72 surveys at 8 cell centres and tiepoints (nodes) of the 1971-72 survey network. Plate 1 shows the overall 1971-73 survey station grid and gravity loop network with initial misclosures and adjusted closures. By tying into the 1971-72 survey the 1973 gravity results were made referable to the 1971-72 base stations 7106.9000 and 7206.0604 (Appendix 1) which were in turn tied to the Benalla isogal station. Two of the 8 free node points (7206.0301 and 7206.0844), which were common to the 1973 and 1971-72 survey networks, were taken as fixed nodes for the 1973 survey adjustment with the remaining 6 nodes being used as free nodes. The observed gravity values of the 6 free nodes from the 1973 adjustment were compared with the values obtained in the earlier 1971-72 adjustment. For the 6 free nodes, an average difference of 0.01 mGal (standard deviation 0.06 mGal) in observed gravities between the 1973 and 1971-72 adjustment was noted. This difference serves to indicate the overall accuracy of the two separate least-squares network adjustments. Appendix 1 gives detailed statistics on the 1973 survey and estimated errors in observed gravities and Bouguer anomalies.

The barometric levelling was carried out simultaneously with the gravity readings using the standard BMR helicopter gravity technique (Hastie & Walker, 1962). Two roving barometers were used on separate gravity loops with one base barometer at the base station. The field loops were reduced on the GRAVHTS computer program to give heights in metres. The relative error of the Bouguer anomalies of the barometric stations is estimated to be $\pm$ 2 mGal. This large inaccuracy has arisen mainly because one of the roving microbarometers

displayed slightly erratic behaviour which was not obvious in the observed drifts in the field. The 2 mGal estimate is based on consideration of errors of barometric levels of bench marks which were used as free nodes in the height adjustment. The area where the barometric levelling was carried out is a narrow linear range which rises some 120 m above the Goulburn and Campaspe valleys. This isolated topographic feature probably distorted the isobaric surfaces so that they tended to follow the topography. In addition, on the day the measurements were taken the presence of northeast winds probably contributed to a pressure high and anomalous vertical pressure gradients on the east of the range (Stripling et al., 1949; Dooley, 1963; Darby, 1970). The range consists of dense Cambrian greenstones (density 3.0 g cm $^{-3}$; Pettifer, 1973), which have an intense gravity high associated with them (Plate 2; Sanaghan, 1971). The terrain correction associated with this feature is estimated to be as large as 3 mGal, depending on the situation of the gravity station.

Taking the above sources of error into account, the Bouguer anomaly values of the barometrically levelled stations are considered to give only an indication of gravity trends in this area. The barometric stations have not been relevelled as the small area affected is located on the extreme southwest margin of the alluvial floodplain of the Goulburn River and is not vital to the interpretation for the objectives of the present survey. In view of presently existing gravity control in the area (Sanaghan, 1971; Zadoroznyj, in prep.) and the large gravity anomaly (+ 20 mGal) above background the large inaccuracy in barometric levelling has been tolerated. The barometrically levelled stations are shown by a solid circle on the Bouguer anomaly map (Pl. 2).

For the optically levelled stations in the lower-lying irrigation areas, ground elevations were taken from SRWSC 0.3-m parish contour plans, and in areas where contour plans were not available SRWSC benchmarks were occupied. All heights of optically levelled stations are within 0.15 m of the Australian Height Datum. A base map was compiled at 1:100 000 scale by L. Kerec. The station latitudes and longitudes were obtained by program PHOTOMAP from the

digitized station co-ordinates. Program AMENDS updated the computer file of observed gravities with the height and latitude and longitude data, and produced Bouguer anomalies at a density of 2.0 g cm^{-3} (Plate 2; Taylor et al., in prep.).

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Appendix 1. Goulburn Valley survey data, 1973

Time of Survey	January 1973.
Personnel	G.R. Pettifer (geophysicist), L. Kerec (draftsman).
Vehicles	Toyota 4-wheel-drive; Holden panel van.
Survey base office	Rochester SRWSC Survey Office.
BMR Survey Number	7306
Survey based on Benalla Isogal	Station No. 6793.9302 May 1965. Isogal Value 979814.12 mGal.
Base Stations (1971-73 Survey)	Station No. 7106.9000 May 1965. Isogal Value 979804.68 mGal. Station No. 7206.0604 May 1965. Isogal Value 979830.37 mGal.
1973 Adjustment based on	Station No. 7206.0301 Value 979,816.84. Station No. 7206.0844. Value 979,833.39.
Meter (calibration factors)	Worden No. 260 (0.1088 F 0.00005) Worden No. 169 (0.1011 F 0.00005) Calibration on Black Mtn. Range Canberra. Interval value 54.76 mGal (12/1/73)
Bouguer Density	2.0 gm cm^{-3}
Area of survey 1973	2400 km^2.
New stations (station density) 1973	684 (1 station/3.5 km^2).
Area of survey 1971-73	7000 km^2.
Total No. of stations (station density) 1971-73	1949 (1 station/3.6 km^2).
Equivalent grid (1971-73 survey)	1.89 km x 1.89 km.
Number of free nodes 1973 (1971-73)	24 (66).
Number of fixed nodes 1973 (1971-73)	2 (2)
Number of gravity loops 1973 (1971-73)	54 (146).

