COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1959 NO.69

PRELIMINARY REPORT ON UNDERWATER GRAVITY SURVEY, GREAT BARRIER REEF AREA, ROCKHAMPTON TO GLADSTONE.

by

J.C. DOOLEY and M.J. GOODSPEED

RECORDS 1959 NO. 69.

PRELIMINARY REPORT ON UNDERWATER GRAVITY SURVEY, GREAT BARRIER REEF AREA, ROCKHAMPTON TO GLADSTONE.

by

J.C. DOOLEY and M.J. GOODSPEED.

CONTENTS.

ILLUSTRATIONS.

ABSTRACT.

As part of an underwater gravity survey along the Great Barrier Reef, two traverses were carried out in approximately easterly directions from Rockhampton and Gladstone to the vicinity of the reef islands. Both traverses show local anomalies near the shore, an easterly rise in gravity culminating near the reef islands, and a decrease in gravity eastwards from the reefs. This is consistent with the hypothesis that the reefs have grown from a basement ridge.

1. INTRODUCTION.

In October, 1958, the Bureau of Mineral Resources commenced a gravity survey along the Great Barrier Reef area of Queensland extending from Thursday Island to Maryborough. The survey was undertaken by the Geophysical Section of the Bureau, in conjunction with Humber Barrier Reef Oils Pty. Ltd. and Lucky Strike Drilling Co., both of whom hold Authorities to Prospect for Oil in the area. The companies contributed the cost of the charter of the vessel, M.V. "Kano", while working in their respective Authorities, i.e. Authority 53P (Humber) and 42P (Lucky Strike).

The survey comprised a regional traverse approximately parallel to the coast with stations at 20 mile intervals, and eight cross-traverses from the coast towards the outer reefs, with stations at intervals ranging from one to five miles.

This report describes Traverses 6 and 7 of the programme, off-shore from Rockhampton and Gladstone respectively, and the neighbouring stations of the regional traverse. Both of these traverses cross part of Authorities 42P and 53P. The earlier part of the work is described by Goodspeed and Williams (1959).

2. OPERATIONS.

The equipment used was North American Marine Gravity Meter UW-2R-7, mounted on M.V. "Kano", a 60-ft. motor launch chartered from Mines Administration Pty. Ltd.

Traverse 6 was carried out in December, 1958, by M. J. Goodspeed, and the regional traverse was completed as far as Gladstone. Delays caused by trouble with equipment and by bad weather during the earlier part of the survey resulted in failure to complete the survey in December as originally planned, and the vessel was tied up in Gladstone. Traverse 7 was carried out by J. C. Dooley in January, 1959. This was not the best season for marine work in this area, and on several days strong winds prevented operations.

After completing Traverse 7, instrumental trouble developed, and an attempt to continue the regional traverse southwards from Cape Bustard was unsuccessful. The vessel was taken to Bundaberg so that repairs could be effected.

The locations of the gravity stations are shown on Plate 1. Traverse 6 runs past Wreck Island, where a deep bore is about to be drilled, and is also close to Heron Is. where a bore was drilled to a depth of 732 feet by the Great Barrier Reef Committee in 1937 (Richards, 1938; Richards & Hill, 1942). This bore showed coralline material to a depth of 506 feet, followed by unconsolidated foraminiferal sands to the bottom of the bore.

Gravity stations on both traverses are approximately five miles apart near the coast. The station interval was reduced to 2 miles across the reef zones, and to one mile in the vicinity of Wreck Island.

Gravity meter drift was checked by repeating observations at a base station before and after readings on the semi-detailed traverse. For the regional traverse, the normal method of checking drift was by making connections to pendulum

stations at the ports visited. A Worden gravity meter was carried on the boat for this purpose. A connection was made at Rockhampton before beginning Traverse 6, and it was intended to connect to the pendulum station at Maryborough at the completion of the survey. However, owing to breakdown of the marine gravity meter, this connection was not made (Dooley 1959).

Gravity values at land stations adjacent to the marine stations were established at Bundaberg and Gladstone after the completion of the underwater survey. This was done by B. C. Barlow with a Worden gravity meter in March 1959, by connecting between the pendulum stations at Maryborough and Rockhampton.

3. SURVEYING AND CORRECTIONS.

Positions were determined where possible by taking bearings on prominent landmarks with horizontal sextant, and plotting with station pointer, or by reading magnetic bearings. Between stations where these methods applied, dead-reckoning was used, and a check was made when landmarks or islands were sighted again. Positions were plotted on Admiralty Charts.

