DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/87

GRAVITY READINGS ON SEISMIC TRAVERSES IN THE MOREE AREA, SURAT BASIN, NSW 1962

by

F.J.G. Neumann

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FOREWORD

The Bouguer anomaly maps in this Record are contoured at closer spacing than is strictly justified by the gravity measurements, and are thus somewhat subjective. It is not BMR policy to prepare contour maps in this way, but this report was written many years ago and is issued now to place the findings of the survey on record.

SUMMARY

This report describes the results of gravity readings taken during 1962 along seismic traverses across the southern part of the Surat Basin between Goondiwindi and Moree south of the New South Wales/Queensland border.

The objective of this work was to supplement the seismic results and to correlate gravity and seismic data with a view to the elucidation of geological structure.

The Bouguer anomaly values measured from shot-point to shot-point were integrated into the general anomaly picture, which has been obtained as a result of BMR's regional gravity work in Queensland and New South Wales during 1960-61.

The gravity data are interpreted in terms of basin structure, basement lithology, and major faulting. In the area reviewed the relation between gravity anomaly and variations in the sediment thickness is more complex than usual. Dense intrusive rocks most probably occur in the basement below the sediments.

Gravity data indicate a probable extension north of the Hunter-Bowen thrust system.

1. INTRODUCTION

During the period April to July 1962, the Bureau of Mineral Resources, Geology & Geophysics (BMR) conducted a seismic survey over the southern part of the Surat Basin. The purpose of this survey was to investigate the area around Moree, located 60 miles south of the New South Wales/Queensland border.

Prior to the survey, i.e. during 1961, two BMR seismic traverses had been completed for the purpose of investigating the structure of the Surat Basin immediately north of the New South Wales/Queensland border between St George and Yelarbon and also in the area extending north of Moree towards the centre of the Surat Basin near Meandarra (Lodwick & Bigg-Wither, 1962). Later in 1961, shot-points of these seismic traverses had been used for taking gravity-meter readings (Gibb, 1965).

A similar procedure was followed during 1962, when gravity observations were made on shot-points of the 1962 seismic survey near Moree. The aim of this gravity work was similar to that in 1961, as it was intended to supplement the seismic data and to investigate the possibility of structure elucidation by more detailed gravity work.

2. GEOLOGY

Stratigraphy

Permian movements initiated the forming of the Surat Basin as the southern extension of the Bowen Basin of Queensland. The basement rocks beneath the Permian beds include slightly metamorphosed argillite, sandstone, siltstone, limestone, tuff, and volcanic flows of Carboniferous to Devonian age.

Near the base of the Permian sediments volcanics occur in relatively great thickness. The Back Creek Group, composed of marine sandstone and mudstone, forms the oldest Permian sediments. This group is conformably overlain by continental siltstone, feldspathic sandstone, and coal measures of the Kianga Formation.

During the Triassic period, clastic terrigenous sediments were deposited in great thickness. In the deepest trough-like portions of the Bowen Basin 7000 ft of Lower Triassic and up to 10 000 ft of Middle to Upper Triassic beds occur (Trumpy & Tissot, 1963).

An important unconformity separates Triassic and Jurassic beds. The Lower Jurassic sequence is mainly sandstone, referred to in the earlier literature as 'Bundamba Group' (Whitehouse, 1955). The Precipice Sandstone at the base of the Jurassic is an important aquifer; it also forms the reservoir beds in the Moonie Oilfield (see below). This sandstone is overlain by the Evergreen Shale and the Hutton Sandstone. The Middle Jurassic Walloon Formation consists of shale, coal seams, and calcareous sandstone.

In the Surat Basin, Lower Cretaceous sediments almost 5000 ft thick include unfossiliferous continental sandstone and transition beds of the Blythesdale Group, overlain by marine glauconitic siltstones and shales of the Roma Group.

For convenience the reader is referred to Table 1, which represents the stratigraphic sequence of the southern Surat Basin in tabulated form.

Basin structure

The Surat Basin and the Bowen Basin form an elongated sub-meridional trough, approximately 600 miles long. In the central part of this trough the depth to the base of Permian deposition reaches 25 000 to 30 000 ft (Trumpy & Tissot, 1963). The structure of this basin is asymmetric as the eastern flank is steeper than the broader and more gently dipping western wing. Complex tectonics control the eastern basin margin, which is formed by major faulting, thrusting, and minor block-faulting.

Prior to BMR's seismic investigations (Lodwick and Watson, 1960) only vague estimates had been made concerning the general structure of the Surat Basin and the probable thickness of the sediments. The southerly extent of the basin structure was problematic. Bores drilled immediately south of the Queensland/New South Wales border had intersected shallow basement in an area where the basin would be expected to continue (Rudd, 1961).

Near Meandarra the maximum thickness of sediments in the Surat Basin has been suggested from seismic work to be at least 19 000 feet. Farther south, near the centre of the Toobeah Trough, the presence of sediments at least 14 800 ft thick has been concluded from seismic data (Lodwick & Bigg-Wither, 1962). In the light of results obtained by recent drilling this figure may be somewhat too large. The Macintyre

No. 1 well, located in the Toobeah Trough (Plate 1), intersected basement rocks at 8319 ft. From seismic work and drilling data it is now evident that in the southern portion of the Surat Basin, more precisely in the area south of Toobeah, the older sediments are rapidly thinning south-westerly beneath the Lower Cretaceous cover beds. Near Moree BMR's 1962 seismic work suggests a narrowing of the southern extension of the Toobeah Trough, associated with a thickening easterly in the sediments, which reach maximum thickness in the area between Moree and the Goondiwindi Fault.

