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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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A RECENT GEOPHYSICAL RECONNAISSANCE OF THE GULF OF PAPUA AND NORTHWEST CORAL SEA

by

J.C. Mutter

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FOREWORD

This paper was presented at the International Marine Science Symposium held by the University of New South Wales on 16-17 August 1971.

SUMMARY

A recent marine geophysical survey of the Gulf of Papua and northwest Coral Sea region has delineated structural trends in the area and suggested answers to some outstanding geological questions. Gravity results are interpreted as showing that the Aure Trough extends southeast down the Moresby Trough to 9°30'S. Confirmatory evidence from the seismic results is given. The Eastern Plateau is shown to lie in a structural setting somewhat similar to the larger Coral Sea Plateau south of the area surveyed. A seismic horizon identified on the Eastern Plateau may be the equivalent of the 'S' horizon on the Coral Sea Plateau, and suggests an ancient link between the two features.

The major structural units are attributed to tensional tectonics, and this proposition is supported by a sketched geological history.

As part of its 1970 program, the Bureau of Mineral Resources contracted Compagnie Generale de Geophysique to survey 5300 miles (9800 km) of multisensor traversing in the extreme northwest Coral Sea including the Gulf of Papua. Continuous bathymetric and seismic profiling with simultaneous gravity and magnetic sensing was maintained on systematic east-west traverses. The primary navigation system was satellite/sonar doppler supplemented by Omega/V.L.F. and two ship's logs to give position accuracy better than 1 nautical mile.

Bathymetric results

In Figures 1 and 4 the basic morphologic units are shown. These include the regular features of continental shelf and slope plus a system of troughs bordering a large fan-shaped plateau, the Eastern Plateau, at an average depth of 1500 metres. The troughs form the drainage systems by which sediment derived from Papua is transported to deeper water - in particular to the Coral Sea Abyssal Plain in the southeast of the area. The Portlock (or Bligh) Trough, marginal to the western side of the plateau, is straight and steep-sided. The plateau itself is tilted south and southeast toward the abyssal plain, both features apparently arising from tectonic movements. South of 12°S a deep-water region with depth exceeding 3000 metres separates the Eastern Plateau from the Coral Sea Plateau which lies immediately south of the area mapped and is bounded in the east by a steep gradient scarp striking northwest toward the central Gulf of Papua and against which abyssal plain sediments abut.

Gravity results

One of the aims achieved by the survey was to determine the south-eastern extent of the Papuan Basin. A deep free-air anomaly low, shown in Figure 2, trends southeast down the Moresby Trough to about 10°S and forms a semi-continuous feature with the Aure Trough (Fig. 4). The zone of thick sediments and thin crust extends southeast to at least 9°30'S. Termination of the trough as it approaches the Papuan Plateau is marked by a decrease in amplitude of the free-air anomalies. The Pandora Basin (Fig. 4) also shows a free-air low and appears to be a shallow embayment in the geosyncline. In the northwest, the margin of the Papuan Basin is controlled by basement rises in the regions of modern reef development discussed below.

South of 10°S, the plateau shows positive free-air anomalies (to 40 milligals) over its entire extent, indicating a general mass excess and implying that the plateau is not yet isostatically compensated. A general subsidence of the plateau as a complete crustal block would bring the region into compensation.

The interplateau region (Fig. 4) also shows positive anomalies over most of its extent; farther west a negative area at the base of the continental slope in the west marks a basin feature which may be an offshore extension of the Laura Basin, which lies just below the southern limit of Figure 4. Further traversing is needed to resolve this possibility.

Magnetic results

As may be expected from the generally deep sedimentary cover, the area is magnetically quiet. Anomalies with respect to the International Geomagnetic Reference Field are shown in Figure 3; they range from -100 to +275 gammas. The Aure-Moresby Trough does not exhibit more than a weak magnetic trend; the long-wave length anomalies in the region indicate a great depth to basement. High-amplitude, short-wavelength anomalies arise from the area of modern reefs (Fig. 4) which are superimposed on positive structures in the crystalline basement. The largest positive magnetic anomaly is associated with the scarp in the east of the interplateau region; it owes its origin to intrusives, which have been identified on seismic sections and which penetrate to the seabed just west of the scarp ("Rift Feature", Fig. 4).