Depths measured with the equipment were corrected for zero error, and for height of the tide above mean sea level. The gravity readings were corrected for tidal gravity forces.

The readings were corrected for normal gravity variation with latitude, and were corrected to mean sea-level by subtracting .0678d milligals (where d is depth in feet). The resulting anomaly is regarded as the free air anomaly. A simple Bouguer correction equal to .0209d was then added, corresponding to the difference in density between sea-water (1.03) and rock (assumed 2.67). No attempt has been made to correct for sea-bottom topography.

The gravity datum for Traverse 6 was based on Rockhampton pendulum station = 978,869.9 mgal. For Traverse 7, a value of 978,904.4 mgal. was adopted for station BRS1 (same station as BR 136), on the basis of Barlow's observations near the wharf at Gladstone. These values have also been used in correcting for drift between Rockhampton and Gladstone.

4. RESULTS.

The locations and depths of the stations for Traverses 6 and 7 are tabulated together with the observed gravity, and Bouguer and free air corrections and anomalies in Tables 1 and 2, respectively. The boundaries of Authorities to Prospect 42P and 53P are also shown. The anomalies, together with sea depths, along Traverses 6 and 7, have been plotted in profile form on Plates 2 and 3 respectively.

The Palaeozoic rocks on the adjacent mainland are regarded by Hill (1954) as effectively basement rocks from the point of view of oil search. Several granite outcrops occur in this area.

Both traverses show local anomalies at the western end near the mainland. These are probably associated with

features in the Palaeozoic rocks. There is no decrease in gravity offshore, such as might be expected if a substantial thickness of younger sediments were present offshore.

A rise in gravity of about 25 milligals occurs on Traverse 6 from approximately the longitude of Cape Capricorn to the western edge of the reefs. Further east the gravity values are lower. Traverse 7 shows very similar characteristics, the rise beginning from the vicinity of Bustard Head; however in this case the gradient is not so high. Again a reversal of gradient occurs east of the reefs.

In interpreting these anomalies it should be borne in mind that a rise in Bouguer anomaly generally occurs oceanwards in marginal continental areas, corresponding to a change in depth of the M-layer. Although the 100-fathom line is only a few miles east of the ends of Traverses 6 and 7, the fall to deeper water is comparatively gradual, and thus the location and gradient of the anomalies associated with this are somewhat doubtful.

The positive gravity anomalies culminating at BR 131 on Traverse 6 and BRS 16 on Traverse 7 are consistent with the hypothesis that the reefs have grown on a basement high or scarp. If it is assumed that no substantial thickness of sediments younger than Palaeozoic is present, then presumably the anomalies would correspond to a denser core of Pre-Cambrian or igneous rock.

Another possibility is to regard the anomalies as superimposed on a gradual rise in gravity to the east. In this case a trough of lighter sediments could be present near Cape Capricorn and Cape Bustard, and the Palaeozoic rocks could form the "basement" ridge for growth of the coral reefs.

The reversal of gravity gradient east of the reefs suggests also the possibility of faulting down-thrown to the east. Many authors have suggested that faulting controls the alignment of the reefs and the edge of the continental shelf (Fairbridge 1950).

5. REFERENCES.

DOOLEY, J.C., 1959 - Preliminary Report on underwater gravity survey, Hervey Bay, Queensland. Bur.Min.Res.Geol. & Geoph., Records 1959/68 (in preparation).

FAIRBRIDGE, R.W., 1950 - Recent & Pleistocene coral reefs of Australia. Jour. Geol., 58, p.330.

