DEPARTMENT OF
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A REVIEW OF THE GEOLOGY, AND GEOPHYSICS OF THE QUEENSLAND PLATEAU

by

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FOREWORD

Reviews have been made of the geology and geophysics of most of Australia's island territories and other records in this series by the same author are:

Record No. 1976/12	Lord Howe Rise and Norfolk Ridge.
Record No. 1976/36	Macquarie Island and Macquarie Ridge Complex.
Record No. 1976/37	Christmas Island and Christmas Rise.
Record No. 1976/38	The Cocos Islands and Cocos Rise.
Record No. 1976/40	Area of Mellish, Frederick, Kenn and Wreck Reefs and Cato Island.
Record No. 1976/41	Marion Plateau.

SUMMARY

The Queensland Plateau supports numerous small islands and reefs which are composed of coralline and algal limestone. The basement of the plateau is probably folded and intruded rocks of the Tasman Geosyncline. It is covered with a relatively thin section of Cainozoic calcareous sediments. Mineral and hydrocarbon prospectivity in the area is extremely low.

INTRODUCTION

The Queensland Plateau (or Coral Sea Plateau) lies under the Coral Sea off northern Queensland and is the largest of the major plateaux in the Australian continental margin (Fig. 1). Its total area is 373 000 km^2 which includes 181 000 km^2 above the 1000-m isobath. The plateau is separated from the continental shelf by well developed troughs and it supports numerous small islands and actively growing coral reefs. The presence of these reefs makes the plateau almost unique and possibly points to a slower rate of subsidence than that of other plateaux.

The main islands and reefs on the Queensland Plateau are shown in Figure 1. They are from north to south: Osprey Reef, Anniversary Reef, Bougainville Reef, Moore Reefs, Sand Cay, Willis Islets, Magdalene Cays, Holmes Reefs, Herald Cays, Coringa Islets, Flinders Reef, Diamond Islets, Lihou Reefs and Cays, Malay Reef, and Abington Reef. The outermost reefs are the Lihou Reefs and Cays which lie about 500 km from the Queensland Coast. All the islands on the Queensland Plateau are formed of coralline and algal limestone, or reef derived sand. The only foreseeable mineral resource is petroleum.

INVESTIGATIONS

The first marine geophysical work done over the Queensland Plateau was a co-operative effort between Lamont-Doherty Geological Observatory and The University of New South Wales in 1967. Gravity, magnetic, and seismic reflection profiles were recorded, and seismic refraction measurements were made using both sonobuoys and the standard two ship method (Ewing, Houtz, & Ludwig, 1970). Gardner (1970), and Falvey (1972, 1974) have both used the results of this work in their studies of the Queensland Plateau. In 1970 the Bureau of Mineral Resources (BMR) completed a systematic multisensor geophysical survey of the Queensland Plateau. Gravity, magnetic, seismic reflection and sonobuoy refraction data were recorded along the tracks shown in Fig. 2. The results of this survey were discussed by Mutter (1974, 1976). A DSDP drill site, (Site 209) located on the Queensland Plateau (Fig. 3) was completed in 1971 (Burns, Andrews et al., 1973).

MORPHOLOGY

The Queensland Plateau is roughly triangular (Fig. 3). Its linear northeastern margin extends for about 600 km and faces the Coral Sea Basin and its southwestern and southern margins are formed by two linear troughs, the Queensland and Townsville Troughs. The margins are dissected by valleys and canyons which lead into the bordering troughs and the Coral Sea Basin. The surface of the plateau lies at an average depth of 1100 m and is generally smooth and flat except in areas of reef development. The plateau surface as a whole has a very gently northwest tilt and it is deepest near Osprey Reef. Slopes on the margin of the plateau are relatively steep, ranging from 1:25 to 1:35 on the northeastern margin. There are fifteen areas of reef development and the total area occupied by these reefs is almost one quarter of the plateau. Reef growth from as much as 1500 m below sea level has been recorded on the plateau (Fairbridge, 1950) which indicates that subsidence was slow enough for such growth to keep pace.

