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Progress of the Reconnaissance
Gravity Survey of Australia
(a summary)

by

F. Darby and K.R. Vale

*Paper Presented at Fourth ECAFE Symposium on the
Development of Petroleum Resources of Asia and the
Far East, Canberra, October - November 1969*



This report is published as part of the series of reports on the progress of the reconnaissance gravity survey of Australia, which is being conducted by the Bureau of Mineral Resources, Geology and Geophysics. The report is intended to provide a summary of the progress of the survey to date, and to provide a basis for the planning of future work. The report is published as part of the series of reports on the progress of the reconnaissance gravity survey of Australia, which is being conducted by the Bureau of Mineral Resources, Geology and Geophysics.



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PROGRESS OF THE RECONNAISSANCE GRAVITY SURVEY OF AUSTRALIA

by

F. Darby and K.R. Vale

Bureau of Mineral Resources, Geology and Geophysics

SUMMARY

A Bouguer anomaly map of Australia which incorporates the available data at the end of 1967 is presented. A network of gravity and elevation control stations has been established throughout Australia and it is anticipated that all gravity surveys in Australia will eventually be on the same datum. The reconnaissance (1 station per 50 square miles or better) gravity survey of mainland Australia is expected to be completed by 1972/73, and that of the continental shelf (traverse separation of 10 miles) by about 1979. The Bouguer anomaly features of Australia have been classified into provinces and units (i.e. regions of common gravity characteristics) and their geological significance is outlined.

Note: A Bouguer anomaly map of Australia at a scale of 1 inch = 40 miles is available separately. A table describing each gravity province and its known or postulated geological correlation is currently being assembled for inclusion in BMR Record No. 69/110 (unpublished). Both of these items may be purchased from:

Production Section,
Commonwealth Printing Office,
Wentworth Avenue,
Kingston, A.C.T. 2604
AUSTRALIA.

INTRODUCTION

At the 1965 E.C.A.F.E. Symposium on the Development of Petroleum Resources of Asia and the Far East, K.R. Vale reported on the progress at that time of the gravity survey of Australia, and presented a Bouguer anomaly map based on the data available at the end of 1964. This report presents a revised map up-dated to the end of 1967 and shows the status of the survey at 1 June 1969.

The land area of Australia is currently (1.6.69) about 65% covered by reconnaissance gravity survey. 300,000 square miles of the continental shelf are also covered. Contributions to this survey have been and are being made by numerous exploration companies, State Mines Departments (notably South Australia and New South Wales) and the Commonwealth Bureau of Mineral Resources, Geology and Geophysics (BMR). BMR is the largest contributor spreading its effort over the entire continent and extending to external territories and the continental shelf. The other organisations confine their surveys to more restricted areas but establish a denser network of stations.

To ensure that the results of these various independent surveys can be integrated and presented on a common gravity datum, BMR has established nine calibration ranges and numerous gravity base stations throughout the country - the Australian National Gravity Network (ANGN) - (Plate 1 and Dooley, 1965). Elevation control is maintained by a network of third order level control traverses.

Many of the independent surveys in Australia, especially those conducted prior to the Isogal Survey (Dooley, 1965), have different and in some cases uncertain gravity and elevation datums. While these

problems are being resolved it is still practicable to produce a map which is adequate for broad geological correlation and interpretation. Results of 1968 surveys covering large areas of New South Wales, Queensland, South Australia, Western Australia, and north-west continental shelf are available for independent study but were not available in time for inclusion in this map and report.

COMPILATION

The base map of the Tectonic Map of Australia (1 inch = 40 miles) was used for the compilation of computed Bouguer anomalies to facilitate a direct comparison between Bouguer anomalies and known regional geological structure. This Bouguer anomaly map is too large for inclusion in this report but may be purchased separately. A reduced version (1 inch = 270 miles) is presented in Plate 2.

In the 1 inch = 40 miles compilation the Bouguer anomalies used are as originally computed for the purpose of individual surveys. The demarcation of areas having different assumed density values used in the Bouguer anomaly calculations and the assumed densities used have been marked on the map.