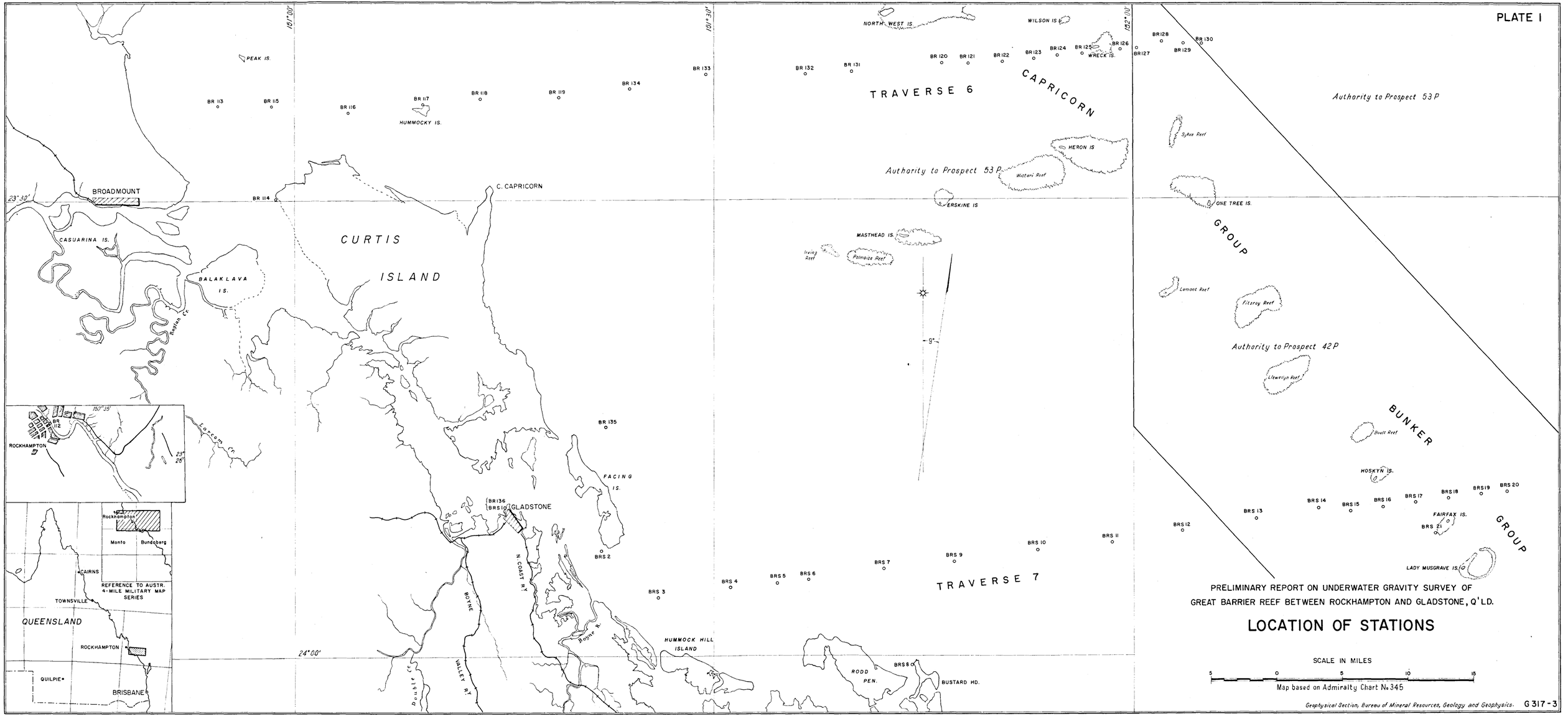
GOODSPEED, M.J., and WILLIAMS, L.W., 1959 - Preliminary report on underwater gravity survey, Great Barrier Reef area, Thursday Island to Rockhampton. Bur.Min.Res. Geol. & Geoph., Records 1959/70 (in preparation).

HILL, Dorothy, 1954 - The geology of the Great Barrier Reefs in relation to oil potential (unpublished manuscript).

RICHARDS, H.C., 1938 - Boring operations at Heron Island, Great Barrier Reef. Reports of Great Barrier Reef Com., Vol. IV, p.135.

RICHARDS, H.C., and HILL, D. 1942 - Great Barrier Reef bores 1926 and 1937. Reps. of Great Barrier Reef Com., Vol. V, p.1.

PLATE I



PRELIMINARY REPORT ON UNDERWATER GRAVITY SURVEY OF GREAT BARRIER REEF BETWEEN ROCKHAMPTON AND GLADSTONE, Q'LD.