Several of the deep-water magnetic anomalies south of 11°S are extended in a north-south direction and form a pattern converging toward the central Gulf of Papua, mirroring the overall fan-shaped aspect of the bathymetry. The source of these anomalies cannot be identified on seismic section, but it is suggested that they arise from deep intrusions injected along faults in the basement material.

Seismic results

Ejective folding is characteristic of the Aure Trough and was traced from the shelf into the deep water of the Moresby Trough, where the folds often show a bathymetric expression. This lends weight to the interpretation that the two troughs are essentially the same feature. Basement cannot be identified in the trough, nor with certainty anywhere in the region except near areas of reef development where it forms structural highs, the reef growth arising from close to basement level. This observation identifies the source of the short-wavelength anomalies discussed above. Sediments in the Pandora Basin are flat-lying and well stratified, ponded between the reef structures.

On the Eastern Plateau, a marked unconformity approximately 500 metres below the sea floor is general. In appearance it is very similar to the 'S' horizon of the Coral Sea Plateau to the south described by Ewing, Houtz & Ludwig (1970). If these two unconformities can be correlated this would provide

strong evidence that the two plateaus once formed a continuous terrace along the Queensland coast and into the Gulf of Papua. In a similar situation to the Queensland Trough, the Portlock (or Bligh) Trough is interpreted from seismic and bathymetric studies as a graben, making the northern area structurally analogous to the Coral Sea Plateau - a submerged block of continental material separated from the mainland by a tension faulted graben (Ewing et al, loc. cit.).

Discussion

Crustal thicknesses shown in Figure 4 and the cross-sections of Figure 5 were derived from gravity profiles and define tectonic units within the region. Crustal thinning associated with the Aure-Moresby Trough is found to parallel the Papuan coast and separate it from the block of sub-continental material forming the Eastern Plateau. Sub-oceanic thicknesses (15-20 km) in the interplateau region suggest that it too may be an area of subsidence.

The origin of all major features may be understood in the framework of an extensional environment, and a plausible geological history may be summarized as follows: Pre-Tertiary erosion and sedimentation formed continental margin deposits and created a low-relief landform to the edge of the now submerged plateaus. This was followed in the early Tertiary by the opening of the Coral Sea (Gardner, 1970). A concomitant rift was formed to the east of the interplateau region and New Guinea was rotated to its present location. The Aure-Moresby Trough was created by tensional thinning of the crust. Deposition in this trough began after the orogenic rise of New Guinea, and subsidence which began along the east coast formed the marginal plateaus which are still subsiding towards isostatic equilibrium. Tension faults arose on the continental side of the plateaus and created troughs which act as an avenue for sediment transport to the Coral Sea Basin.

The pre-rotational position of New Guinea may be recreated by matching the scarp (rift) feature (Fig. 4) with the northeastern edge of the Papuan Plateau.

