absent and the sequence from subsidence to breakup is reversed compared with the general Atlantic model. Although Falvey's model was not intended to define precisely the evolution of all Atlantic type margins, the significant differences observed may imply that the Coral Sea Basin is not of the general Atlantic type.

Karig (1971) classified the Coral Sea Basin as a Western Pacific 'marginal' basin. Such basins evolve by accretion of oceanic crust behind an island-arc trench system. If his model applied to the Coral Sea Basin, a south-dipping subduction zone should have been present in the position now occupied by eastern Papua and the Louisiade Archipelago at the time of basin formation in upper Paleocene and early Eocene. There is no geological evidence for such a subduction zone, and hence Karig's model may be discounted. The Coral Sea Basin must therefore be of a modified Atlantic type.

The absence of a rift valley stage may be explained by invoking rapid basin evolution; so rapid that the characteristic rift valley sediments would not have time to develop. Before this, a protracted uplift stage would occur. To explain this it is necessary to postulate a warm thermal anomaly, or more likely a hotter anomaly located some distance from the Coral Sea Basin. This thermal anomaly must have been capable of causing uplift of the crust without inducing metamorphism at its base. If the influence of this anomaly was later replaced by an intense but short-lived anomaly located in the Coral Sea Basin and associated with its opening, then the observed evolutionary scheme presents no difficulties. Subsidence of the Plateau will follow basin evolution as the intense anomaly would promote thermal metamorphism and crustal subsidence (Falvey, 1974). Lithospheric cooling and contraction in the basin after spreading ceases would heighten this effect.

Thus the continental margin of northern Queensland appears to have formed by a modified type of Atlantic margin development, the key to which is rapid evolution following some time after the action of a remote thermal anomaly located outside the Coral Sea Basin.

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DEPOSITIONAL AND TECTONIC PATTERNS IN THE NORTHERN LORD HOWE RISE – MELLISH RISE AREA

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Seismic profiling carried out by the Australian Bureau of Mineral Resources, the Deep Sea Drilling Project and Scripps Institution of Oceanography has provided data for the interpretation of the sedimentary and tectonic history of the area bounded by the Australian continent and the Tasman and Coral Seas, and extending eastwards towards New Caledonia.

The regional bathymetry reveals two dominant physiographic trends. The Australian margin, Tasman Basin, Cato Trough, Dampier Ridge, Middleton Basin, Lord Howe Rise and New Caledonia Basin all trend in a northerly or west of north direction. The western New Hebrides Basin, the broken ridge named the Rennel or Mellish Fracture Zone, and the faulted depression named the Louisiade Fracture Zone (Landmesser *et al*, 1975), in the northern part of the region, all trend in a northeast-southwest direction.

Nature of the Crust

The crustal structure of a number of these features has been established by previous workers (Ewing *et al* 1970, Shor *et al* 1971, Woodward and Hunt 1971). The Coral Sea, Tasman Sea and New Caledonia Basins are accepted as having crust of oceanic origin. The Queensland Plateau and Lord Howe Rise are considered to be continental.

The Cato Trough is rift bounded and has a basement deeper than 4.5 km, and is thus interpreted as being oceanic in origin. Interpretation of the structure of the Middleton Basin is complicated by the presence of volcanic highs in its eastern half)including Capel and Kelso Banks), but deep basement (4.5 km) has led to its interpretation as also being oceanic crust.

The Dampier Ridge has previously been considered as being volcanic, but more recently Ringis (1972) has suggested a continental origin. Profiles across the northern Dampier Ridge and its northern extension, herein named the Kenn Plateau, show a sedimentary sequence above basement which is identified as corresponding to a rift valley stage of sedimentation (as described by Falvey, 1974). This sequence is terminated by a pronounced angular unconformity identified as a break-up unconformity. Overlying this are more horizontal sediments. It is thus considered that the Dampier Ridge developed as a marginal plateau with rifting occurring initially to the east with the formation of the Middleton Basin, and later to the west with crustal generation in the north Tasman Basin and Cato Trough. Ringis (1972) in his analysis of Tasman Sea opening suggests a jump of the spreading axis from the Middleton Basin to the north Tasman Basin at around Anomaly 29 time.

This interpretation is complicated by the presence of many intrustions and possibly a large volume of extruded material. The original continental mass of the Dampier Ridge has been enlarged to the present size and shape by these

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volcanics. This "artificial" widening of the Ridge has contributed to the difficulty in interpreting the magnetic anomaly pattern, particularly in the north Tasman Basin.

The Chesterfield Reefs lie on a large high (herein named the Chesterfield Plateau) which is interpreted as being continental in origin and as such, is attached to the Kenn Plateau. The Mellish Rise further north is highly fragmented by faulting and interpretation of its structure is further complicated by the presence of many intrusions. It may originally have been a segment of continental crust similar to the Dampier Ridge — Kenn Plateau which has been fragmented by movement along the Rennel and Louisiade Fracture Zones. The Louisiade Rise has not received much attention in this study but basement appears block faulted in the same way as basement of the Queensland Plateau. This would suggest, by analogy that the Rise is also continental.