LOCATION OF STATIONS

SCALE IN MILES

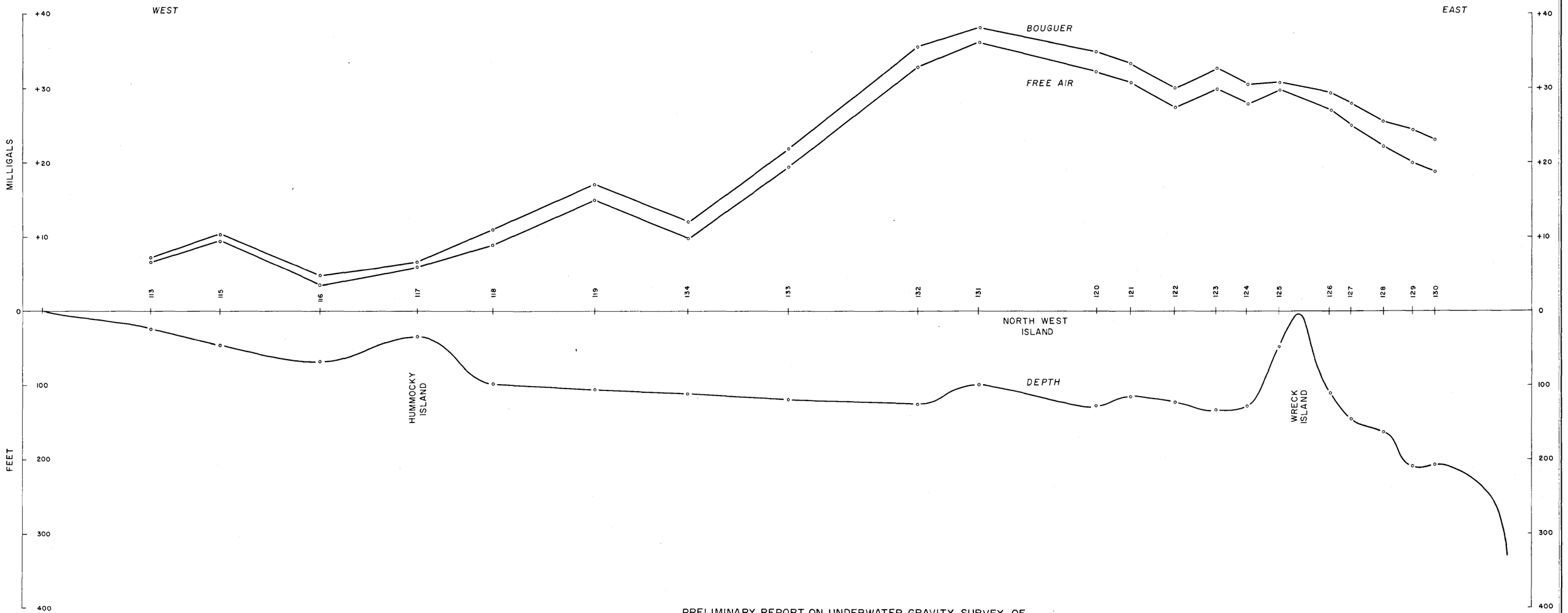
5 0 5 10 15

Map based on Admiralty Chart No. 345

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G317-3

To accompany Records 1959, No 69

PLATE 2



PRELIMINARY REPORT ON UNDERWATER GRAVITY SURVEY OF
GREAT BARRIER REEF BETWEEN ROCKHAMPTON AND GLADSTONE, Q'LD.