The results obtained by drilling a number of bores (Plate 1) into basement rocks mainly in the NARRABRI 4-mile Sheet area indicate a widening in the basin structure south of 30° latitude and east of Coonamble. An immediate connexion south from the Surat Basin into the Oxley Basin is probable.

Oil potentiality

Geologically the discovery of oil and natural gas in the eastern Surat Basin near Tara late in 1960 was based on the assumption that beds of Permian age might be present at depth in considerable thickness in the deeply depressed Surat Basin. It was also assumed that Permian beds, which are predominantly freshwater depositions in the Springsure region, would be more marine in the area southeast of Roma (Rudd, 1961). As the Mesozoic sandstone reservoir rocks in the gasfields around Roma are not associated with typical source beds, the assumption was reasonably well based, that petroliferous gas together with oil might have migrated up-dip northwesterly from truncated Permian source beds, believed to occur under a thick Mesozoic cover in the deeper portions of the Surat Basin.

Alternatively the total absence of Permian beds under most of the northeast of Thallon was also suggested in the earlier literature (Whitehouse, 1955). BMR's seismic work during 1959 in the area east of Surat confirmed Rudd's concept.

Drilling for oil in the Surat Basin has shown that the Precipice Sandstone of Lower Jurassic age is a persistently good reservoir (Trumpy & Tissot, 1963). Potential reservoir beds also occur in the Permian and in the Triassic formations. The Triassic sandy beds vary in thickness, are lenticular, and display varying porosity and permeability. Drilling during 1963-64 period indicated that Mesozoic sands improve in quality generally to the west, whereas these sands are more irregular in the east (Graves, 1964).

TABLE 1: STRATIGRAPHIC SEQUENCE IN THE SOUTHERN SURAT BASIN

Age	Formation	Estimated maximum thickness (ft)	Lithology
Lower Cretaceous	ROMA	2500	marine glauconitic siltstone, shale, intercalated limestone.
	BLYTHESDALE	2300	transition beds of sandstone, siltstone, lenses of coal underlain by fine-grained continental sandstone.
Unconformity			
Jurassic	WALLOON	1000 to 1500	shale, calcareous lithic sandstone, limestone; coal seams near the base.
	HUTTON	700 to 800	brown lithic to quartzose sandstone, sandy shale underlain by white evaporitic sandstone, siltstone, shale.
	EVERGREEN	700	evaporitic sandstone, siltstone, mudstone, coal seams, fossil wood pebble bands.
	PRECIPICE	600	massive siliceous sandstone productive in Moonie Oil field.
Major Unconformity			
Triassic	WANDOAN	1300	sandstone, shale, minor coal seams deposited in the Meandarra Trough.
	CABAWIN	2200(+)	conglomeratic sandstone, cross-bedded feldspathic lithic sandstone, coarse-grained sandstone, post-tectonic fill type deposit in the Meandarra Trough.
Permian	KIANGA	520	siltstone, feldspathic sandstone, coal measures, suggested to correlate with Upper Coal Measures of NSW.
	BACK CREEK	1300	marine sandstone, mudstone.
	VOLCANICS	370(+)	andesitic and rhyolite lava, tuff, agglomerate; equivalent to Lower Bowen Volcanics.
Unconformity			

TABLE 1 (Contd)

Age	Formation	Estimated maximum thickness (ft)	Lithology
Carboniferous and Older	BASEMENT		folded basement rocks formed of slightly metamorphosed argillite, siltstone, sandstone, limestone, volcanics.

Note: For the compilation of the stratigraphic sequence tabulated above the correlated chart of stratigraphic sections in the Great Artesian Basin has been used (Reynolds, 1963) in connexion with the recently suggested revised terminology for Jurassic beds (De Jersey & Paten, 1963; McTaggart, 1963).

Crude oil was first struck in the Surat Basin early in 1961. This oil occurred in a Permian sand intersected at 9933 ft in the Cabawin No. 1 well, 27 miles south of Tara. This well was drilled by the Union-Kern-A.O.G. Group, subsidized by the Commonwealth Government. By the middle of November 1961, the same group of companies commenced drilling Moonie No. 1, located 50 miles south of Tara. This intersected productive oil sands in two horizons, in the intervals from 5638 to 5650 ft and from 5798 to 5840 feet depth. By the end of 1963 the Moonie oil field with 15 bores producing from the Jurassic Precipice Sandstone was the first commercial field in Australia.

In October 1963 the Wunger No. 1 well in the southwestern part of the Surat Basin produced oil at the rate of ten barrels a day accompanied by a flow of gas at the rate of 180 000 cubic feet a day from a sand intersected from 6283 to 6309 ft depth. This productive sand is the Wandoan Sandstone of Upper Triassic age.

During July 1964, at the time when this report was written, a further oil strike was made by the Union-Kern-A.O.G. Group. Oil flowed from the Alton No. 1 well, located between Moonie and St. George in the southwestern part of the Surat Basin (Plate 1), at the rate of 1050 bbls a day from the 6060 to 6120 ft interval, accompanied by 440 000 cubic feet a day of petroliferous gas; a deeper oil sand, occurring from 6820 to 6853 ft depth, was also intersected.