The ANGNI has been used as the gravity datum and the national network of third order level control traverses has been used as the elevation datum for all surveys. However, as mentioned previously, some problems still exist and it will probably be necessary to make additional ties to some surveys to ensure that the correct datum has been used.

Many of the base maps used for individual surveys do not conform to the latest 1:250,000 base maps, but the mapping was of sufficient standard to fit on to the 1 inch = 40 mile map. However, in some cases further work is needed for consistent detailed presentation.

The final presentation of the Gravity Map of Australia will involve a more rigorous compilation in which all surveys will be reduced to common elevation and gravity datums, have consistent base mapping and be reduced with a common density. This is the subject of another continuing project but for the present map less rigorous standards have been adopted especially in areas where there is a paucity of gravity data.

DESCRIPTION AND INTERPRETATION OF BOUGUER ANOMALIES

Plate 2 is a Bouguer anomaly map of Australia prepared at 1 inch = 200 miles and reduced for inclusion in this report. Contour interval is 10 milligals.

The gravity features are classified into "provinces" and "units". The detail of the gravity data is adequate for a further division into "sub-units" consisting of local "highs", "lows", "gradients" etc. on the 1 inch = 40 miles scale. Plate 3 shows the province and unit boundaries.

A gravity province is usually a large region over which the Bouguer anomaly pattern exhibits at least one or more distinctive characteristics such as trend or change of mean level that marks it off from surrounding gravity provinces. The size of a province can

vary considerably - the smallest being approximately 6,000 square miles (the Springvale Regional Gravity Ridge, Province 17) and the largest being approximately 100,000 square miles (the Georgina Regional Gravity Shelf, Province 43). A province may contain one or more gravity units.

A gravity unit is an area of major feature within a gravity province, the Bouguer anomaly pattern of which has characteristics distinguishing it from other parts of the province.

In general, provinces and units have been adapted from the work of previous authors who have dealt with the results of individual surveys over discrete areas. Some of their divisions have been revised in the light of added data from the surrounding areas.

A table has been prepared which includes a brief description of the gravity features of each province and also a brief interpretation in terms of their correlation with known or postulated geology. This table is not included with this report but is presently being assembled for inclusion in BMR Record No. 69/110 (unpublished). Appendix A gives a sample extract from this table.

The most outstanding features of the Bouguer anomalies of Australia are:

1. High Bouguer anomaly values occur in the following places:
 - (a) up to 200 miles offshore in the northwest of the continent,
 - (b) along the east coast of the continent, and
 - (c) along the northern New Guinea coast.

These high Bouguer anomalies are thought to be associated with the thinning of the continental type crust. This type of Bouguer anomaly feature is known on a worldwide basis. The high values on the north-eastern coast of the eastern tail of New Guinea are associated with an ultramafic belt that may be an exposed intrusion of mantle material.

2. Pronounced Bouguer anomaly lows presumably associated with major downwarping of the crust occur in the Perth Basin, Amadeus Basin and Timor Trough regions.

3. The most rhythmical large-scale variations in Bouguer anomaly occur in central Australia where there is a series of east-trending highs and lows with an amplitude up to 160 mgals and a wavelength up to 130 miles. These Bouguer anomaly features generally cannot be accounted for by known geological structure. The Bouguer anomaly gradients indicate a shallow crustal source for the features and may involve major intrusions of mantle material.

4. The most complex series of Bouguer anomaly features occurs along the eastern margin of the Australian mainland - over the Tasman Geosyncline where metamorphosed and intruded sediments occur. In some places there is direct correlation between surface geology and Bouguer anomaly features but in many cases there is not.

ACKNOWLEDGEMENTS

It would not be practicable to give individual acknowledgement to all persons who have contributed to the compilation of the present Bouguer anomaly map of Australia. However, special mention must be made to the untiring efforts and co-operation of the Gravity Drafting Group of BMR in preparing the maps for presentation.

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*Vale (1965) includes all major references for work completed before 1965.

