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THE QUEENSLAND TROUGH: SOME RECENT GEOPHYSICAL RESULTS, AND ITS PETROLEUM POTENTIAL

by

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AND ITS PETROLEUM POTENTIAL

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ABSTRACT

The Queensland Trough, about 130 km wide, lies between Queensland and the Coral Sea Plateau. It runs from a water depth of 1000 m off Townsville to 3000 m opposite Cape Melville.

The most extensive and systematic geophysical survey of the area to date is that conducted by BMR during 1971 as part of the survey of the Australian continental margin.

The BMR sparker seismic sections show a rugged and eroded basement surface. It is concluded that this represents the top of mildly metamorphosed Palaeozoic sediments of the Tasman Geosyncline which were uplifted, folded, and faulted during the Permian and were subsequently severely eroded. In places coral reefs have grown from this basement surface. Some are now buried and some, especially those atop basement highs, are still growing.

The Eocene/Oligocene unconformity encountered in the DSDP hole 209 on the outer edge of the Coral Sea Plateau can be traced as an unconformity over the entire Plateau and as a conformable Eocene seismic horizon over most of the Trough. This horizon lies close to the basement over much of the Plateau and at least 1.5 km above the basement in the centre of the Trough. It is overlain by about 0.5 km of sediments over both the Trough and the Plateau.

It appears that the Trough was low relative to the Plateau and the mainland since the beginning of the Mesozoic and received terrestrial

and shallow marine sediments.

Regional subsidence of the Trough and Plateau probably began in the Early Eocene. Small basins on the Trough's eastern margin and on the Plateau were formed by differential subsidence along rejuvenated basement faults. These small basins contain lower to middle Eocene shallow marine sediments.

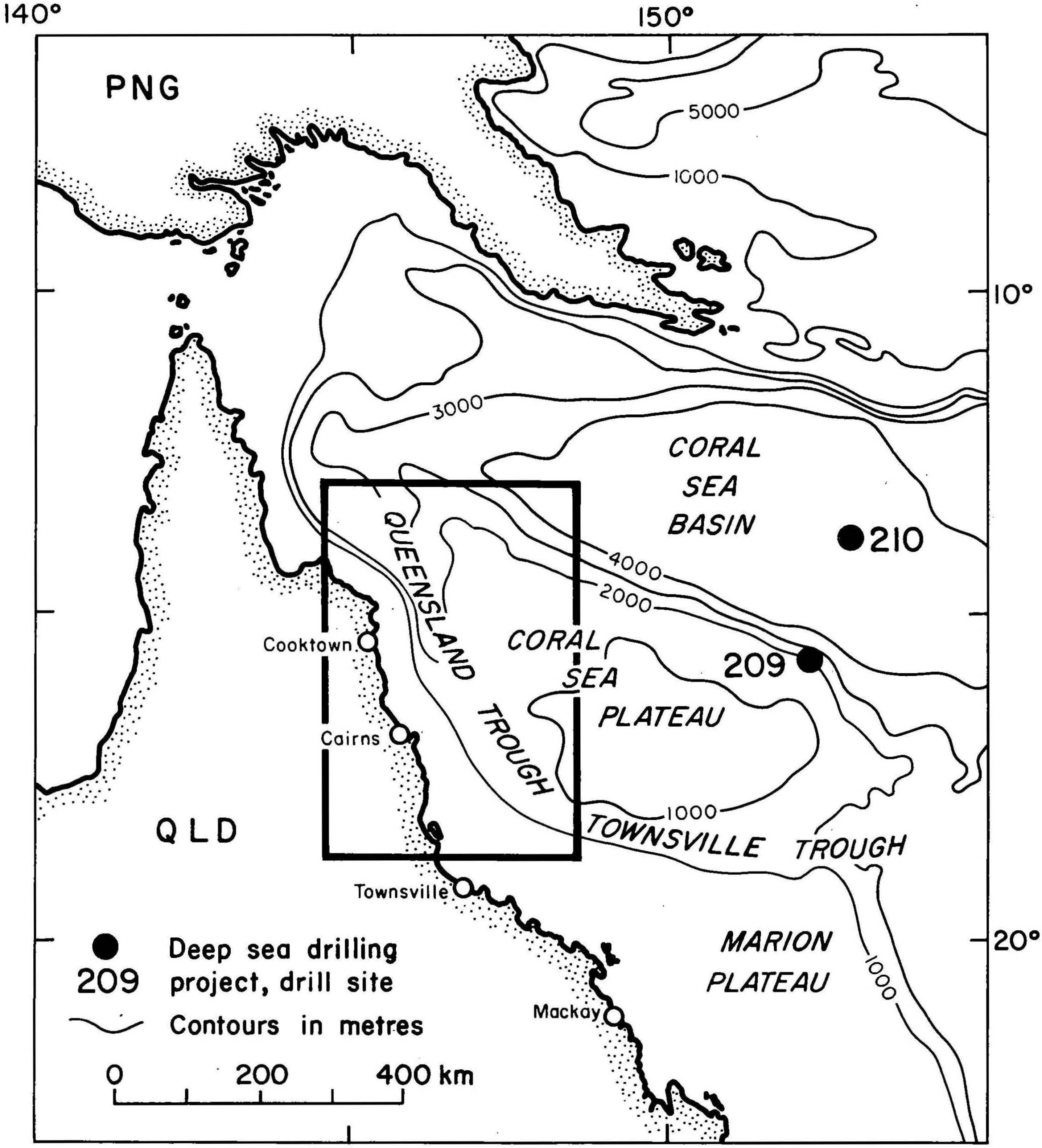
Petroleum prospects appear favourable in the south of the Trough, especially in the trough's marginal reef development and in the region of pre-Eocene pinch-out against Palaeozoic basement.

INTRODUCTION

Several submarine plateaus around the continental margin of Australia are separated from the mainland by sediment-filled troughs; these include the Exmouth Plateau, the Coral Sea Plateau, the Naturaliste Plateau, and the Cascade Plateau. The Queensland Trough, about 130 km wide and 600 km long, lies between Queensland and the Coral Sea Plateau (Fig. 1).

The first extensive geophysical survey of the Coral Sea Basin, the Coral Sea (or Queensland) Plateau, and the Queensland Trough was conducted in 1967 by Lamont Observatory and the University of New South Wales. Seismic refraction and reflection profiles were recorded, and the results were interpreted in terms of the sediment distribution and crustal structure (Ewing, Houtz & Ludwig, 1970; Ewing, Hawkins & Ludwig, 1970). The locations of those profiles within the area discussed here are shown in Figure 2. Also in 1967 an aeromagnetic survey was flown for Shell Development (Australia) Pty Ltd (confidential report). The Halifax Basin or Depression which lies at the head of the Queensland Trough near its junction with the Townsville Trough, was mapped on the results of this survey.

In December 1971 the Glomar Challenger drilled 344 m into the sediments at Site 209 (see Fig. 1) on the outer edge of the Coral Sea Plateau (Burns, Andrews et al., 1973). The cores from this hole provided much valuable information on the tectonic history of the plateau and enabled the main sedimentary reflecting



LOCALITY MAP

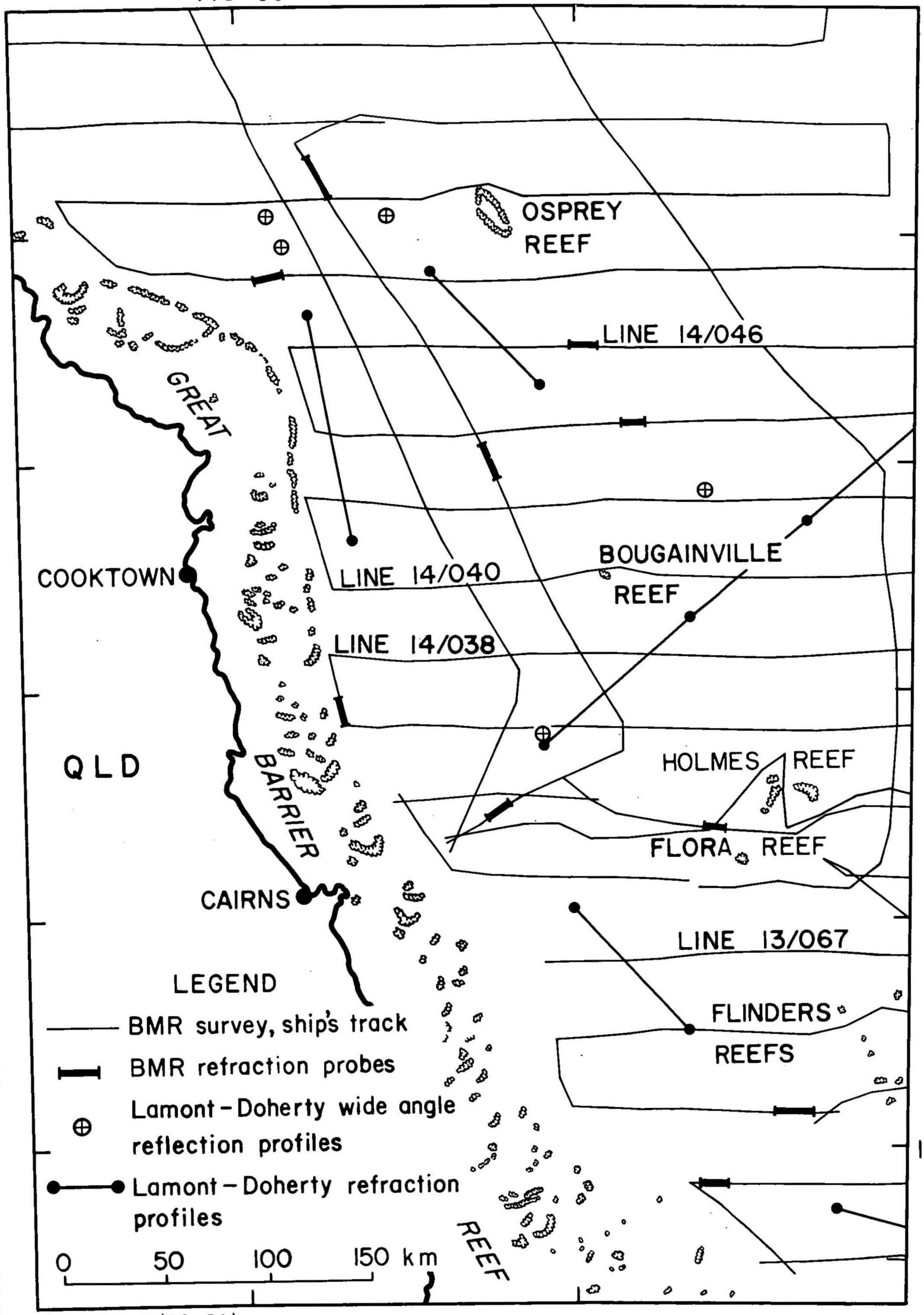
horizons to be dated.

The most extensive and systematic geophysical survey of the area to date is that conducted by BMR during 1971 as part of the survey of the Australian continental margin. The area was surveyed at a spacing of 40 km along east-west lines which extended from the Great Barrier Reef to longitude 156°E (see Fig. 2). Gravity, magnetic, seismic reflection, and water depth data were recorded continuously and seismic refraction profiles were recorded at intervals by using sonobuoys. The initial results of the BMR survey in the Coral Sea have been described by Mutter (1974).