3. OBJECTIVES OF THE SURVEY

The main objectives of the 1962 gravity survey in the Moree area were:

(a) Firstly it was considered desirable to supplement the results of the 1962 seismic survey.

(b) Secondly it was intended to supplement the regional gravity anomaly picture provided by BMR's 1961 and 1962 regional surveys in eastern Queensland and New South Wales.

(c) Thirdly, more information was wanted on the apparent reverse correlation between gravity readings and thickness of sediments in the deepest portion of the Surat Basin (Meandarra and Toobeah Trough), particularly in the southern part of the Surat Basin.

(d) Fourthly it was hoped, with the availability of more complete gravity information, to advance the knowledge of the general structure of the Surat Basin. In particular a possible extension south of the Goondiwindi Fault could be expected to be evidenced by a gravity variation similar in magnitude and type to that measured near Goondiwindi during the 1961 gravity survey (Gibb, 1965).

4. FIELD PROCEDURE AND REDUCTIONS

Field procedure

Prior to the 1962 seismic field work, shot-points on seismic traverses, which were later used as gravity stations, had been pegged and surveyed by the Department of the Interior, Canberra. The shot-points were positioned at 1320 ft or 1800 ft intervals with altitudes referred to Mean Sea Level datum.

The arrangement of the traverses in the Moree area is shown in Plate 5. Traverses are represented as solid lines marked R, S, T, U, V, W, and J. Also shown in this plan are the gravity traverses surveyed during the course of BMR's 1961 and 1962 regional work. Regional gravity traverses are prefixed 2, 5, 6, 6BT, MBI, CM, MTN, and YB.

Superimposed on the traverse map (Plate 2) are the boundaries of the 1:250,000 Sheet areas: MOREE, INVERELL, NARRABRI and MANILLA.

Not all of the seismic shot-points could be recovered during the 1962 field work, because at the time of the gravity survey many of the seismic shot-hole markers had been removed by road-making machines. Where possible, speedometer readings were made in order to re-establish as many shot-point positions as possible.

In all, 136 new gravity-meter stations were completed on the traverses R, S, T, V, and J. No readings were taken on traverses U and W. Numerous gravity ties were made between the stations of the new work and BMR's regional gravity stations of the same area.

Observed gravity values at BMR Pendulum Stations as revised by Dooley (1965), which were used as datum ties, are tabulated in Table 3.

TABLE 3: BMR PENDULUM STATIONS IN THE SURAT BASIN AND VICINITY

No.	Station	Latitude	Longitude	Observed Gravity (mGal)
47	Brisbane	27°30.0'	153°00.8'	979, 169.8
46	Armidale	30°29.1'	151°38.9'	113.9
5	Sydney	33°53.4'	151°11.4'	685.7
44	Parkes	33°08.0'	148°10.6'	509.0
45	Walgett	30°01.4'	148°06.1'	319.8
59	Roma	26°34.4'	148°46.5'	978, 979.1

Information on the staff members participating in the field work, the equipment taken to the field and the timetable of the survey is listed in the Appendix.

Reductions

For each station the gravity-meter readings were corrected for instrument drift by using the results of repeated readings in order to control the time-drift of the instrument. The drift-corrected readings were then converted into milligals by using the calibration factor. The converted reading results were finally referred to the observed gravity values established at the stations of BMR's 1960-61 regional gravity surveys in Queensland and New South Wales. Corrections for latitude or normal gravity, and for station altitude referred to Mean Sea Level, were applied to obtain the relative Bouguer anomaly value for each station. An average density of 1.8 g/cm^3 for the rocks between station site and Sea Level was assumed.

Most of the area surveyed is covered at the surface by beds of Jurassic and later age (Plate 3B). In the southeastern portion of the area, Middle Palaeozoic rocks are exposed. In this portion of the gravity map the assumption of a somewhat higher rock density would be more appropriate. Higher density used in the computing of Bouguer anomalies would lead to somewhat lower values.

As far as possible, gravity reductions were computed by using the electronic Ferranti 'Sirius' computer at Monash University, Clayton, Victoria.

Map presentation

The combined results of the 1962 gravity readings on seismic traverses in the Moree area and the gravity data obtained from BMR's 1960-61 regional work have been presented in the form of a Bouguer anomaly contour plan in Plate 2. The same contours are shown in Plate 3 at reduced scale, to match the geological map (Plate 4), taken from the 1:1,000,000 Geological Map of New South Wales (Department of Mines, Sydney, 1962).

To further illustrate the correlation between gravity anomaly features, seismic soundings, and drilling data, two east-west cross-sections A and B have been drawn (Plates 5, 6).

5. DISCUSSION OF RESULTS

Gravity anomaly picture

A predominantly north-south trend is clearly expressed in the general pattern of the contours in the area around Moree (Plates 2, 3).

A predominant linear feature of the gravity map is a strip, approximately 4 miles wide, which extends south from Goondiwindi. On this strip, gravity anomaly values vary from -20 to -10 mGal, corresponding to an average gradient of about 2 mGal per mile. This gradient bounds to the east an elongate gravity 'low' which encloses Bouguer anomaly values as low as -25 mGal. The axis of the 'low' referred to extends for over 100 miles south from a point about 5 miles west of Goondiwindi.