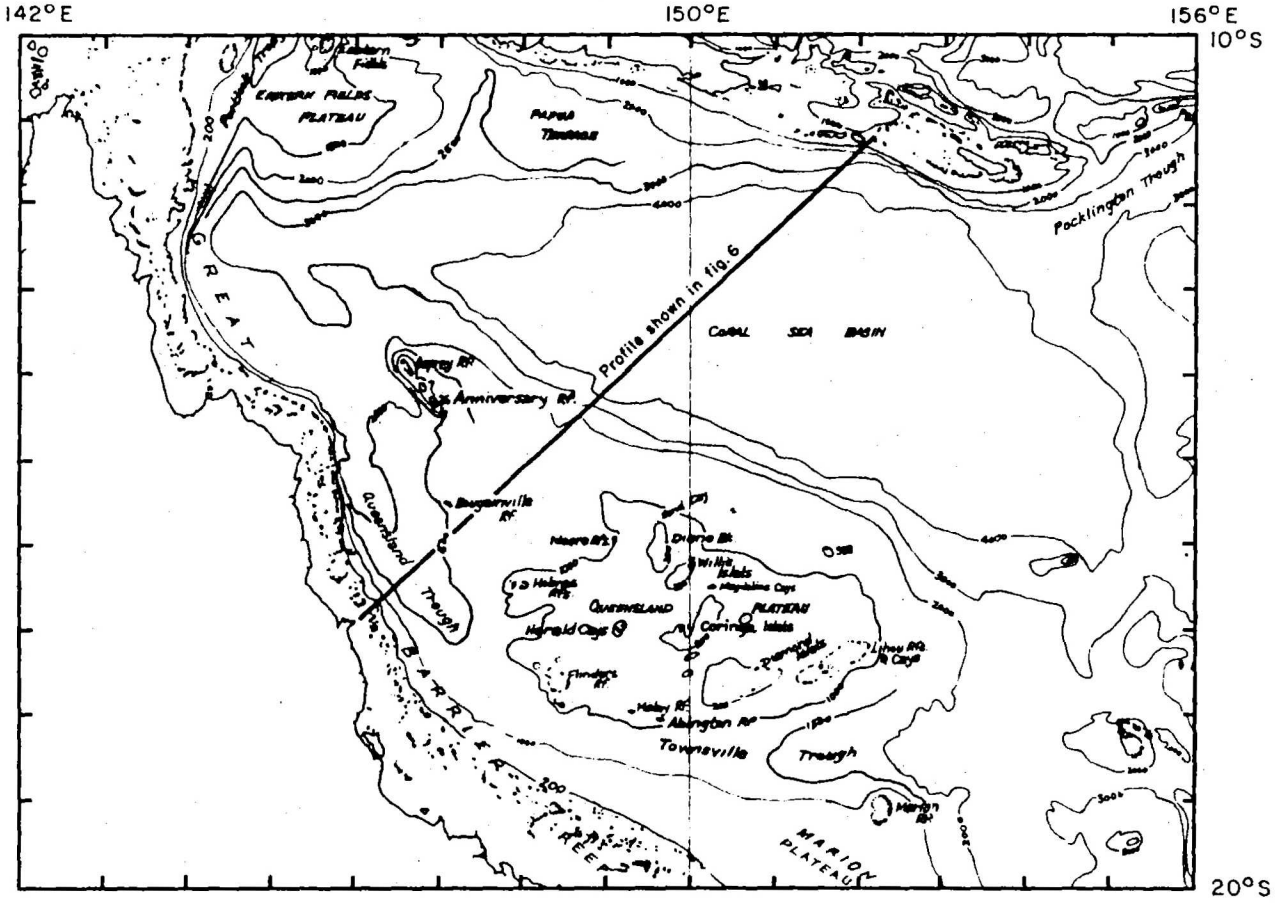
The reefs on the Queensland Plateau appear to be distributed along three main lineaments. The westernmost lineament extends from Osprey to Flinders Reef. To its east, a lineament is formed by the Moore Reefs, Herald Cays, and Malay Reefs. The easternmost lineament extends from Sandy Cay to Lihou Reefs. All these lineaments are parallel to the onshore Tasman Geosynclinal trends.

The Queensland Trough to the west of the plateau extends parallel to the overall trend of the Tasman Geosyncline. It has a smooth flat floor and is deepest in its northwestern part with depths of up to 3000 m. The western margin of the trough is much steeper than the eastern margin with gradients of up to 1:3. In contrast with the Queensland Trough, the Townsville Trough at the southern margin of the plateau is almost at right angles to onshore structural trend. Mutter (1976) has suggested that the trough is a Tertiary feature which lies along an older structural trend.

