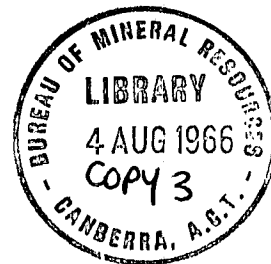


COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1966/108



NATIONAL REPORT ON GRAVITY IN
AUSTRALIA,

JANUARY 1960 TO DECEMBER 1962

by

W.J. LANGRON

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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SUMMARY

During the period January 1960 to December 1962, the introduction of helicopters for transport has enabled gravity coverage in central portions of Australia to be increased considerably.

Ground gravity coverage in Victoria, north-east New South Wales, and south-east Queensland has been extended. Gravity measurements were made at several airstrips in the vicinity of Broken Hill and at shot-points along approximately 650 miles of seismic traverse in Queensland.

A considerable amount of gravity data has been obtained through provision of the Petroleum Search Subsidy Act, 1959.

Further gravity work has been carried out in Antarctica. Ties between Australia and Antarctica (and America) using Gulf pendulums have assisted in the adjustment of this work. Other international tie data have been supplied by the "Monsoon" and "Magnet" projects.

A set of G.S.I. quartz pendulum apparatus was purchased from Japan in 1962 and is presently being used to measure the gravity interval between Tokyo and Melbourne.

The basic gravity reference network was adjusted in 1962. A new gravity meter calibration range was established near Melbourne.

Earth tide recording at a site near Melbourne has been commenced.

Automatic computing procedures have been introduced to process gravity data.

1. INTRODUCTION

This Record gives an account of gravity work carried out in Australia and Australian Territories between 1st January, 1960 and 31st December, 1962. It incorporates the report prepared for the meeting of the International Gravity Commission at Paris in September 1962 and brings up to date the report prepared by Dooley (1959).

The contribution of gravity data from private companies, particularly under the provision of the Petroleum Search Subsidy Act 1959, is acknowledged. Under this Act, the Australian Government pays half the cost of approved geophysical surveys.

2. CONNECTIONS TO STATIONS OF THE FIRST-ORDER SURVEY AND TO OTHER

INTERNATIONAL BASE STATIONS

Results are to hand for the gravity connection made in 1959 between Tokyo and Melbourne using a new type of Geographical Survey Institute (G.S.I.) quartz pendulum apparatus (Inoue and Seto, 1961).

In 1960-61, Mr. O. Strickholm of the University of Wisconsin read the loop: Madison - San Francisco - Melbourne - Mirny - Mawson - Melbourne - San Francisco - Madison, using a set of Gulf pendulums (Woollard & Rose, 1963).

Singly run ties using a La Coste gravity meter between Honolulu and Cairns and between Hobart and Wellington were included in the cruise of the Scripps Institution vessel "Argo" in 1961. Similar type connections using a La Coste gravity meter were included in project "Magnet" and flights by members of the University of Wisconsin during 1962.

In 1962, the Bureau of Mineral Resources (BMR) took delivery of a set of G.S.I. quartz pendulum equipment. The author made a set of measurements at Tokyo and it is planned to recheck the interval between Tokyo and the National Gravity Base Station (N.G.B.S.) at Melbourne.

[Editor's note: the results of this work have recently been published (Langron 1966a)].

3. GRAVITY COVERAGE IN AUSTRALIA AND NEW GUINEA

The gravity coverage of the continent has been speeded up considerably by the use of helicopters for transport, particularly in the desert areas. During this period, approximately 375,000 square miles have been covered in south-west Queensland, the Northern Territory, and central Western Australia, with a density of one gravity station per 50 square miles or better. Stations are located on an approximate 7-mile x 7-mile grid. This work is primarily in connection with oil search but with adjustment using a density value of 2.67 g/cm^3 , the data can be used for regional gravity purposes.

The practice has been adopted of reading gravity at the shot-points along all seismic lines to which the BMR has access. To date, approximately 650 miles of seismic traverse have been occupied in Queensland, New South Wales, and central Australia. It is planned to extend this work to include the recovery of data along earlier seismic traverses as well as to keep abreast of current seismic projects.