East of the consistent gravity gradient described above is a gravity ridge, on which three separate 'highs' are enclosed by -5 mGal contours. This gravity ridge widens considerably near the southeastern portion of the gravity map, where Bouguer values rise to zero on a separate closed anomaly feature.

On the western half of the Bouguer anomaly map there is also a ridge-like 'high', which is broader and more arcuate than the eastern ridge and includes two major, closed anomalies. The first is south of Moree and is referred to in the following text as 'Moree Gravity High'. The second on the western gravity ridge occurs in the northwestern portion of the gravity map, from where it extends into the 'Toobeah Gravity High' north of the New South Wales/Queensland border (Gibb, 1965).

Seismic results

By traversing the southern portion of the Surat Basin from Yelarbon to St George, BMR's 1961 seismic work has revealed the general structure of the basin in the area immediately north of the New South Wales/Queensland state boundary (Lodwick & Bigg-Wither, 1962): In the tectonic setting of the basin structure four major divisions have been distinguished; these are arranged from east to west as follows:

(a) High-standing pre-Permian rocks east of Goondiwindi.

(b) 'Goondiwindi Fault', comprising a system of faulting and thrusting, which forms the western boundary of the pre-Permian rocks mentioned above.

(c) 'Toobeah Trough', a deeply depressed portion of the Surat Basin immediately west of the 'Goondiwindi Fault', with Permian and Mesozoic sediments deposited in maximum thickness.

(d) 'Western Shelf', an area where Permian beds are probably absent and older Mesozoic beds, which are thinning westerly and southwesterly, directly overlie granitic or metamorphic basement rocks.

Cross-section correlation

The results of the geophysical work in relation to geology can be further assessed by cross-section analysis, based on known or accepted rock densities, geology, drilling results, and seismic soundings. In combining the empirical data known, the probable cause is examined of the various anomaly features. The results of the analysis is relation to major structure elements of the surveyed area are summarized below.

Goondiwindi fault extension. The strongest gravity gradient measured during the course of the 1961 survey on the St George to Yelarbon gravity traverse occurs at seismic shot-points immediately east and west of Goondiwindi. The rapid gravity variation in this area is clearly related to the position of the Goondiwindi Fault. BMR's 1961 seismic work located this fault or thrust on the St George to Yelarbon traverse approximately four miles west of Goondiwindi.

It has been mentioned above that from this point south a consistent gravity gradient of about 2 mGal per mile has been measured across the whole length of the gravity map. It is important to note that south-southeast of Moree this gravity gradient is clearly related to a point where a major fault system in Permian and older rocks disappears under a blanket of Jurassic and younger sediments and Tertiary basalt (Plates 1, 4).

In eastern Queensland and New South Wales folding and faulting occurred towards the end of the Permian period during the Hunter-Bowen Orogeny (David, 1950). Closely following David, the specific problems involved in these movements can be described within the frame of major tectonics of Eastern Australia as follows:

> "In New South Wales submeridional folding and faulting took place at or towards the close of 'Upper Marine' sedimentation, followed by overthrusting and further folding with a north-northwest trend during the deposition of the 'Upper Coal-measures' of Upper Permian age. In Queensland and in the north-coast area of New South Wales diastrophism began before 'Upper Coal-Measures time during the Upper Bowen period and later spread west. Over a considerable distance younger rocks separate Palaeozoic areas of Queensland and New South Wales, so that it is impossible to trace the possible continuity in major structure. However the type of folding known from New South Wales Carboniferous and Permian rocks indicates a possible extension of tectonics further north.

This poses the problem whether or not the thrusts in the Permian strata in Queensland should be linked with the Mooki and Hunter thrusts in New South Wales. If so, this huge fault system traversing a distance of 850 miles is among the most stupendous tectonic features of the Commonwealth."

Seeing this problem in the light of geophysical data available from the Moree area, it is quite obvious that the concept of a probable extension of the Hunter-Bowen thrust system north of 30° latitude is supported by the gravity results in this particular area. As pointed out above, a consistent gravity anomaly has been measured in the critical area south of Goondiwindi, where the Hunter-Bowen tectonics could be most likely expected to extend under younger rocks. The magnitude and regional extent of this anomaly would require as an explanation a correspondingly large geological feature. The anomaly curve, with a maximum to the east and lowest readings to the west of a steep gravity gradient, is in accord with the concept of denser, older rocks being over thrust from the east upon younger sediments of lower density. The position of the thrust plane under younger beds may be somewhere near the -20 mGal contour. The appropriate position of the fault is shown on cross-sections A and B (Plates 5 and 6). The interpretation is based on the correlation of seismic data and gravity anomaly along the St George to Yelarbon traverse near Goondiwindi (Gibb, 1965).

Toobeah Trough. The 1961 seismic survey (Lodwick & Bigg-Wither, 1962) has shown that the Toobeah Trough is likely to exist as a relatively narrow feature in the area east of Moree. The high gravity anomaly, named 'Toobeah Gravity High' continues south of Toobeah into the western gravity ridge (Plates 2, 3), where another culmination, the 'Moree Gravity High', has been located. In Queensland the 'Toobeah Gravity High' closely follows the synclinal axis of the 'Toobeah Trough', with the axis of the gravity anomaly offset to the west of the axis of the syncline (Gibb, 1965).