BATHYMETRY

The water depth contours shown in Figure 3 are plotted from the recordings made by BMR. The Queensland Trough lies between the Great Barrier Reef and the Coral Sea Plateau. At its southern end, where the trough is about 1000 m deep, it adjoins the head of the Townsville Trough; and at its northern end, where it reaches a depth of 3000 m, it drains into the western arm of the Coral Sea Basin (see Fig. 1). The western slope of the trough up to the Barrier Reef is steep and linear, suggesting a faulted origin. This slope is as steep as 15° in places and is crossed by numerous minor canyons which most likely have been cut by, and serve as channels for, turbidity currents down the continental slope. These canyons are not shown in Figure 3 because the water depths were sampled only at

Fig. 2



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MARINE GEOPHYSICAL SURVEYS

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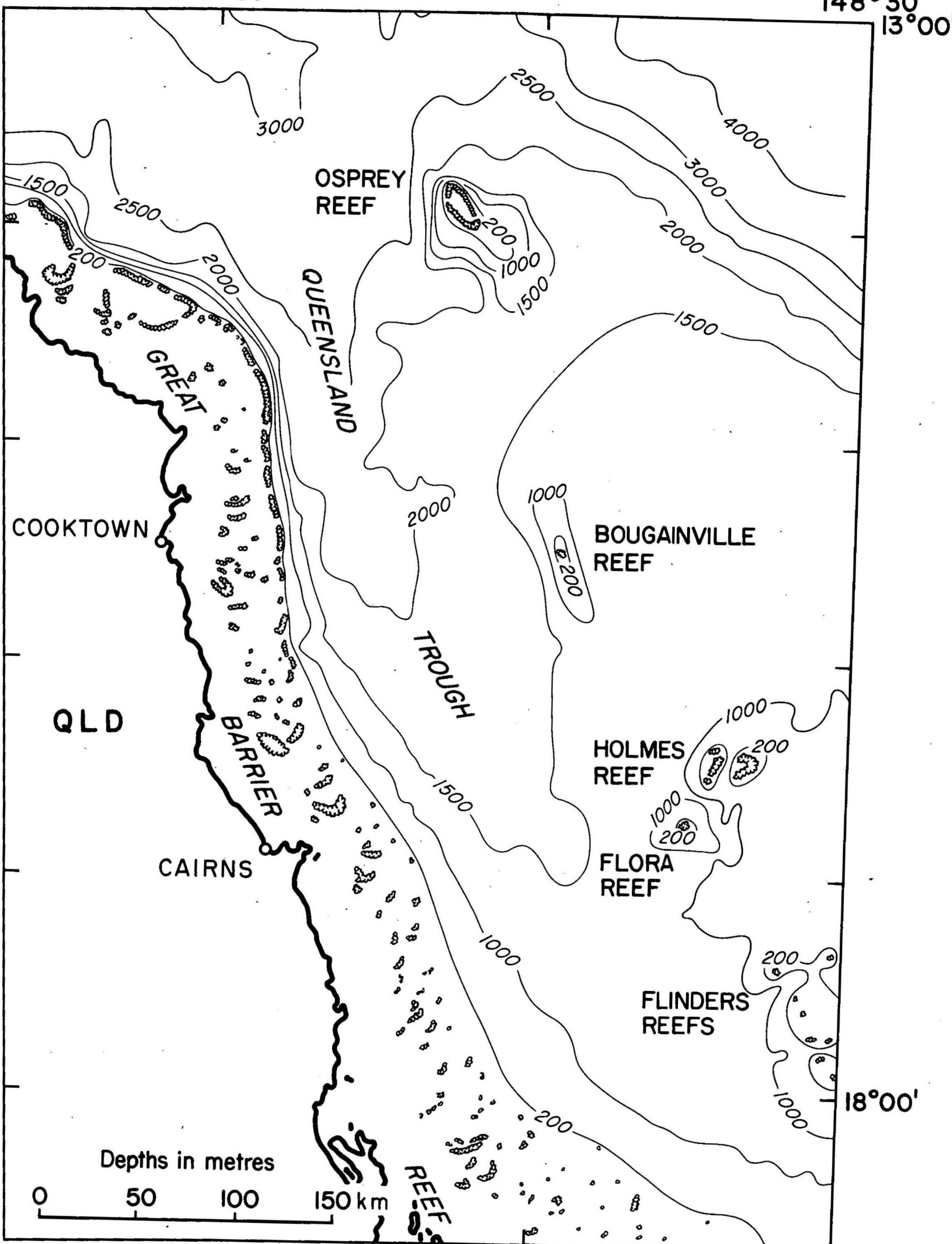

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BATHYMETRIC CONTOURS

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intervals of 18 km along the traverses, and the map shows insufficient detail. The floor of the trough is smooth and almost flat. However, there is a slight overall gradient down to the east, and this seems to indicate the western, Barrier Reef side as the chief source for the trough floor sediments.

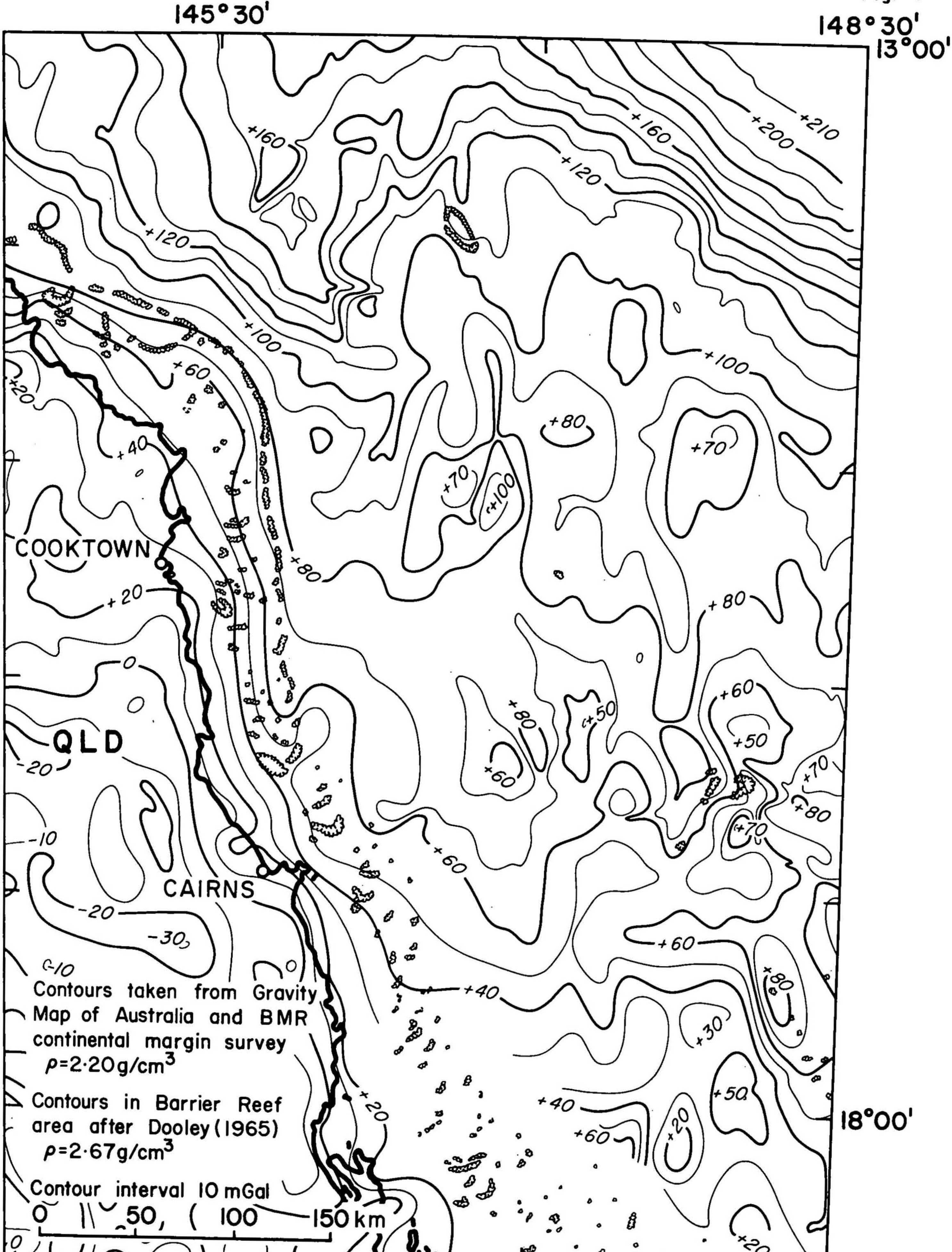
The trough is bounded to the east by a more gentle slope which rises in a series of steps upon the top of which has grown a discontinuous line of coral reefs. Thus a line through Osprey, Bougainville, Holmes, and Flinders Reefs would roughly mark the eastern side of the trough and the western edge of the Coral Sea Plateau.

GRAVITY INTERPRETATION

Figure 4 shows the regional Bouguer anomaly contours compiled from the BMR gravity map of Australia, the BMR marine survey data, and results of an earlier BMR gravity survey of the northern Great Barrier Reef (Dooley, 1965). A rock density of 2.2 g/cm^3 was used for the Bouguer correction except for the Barrier Reef results, for which a value of 2.69 had been used.

The regional gravity gradient from west to east is due to the thinning of the crust from the continent towards the Coral Sea Basin. Crustal refraction studies (Finlayson, 1968) show that the Moho deepens landwards from a depth of 25 km below the Great Barrier Reef. A rough estimate of the crustal thickness based on the Bouguer anomalies yields a

Fig. 4



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REGIONAL BOUGUER ANOMALY CONTOURS

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figure of about 25 km below the Coral Sea Plateau compared to 10 km below the Coral Sea Basin and 33 km below the continent. The gravity field also indicates a slight thinning of the crust beneath the centre of the Queensland Trough to a minimum of 21 km (Falvey, 1972). Refraction results from the Lamont survey (Ewing, Houtz & Ludwig, 1970) confirm the near-continental thickness of the Coral Sea Plateau and the Queensland Trough.