GEOLOGY

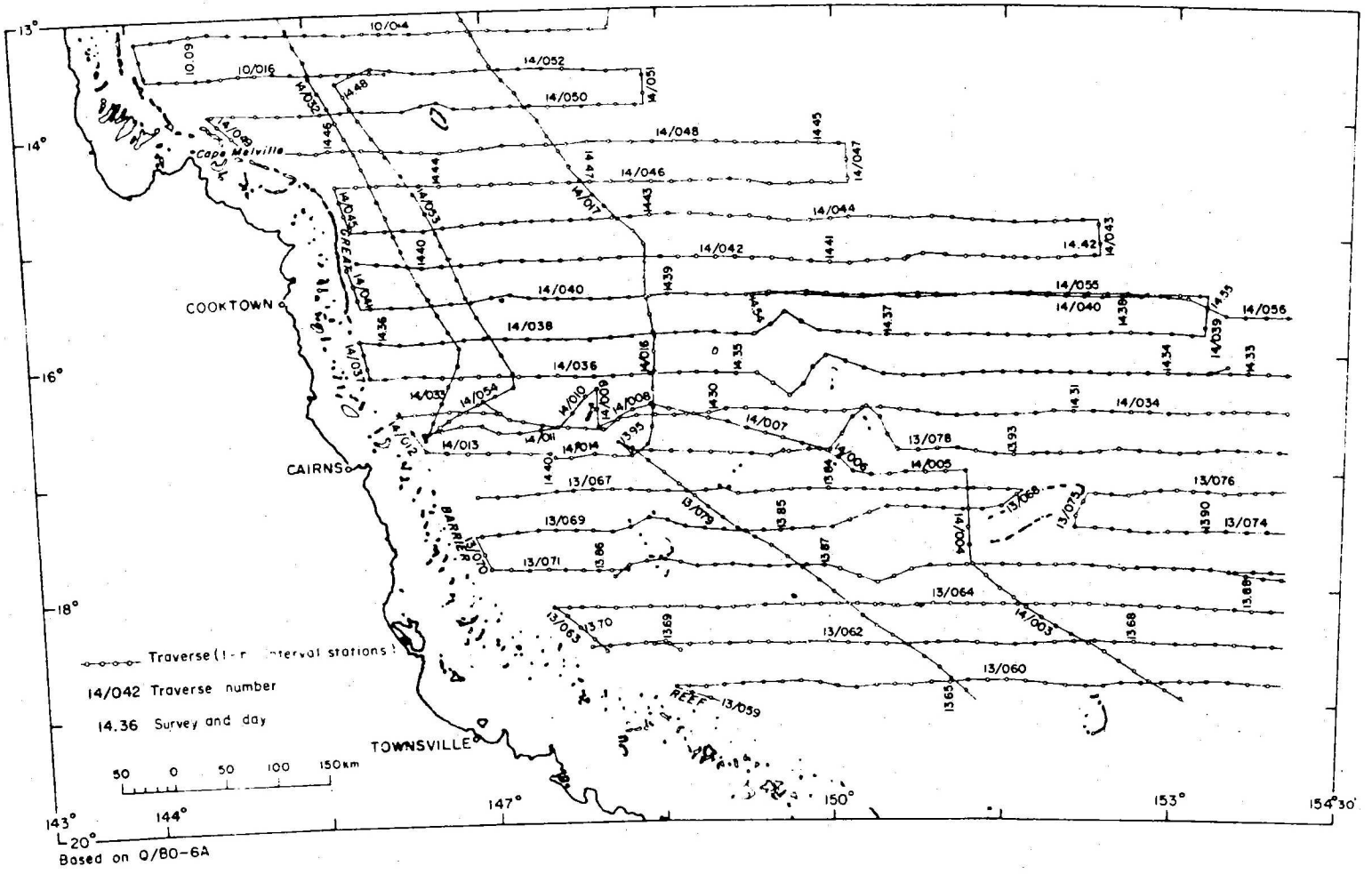
The Queensland Plateau is made up of basement of unknown age and composition which is overlain by Tertiary and Quaternary sediments. The basement rocks underlying the Queensland Plateau have not been sampled and