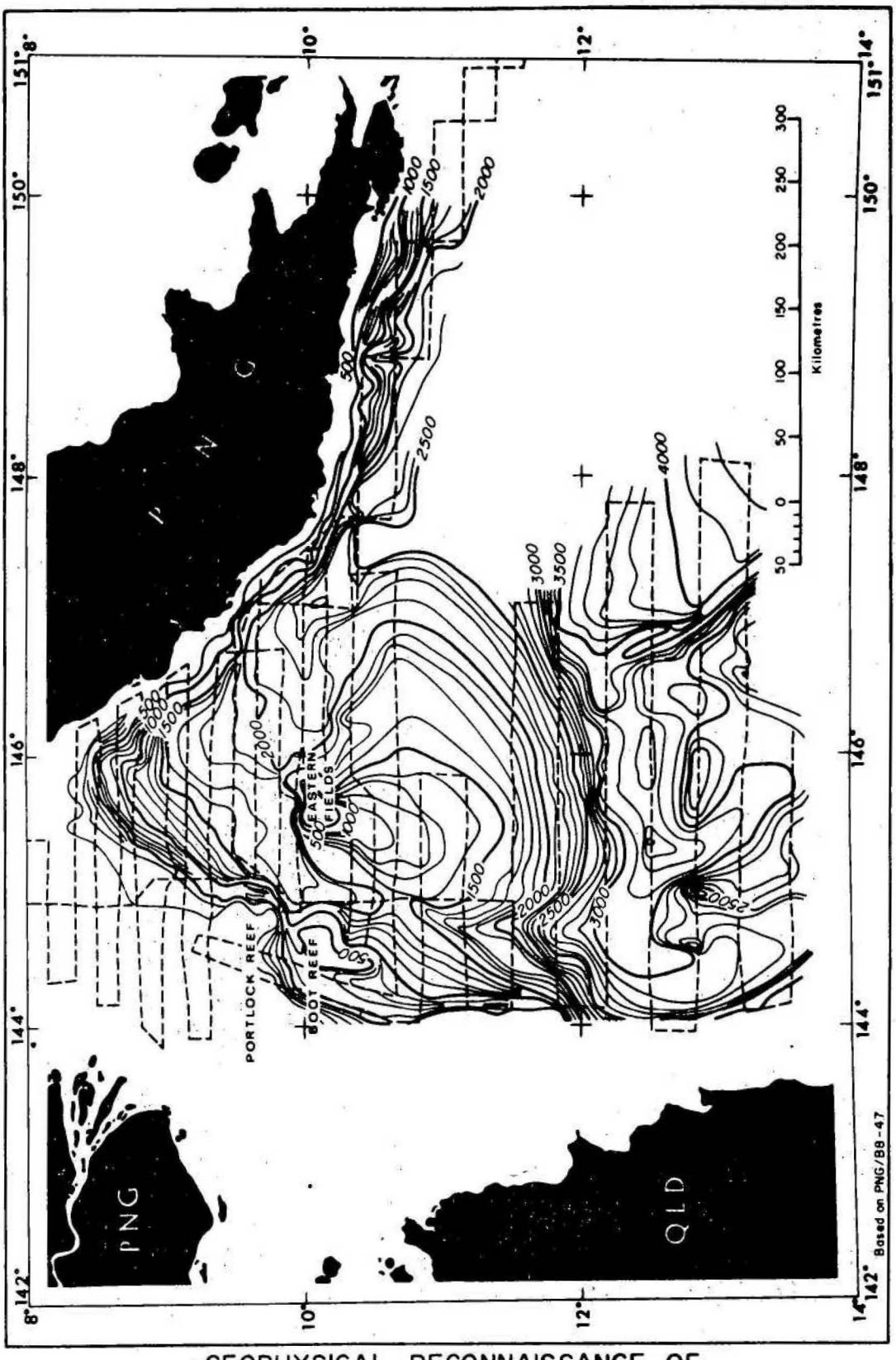
References

EWING, J.I., HOUTZ, R.E., & LUDWIG, W.J., 1970 - Sediment distribution in the Coral Sea. J. geophys. Res., 79(11), 1963-72.

GARDNER, J.U., 1970 - Submarine geology of the western Coral Sea. Bull. geol. Soc. Amer., 81, p.2599-614.

FIGURE TITLES

Figure 1. Bathymetric Contours with traverse plan
Figure 2. Free Air Anomaly Map
Figure 3. Magnetic Anomaly Map
Figure 4. Structural Map showing Crustal Thicknesses
Figure 5. Crustal Sections derived from Gravity Results



GEOPHYSICAL RECONNAISSANCE OF
THE GULF OF PAPUA & N.W. CORAL SEA, 1970.