In New South Wales the axis of the 'Moree Gravity High' is also offset to the west of the geological axis of the 'Moree Trough', established by seismic soundings on Traverse T and also on Traverses R and P (Plates 5, 6).

In cross-section A (Plate 5) the axis of the gravity 'high' is almost 20 miles west of the synclinal axis, so that the normal correlation of low gravity anomaly and increased sediment thickness is almost complete. Consequently no 'reversed correlation' between gravity readings and the thickness of the sediments is noticeable in this cross-section. On the other hand no variation in the bedding of the sediments is indicated by seismic data along cross-section A, so the 'Moree Gravity High' cannot be due to denser sediments of varying thickness overlying a less dense basement.

Estimates of depth to the dense mass that causes the 'Moree Gravity High' produce large depth figures. Accepting the theoretical case of a two-dimensional layer a simple geometric method has been suggested to determine approximately the depth to this layer (Jung, 1953). According to this method the depth to the two dimensional layer would be within the range 20 000 to 25 000 ft. As seismic soundings in the 'Moree Gravity High' area indicate a maximum thickness of sediments of about 8000 ft, the estimated depth of the assumed dense mass would place it deep into the basement and well below the base of the sediments.

Summing up, it is concluded that the 'Moree Gravity High' is due to a density variation within the basement rather than to denser sediments overlying a less dense basement. Igneous rocks are probably present in the basement under the area of the gravity 'high'. These rocks must include basic and ultrabasic components, which would be dense enough to give rise to gravity anomalies as large as the 'Moree Gravity High'.

Pre-Permian rocks. In the southeastern portion of the gravity map (Plates 2, 3) two elongate gravity 'highs' correlate with the outcrops of Carboniferous and Devonian rocks. As mentioned above, these pre-Permian rocks have been dislocated by movements during the Hunter-Bowen Orogeny, and now occur in the upthrown block east of the major thrust, known as the Hunter-Bowen thrust system.

Bouguer anomalies become more negative north of the outcrops of the Palaeozoic rocks in the INVERELL 1:250,000 Sheet area, where Jurassic beds and Tertiary basalt overlap on the older rocks. The gravity anomaly is lowest near the northeast corner of the gravity map near the valley of the Macintyre River.

In the area farther east, beyond the eastern edge of the gravity anomaly plan, major granitic intrusions occur, which in this area form the core of the 'New England Block'. Gravity anomalies measured during the course of BMR's regional surveys decrease easterly towards the granite outcrops, with the lowest anomaly value upon granite southeast of Yelarbon. For this reason it is suggested that granite concealed under younger beds is the most likely explanation for negative anomalies in the area east of the probable extension of the Hunter-Bowen thrust (Plates 3, 4).

6. CONCLUSIONS AND RECOMMENDATIONS

An important result of the gravity work is evidence that the continuation north of the Hunter-Bowen thrust system is geophysically supported. This tectonic system most likely extends from 30° latitude into the area north of Goondiwindi, under younger deposits.

Gravity data also indicate major density variations within the rock complex which forms the basement of the Surat Basin below the sediments.

Stronger negative gravity anomalies in the eastern portion of the area surveyed are probably caused by the occurrence of major masses of granite.

It is recommended to investigate in more detail the gravity anomaly produced by the Hunter-Bowen thrust system.

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APPENDIX

ORGANIZATION OF THE SURVEY

Staff

Geophysicist:	L.M. Hastie (BMR)
Field-assistant:	K. Kirby (BMR)
Surveyor-in-charge:	W. Lamond (Dept of the Interior).

Equipment

1 Gravity meter 'Worden' No. 169.

1 Land-Rover

1 International 1-ton truck, 4 x 4.

Comment on performance

Worden gravity meter No. 169 was calibrated before and after the survey on the Brisbane, Sydney, and Melbourne calibration ranges. Calibration factor was determined as 0.1060 mGal per scale division. The time drift of the instrument was checked by repeat readings. The drift remained within reasonable limits; no 'jumps' in the readings were observed. Accuracy control was obtained by repeat readings and gravity ties to the stations of the 1960-61 regional gravity surveys by BMR in eastern Queensland and New South Wales.

TOPOGRAPHIC CONTROL

Elevation

Shot-points were levelled by the level and staff method. Survey party was provided by the Lands and Survey Branch, Commonwealth Dept of the Interior, Canberra. State Survey Bench Marks of the New South Wales Land and Survey Department were used as datum ties. Elevations of the 1960-61 regional gravity stations were conventionally levelled and surveyed by the Dept of the Interior's survey party.

Plotting

The positions of the shot-points and of the regional gravity stations were plotted on surface control sheet No. 1, 'Misc. 151', of 4 mile to 1 inch scale. This sheet was used as topographic base for the preparation of Plate 2.

Detailed maps of 40 chains to 1 inch scale were issued by the Lands and Survey Branch, Dept of the Interior for the seismic field work.

These maps include 'Misc. 151', sheets Nos. 2 to 10.

SURVEY STATISTICS

Party commenced field work	-	22 October 1962.
Party completed field readings	-	2 November 1962.