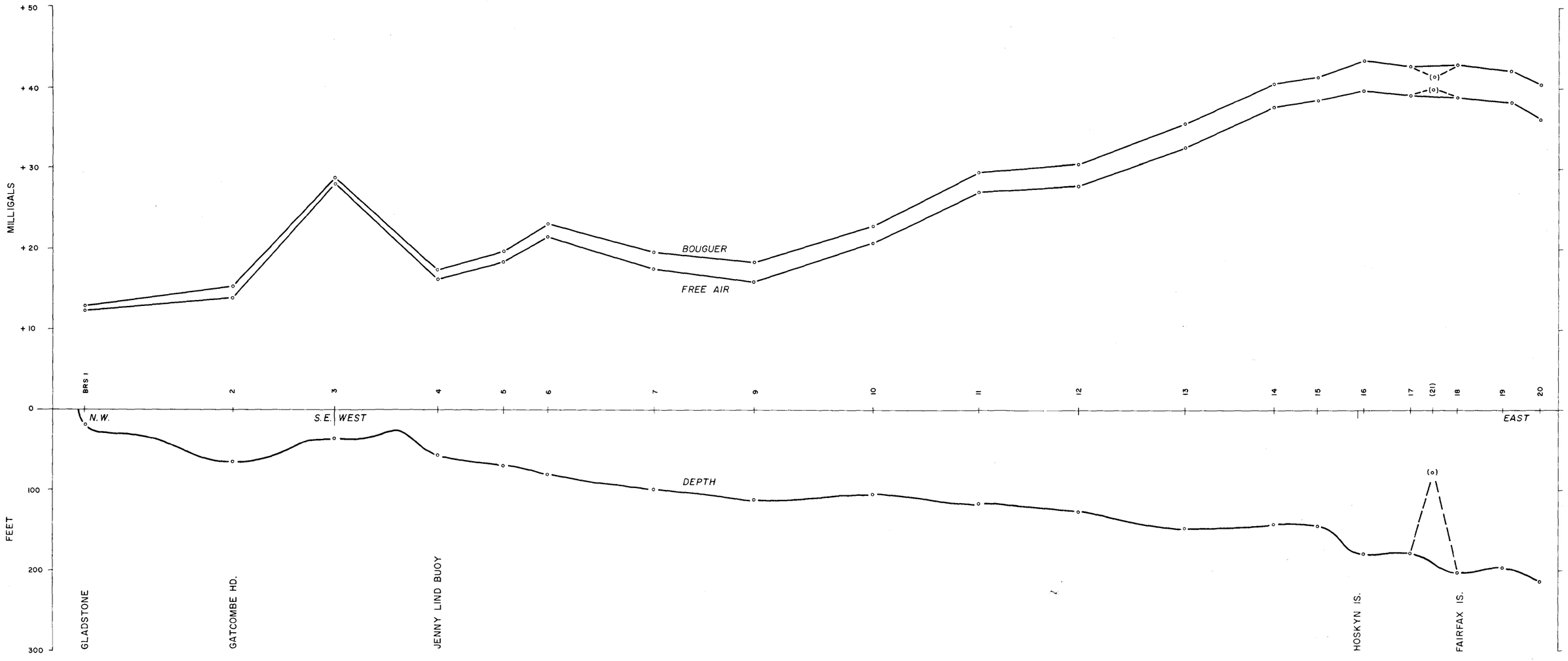
PROFILE SHOWING GRAVITY ANOMALIES AND SEA DEPTH TRAVERSE 6

HORIZONTAL SCALE IN MILES
5 0 5 10
VERTICAL SCALES AS SHOWN

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G317-6

To accompany Records 1959, No 69

PLATE 3



PRELIMINARY REPORT ON UNDERWATER GRAVITY SURVEY OF
GREAT BARRIER REEF BETWEEN ROCKHAMPTON AND GLADSTONE, Q'LD.

PROFILE SHOWING GRAVITY ANOMALIES AND SEA DEPTH TRAVERSE 7

HORIZONTAL SCALE IN MILES
5 0 5 10
VERTICAL SCALE AS SHOWN

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G 317-5

TABLE 1.

PRINCIPAL FACTS FOR GRAVITY STATIONS - TRAVERSE 6.

Area: Gt. Barrier Reef. Traverse 6 - Rockhampton-Wreck Is. Date of Survey: Dec. 58. Meter: UW-2R-7
Sensitivity: .12665 m/gal.per div. Datum: PS 49 = 978,869.9. Density: 2.67

Station.	Latitude.	Longitude.	Depth.	Observed Gravity.	Normal Gravity.	Free Air Correction.	Free Air Anomaly.	Bouguer Correction.	Bouguer Anomaly
BR 112	23°22.8'	150°31.2'	16	978,872.2	978,860.4	- 1.1	+10.7	+ 0.3	+11.0
113	23.8'	54.6'	25	869.9	861.5	- 1.7	+ 6.7	+ 0.5	+ 7.2
114	29.8	58.7	35	883.1	868.1	- 2.4	+12.6	+ 0.7	+13.3
115	23.9	58.4	47	874.2	861.6	- 3.2	+ 9.4	+ 1.0	+10.4
116	24.3	151°03.9	69	870.3	862.1	- 4.7	+ 3.5	+ 1.4	+ 4.9
117	23.8	09.2	35	869.8	861.5	- 2.4	+ 5.9	+ 0.7	+ 6.6
118	23.4	13.2	98	876.6	861.1	- 6.6	+ 8.9	+ 2.1	+11.0
119	23.3	19.0	106	883.0	861.0	- 7.2	+14.8	+ 2.2	+17.0
120	21.1	46.3	128	899.4	858.6	- 8.7	+32.1	+ 2.7	+34.8
121	21.1	48.2	116	897.3	858.6	- 7.9	+30.8	+ 2.4	+33.2
122	21.0	50.6	123	894.2	858.5	- 8.3	+27.4	+ 2.6	+30.0
123	20.7	53.0	133	897.0	858.2	- 9.0	+29.8	+ 2.8	+32.6
124	20.5	54.6	128	894.4	857.9	- 8.7	+27.8	+ 2.7	+30.5
125	20.3	56.5	49	890.7	857.7	- 3.3	+29.7	+ 1.0	+30.8
126	20.2	59.1	110	892.0	857.5	- 7.5	+27.0	+ 2.3	+29.3
127	20.1	152°00.3	146	892.2	857.4	- 9.9	+24.9	+ 3.1	+28.0
128	19.6	02.1	164	890.2	857.0	-11.1	+22.1	+ 3.4	+25.5
129	19.8	03.6	209	891.4	857.2	-14.2	+20.0	+ 4.4	+24.4
130	19.8	05.0	208	890.0	857.2	-14.1	+18.7	+ 4.4	+23.1
131	21.6	151°39.9	100	901.8	859.1	- 6.8	+35.9	+ 2.1	+38.0
132	21.8	36.6	126	900.7	859.4	- 8.5	+32.8	+ 2.6	+35.4
133	21.8	29.4	119	886.9	859.4	- 8.1	+19.4	+ 2.5	+21.9
134	22.8	24.0	111	877.7	860.4	- 7.5	+ 9.8	+ 2.3	+12.1
135	44.9	22.3	67	898.1	884.7	- 4.5	+8.9	+ 1.4	+10.3
136	23°50.2	15.1	21	904.4	890.6	- 1.4	+12.4	+ 0.4	+12.8