APPENDIX A

EXAMPLE OF THE PRESENTATION TO BE USED IN DESCRIBING THE BOUGUER ANOMALY MAP OF AUSTRALIA

PROVINCE 2

A 500-mile long, generally narrow, gravity province extending from BYRO in the north to PEMBERTON in the south. The province is open to the sea between Dongara and Busselton; otherwise it is bounded by steep gravity gradients and Bouguer anomalies range from zero to - 130 mgals. The province has been divided into 6 units.

UNIT 2A Byro Gravity Low

A small Bouguer anomaly low on eastern BYRO. The gravity coverage is too sparse for good definition of the feature.

UNIT 2B Coolcalalaya Gravity Low

An elongate Bouguer anomaly low that is generally bordered by steep gravity gradients. The gravity coverage is too sparse for good definition of the feature.

PERTH REGIONAL GRAVITY LOW

Corresponds with the Perth Basin which is bounded by the Darling Fault in the east. The Tertiary and Mesozoic cover over most of this Basin gave little indication of a deep basin, and the concept of a shallow basin was held until the late 1940's. The first gravity readings indicated that this concept needed revision. It was predicted that there would be 30,000 feet of sediments. Subsequent seismic work and drilling tend to confirm this prediction.

The concept of the Byro and Coolcalalaya Basins, as an extension of the Perth Basin rather than the Carnarvon Basin is substantially based on gravity interpretation. Seismic evidence tends to confirm the appropriateness of the concept. However, the Byro Basin appears to have stratigraphic affinities with the Merlinleigh Basin.

UNIT 2C Watheroo Gravity Depression

A well-defined Bouguer anomaly low bounded on its landward sides by steep gravity gradients.

Undoubtedly corresponds to thick sediments within the Perth Basin.

UNIT 2D Beagle Gravity High

A Bouguer anomaly high, open to the sea, to the west of the Watheroo Gravity Depression. The extent of this high is unknown.

Corresponds with the Beagle Ridge discovered by aeromagnetism and confirmed by drilling. Its complete definition seawards may be very important.