BATHYMETRY AND TRAVERSES

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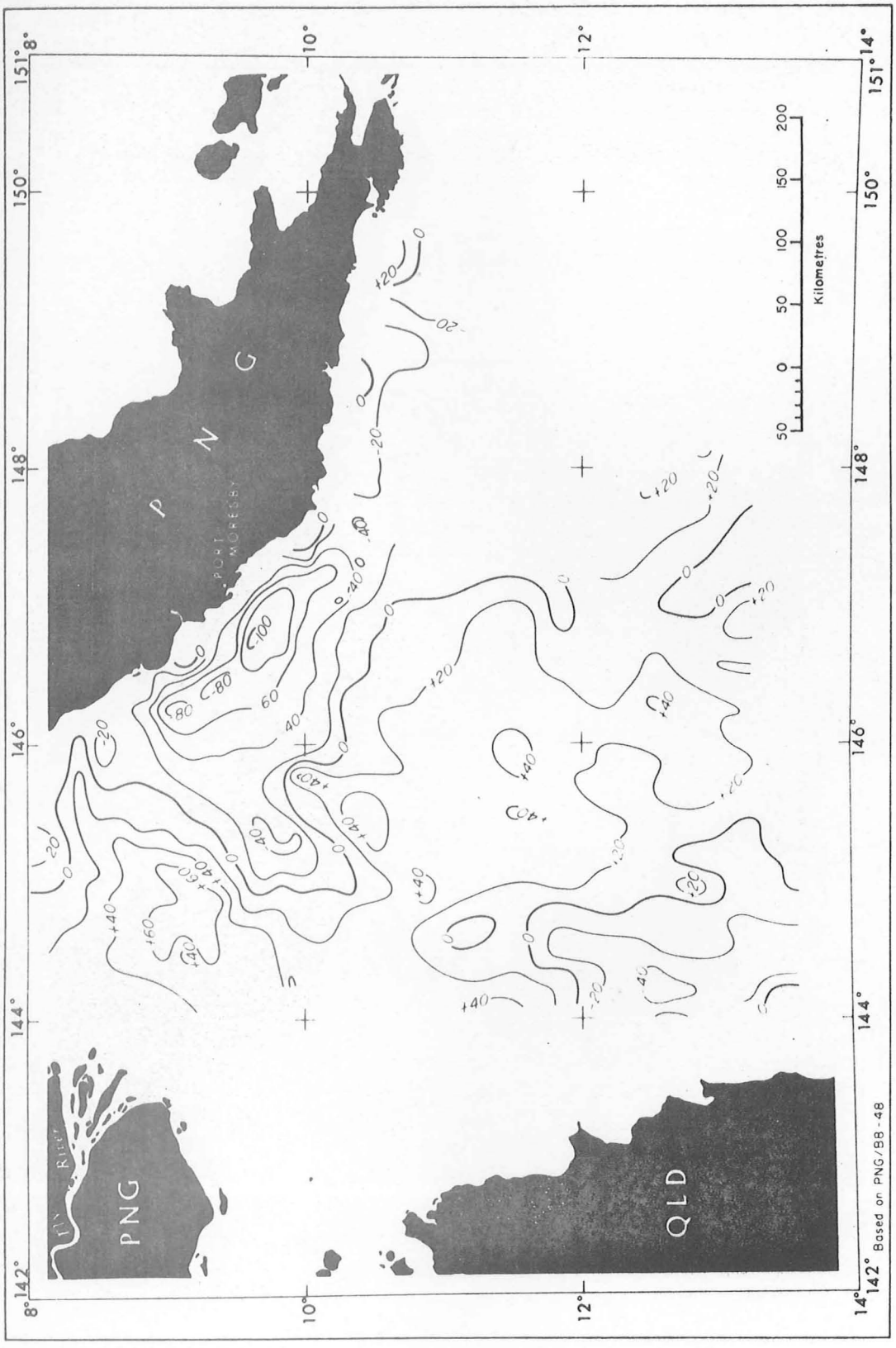
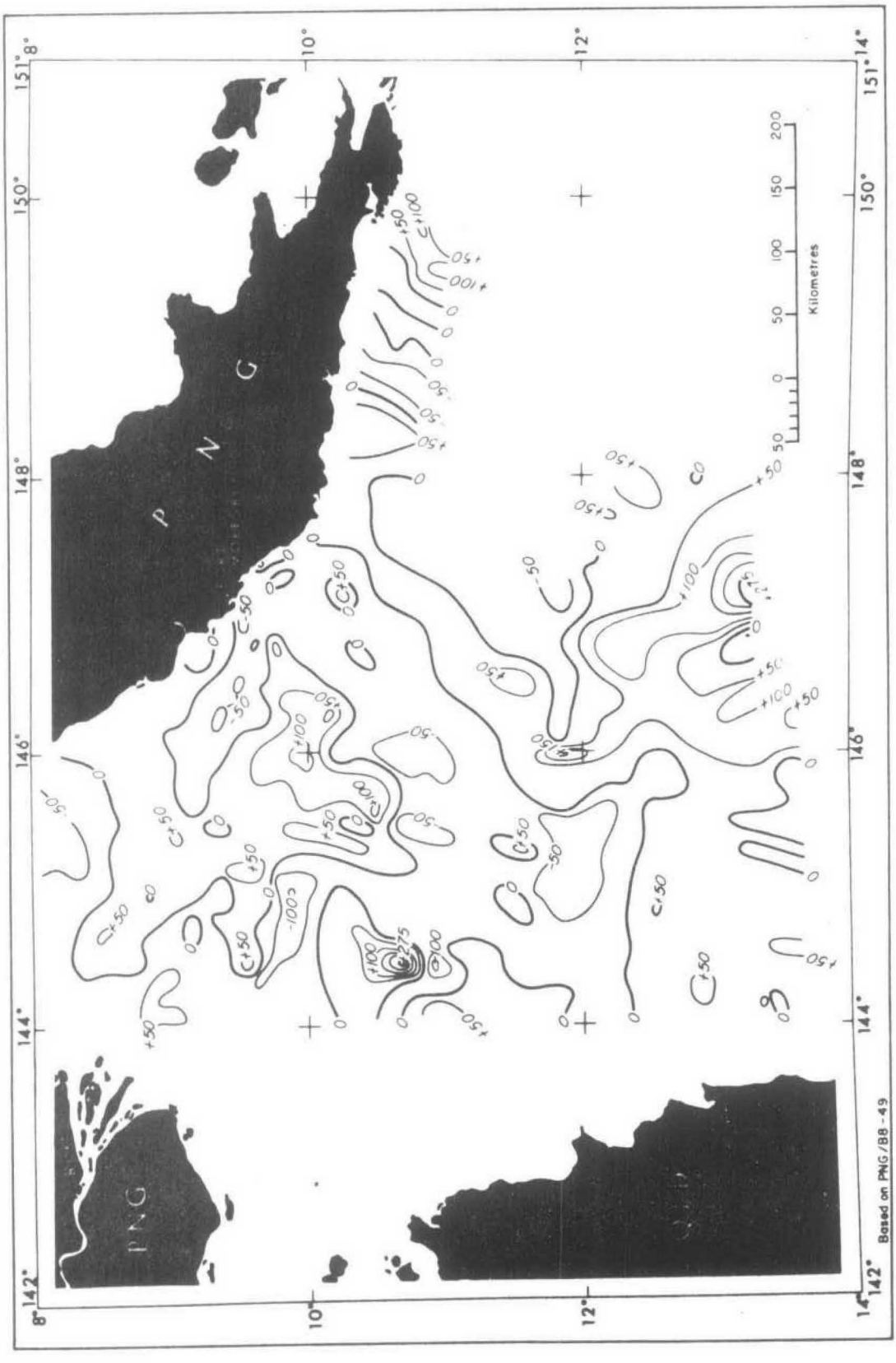