FIG. 1



BATHYMETRY OF THE QUEENSLAND PLATEAU

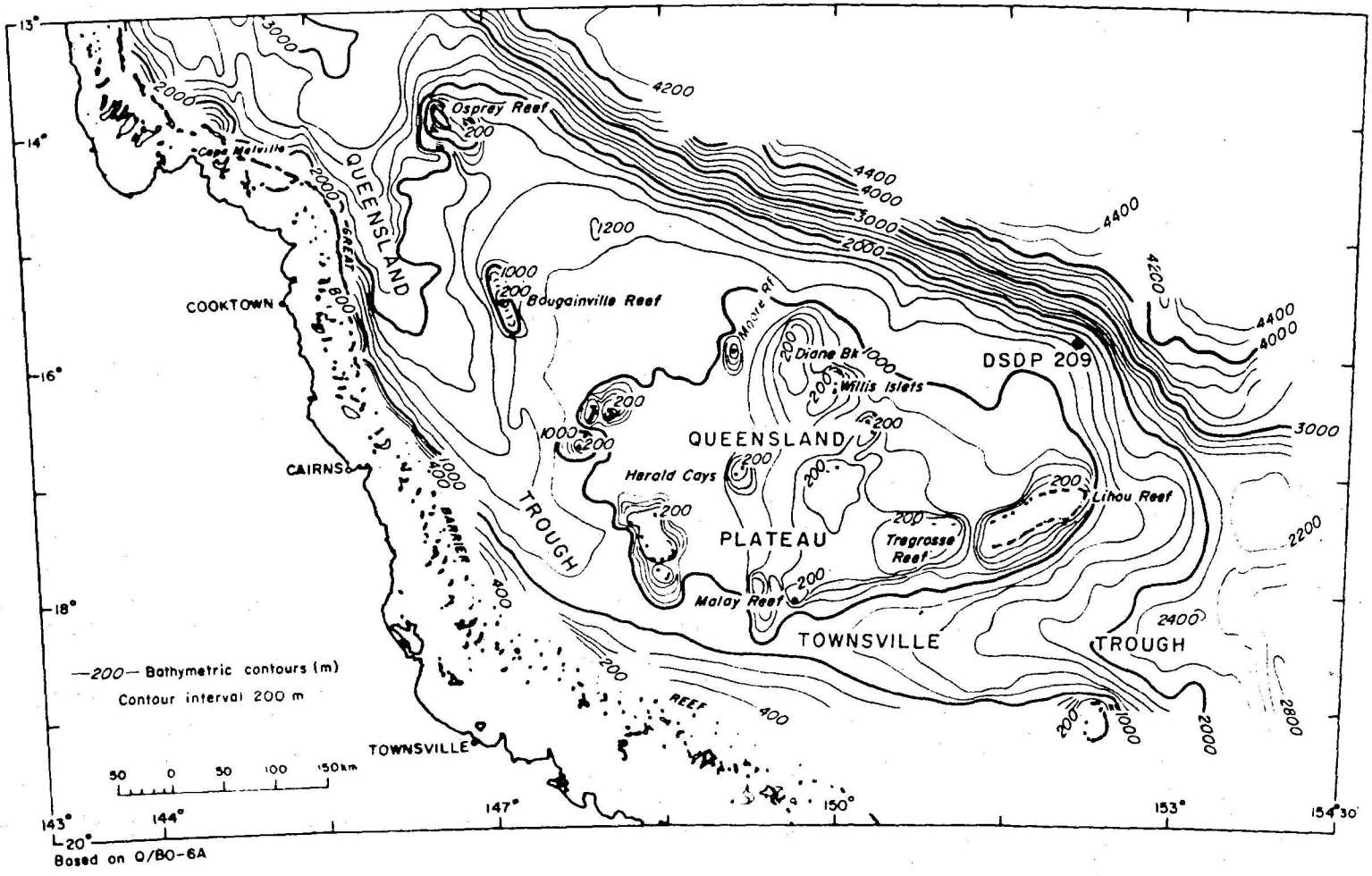
(Detail of General Bathymetric Chart of the Oceans. Sheet AIII, Hydrographic Office R.A.N. Sydney, Australia, 1975)



TRACKS OF BMR SURVEY OVER THE QUEENSLAND PLATEAU

(After Mutter, 1976)

FIG. 2



DETAILED BATHYMETRY OF THE QUEENSLAND PLATEAU

(After Mutter, 1976)

FIG. 3

the only information on their nature is derived from refraction work. This work indicates a layer of velocity 5.1 to 5.7 km/s some 2 km thick, which is underlain by a layer of velocity 5.9 to 6.3 km/s. These layers may represent Mesozoic-Palaeozoic and Palaeozoic-Precambrian sections respectively, which are thought to have been deposited as sediments within the Tasman Geosyncline (Ewing, Hawkins, and Ludwig, 1970).

The Cainozoic sediments on the Queensland Plateau are relatively thin, varying from 0.5 to 1.0 km in thickness. A DSDP drill hole in 1428 m of water on the outer edge of the plateau (site 209, see Fig. 3), cored three lithologic units which date back to middle Eocene (Fig. 4). The upper unit consists of 140 m of foraminiferal ooze and nannofossil ooze of upper Oligocene to Pleistocene age. This unconformably overlies 134 m of sand-bearing foraminiferal ooze and chert deposited from middle Eocene to upper Eocene. The basal unit consists of 69 m of sand-rich foraminiferal limestone with secondary chert. Drilling did not reach basement and the oldest sediment cored was middle Eocene (Burns, Andrews et al., 1973). The sequence of geological events at the site has been deduced from the core data. Shallow-water deposition in the middle Eocene was followed by subsidence and reduction of terrigenous input from late middle to upper Eocene, a 16 m.y. period of non-deposition or erosion from the upper Eocene to the upper Oligocene, further subsidence from the upper Oligocene to the late middle Miocene, another non-depositional period of 8 m.y. from the late middle Miocene to middle Pliocene, and finally, subsidence of the plateau to mid-bathyal depths since the middle Pliocene.

Using the data collected by BMR, Mutter (1974, 1976) has mapped the distribution of upper Eocene shallow marine sediments and the later pelagic sediments. In many places buried Eocene to Miocene reefs are visible on the seismic sections. A total sediment thickness map (Fig. 5) shows that over most of the Queensland Plateau there is less than 1 km of sediment. Depositional maxima occur between Flinders Reef and Malay Reef (1.4 km) and northeast of the Willis Islets (1.2 km). The present reef growth appears to coincide with basement highs.

GEOPHYSICS

The general crustal thickness (Fig. 6) under the plateau is around 25-26 km as determined from seismic refraction and gravity data (Falvey, 1972; Mutter, 1976). This suggests a quasi-continental structure for the Queensland

Plateau. Free-air anomalies on the plateau are regionally positive, ranging from 0 to 50 mGal; local variations show correlation with sedimentary thickness variations and basement relief. The overall pattern of the regional free-air anomalies shows that the Queensland and Townsville Troughs are both regionally negative.