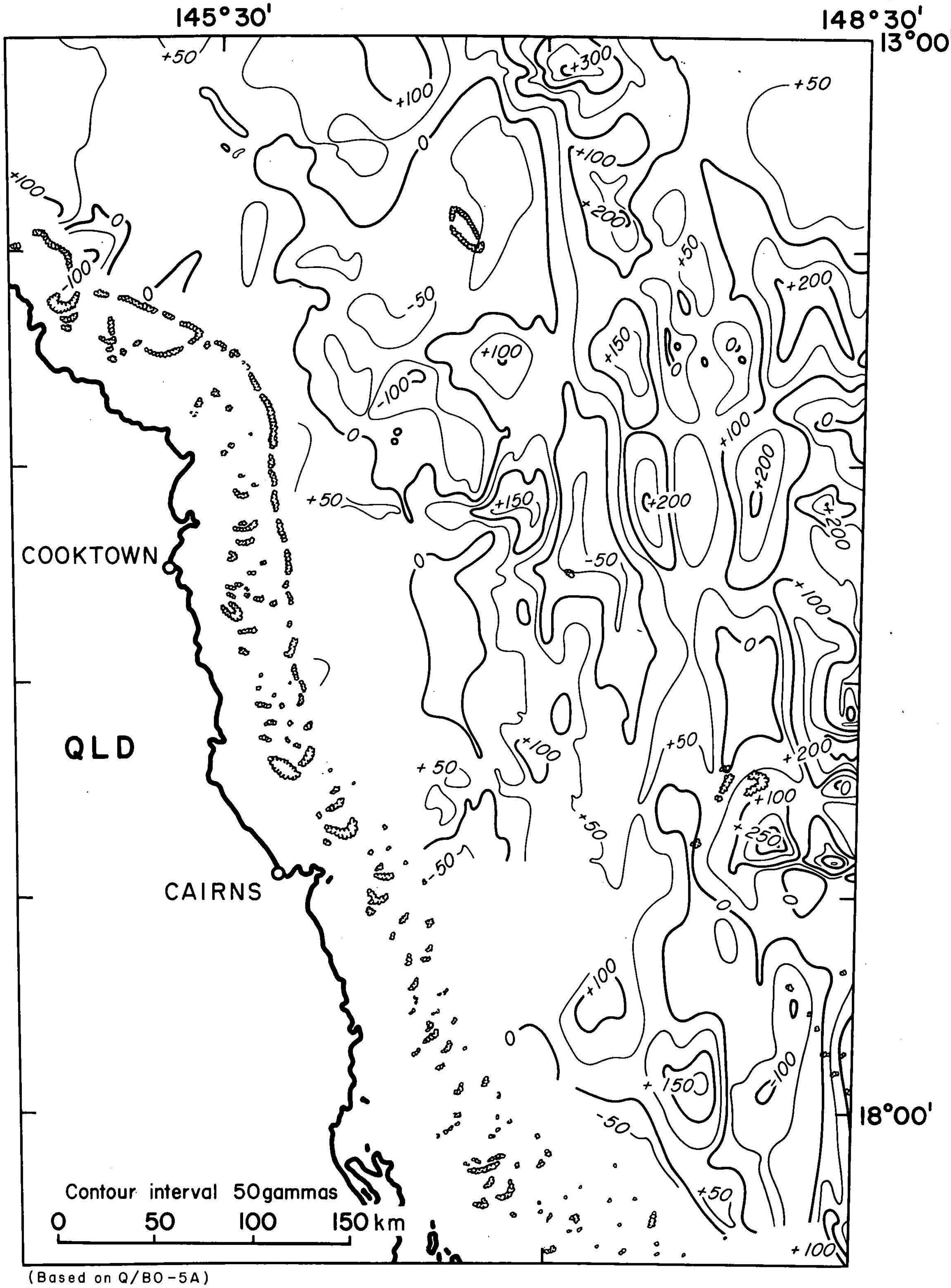
A faint gravity ridge which starts from the +80 mGal high over Flinders Reefs trends north-north-west, lies to the east of a seismic basement ridge and roughly delineates the eastern side of the trough.

The two small gravity lows of +20 mGal in the southeast corner of the map in the area known as the Halifax Basin may indicate a relative thickening of sediments; but the BMR seismic sections do not show a basement reflection here and thus cannot directly confirm basement depths.

MAGNETIC INTERPRETATION

Figure 5 shows the regional magnetic anomalies, relative to the International Geomagnetic Reference Field, as recorded by BMR. A map showing interpreted depth to magnetic basement has not been prepared as calculations show that along all of the traverses the magnetic basement lies well below the seismic basement. Therefore a magnetic basement depth map would be of little economic significance.

Fig. 5



REGIONAL MAGNETIC ANOMALY CONTOURS

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The magnetic intensity contours over the area of the trough are generally of low amplitude and long wavelength, indicating the great depth to magnetic basement. The contours display the same north-north-west trend as the topography: that is, parallel to the structural trend of the Tasman Geosyncline here. A line of positive magnetic anomalies extends from the two +250 gamma anomalies at the latitude of Cairns to the +300 gamma anomaly at the north of the map. This line coincides with the gravity ridge that marks the eastern edge of the trough.

The magnetic profiles shown in Figures 6, 8, 10, and 11 also display the flat magnetic anomalies over the Trough and stronger anomalies which indicate shallower magnetic basement over the Plateau.

It is clear that structures below seismic basement, which appear to control the regional magnetic and Bouguer anomaly trends, form a wider and deeper trough than does either the seismic basement or the sea bed. This effect can also be seen if the contours of depth to magnetic basement in the Halifax Basin, as presented in the Tectonic Map of Australia and Papua New Guinea (Geological Society of Australia, 1971), are compared with the seismic basement depth map discussed later in this paper.

DSDP SITE 209 RESULTS

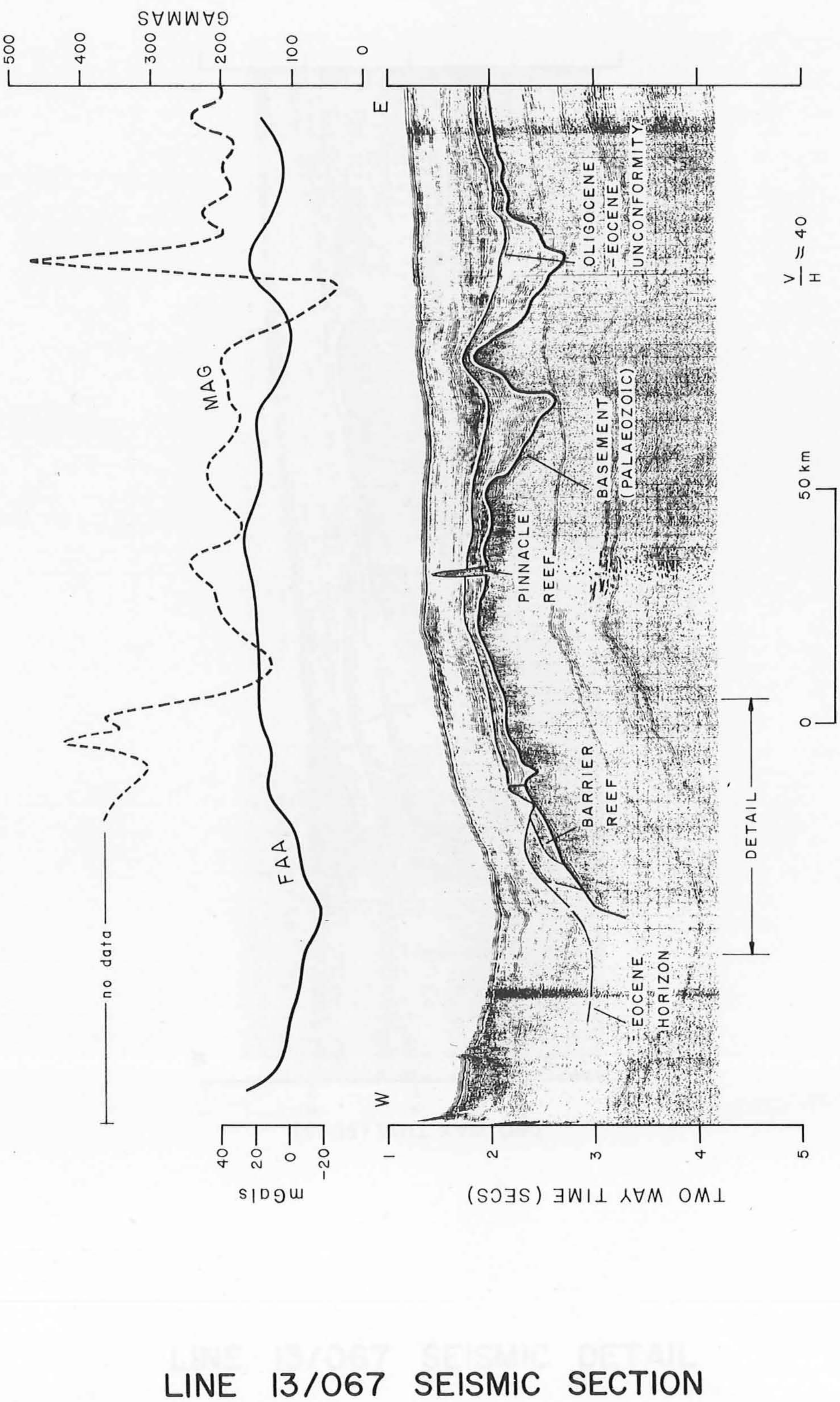
The lithology at DSDP Site 209 and the inferred sequence of geological events (Burns, Andrews et al., 1973) suggest that shallow-water sediments were deposited just above the seismic basement and that the depositional environment then became progressively deeper with time. The late middle Eocene shallow marine sediments consist of sand-rich foraminiferal limestone with secondary chert filling of voids. Middle to upper Eocene sand-bearing foraminiferal ooze and chert were deposited in a gradually deepening environment associated with a reduction in terrigenous detritus reaching the site. The upper Oligocene to Pleistocene foraminiferal ooze and nannofossil ooze were laid down in deep water in the presence of submarine currents. The two unconformities, from late Eocene to late Oligocene and from late middle Miocene to middle Pliocene, were both periods of non-deposition or slight submarine erosion. The former is a regional unconformity which has been related to the change in the oceanic current pattern that followed the separation of the Australian and Antarctic continents (Kennett et al., 1972).

SEISMIC INTERPRETATION

Basement Horizon

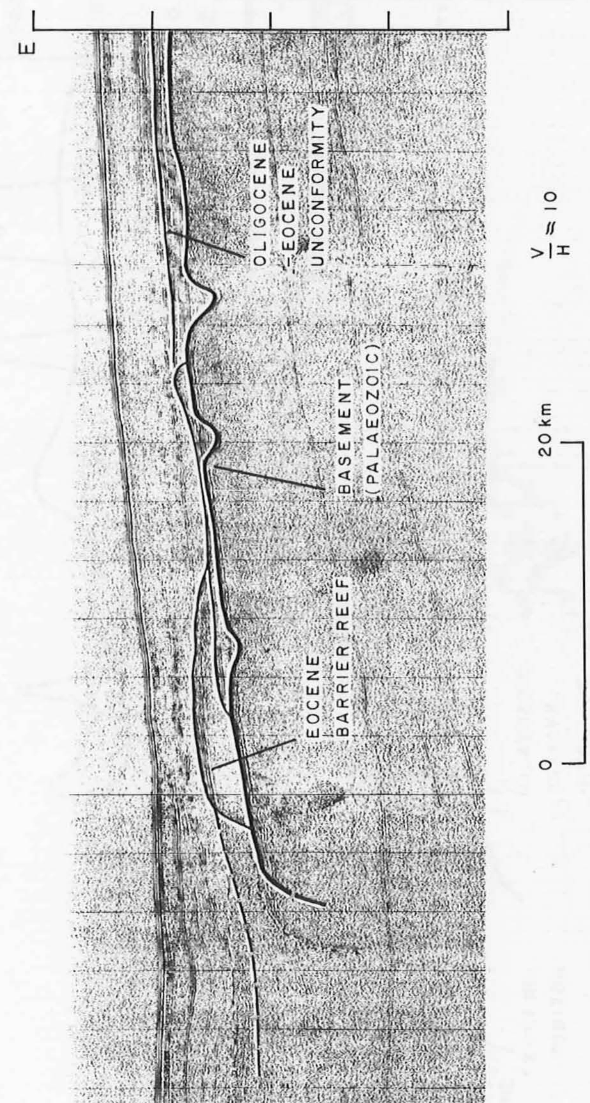
A strong reflector interpreted as acoustic basement is perceptible on the seismic records except where its depth exceeds the depth of seismic penetration. Throughout the area this basement is rugged and eroded as can be seen on the seismic sections, Figures 6 to 11. Traces of intrabasement stratification truncated above by the basement reflector are evident on some seismic