Regional gravity coverage to five stations of mean spacing approximately 15 miles (20 - 30 kilometres) has been extended in Victoria, north-east New South Wales, and south-east Queensland. Some work remains to be done

in Victoria to provide basic control for helicopter surveys or for tie purposes between pendulum stations. In addition to traverses in the eastern Australia calibration chain, regional traverses include :

Darwin - Odnadatta	1250 miles
Wyndham - Burketown	1050 miles
Quilpie - Roma	375 miles
Alice Springs - Boulia	700 miles
Wiluna - Alice Springs	1150 miles

In 1961, a gravity connection by air was made between N.G.B.S. (Melbourne) and Hobart, using only the small dial of a Worden gravity meter; intermediate readings were made at Launceston and King Island.

Gravity measurements were made in north Australian waters by the Scripps Institution vessel "Argo". One of the scientific party, M. Helfer, made a gravity connection by air between Cairns, Townsville, Hughenden, Cloncurry, Mount Isa, and Tennant Creek. He also accompanied a BMR geophysicist to double-read a land traverse between Tennant Creek and Darwin.

Some measurements were made at airstrips in the Broken Hill Royal Flying Doctor network using the BMR Cessna aircraft.

New ex-centres have been established at the Essendon airport, Melbourne, and at the old Melbourne Observatory.

Small areas of detailed gravity for engineering and base-metal search projects have been surveyed by the BMR in Queensland, New South Wales, and Tasmania. These surveys are tied in to the national network.

A considerable amount of gravity data was obtained through Commonwealth-subsidised surveys. These data are usually located in, or near, the margins of sedimentary basins and have originated from all States, but in particular from Queensland and Western Australia.

Further private company gravity data have been made available for the Papuan and Eastern New Guinea region. Preliminary results are to hand for a network read by T. Lauden of the University of Wisconsin in 1961. This survey established base control for the recovery of oil company data in Western New Guinea and for control of work currently in progress in the British Solomon Islands Protectorate.

4. COMPILATION OF GRAVITY DATA IN AUSTRALIA

Plate 1 shows the density of data available to the 31st December 1962. Plate 2 shows the areas covered in helicopter operations and also the principal regional gravity traverses read during the period of this Record.

Some revision of the provisional contours of the mean Bouguer anomalies for one-degree squares has also been made and a similar map for free air anomalies has been commenced. Only a few additional isostatic anomalies have been computed during this period.

Automatic computing methods have been introduced to assist in the reduction and preparation of gravity data.

Dooley (1962) has revised the values of gravity for the 59 stations established with the Cambridge Pendulums during 1950-51. The revision has been made using all available pendulum and gravity meter ties between these stations; connections to Christchurch, Singapore, and Tokyo were also included in the adjustment.

5. CALIBRATION

The programme of gravity meter loops between Melbourne and Cairns, to form the east coast calibration chain, is well advanced, but some of the loops done in the initial programme proved unsatisfactory and will have to be repeated. In the first instance, however, it is proposed to reoccupy the Cambridge Pendulum stations in this calibration chain using the G.S.I. pendulum equipment.

A new calibration range has been established near the old Ferntree Gully - Kallistra range, which is now no longer used. The interval of this new range is :

Ferntree Gully - Ferny Creek (M.C.S.1.-M.C.S.2) = 53.00 ± 0.01 mgals.

In addition, for BMR purposes and also to enable private companies to fulfil requirements under the Petroleum Search Subsidy Acts, calibration ranges have been established at several other locations throughout Australia. The locations and values of these ranges (Barlow, 1965) are :

<u>Calibration range</u>	<u>Interval (mgals) and probable accuracy</u>
Sydney	S.C.S.1 - S.C.S.2 = 58.99 ± 0.02
Brisbane	B.C.S.1 - B.C.S.2 = 58.26 ± 0.02
Townsville	T.C.S.1 - T.C.S.2 = 60.51 ± 0.02
Alice Springs	A.S.C.S.2 - A.S.C.S.1 = 52.10 ± 0.02
Perth	P.C.S.2 - P.C.S.1 = 53.98 ± 0.02
Adelaide	A.C.S.1 - A.C.S.2 = 62.61 ± 0.02
Hobart	H.C.S.1 - H.C.S.2 = 54.71 ± 0.02

6. GRAVITY MEASUREMENTS IN ANTARCTICA

Further ties have been made by Worden gravity meters during the annual relief expeditions to the Australian National Antarctic Research Expedition stations at Macquarie Island, Heard Island, Mawson, and Wilkes. Readings have also been made at several landing points along the coast of Antarctica.