UNIT 2E Mandurah Gravity Rise

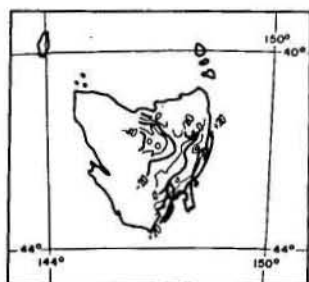
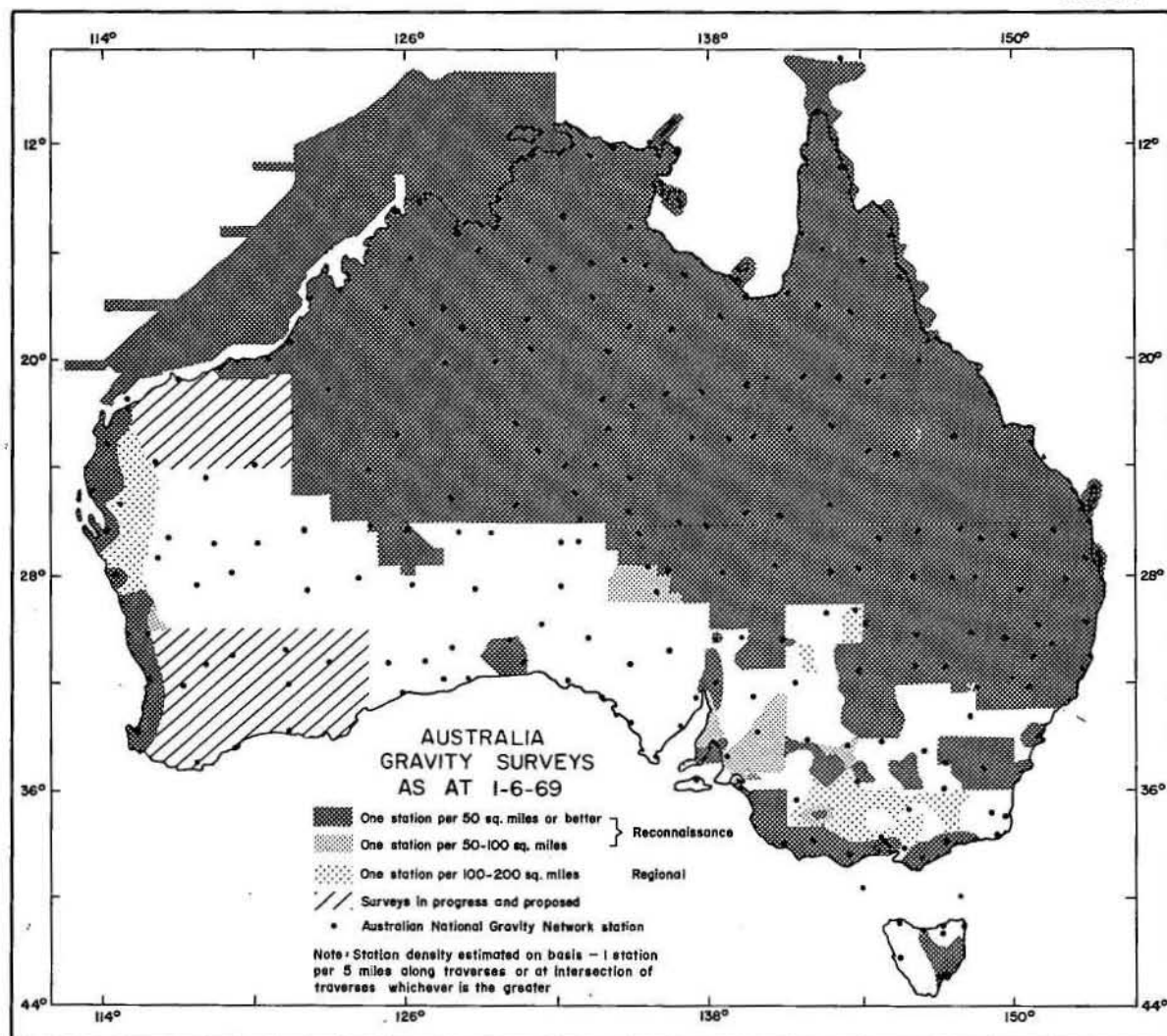
A Bouguer anomaly feature, open to the sea, to the south of the Watheroo Gravity Depression.

Although thick sediments have been indicated by seismic surveys, the sediments are probably thinner than in the areas of the Watheroo and Bunbury Gravity Depressions.

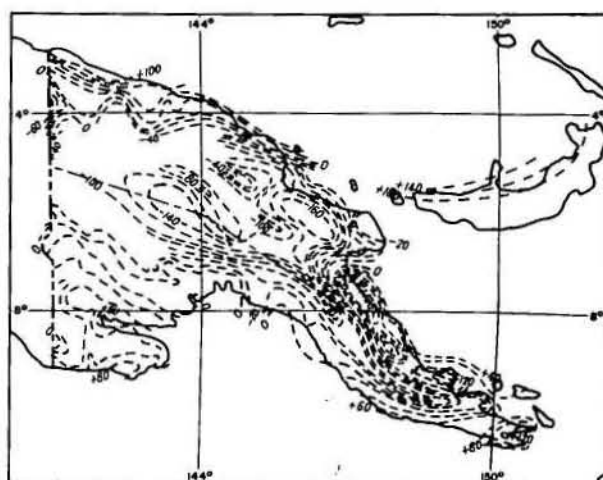
UNIT 2F Bunbury Gravity Depression

An intense Bouguer anomaly low. Its seaward extent is not known.

Seismic results have indicated thick sediments. It is bounded by the Darling Fault in the east and by Archaean gneiss of the Dunsborough Block in the west.



TASMANIA - BOUGUER ANOMALIES



TPNG - BOUGUER ANOMALIES