FREE AIR ANOMALIES



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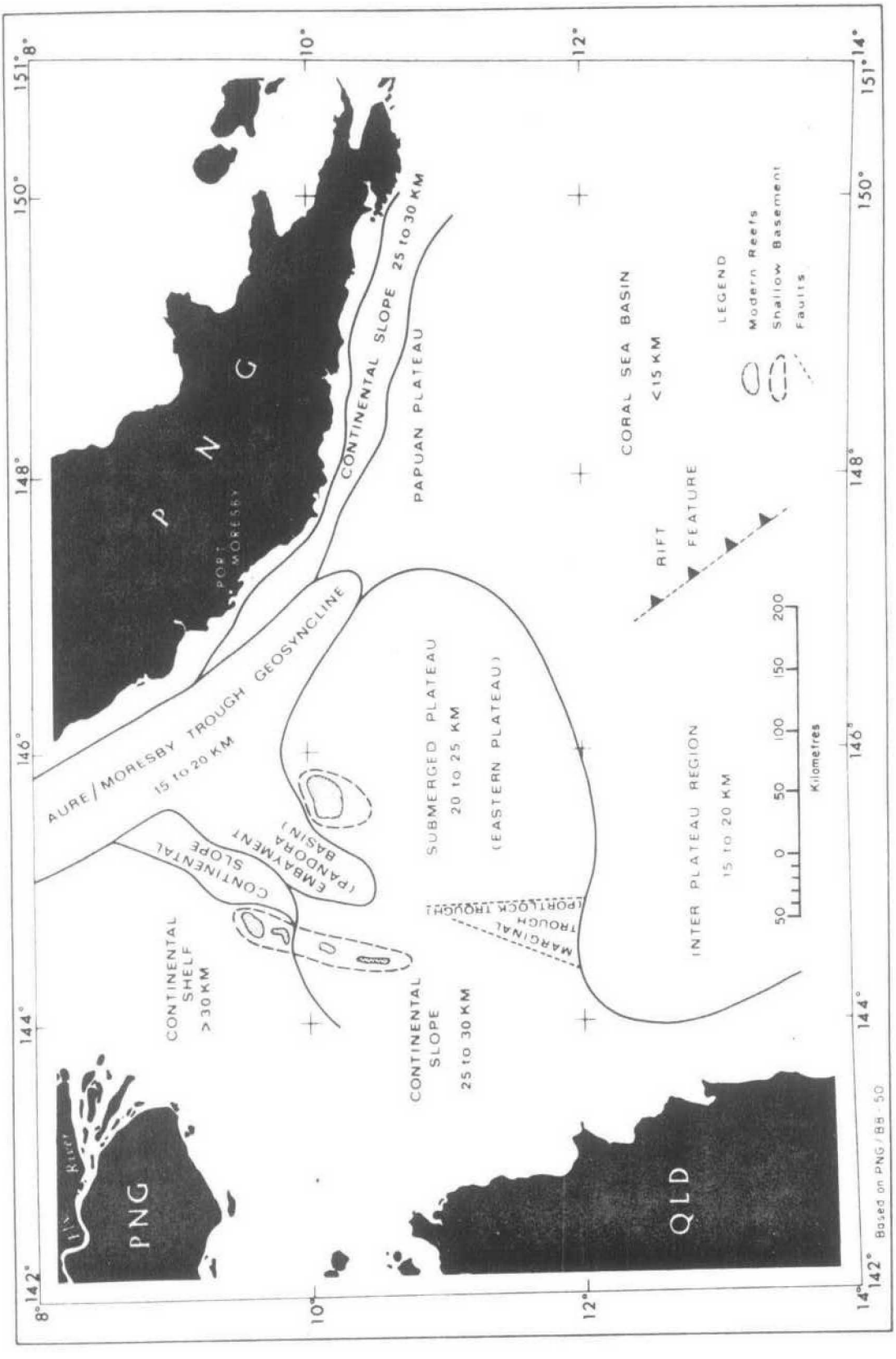