Analysis of the gravity meter ties to Antarctica has not been completed although further adjustments have been made incorporating the pendulum results of Strickholm. Field and laboratory studies of the calibration of gravity meters, temperature and barometric effects, and irregularities in drift are being carried out and it is expected that the results of these tests, which will be completed shortly, will assist in the adjustment of the gravity ties to Antarctica. [Editor's note : the results of this work have recently been published (Langron, 1966b)].

Gravity work in connection with the Antarctic ice-cap is summarised in reports by Jesson (1959) and Goodspeed and Jesson (1959). In 1962, gravity (and seismic) traverses were read from Wilkes base (Walker, in preparation) and this work is continuing.

7. EARTH TIDE RECORDING

The underwater gravity equipment has been temporarily set up in the old Melbourne Observatory to record Earth tides. Records are being scaled to provide information for the International Centre for Earth Tides.

One of the early type Heiland gravity meters is also being modified for use as an Earth tide recorder. [Editor's note : this modification has recently been completed (Burch, 1965)].

8. PLANS FOR FUTURE GRAVITY COVERAGE

These plans will include :

- (a) Reconnaissance (i. e. approximately 7-mile x 7-mile) coverage of Australia using helicopters for transport is expected to continue at the rate of at least 140,000 square miles per year. This annual coverage could be increased with the added participation of the Division of National Mapping and the Army in the project.

Flying patterns have been varied to give an improvement in the accuracy of elevations obtained by barometric methods in remote localities and, for purposes of loop adjustment, at least one spirit levelled station is included in each loop flown. The limitation of accuracy in all gravity measurements by airborne parties will be in the measurement of altitudes of the stations.

It is planned to make gravity observations from more centres served by the Royal Flying Doctor Service using the BMR Cessna aircraft for transport.

- (b) Occupation of the stations comprising the east coast chain with the G.S.I. pendulum equipment and the extension of this range to Port Moresby (Papua). A gravity meter calibration range will also be established near Port Moresby.

It is also planned to re-occupy the north-south pendulum line from Adelaide to Darwin and another north-south line along the west coast of Australia. West-east ties using the BMR Cessna aircraft will be made between these stations and other (including pendulum) stations throughout Australia.

Loops in the east coast chain, which are at present unsatisfactory, will be re-read with gravity meter.

- (c) Completion of the gravity connection, Tokyo-Melbourne-Tokyo-Melbourne using the G.S.I. pendulum equipment. [Editor's note : this has recently been completed (Langron, 1966a)].

Pendulum observations at some of the Australian Antarctic bases during the 1963/64 or 1964/65 changeover.

- (d) Further underwater gravity observations in selected areas around the Australian coast.
- (e) Continuation of the earth-tide recording programme at the old Melbourne Observatory site with temporary field stations situated on the Australian Shield, e.g. Kalgoorlie (WA), Alice Springs (NT), and other centres.
- (f) Local surveys around selected sites for determinations of geoid undulations and deflections of the vertical. No definite plans for this work have been made yet.

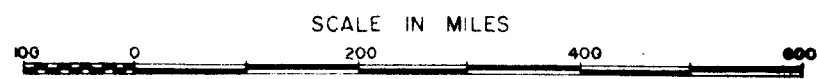
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AUSTRALIA AND NEW GUINEA