The magnetic anomaly pattern (Fig. 7) shows no direct correlation with basement elevation which, according to Mutter (1976), indicates that the source of the magnetic anomalies is not seismic basement. This supports the suggestions that the Tertiary sediments are underlain by highly lithified Palaeozoic strata. The magnetic anomalies have a general northwesterly trend which may indicate that they are due to deeper material within the Tasman Geosyncline.

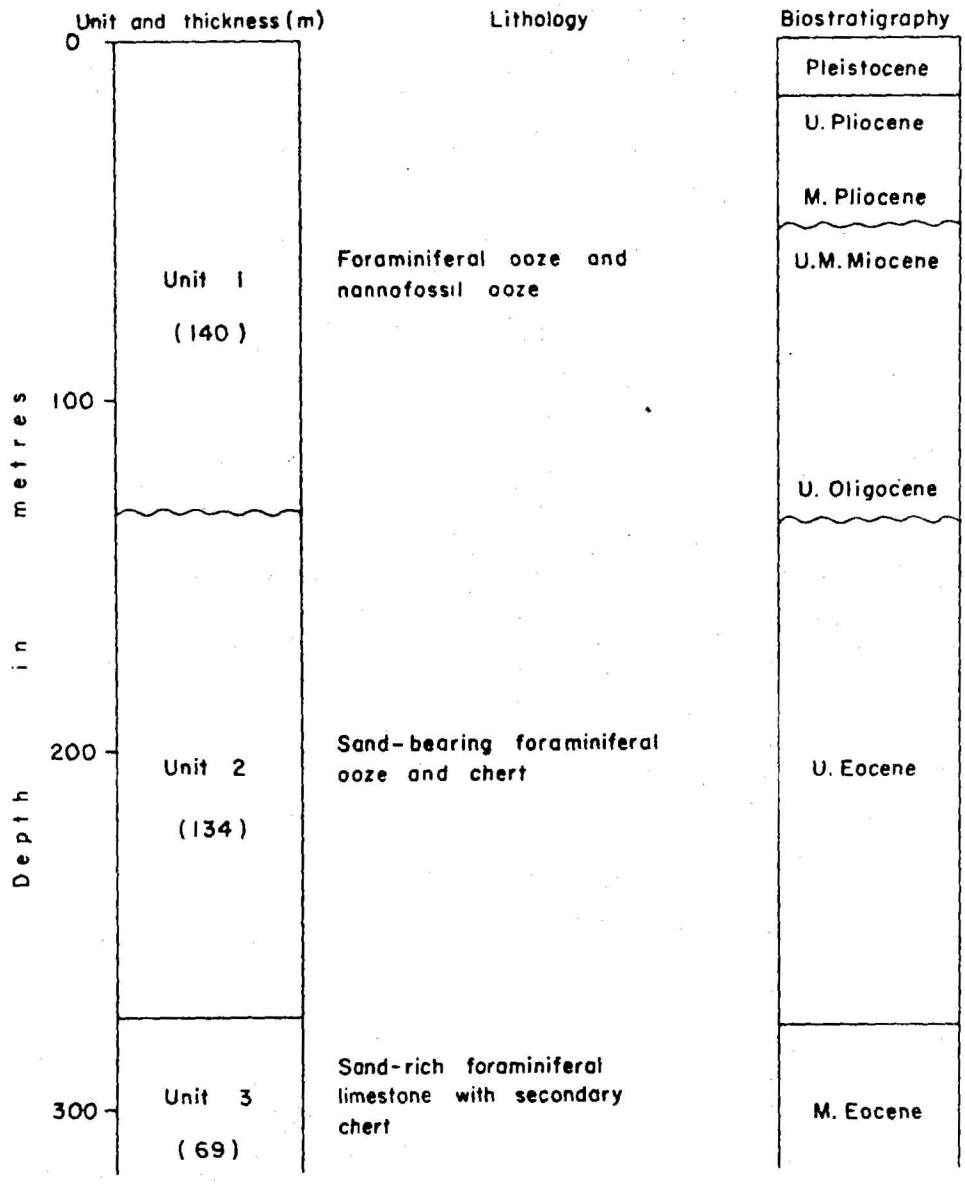
The heat flow on the plateau is slightly higher than normal. Oceanographic measurements give values which range between 1.48 H.F.U. and 2.0 H.F.U. At DSDP site 209 an average heat flow of 2.0 H.F.U. was measured (Von Herzen, 1973).

Seismic reflection profiling results, discussed earlier in the section on geology, indicate 0.5 to 1.0 km of Tertiary sediments overlying a supposed Palaeozoic basement. To the west and south of the plateau two troughs contain considerably thicker sedimentary section, in excess of 2 km (Pinchin & Hudspeth, 1975).