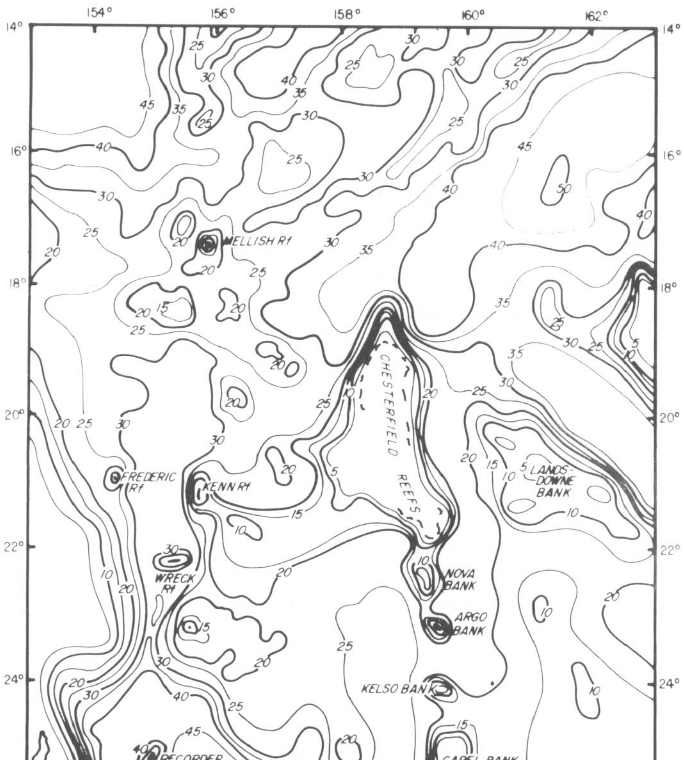
Fracture Zones

Synthetic fracture zones have been generated for the region using an average of the Tasman opening poles calculated by Ringis (1972) located at 6° S, 146° E. These lineations are seen to coincide with the dominant trends of the Rennel and Louisiade Fracture Zones. These fractures are thus considered to be transform features associated with Tasman Sea opening. Other major transforms have been identified. The Kenn Fracture marks the northern termination of continental crust of the Kenn and Chesterfield Plateaux and is delineated by faulting and intrusions. The Cato Fracture marks the southern boundary of the continental Marion Plateau, the northern extent of the oceanic Middleton Basin and the northern extent of the Lord Howe Rise. This same lineation may also mark the northern extension of the Norfolk Ridge and delineate a transform which has moved the spreading axis of the New Caledonia Basin into the New Hebrides Basin. The Kenn and Cato Fractures also coincide with synthetic fractureses calculated from the Tasman Pole.

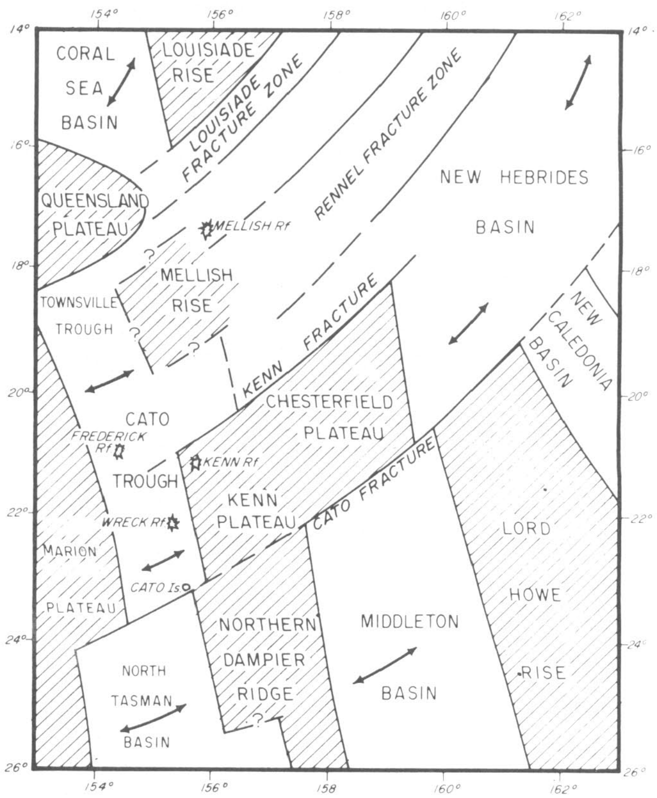
Sediment Distribution

The sedimentary pattern in the region has also been interpreted from the seismic profiles. Control over these interpretations is afforded only by the DSDP sites on the Lord Howe Rise (sites 207 and 208), the Queensland Plateau (site 209) and the Coral Sea (sites 210 and 287). Thick sediments are common in all the basins in the region with upwards of 2 km in places in particular in the Tasman and Middleton Basins. Pelagic sediments are widespread throughout the region and clastic sediment has been deposited in a number of the basins. Sediments derived from Papua have been cored in the Coral Sea Basin (Burns *et al* 1973) and the Australian mainland must have supplied a considerable volume of sediment to the Tasman Basin. The Cato Trough would have been supplied by the Marion Plateau prior to its subsidence, and the Middleton Basin by the Lord Howe Rise. More recently, reefs on the Marion Plateau and those on the Chesterfield Plateau would have supplied sediment to these basins.