DISTRIBUTION OF GRAVITY STATIONS

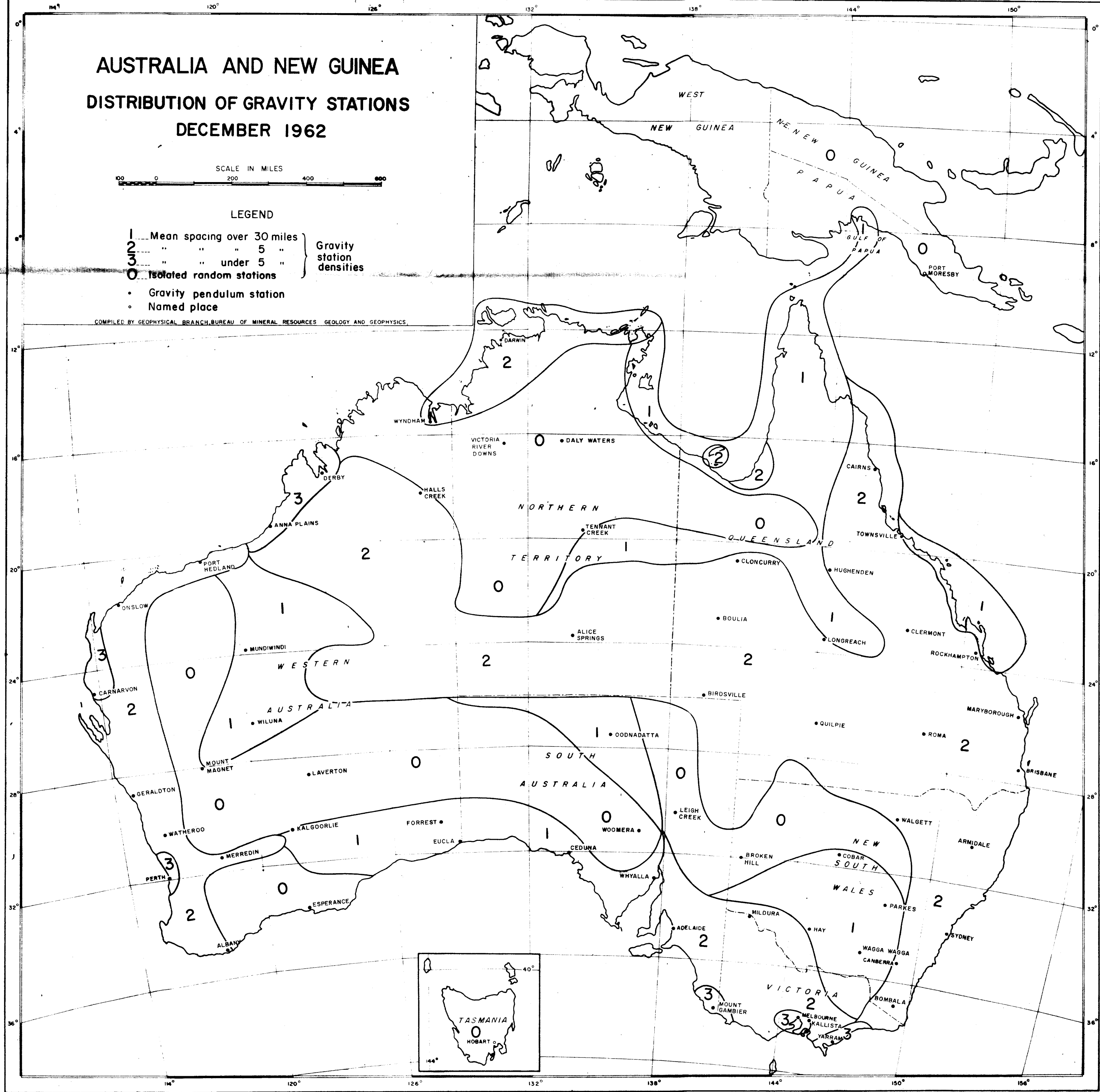
DECEMBER 1962



LEGEND

- | | | |
|---|----------------------------|---------------------------|
| 1 | Mean spacing over 30 miles | Gravity station densities |
| 2 | " " " 5 " | |
| 3 | " " " under 5 " | |
| 0 | Isolated random stations | |
| • | Gravity pendulum station | |
| • | Named place | |

COMPILED BY GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.







AUSTRALIA AND NEW GUINEA

GRAVITY COVERAGE
1.1.1960 to 31.12.1962

SCALE IN MILES
0 100 200 400 600

LEGEND

-  Helicopter surveys
-  Principal regional traverses
-  Gravity pendulum station
-  Named place

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