EVOLUTION

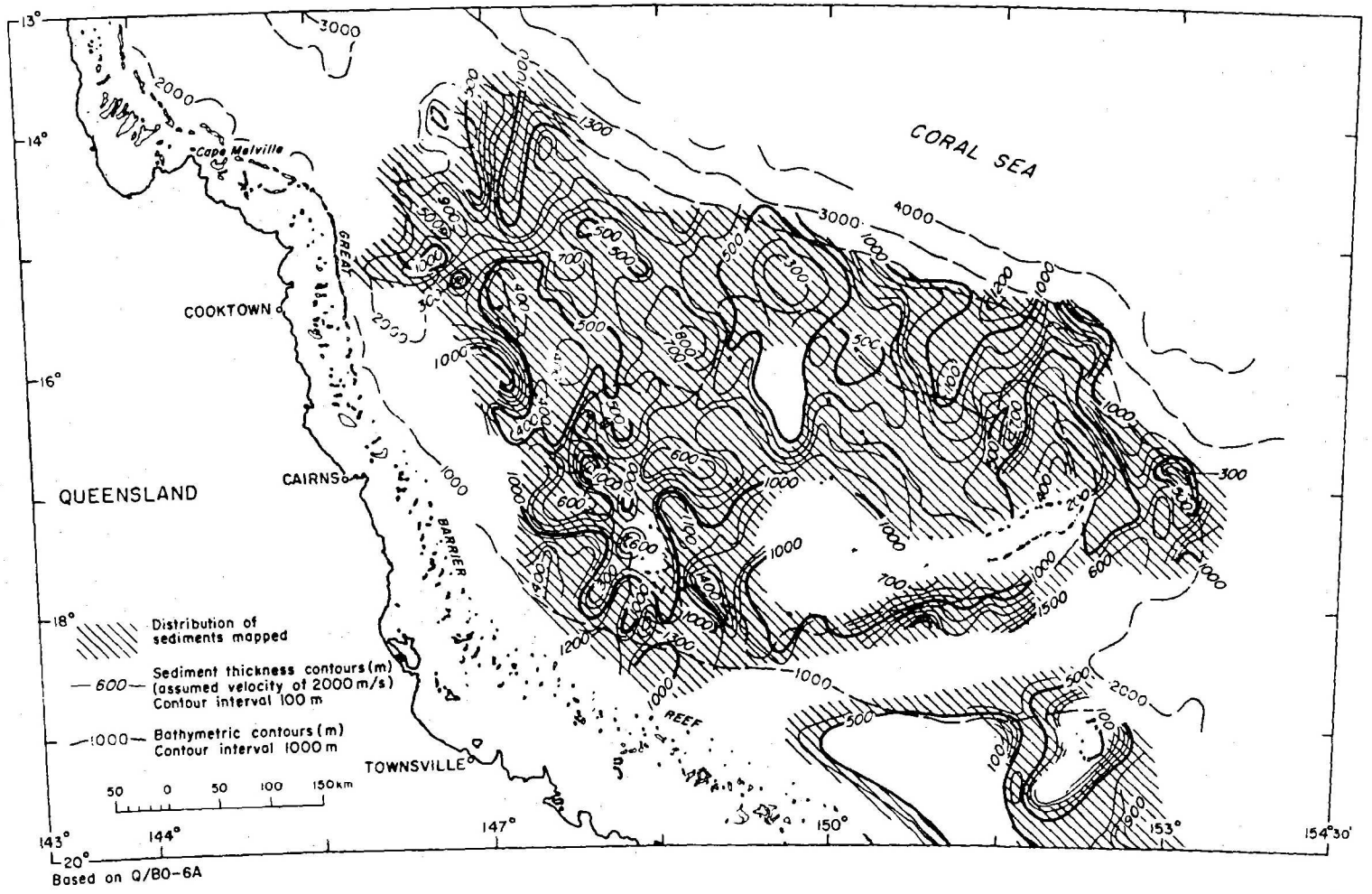
The evolution of the Queensland Plateau is intimately connected with the formation of the Coral Sea Basin. The Coral Sea Basin probably formed by spreading between the upper Palaeocene and lower Eocene (Mutter, 1976). After rifting and the formation of oceanic crust in the Coral Sea Basin the plateau started to subside in the late middle Eocene. Formation of the Queensland and Townsville Troughs is proposed to have taken place from the upper Eocene to upper Oligocene. During this period the continued subsidence of the plateau resulted in the drowning and burial of some reefs. The present-day islands and reefs are situated on basement highs, and growth on them has kept pace with the uniform subsidence of the plateau from the Miocene to the present.