Fig. 6



LINE 13/067 SEISMIC SECTION

Fig. 7



LINE 13/067 SEISMIC DETAIL

LINE 14/038 SEISMIC SECTION

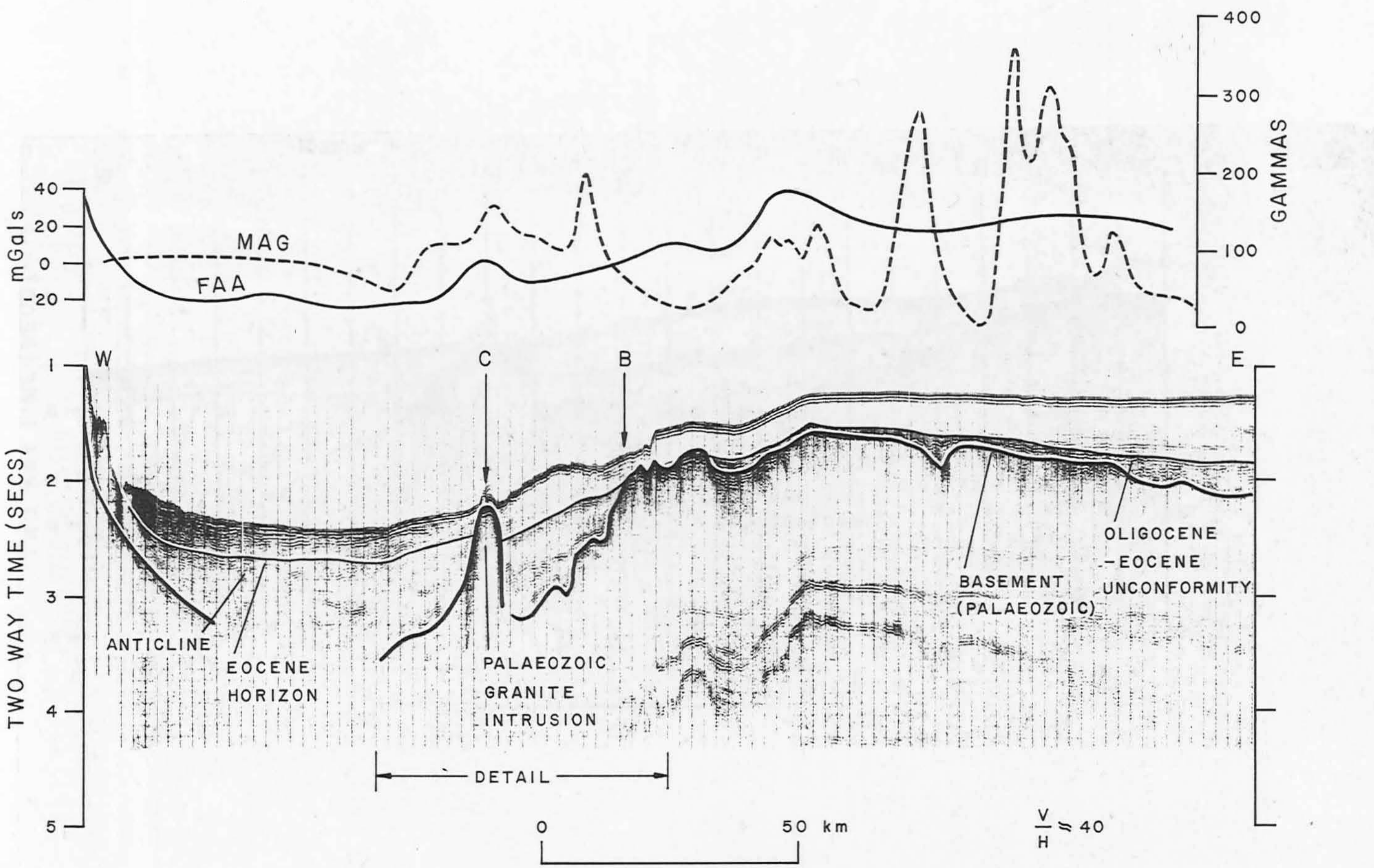
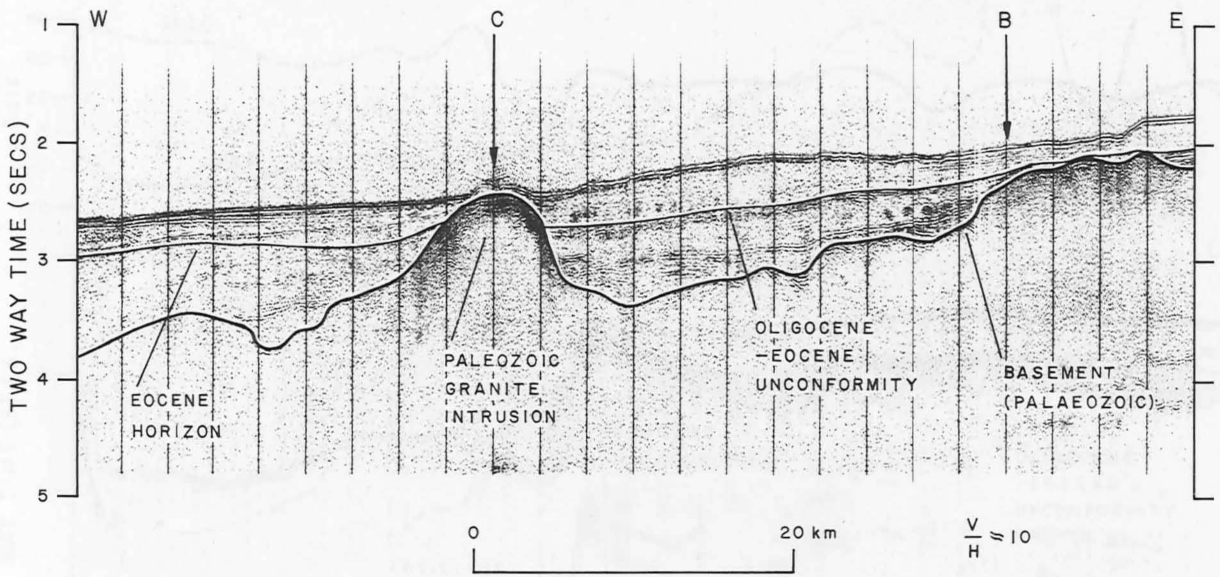