Number of new gravity stations established:

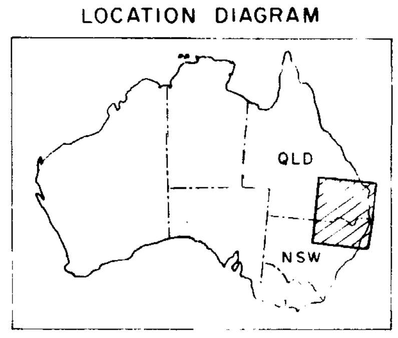
Traverse R	46
Traverse S	26
Traverse T	20
Traverse V	26
Traverse J	18
Total number of new stations:	136

LEGEND

Cz	Cainozoic
M	Mesozoic
T	Tertiary
Pzu	Upper Palaeozoic
Pzm	Middle Palaeozoic
Pzl	Lower Palaeozoic
+ +	Granite
(heavy line)	Serpentine
v v v	Basalt (Tertiary)
^ ^ ^	Andesite (Pzu)
Roma	1:250,000 map area
■	Named place
2000'	Structure formline - Depth to basement
(dotted line)	Geological boundary
(line)	Anticlinal axis
(toothed line)	Fault or thrustfault
(dashed line)	State boundary
☼	Gas bore
◆	Oil bore
◇	Bore
(hatched)	Gravity gradient trend

Reference: BMR Tectonic map of Australia 1960
Union Oil Development Corporation
Surat Basin Aeromagnetic Surveys 1959/60