FIG. 4



DSDP SITE 209 SIMPLIFIED RESULTS

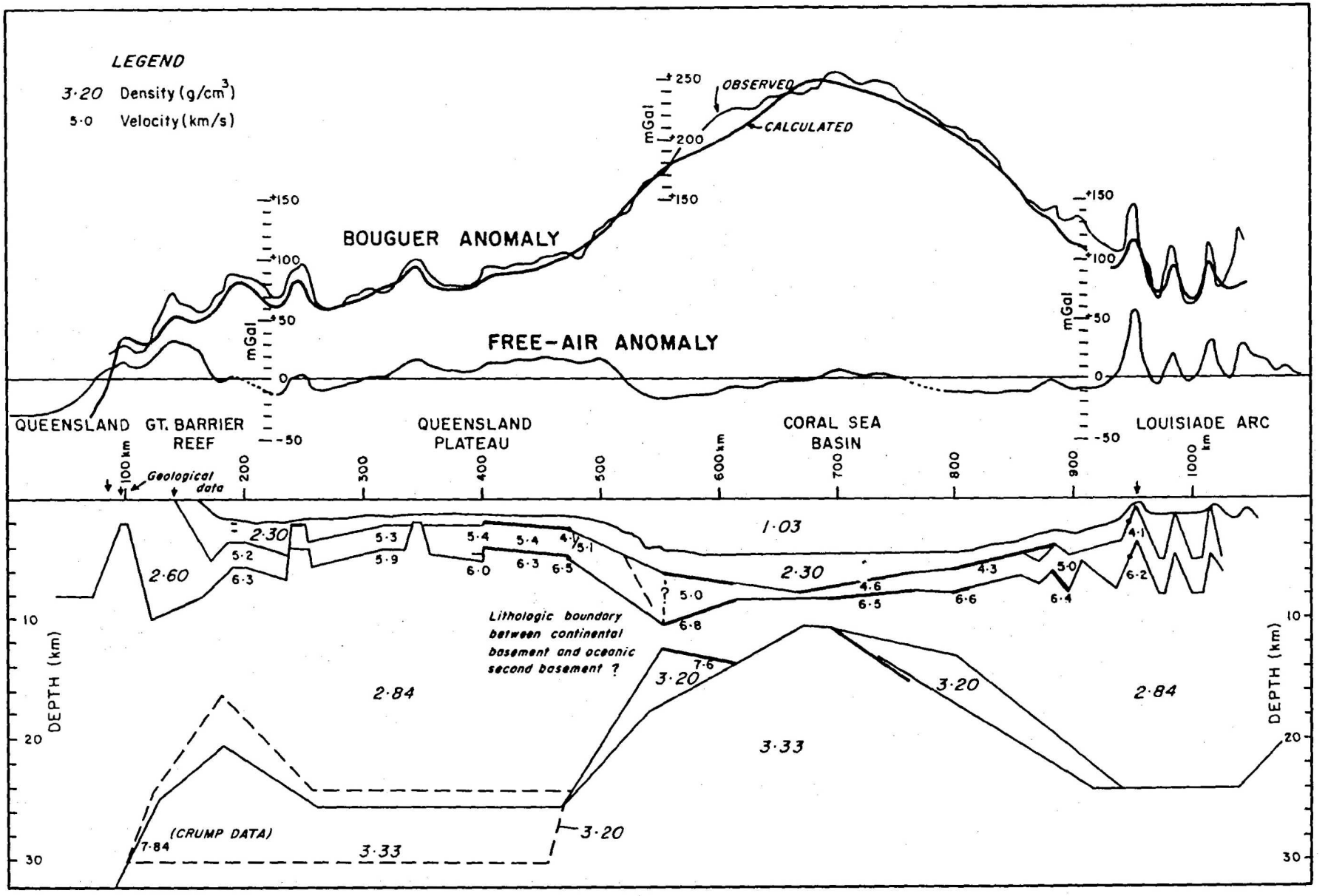
(After Mutter, 1976)