Fig. 8



LINE 14/038 SEISMIC DETAIL

Fig. 9

LINE 14/040 SEISMIC SECTION

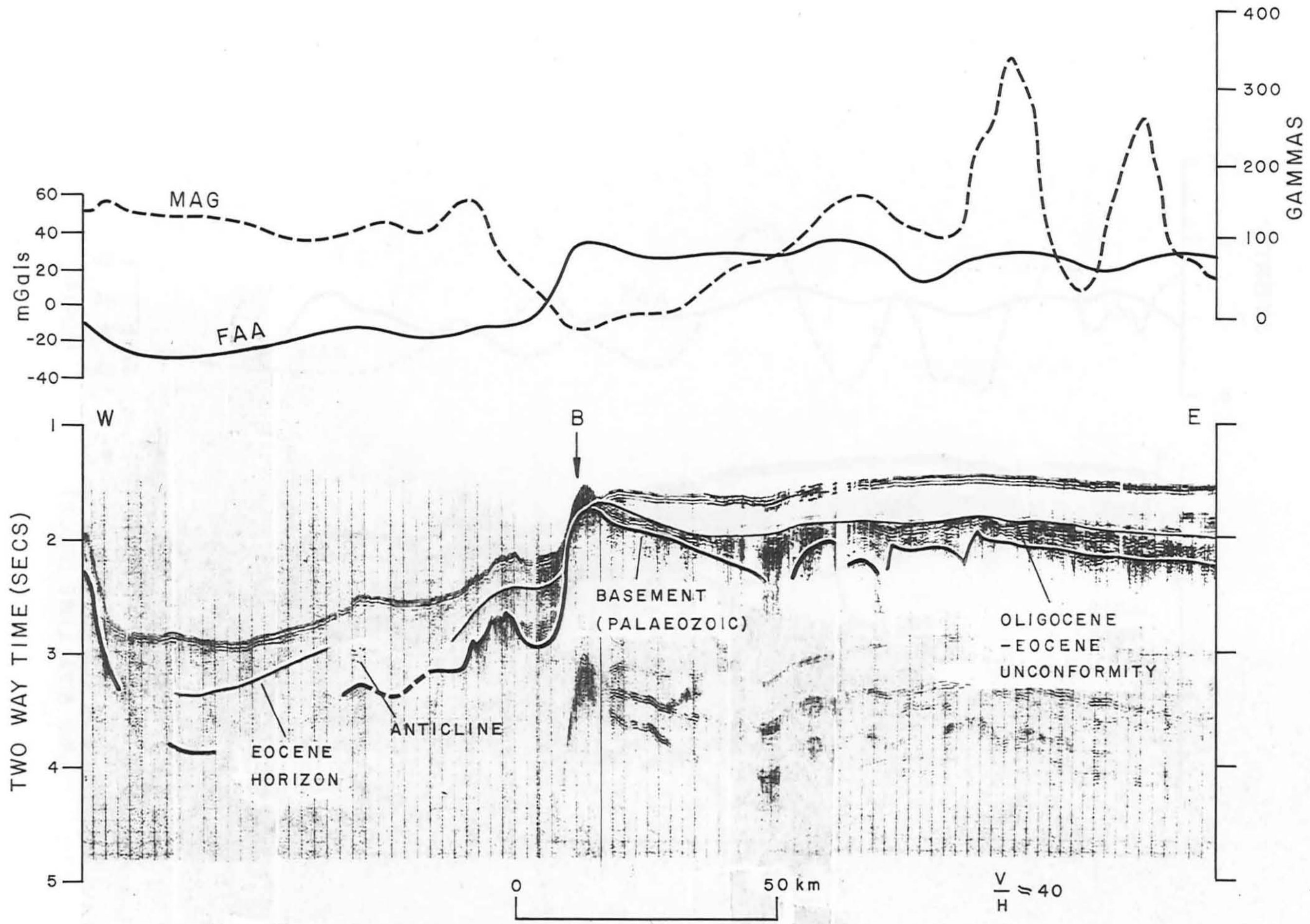


Fig. 10

LINE 14/046 SEISMIC SECTION

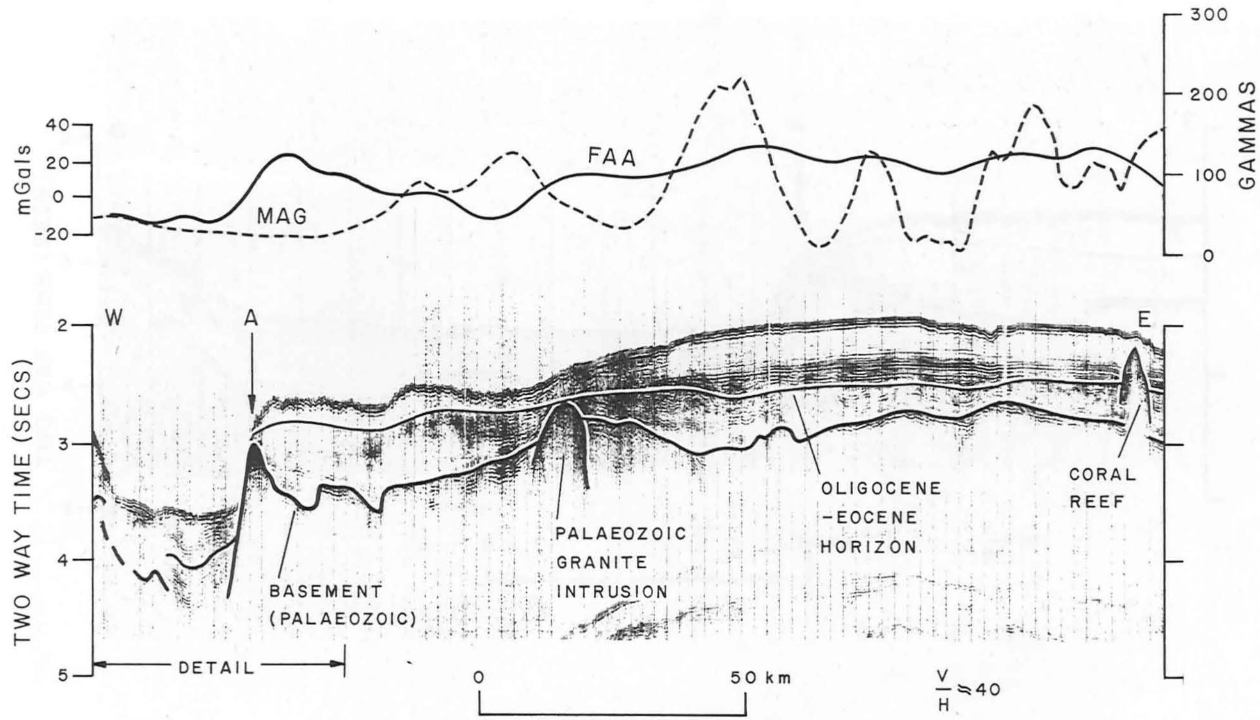
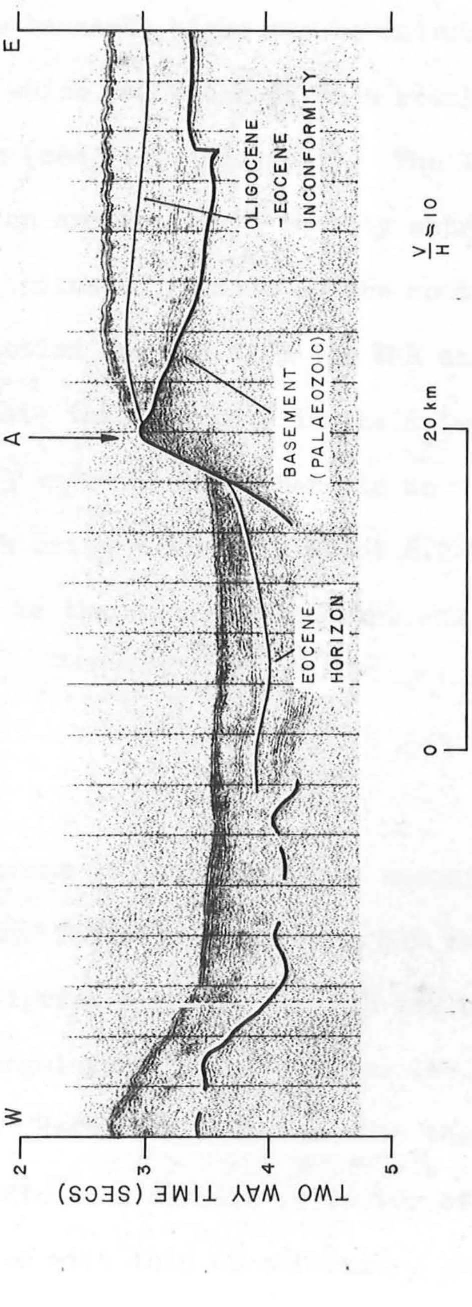


Fig. 11

Fig. 12



LINE 14/046 SEISMIC DETAIL

sections as faint reflectors, generally of appreciable dip. This and the concomitant evidence of a non-magnetic seismic basement suggest that the basement rocks are non-crystalline, possibly mildly meta-morphosed sediments which have been folded and then eroded. Some of the basement highs may be intrabasement plutonic intrusions which now protrude as a result of differential erosion (see Figs. 8, 9, 11). The lack of magnetic expression and the small gravity expression of these intrusions indicates granite as the most likely composition. Refraction results from the BMR and Lamont surveys indicate that velocity in the seismic basement is about 5.3 km/s and that there is an underlying layer with seismic velocity about 6.2 km/s. This lower layer may be the magnetic basement and is probably crystalline.

Sedimentary Horizons

The late Eocene to late Oligocene unconformity can be traced from DSDP Site 209 across the BMR seismic records as shown in Figures 6 to 12. Across the plateau the unconformity is angular above but follows the stratification below. Refraction results from the BMR and Lamont surveys indicate a seismic refractor of 2.4 km/s closely associated with this unconformity, compared with a velocity of 1.8 km/s for the layer above. Utilization of these results enabled the unconformity to be mapped into the trough, where it appears to be a conformable reflecting horizon - the 'Eocene horizon' (see Figs.9 and 12).

Owing to insufficient sparker energy, deep reflections in the trough are weak and the structure and character of the pre-Oligocene reflectors obscure (Figs, 6 and 8).

On the plateau the sediments below the unconformity exhibit a layered character and are variable in total thickness. They are draped across basement highs and infill basement depressions. Within these small basins or grabens, both on and at the edge of the plateau, a sequence of strong reflectors indicates a definite difference in lithology from the overlying layers. Comparison with the results from Site 209 suggests that these basins (see Figs. 6, 8, and 9) probably contain shallow-marine sediments of middle Eocene age. Syndepositional faults within the sediments show that the basins have subsided more rapidly than the adjacent basement highs. Minor faulting below the Eocene/Oligocene unconformity occurs across the northeast of the plateau and the trough margin.

The post-Eocene sediments are of a fairly even total thickness throughout the area. Across the plateau these pelagic sediments show current-controlled bedding structures, giving rise to the other angular unconformities visible on the seismic records. One of these unconformities may be the late middle Miocene to middle Pliocene unconformity. Very minor faulting occurs in the post-Eocene sediments, both on the plateau and in the trough.

Buried Coral Reefs

Figure 6 shows two types of buried coral reef which have grown from near the basement surface. Several examples of both the pinnacle reef and the barrier reef were recorded on other BMR traverses. The barrier reef section of Figure 6 is shown at the same vertical scale but enlarged horizontal scale in Figure 7. A complex of reefs has grown near the edge of an ancient continental shelf. As the dip of the basement here is less than 1° which is about the same as the slope of present day continental shelves the area has probably undergone regional subsidence without any tilting. This reef complex appears to have formed a dam behind which shallow-marine sediments accumulated on the plateau.

Seismic reflectors beneath the reefs show very little apparent velocity uplift, so the reef material is of fairly low velocity, possibly 2.6 to 2.8 km/s, and may be very porous with little secondary lithification.

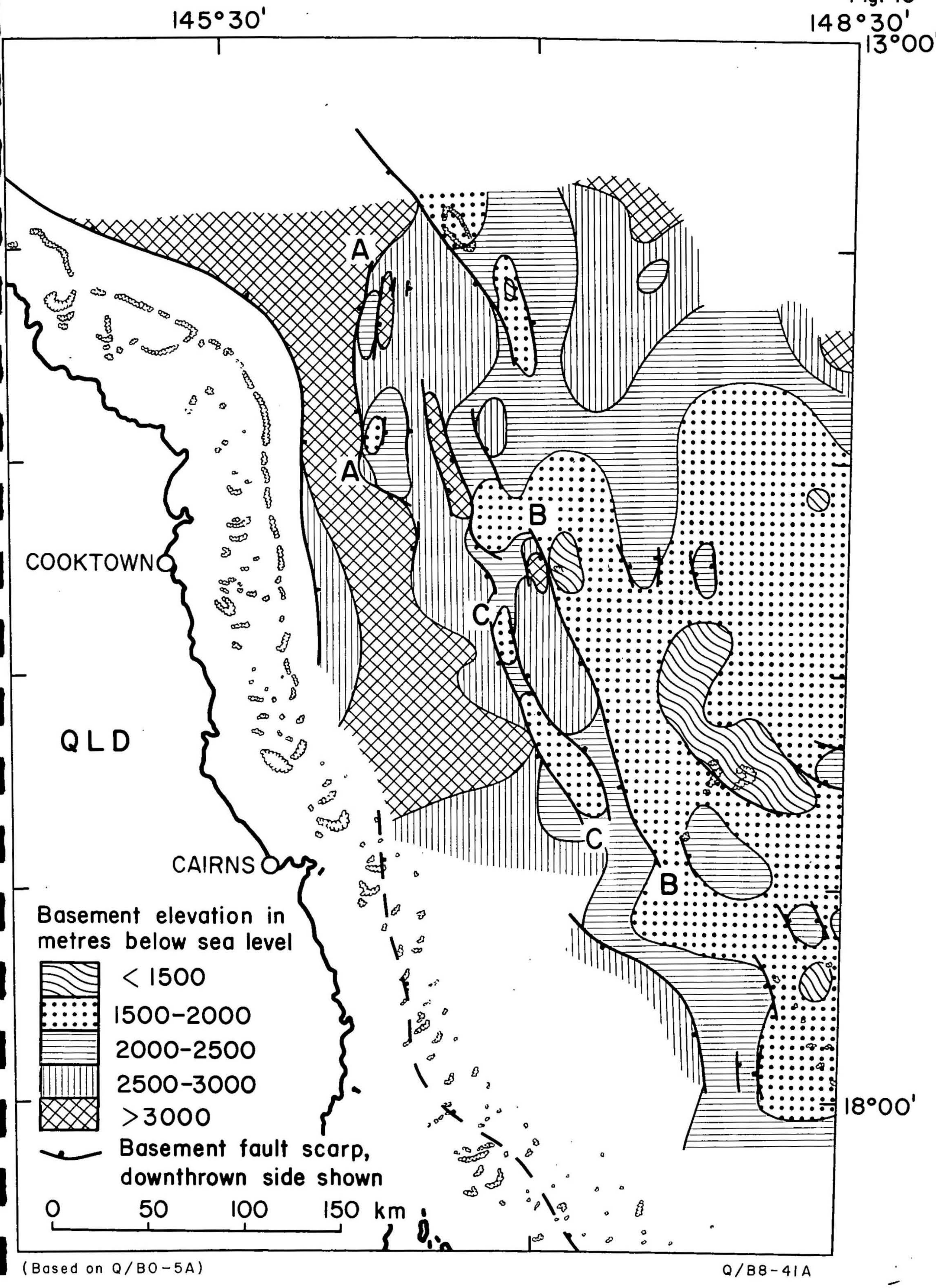
Assuming that the plateau subsided en masse resulting in shallow marine facies being developed contemporaneously throughout the area, then the coral reefs began to grow about the early to middle Eocene. The present day reefs such as Osprey Reef are growing atop basement highs and so may be slightly younger than the buried reefs. The fact that the buried reefs all reach different relative levels within the sedimentary section points to increased rates of subsidence at different places and different times, suggesting that Eocene faulting occurred over the plateau. Of course other causes such as temperature or salinity changes could have killed the reefs.