A feature common to most of the seismic profiles west of the Lord Howe Rise is the presence of a regional reflector. This is correlated with Eocene charts and siliceous limestone directly below the Eocene — Oligocene Regional Uncon-



MELLISH RISE AREA — BATHYMETRY
CONTOURS ; METRES x 100 .... INTERVAL 500 METRES



MELLISH RISE AREA— TECTONIC ELEMENTS
CONTINENTAL CRUST ▨ OCEANIC CRUSTAL SPREADING ⟷

formity at site 209 (Burns *et al* 1973). It is probably valid to consider this reflector as being associated with silicification and thus as an Eocene time-line wherever it occurs. This reflector abuts unconformably against basement on the Marion Plateau, local highs on the Queensland Plateau and basement of the higher parts of the Dampier Ridge. It is hypothesised therefore that these areas were emergent during this period of siliceous deposition.

Tectonic Evolution

The regional history can be summarised as follows: Opening of the southern Tasman Sea commenced at about Anomaly 36 time (6o m.y.) about a pole located at 6° S, 146° E. This opening extended northwards into the Middleton Basin moving the Lord Howe Rise away from Australia and the Dampier Ridge. Possibly at the same time, the New Caledonia Basin opened about the same pole, moving the Norfolk Ridge eastward. This opening was linked by a transform fault to a spreading axis at an unknown locality in the New Hebrides Basin. At around Anomaly 29 time (69 m.y.), spreading in the Tasman-Middleton Basin jumped westward into the north Tasman Basin and Cato Trough moving the Dampier Ridge and Kenn-Chesterfield Plateau away from Australia. This same spreading system may have separated the Louisiade Rise from the Queensland Plateau area. At around 65 m.y., as opening around the Tasman pole was drawing to an end, opening commenced in the Coral Sea Basin with the axis orientated in a more westerly direction. This opening moved the Louisiade Rise further north, and was probably superimposed upon the Tasman Sea opening in the Mellish Rise arc. The Rennel and Louisiade Fracture Zones, activated by Tasman opening were further activated by Coral Sea opening and spreading continued into the New Hebrides Basin.

Tasman opening ceased around 60 m.y. and Coral Sea opening continued at least into the early Eocene by which time the continental fragments in the region commenced to subside.

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THE RELATIONSHIP BETWEEN STRUCTURES ON THE SOUTHEAST AUSTRALIAN MARGIN AND IN THE TASMAN SEA

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A study of the magnetic anomaly pattern in the Tasman Sea has shown that it opened by a process of sea floor spreading between about 80 and 60 my.b.p. (Hayes and Ringis, 1973). The spreading pattern appears to have been quite complex. The basin is disected by many fracture zones (transform faults) and there appears to have been considerable variation in spreading rates within blocks bounded by these fracture zones. This is clearly shown by the varying widths of crustal blocks generated in periods of 5 m.y., as shown in Figure 1. Further, the trend of the magnetic pattern, and hence crustal isochrons, intersects the trend of the southeast Australian margin at an angle of about 45° to 50° . As a result, progressively older oceanic crust is absent north of Bass Strait.

Based on this and on seismic profiles which show the presence of a basement trough adjacent to the margin, Hayes and Ringis (1973) postulated the existence of a subduction zone which would have operated for a limited period of about 6 to 7 m.y. during Tasman Sea opening. This postulate is further supported by the presence along the southeast Australian margin of many of the features adduced by Inman and Nordstrom (1971) as typical of collision coasts. These include first order characteristics such as the relatively straight and mountainous coast, a narrow continental shelf and steep slope, and the presence of the postulated residual trench offshore.

Wilson (1965) proposed that lines of old crustal weakness on the continental block determine the site of transform faults when sea floor spreading commences. Fuller (1971) showed that this appears to be the case for South Atlantic fracture Zones, which can be related to lines of old crustal weakness in southern Africa.

The present study of major structural features along the south-eastern Australian margin was undertaken to determine if a similar relationship also exists between south-eastern Australia and the Tasman Sea. The results are presented in Table 1.

The above summary clearly shows that many of the major structural features in southeastern Australia intersect the coast at or near the extension of Tasman Sea fracture zones. Several discordant igneous intrustive masses on the coast or shelf also occur along fracture zone trends. All of these features predate Tasman Sea opening, in some cases by more than 200 m.y., and all are indicative of the existence of zones of weakness in the crust. There are no clearly defined fracture zones in this part of the Tasman Sea which are not associated with such zones of weakness.

It therefore appears that the development and location of fracture zones in this part of the Tasman Sea was determined by the location of pre-existing zones of weakness in the pre-drift continental crust.

If this relationship is valid for the whole of the Tasman Sea, then it should be possible to predict the possible location of fracture zones in those parts of it where a good