LOCATION DIAGRAM



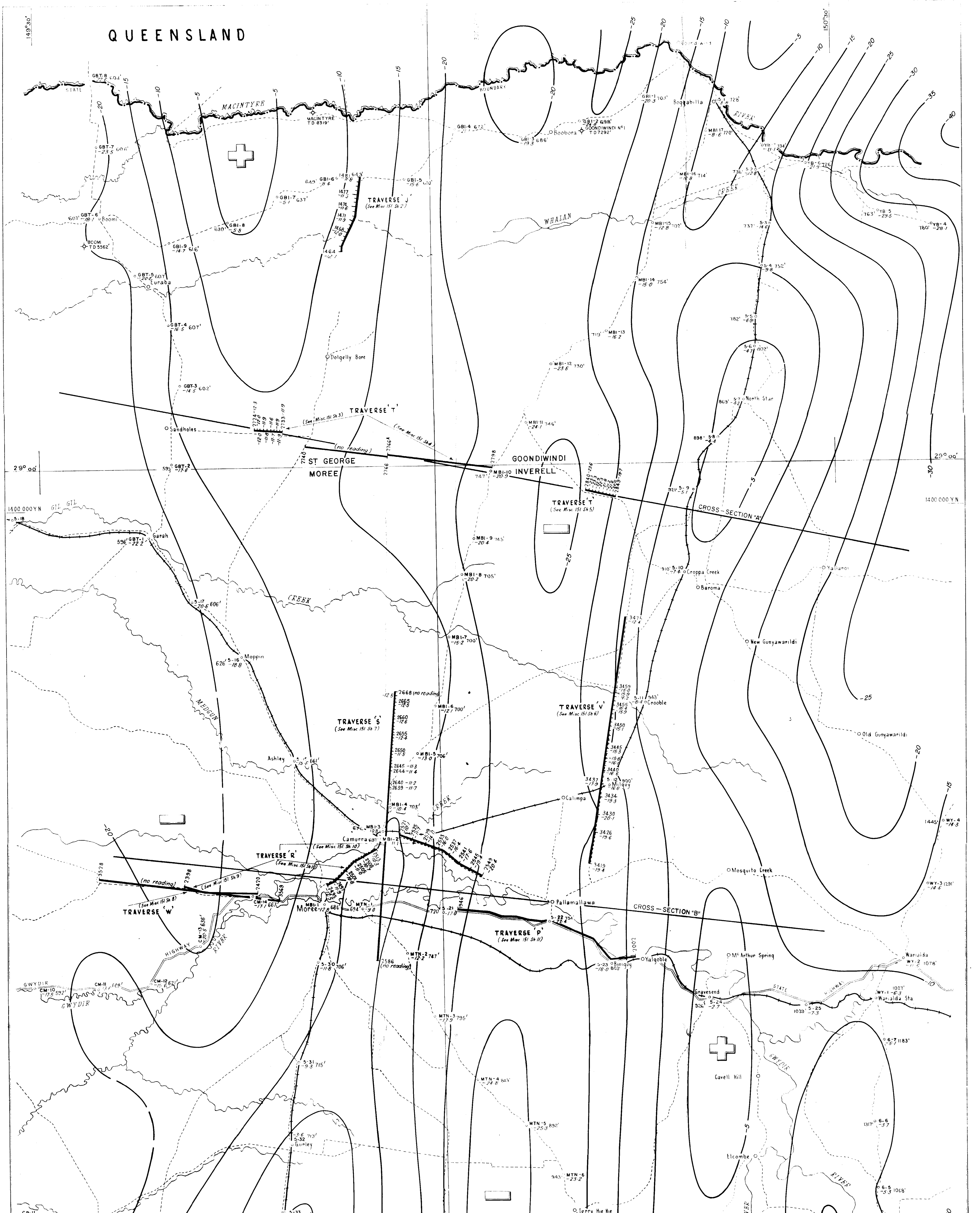
SURAT BASIN STRUCTURAL PLAN

SCALE

40 0 40 80 120 MILES

TO ACCOMPANY RECORD NO 1973/87

G55/B2-20



LEGEND

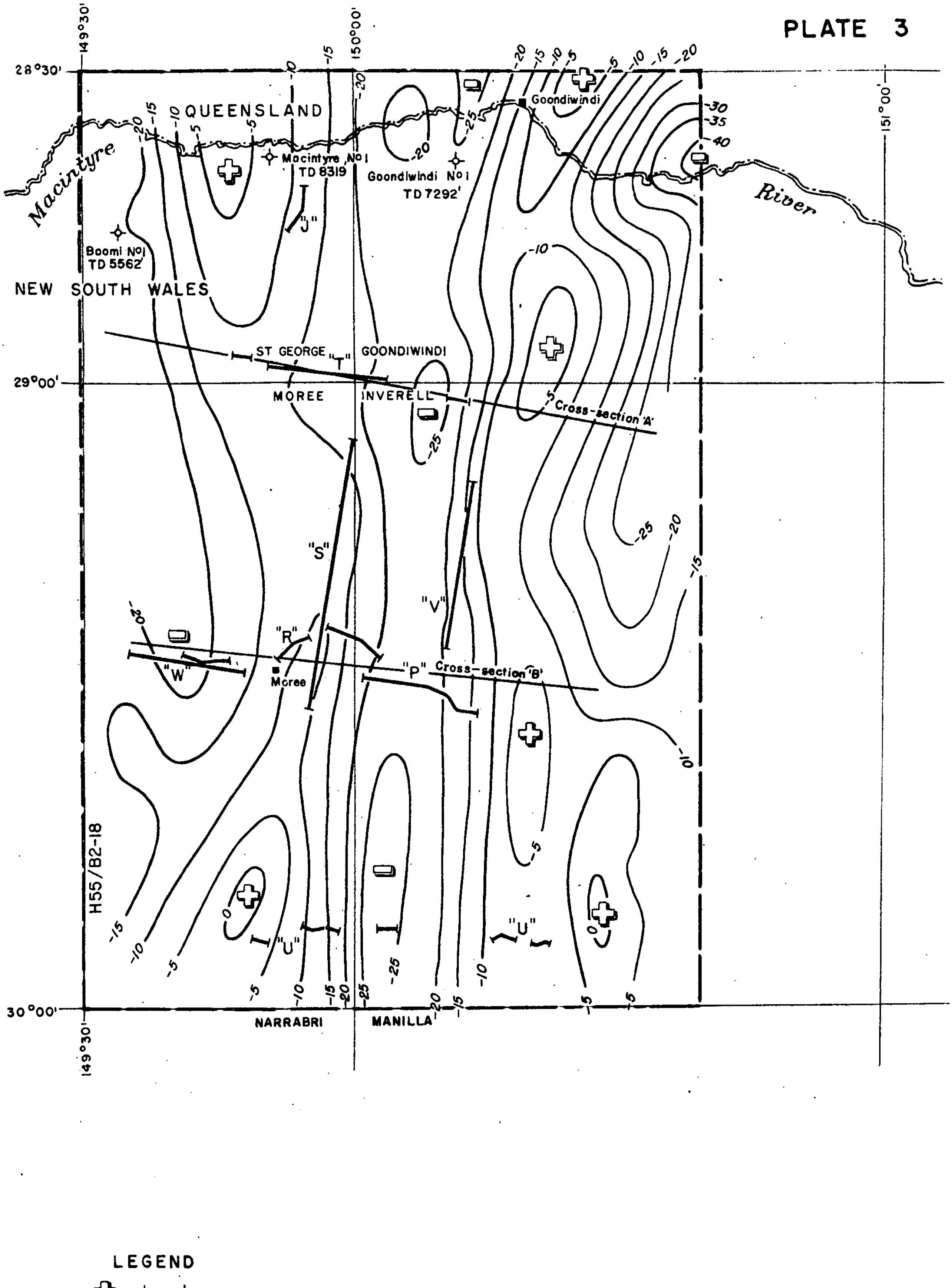
Railway		Gravity station	
Road		Bouguer anomaly in milligals, based on 1·9 g/cm³ rock density	−6·8
Track		Elevation (feet)	713'
Drainage		Isogals	5
Bore		'High' anomaly	
Seismic traverse		'Low' anomaly	
BMR 1:250,000 map area	MOREE		

GRAVITY READINGS ALONG SEISMIC TRAVERSES
MOREE AREA, NSW (1962)