TABLE 2.

PRINCIPAL FACTS FOR GRAVITY STATIONS - TRAVERSE 7.

Area: Gt. Barrier Reef. Traverse 7. Date of Survey: January, 1959. Meter: UW-2R-7
Sensitivity: .12665m/gal. per div. Datum: BRS1 Gladstone tied between P.S.48 & 49. Density Factor: .0209mgal/ft.

Station.	Latitude.	Longitude.	Depth.	Observed Gravity.	Normal Gravity.	Free Air Correction.	Free Air Anomaly.	Bouguer Correction.	Bouguer Anomaly.
BRS 1	23°50.2	151°15.1	20	978,904.4	978,890.6	- 1.4	+ 12.4	+ 0.4	+ 12.8
2	53.1	22.0	66	912.2	893.8	- 4.5	+ 13.9	+ 1.4	+ 15.3
3	56.1	26.0	37	927.7	897.2	- 2.5	+ 28.0	+ 0.8	+ 28.8
4	55.5	31.3	58	916.4	896.5	- 3.9	+ 16.0	+ 1.2	+ 17.2
5	55.3	34.6	71	919.3	896.3	- 4.8	+ 18.2	+ 1.5	+ 19.7
6	55.0	36.8	81	922.7	895.9	- 5.5	+ 21.3	+ 1.7	+ 23.0
7	54.3	42.2	100	919.4	895.2	- 6.8	+ 17.4	+ 2.1	+ 19.5
8	24°00.7	44.3	16	918.4	902.3	- 1.1	+ 15.0	+ 0.3	+ 15.3
9	23°53.8	47.1	113	918.2	894.6	- 7.7	+ 15.9	+ 2.4	+ 18.3
10	53.2	53.1	106	921.7	893.9	- 7.2	+ 20.6	+ 2.2	+ 22.8
11	52.6	58.5	118	928.2	893.3	- 8.0	+ 26.9	+ 2.5	+ 29.4
12	51.9	152°03.5	128	928.9	892.5	- 8.7	+ 27.7	+ 2.7	+ 30.4
13	51.1	08.9	148	934.0	891.6	-10.0	+ 32.4	+ 3.1	+ 35.5
14	50.4	13.2	142	937.8	890.8	- 9.6	+ 37.4	+ 3.0	+ 40.4
15	50.7	15.5	143	939.3	891.2	- 9.7	+ 38.4	+ 3.0	+ 41.4
16	50.4	18.0	178	942.6	890.8	-12.1	+ 39.7	+ 3.7	+ 43.4
17	50.3	20.1	177	941.8	890.7	-12.0	+ 39.1	+ 3.7	+ 42.8
18	50.0	22.5	201	942.8	890.4	-13.6	+ 38.8	+ 4.2	+ 43.0
19	49.7	24.9	195	941.4	890.1	-13.2	+ 38.1	+ 4.1	+ 42.2
20	49.5	26.7	212	940.3	889.8	-14.4	+ 36.1	+ 4.4	+ 40.5
21	52.2	21.6	78	938.0	892.8	- 5.3	+ 39.9	+ 1.6	+ 41.5