SEISMIC BASEMENT MAP

The seismic basement depth map (Fig. 13) shows the system of basement fault scarps which have controlled deposition within the trough. The dominant trend of these faults is north-northwest. They probably began as normal faults during the Permian orogeny. Subsequent erosion has produced rounded and fairly gently-dipping basement structures that are here termed fault scarps. However, as the sediments above many of the smaller basement faults also show signs of being faulted, the faulting in the area has been semi-continuous or periodic.

Several horst and graben-like structures split the trough into two or more parallel basins. Three structures - faults A and B and horst block C - have been marked on both the seismic basement map (Fig. 13) and the isopach maps (Figs. 14 to 16), and also on the seismic sections (Figs. 8 to 12). These north-south structures are broken by minor east-west trends, which have not been mapped because they lack continuity across the predominantly east-west BMR traverses.

Fig. 13



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SEISMIC BASEMENT DEPTH MAP

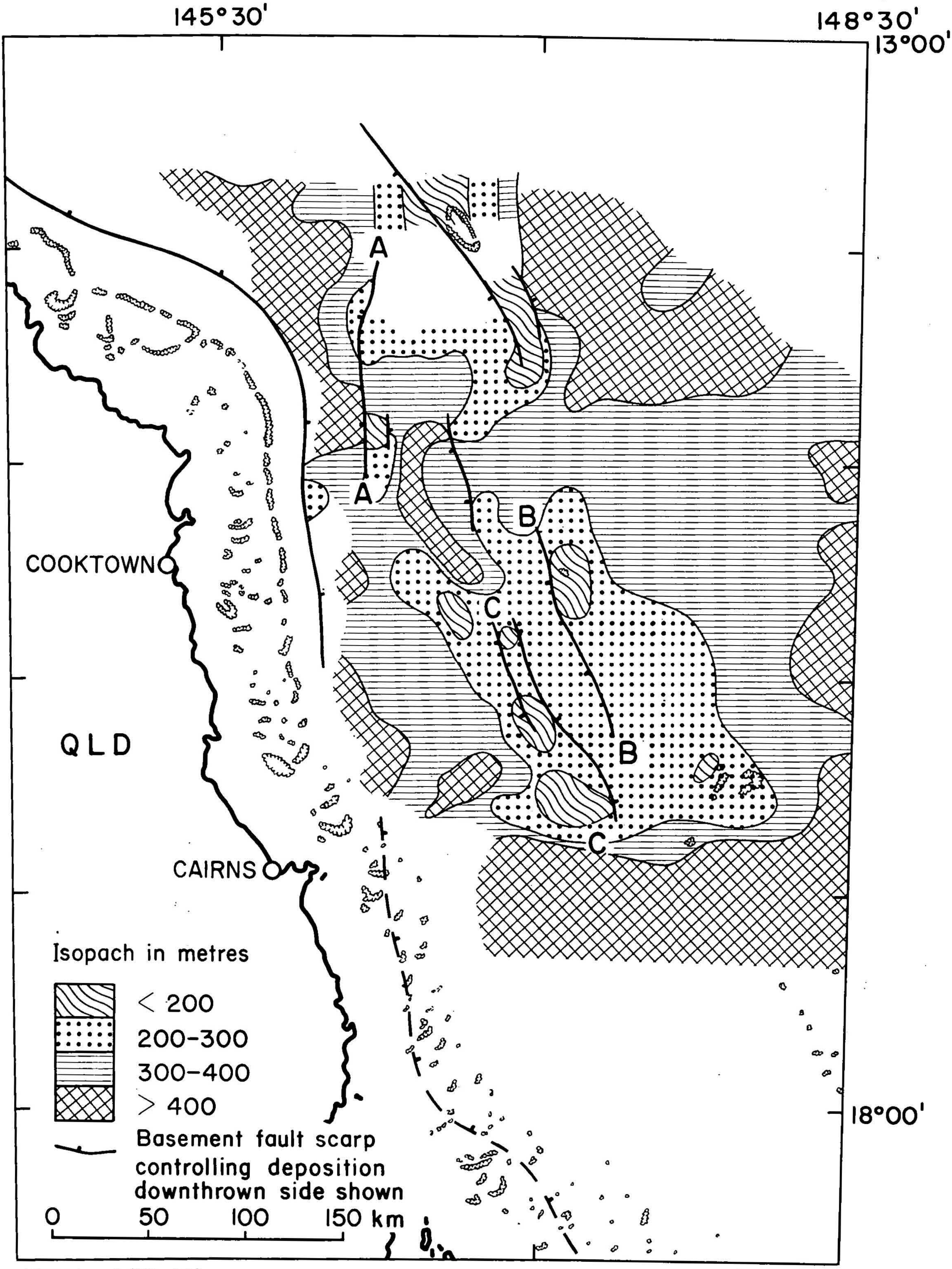
ISOPACH MAPS

Seabed to late Eocene isopachs (Fig. 14)

An interval velocity of 1.8 km/s has been used in mapping the variation in thickness of the post-Eocene sediments. Over the Coral Sea Plateau these sediments are judged to be Oligocene to Pleistocene chiefly pelagic sediments as shown by the results from DSDP Site 209. Within the western basin of the trough, the post-Eocene sediments thicken towards the Great Barrier Reef and most likely consist chiefly of turbidites derived from the continental slope. After flowing down the continental slope to the trough floor the turbidity currents probably turn northwards and flow down the trough. The parallel bedding shown by the seismic section along the northern line 14/046 (Fig. 12) indicates a direction of sediment transportation within the trough that is at right angles to the section, most likely from the south.

The only basement fault scarps shown on this map are those which have affected the distribution of the post-Eocene sediments. Along fault 'A' the basement rocks are exposed; the gradient of this scarp at line 14/046 is about 14°. One might expect pelagic sediments to be draped over this slope or to have slumped to its base. There are no such sediments preserved either on the slope or at its foot, so it is suggested that strong deep sea currents have swept the scarp free of sediments.

Fig. 14



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SEABED TO LATE EOCENE ISOPACH MAP

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North-flowing surface currents of about $2\frac{1}{2}$ knots were recorded in the trough during the BMR survey, and the seafloor currents could perhaps be as strong in the narrow constriction near line 14/046. Currents of less than 1 knot are capable of eroding coarse sand (Hjulstrom, 1935), so that this interpretation is very reasonable.

The Oligocene to Pleistocene sediments thicken towards the north of the plateau where the seismic sections show them to contain large lenses of sediment up to 50 km across that are believed to have been formed by the action of strong deep-sea currents.

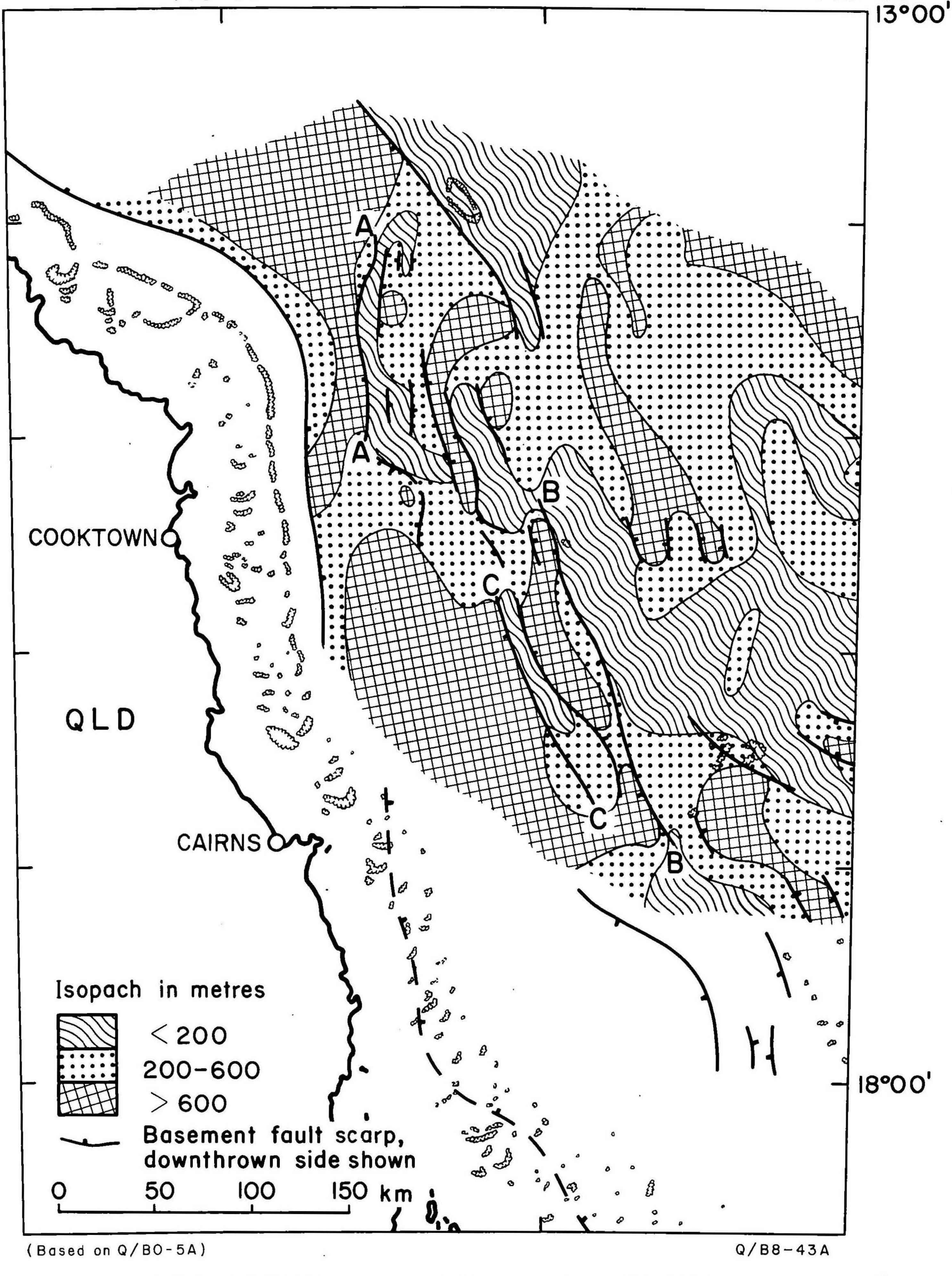
The Eocene horizon has not been definitely identified in the south of the map area owing to the absence of tie-lines, so post and pre-late Eocene isopachs have not been mapped.

Late Eocene to basement isopachs (Fig. 15)

An interval velocity of 2.4 km/s was used to correct the reflection times to thicknesses for these sediments. This figure was computed by averaging the Lamont and BMR refraction and wide-angle reflection results. This isopach map includes the probable shallow-marine deposits of possible early Eocene age that accumulated in the basement depressions on the plateau and smaller grabens at the edge of the trough.