BOUGUER ANOMALY AND TRAVERSE PLAN

SCALE
4 0 4 8 12 16 MILES

PLATE 3



LEGEND

'High' Anomaly

'Low' Anomaly

Bouguer Anomaly Contour

Seismic Traverse

Bore

BOUGUER ANOMALY CONTOUR PLAN

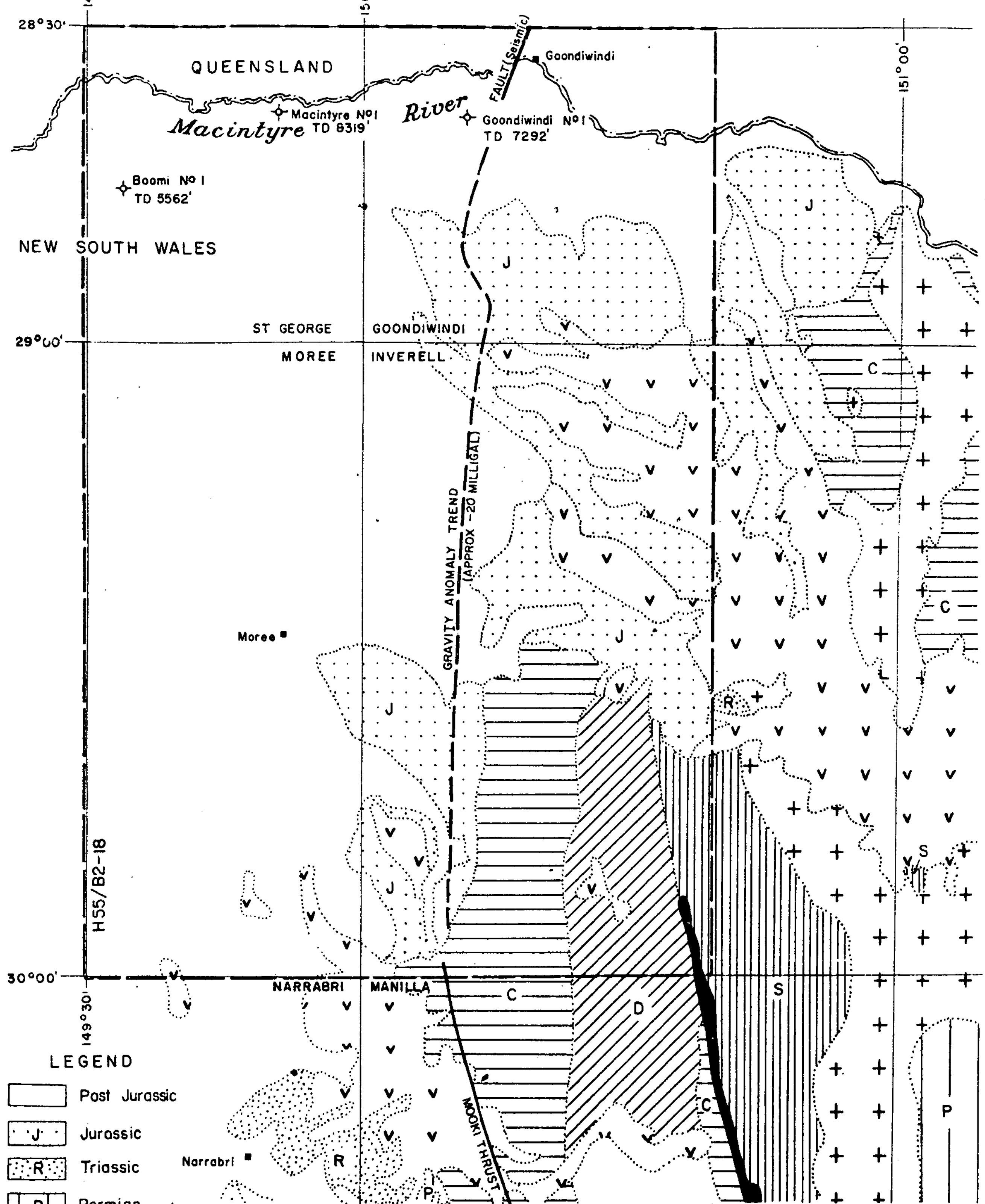
MOREE AREA, SURAT BASIN, N.S.W.
GRAVITY READINGS ON SEISMIC TRAVERSES – 1962

SCALE
MILES 10 0 10 20 30 40 MILES

TO ACCOMPANY RECORD NO. 1973/87

H 55/B2-19 A

PLATE 4



LEGEND

- Post Jurassic
- J — Jurassic
- R — Triassic
- P — Permian
- C — Carboniferous
- D — Devonian
- S — Silurian
- V v — Basalt (Tertiary)
- + + — Granite
- Serpentine and Ultrabasics
- MOREE — 1:250,000 map area
- State boundary
- Bore

GEOLOGY

MOREE AREA, SURAT BASIN, N.S.W.
GRAVITY READINGS ON SEISMIC TRAVERSES – 1962

SCALE

MILES 10 0 10 20 30 40 MILES

Reference: Geological Map of N.S.W. 1962, Department of Mines, Sydney

TO ACCOMPANY RECORD NO. 1973/87

H55/B2-20A

LEGEND

- ⊗ Regional gravity station
- • Seismic shotpoint, used as gravity station

CROSS-SECTION "A"
CORRELATION OF SEISMIC AND GRAVITY DATA
ALONG SEISMIC TRAVERSE "T"

HORIZONTAL SCALE

2 1 0 2 4 6 MILES

VERTICAL SCALE AS SHOWN

TO ACCOMPANY RECORD NO. 1973/87 H55/B2-21

CROSS-SECTION "B"

CORRELATION OF SEISMIC AND GRAVITY DATA

ALONG EAST-WEST TRAVERSE THROUGH MOREE

HORIZONTAL SCALE

2 1 0 2 4 6 MILES

VERTICAL SCALE AS SHOWN