Gravity Misclosures (in mGal)	Initial	Adjusted
Mean	0.06	0.01
Std Devn	0.07	0.01
Maximum	0.28	0.08

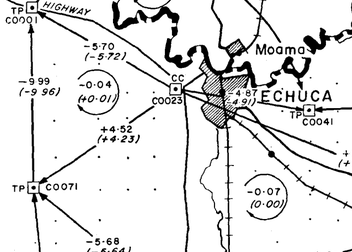
Adjustments		Initial		
	Mean	0.02		
	Std Devn	0.03		
	Maximum	0.13		
B.A. Errors (in mGal)		Levelled Stations	Barometric Stations	
		Height 0.05	Height	2.00
		Latitude 0.05	Latitude	0.05
		Base Station 0.02	Base Station	0.02
		Misclosure 0.03	Misclosure	0.03
		RMS Error 0.08	RMS Error	2.00
Barometers (Serial numbers)		Mechanism Aneroid 317/62M		
			742M	
			574/63M	
No. of barometrically levelled stations (1973)		81		
No. of optically levelled stations (1971-73)		1868		
Estimated maximum error of B.A. due to terrain effects		**3 mGal**		

PLATE 1

GOULBURN VALLEY REGIONAL GRAVITY SURVEYS

1971, 1972 AND 1973

LOOP CLOSURE DIAGRAM



REFERENCE TO AUSTRALIA STANDARD 1:250,000 MAP SERIES ; DENILIQUIN JERILDERIE , BENDIGO , WANGARATTA.

ADJUSTMENT BASED ON;
7106·9000 979,804·68
7206·0604 979,830·37 — FIXED NODE
6793·9302 979,814·12 — 2°ISOGAL STATION

· GRAVITY STATION △ SECONDARY BASE STATION

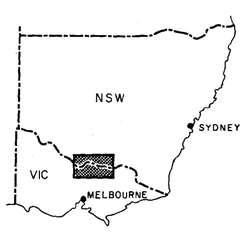
TP ⊡ TIE POINT

CC8 ⊡ CELL CENTRE & NUMBER

+0·13 — INITIAL VALUE (mgals)

(+0·00) — LEAST SQUARES ADJUSTED VALUE IN BRACKETS

A=7206 B=7106 C=7306



BUILT-UP AREA

HIGHWAY

SECOND CLASS ROAD

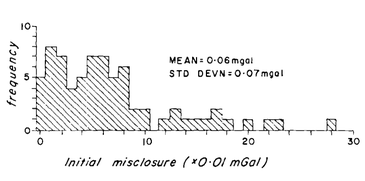
RAILWAY WITH STATION

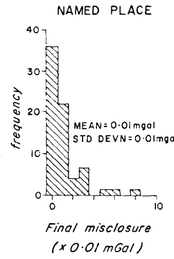
LAKE, RIVER OR STREAM

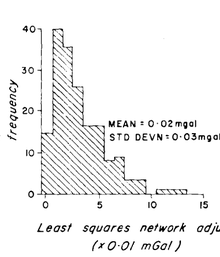
MARSH OR SWAMP

STATE BOUNDARY

NAMED PLACE







5 0 5 10 15 20 KILOMETRES

GOULBURN VALLEY SURVEYS
7106, 7206 & 7306
(NETWORK ADJUSTMENTS)
&
(LOOP MISCLOSURES)

GOULBURN VALLEY GRAVITY SURVEY 1971–73
PRELIMINARY BOUGUER ANOMALIES

5 0 5 10 15 20 KILOMETRES

A = 7206 B = 7106 C = 7306

Contour interval 1 milligal

- Built-up area
- Major, secondary road
- Minor road, vehicle track
- State boundary
- Railway
- Lake, river, stream
- Water channel
- Gravity station
- Barometrically levelled gravity station
- 3·54 Bouguer anomaly (milligals)
- —5— Isogal
- 'High' anomaly
- 'Low' anomaly

For the calculation of Bouguer anomalies 2·0 g/cm³ has been adopted as an average rock density

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