Within the main western basin of the trough

Fig. 15



LATE EOCENE TO BASEMENT ISOPACH MAP

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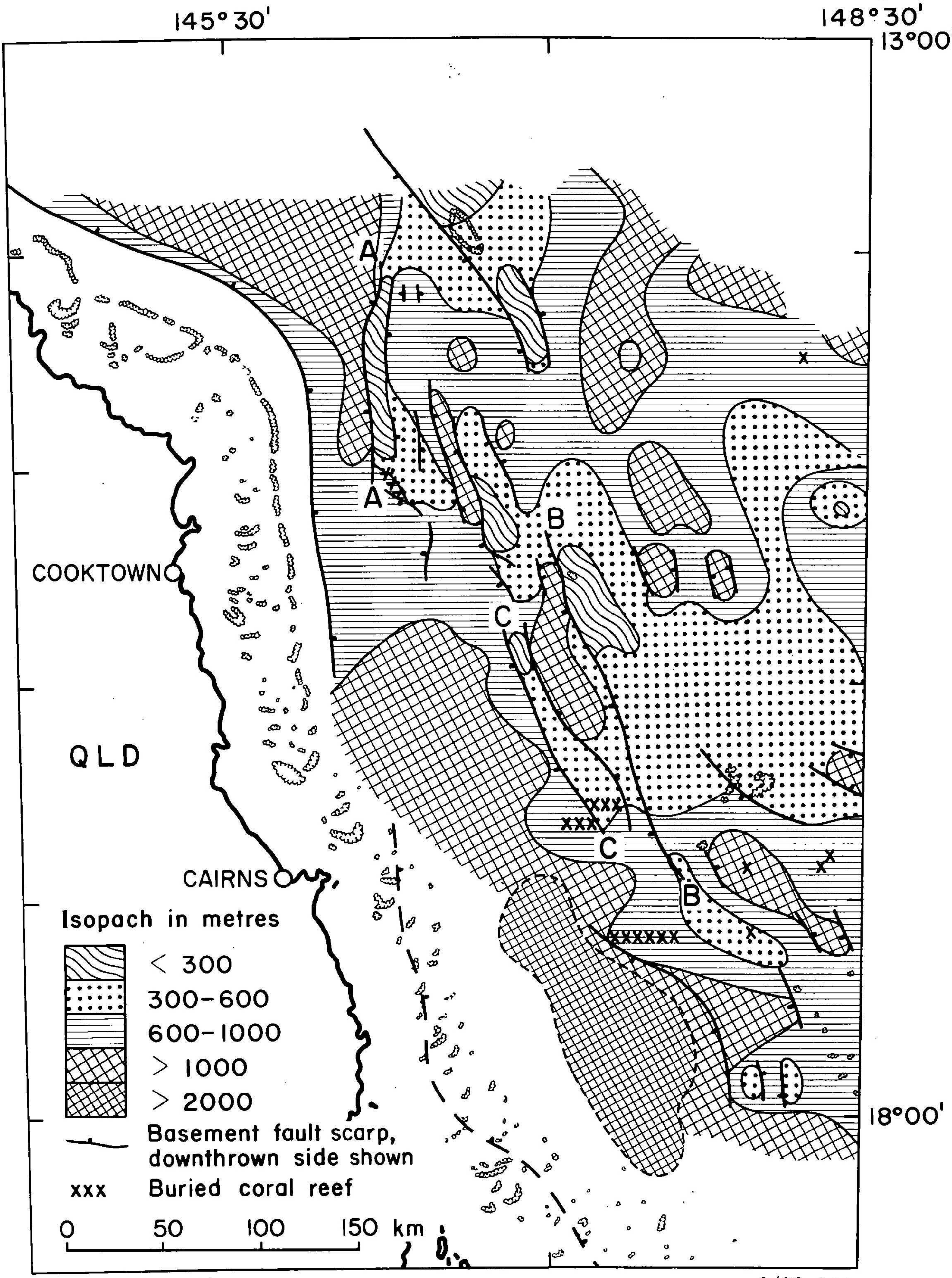
the sediments could range in age from late Eocene to Mesozoic and range in nature from pelagic or turbiditic to shallow marine, but as the reflections are weak here (as mentioned previously) it is impossible to make any more detailed environmental interpretation.

Total sediment isopachs (Fig. 16)

In the areas where the Eocene/Oligocene unconformity, the 'Eocene horizon', and the basement horizon can be identified, the total sediment isopachs are a summation of the two previous isopachs. In the areas where no Eocene horizon can be mapped, a sediment velocity of 2.2 km/s was used to estimate total sediment thickness.

The locations of the buried coral reefs that can be seen on the BMR seismic sections are shown in this map. Probably many more of these reefs exist between the survey lines; and some reefs may have considerable north-south extent, but are shown here as extending only along the traverse direction.

The thickest sediments lie in the southern end of the trough, within and to the north of the aeromagnetically mapped Halifax Basin. It should be noted that this is the shallow-water end of the trough. The main area of buried and exposed coral reefs lies to the northeast of this, where the basement becomes shallower. The larger buried reefs generally occur



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TOTAL SEDIMENT ISOPACH MAP

closer to the thick sedimentary section within the trough, and the present-day reefs more towards the centre of the Coral Sea Plateau.

The map shows the fairly thick sedimentary sequences that fill the small basins or grabens on the Coral Sea Plateau. The northern edges of the Plateau also appear to be covered with thick sediments, showing that the northern edges have also possibly subsided more rapidly than the central massif.

GEOLOGICAL EVOLUTION

The magnetic basement rocks of the Queensland Trough and Coral Sea Plateau generally lie well below the seismic basement and appear to correlate with a refractor of velocity 5.9 to 6.2 km/s. It is suggested therefore that the magnetic basement is formed by Precambrian crystalline rocks, such as the Proterozoic Dargalong Metamorphics which consist of schist, gneiss, quartzite etc. (de Keyser & Lucas, 1968).

The seismic basement is non-magnetic, has a refraction velocity of 5.3 km/s and contains faint traces of stratification. By comparison with the onshore geology the basement is probably formed by the rocks of the Devonian-Carboniferous Hodgkinson Formation or possibly its low-grade metamorphic equivalent the Barron River Metamorphics. These greywackes, turbidites, shales, slates, conglomerates etc. were deposited in a trough which lay either to the east of the Chillagoe Shelf or to the east of a volcanic arc in a fore arc zone (Packham, 1973) and formed part of the Tasman Geosyncline. They were subsequently metamorphosed, folded, faulted, and uplifted during the Carboniferous and Permian (de Keyser & Lucas, 1968). This orogeny was accompanied and followed by the intrusion of granites; an example of these is the Mareeba Granite of the Hodgkinson Basin (de Keyser & Lucas, 1968). A couple of these granite plutons can be seen on the BMR seismic sections (Figs. 8 and 11).

A long period of erosion during the late Permian and Mesozoic followed; during this time the main western part of the trough may have been low and received non-marine or shallow marine sediments. Seismic refractors within the velocity range 2.7 to 3.2 km/s were recorded within the deeper sediments of the trough, indicating a change in age or lithology below the middle to upper Eocene sediments of velocity 2.4 km/s. Two wells in the Capricorn Basin, Aquarius No. 1 and Capricorn No. 1, encountered Mesozoic conglomerate of velocity 2.2 and 3.7 km/s (Carlsen & Wilson, 1967a and b), and although that basin lies about 800 km southeast of the Queensland Trough it occupies roughly a similar structural position relative to the Tasman Geosyncline and sediments in the two basins may be partly equivalent.

Results from DSDP Sites 209 and 210 (Burns, Andrews et al., 1973) indicate that the Coral Sea

Basin began to form in the early Eocene, and the Coral Sea Plateau has subsided from near sea level in the mid-Eocene to its present depth of 1000 to 2000 m. The growth of coral reefs from the seismic basement surface provides additional evidence that the Plateau and Trough margins were once at sea level.

On the evidence from the BMR seismic reflection sections assisted by the refraction results it is thought that the main western graben of the trough is Mesozoic in age. The rugged, eroded basement topography and the relatively undisturbed trough sediments show that the major basement structures existed before most of the sedimentary deposition. However both Trough and Plateau subsided enmasse during the Cainozoic and the marginal grabens within the Trough have formed by further Cainozoic faulting, possibly along reactivated basement faults, to produce the modern trough structure.

These small basins or grabens initially received shallow-marine sediments as the plateau subsided below sea level. The shallow-marine sediments at Site 209 are mid-Eocene in age. That the subsidence was not even throughout the area is shown by the minor faults within the middle and late Eocene sediments, and also possibly by the differing heights reached by the buried coral reefs before they died. The relatively undisturbed sediments within one of these marginal grabens (between points B and C, Figs. 8 and 9) show that little post-depositional structural movement has occurred. The shallow-marine basal sediments of this minor trough are therefore probably pre-middle Eocene.

It is probable that the subsidence of the Plateau and Trough was a complex series of tectonic movements and the present seismic evidence is inadequate for a precise interpretation. The seismic data from parts of lines 13/067 (Fig. 6) and 14/038 (Fig. 8) are currently being digitally processed and stacked. It is hoped that the section quality will be sufficiently improved for further details of the structure to become apparent.

If crustal rifting during the early Eocene had produced the Trough and initiated the regional subsidence, one might expect Tertiary volcanism especially within the Trough. That there is no seismic or magnetic evidence for such volcanism suggests that the major structure of the Trough is pre-Tertiary and the Cainozoic differential subsidence and faulting are due to purely vertical movements, such as isostatic subsidence.

The area is seismically inactive at present and the near-surface structures are probably caused by submarine erosion and by sediment slumping.

The relationship of the Cainozoic evolution of the Coral Sea to plate tectonic theory involves a study of the entire Coral Sea Plateau and adjacent areas, and a consideration of the Cainozoic history of the southwest Pacific. This study is currently being undertaken by J.C. Mutter of BMR.

PETROLEUM POTENTIAL

The economic potential of the Queensland Trough is most likely confined to petroleum. There is less likelihood of recoverable sea-floor mineral deposits, such as the manganese nodules of the deep ocean basins, being found here.

Future petroleum exploration in the area should be concentrated on the continental slope outside the Great Barrier Reef, and within the southern end of the Trough.

The continental slope is formed by a sedimentary wedge as much as 3 km thick near the south of the Trough. The slope is 40 km wide here, with a gradient of only 1°. Sedimentary onlap against the western basement fault scarps and other basement rises provides possibilities for stratigraphic hydrocarbon traps.

The central southern part of the trough lies at a water depth of about 1000 m, which will soon be within drilling and exploitation capabilities. Basement depth is unknown, being beyond the limit of penetration of the BMR sparker seismic signals, but the sediments here are at least 2 km thick. The buried coral reefs which lie in a group to the northeast of this area provide another possible exploration target. These reefs occur generally up-dip from the thick sediments in the centre of the Trough, and appear to have a low seismic velocity and consequently high probable porosity.

There could be many more reefs in this area that were not crossed by BMR survey lines, and smaller reefs may be recorded but not recognized owing to the lack of seismic resolution.

A third type of possible hydrocarbon trap lies with anticlinal structures within the trough sediments. Two anticlines can just be seen in Figures 8 and 10, but many larger ones were recorded on the BMR seismic sections near the southern end of the Trough. They are large-scale structures up to 20 km across and 300 m high, and appear to have been formed entirely by sedimentary draping and differential compaction over shallow basement highs. Syndepositional faults add further amplitude to the anticlines. It is not known, however, if any anticlines have north-south closure because of the wide traverse spacing and lack of cross-lines.