TOTAL SEDIMENT THICKNESS

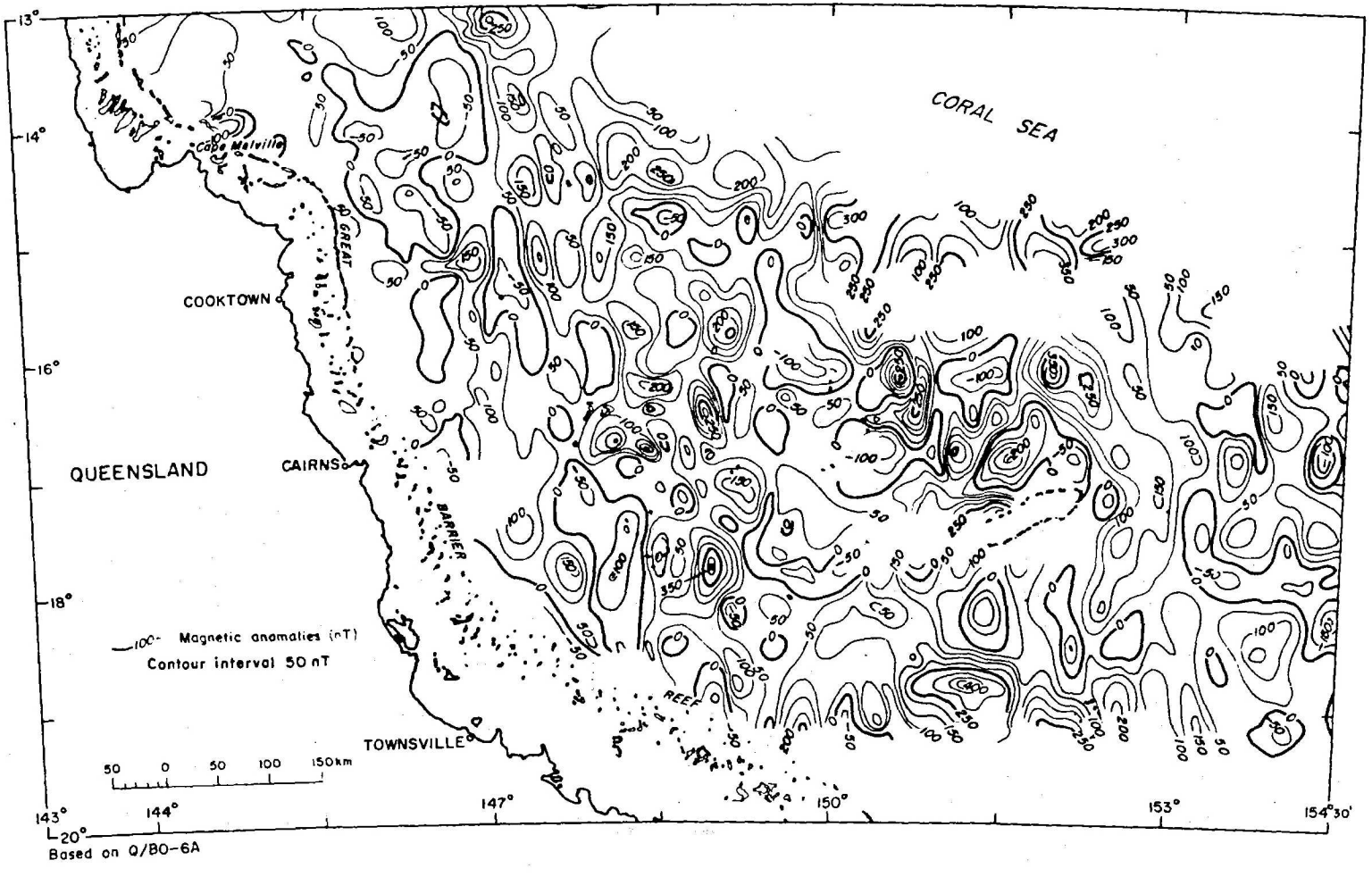
(After Mutter, 1976)

FIG. 5



CRUSTAL STRUCTURE ACROSS THE QUEENSLAND PLATEAU AND THE CORAL SEA
(After Falvey, 1972)

FIG. 6



MAGNETIC ANOMALIES ON THE QUEENSLAND PLATEAU

(After Mutter, 1976)

FIG. 7

PROSPECTIVITY

The islands on the Queensland Plateau are composed of coral reefs and derived calcareous sand and have no associated mineralization. The thin cover of Tertiary sediments on the Queensland plateau and the probably disturbed underlying sediments of the Tasman Geosyncline do not present favourable conditions for the accumulation of hydrocarbons. The only area which may be prospective for petroleum lies at the southern end of the Queensland Trough where sediments are thick and structural and stratigraphic traps may have developed.

REFERENCES

BURNS, R.E., ANDREWS, J.E., et al., 1973 - Initial Reports of the Deep Sea Drilling Project. Vol. 21. Washington, U.S. Govt Printing Office.

EWING, J.I., HOUTZ, R.E., & LUDWIG, W.J., 1970 - Sediment distribution in the Coral Sea. J. geophys. Res. 75, 1963-72.

EWING, M., HAWKINS, L.V., & LUDWIG, W.J., 1970 - Crustal structure of the Coral Sea. J. geophys. Res., 75, 1953-62.

FAIRBRIDGE, R.W., 1950 - Recent and Pleistocene coral reefs of Australia. J. Geol., 5 8(4).

FALVEY, D.A., 1972 - The nature and origin of marginal, plateaux and adjacent ocean basins off Northern Australia. Ph.D. Thesis, Univ. N.S.W. (unpubl.).

FALVEY, D.A., 1974 - The development of continental margins in plate tectonic theory. APEA J. 14 (1), 95-106.

GARDNER, J.V., 1970 - Submarine geology of the western Coral Sea. Bull. geol. Soc. Am., 70, 1399-424.

MUTTER, J.C., 1974 - Geophysical results from the Coral Sea: continental margins survey report. Bur. Miner. Resour. Aust. Rec. 1974/116 (unpubl.).

MUTTER, J.C., 1976 - The Queensland Plateau. Bur. Miner. Resour. Aust. Bull. (in press).

PINCHIN, J., & HUDSPETH, J.W., 1975 - The Queensland Trough: Its petroleum potential based on some recent geophysical results. APEA J., 21-31.

VON HERZEN, R.P., 1973 - Geothermal measurements. In BURNS et al., - Initial Reports of Deep Sea Drilling Project, Vol. 21. Washington, U.S. Govt Printing Office.