Suitable cap rocks for these traps could be formed by the Cainozoic turbidites or pelagic foraminiferal ooze which either separately or together make up the upper 0.5 km of sediments over the Trough and Plateau. Possible shaly sequences deposited within the Trough contemporaneously with the early Eocene growth of the marginal coral reefs could cap deeper petroleum traps.

So it seems that the controlling factor for the petroleum potential of the area is the occurrence of source rocks. The current burial depth of the oldest trough sediments (Mesozoic ?) is 3 km or more; however, except beneath the continental slope, this includes 1 km of water. Whether conditions have been suitable for hydrocarbon generation would depend on the temperature at depth. Possibilities for the occurrence of source rocks within the trough are conjectural at this stage. If an enclosed Mesozoic basin lay where the Trough now lies, then the basal sediments could have been deposited in a quiet reducing environment and could be a potential petroleum source.

There may have been appreciable extrusion of Mesozoic volcanics as in the Maryborough Basin (Clarke, Paine & Jensen, 1971), and the petroleum prospects of the trough would consequently be downgraded. However, as the magnetic profiles across the trough are flat, any volcanics present would have to be of acid composition such as the rhyolites of the Maryborough Basin (Hill & Denmead, 1960). This possibility will have to await further exploration.

So conditions for the deposition of source rocks within the trough appear to have been good, and the level of organic metamorphism may decide the petroleum prospects.

CONCLUSION

The next step in the petroleum exploration should be a seismic survey in the area between the Great Barrier Reef and Flinders Reefs. A rectangular grid of survey lines at a spacing of 10 km would be adequate for a regional interpretation. A higherpowered seismic energy source coupled with modern digital recording and data processing techniques should provide seismic records much better than the present ones.

However these initial surveys have shown a possible unexplored petroleum prospect to lie at the southern end of the Queensland Trough.

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ADDENDUM - GEOLOGICAL EVOLUTION

Some sketches showing the palaeogeographic history of northeast Australia (Figure 17) have been drawn based on the maps of Brown, Campbell & Crook (1968) with the addition of data from the BMR marine survey, from DSDP Sites 209 and 210, and from the wells in the offshore Capricorn Basin. These reconstructions have been rapidly sketched and while considered suitable for presentation as slides at the APEA conference, they are not considered to be sufficiently researched for publication.

The maps illustrate several points about the geological evolution which have been mentioned in the main text. Firstly the large-scale geosynclinal or fore-arc sedimentation during the Devonian and Carboniferous is illustrated. The volcanic arc of Packham (1973) is shown in the Devonian, Carboniferous, and Permian maps. The uplift of the Coral Sea and Marion Plateaus occured in the Late Permian, although Brown, Campbell & Crook show the Hunter Bowen Orogeny to be Triassic. Regional subsidence began in the Jurassic, with non-marine sedimentation in the Queensland and Townsville Troughs. The area of these two troughs plus the Capricorn Basin is then shown to be the site of a marine transgression in the Early Cretaceous, a regression in the Late Cretaceous and a final transgression in the Early Eocene. However, several other transgressive/regressive cycles probably took place. The latest transgression accompanied the opening of the Coral Sea Basin. Since then the area to the east of the Great Barrier Reef has subsided to produce the present submerged troughs and marginal plateaus.

Figure 18 shows the simplified regional geology, this map has also not been sent to APEA.

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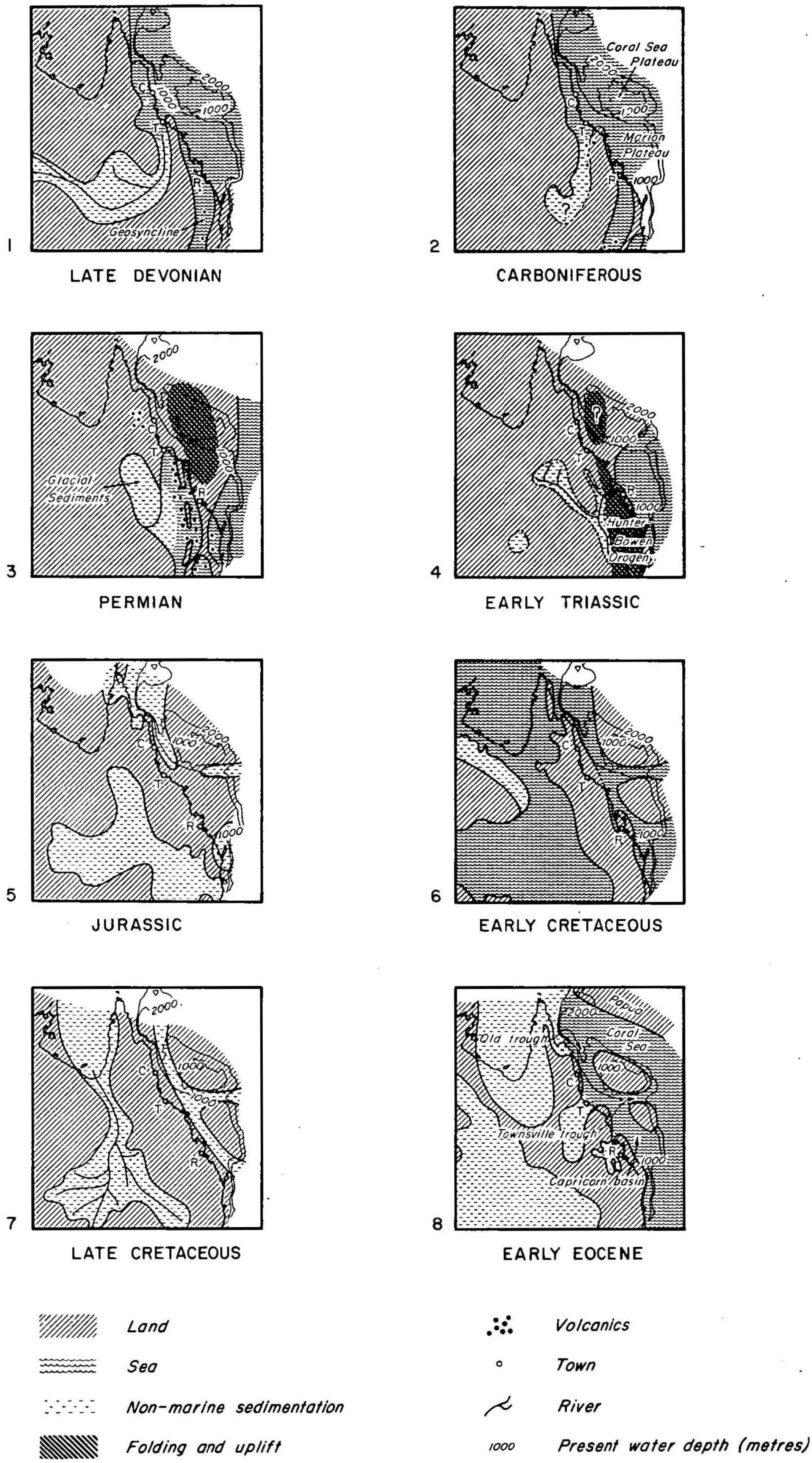

PALAEOGRAPHY OF NORTHEAST AUSTRALIA

(Adapted from Brown, Campbell and Crook, 1968)

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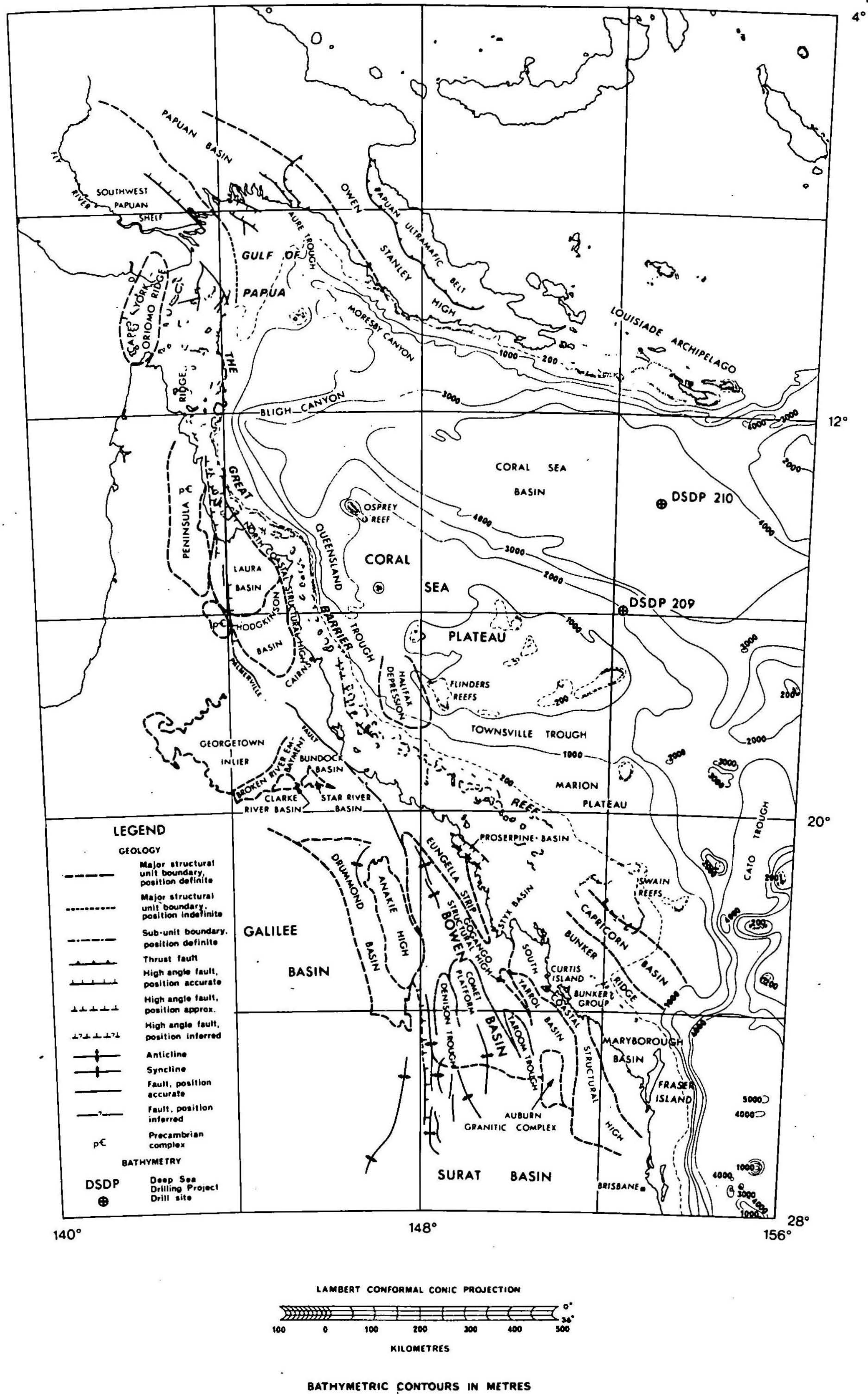
Fig. 18



SIMPLIFIED REGIONAL GEOLOGY

Compiled by C J Watt and J C Mutter

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