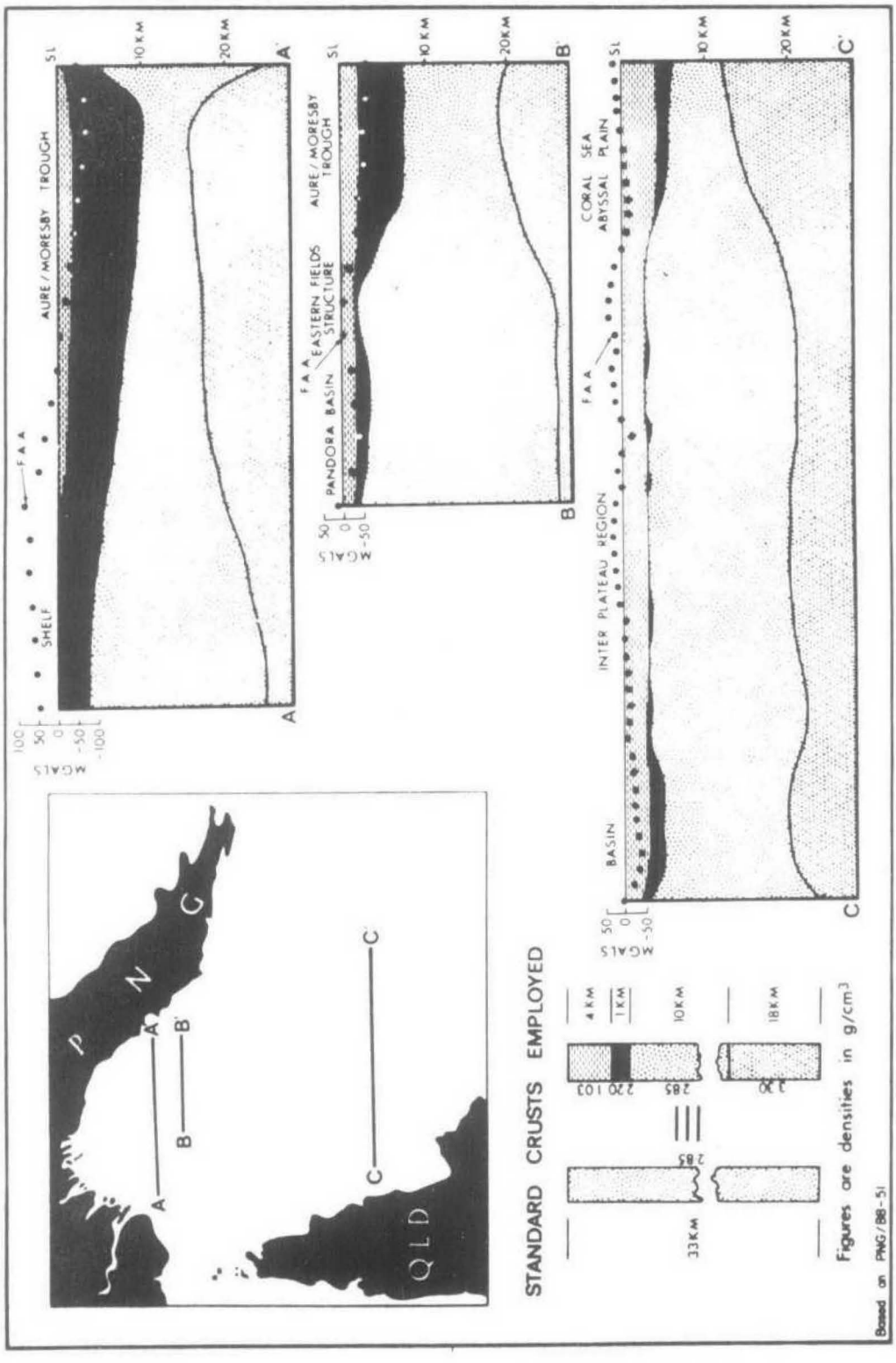
MAGNETIC ANOMALIES


P N G
PORT MORESBY
PAPUAN PLATEAU
CONTINENTAL SLOPE 25 to 30 KM
CORAL SEA BASIN
<15 KM
RIFT FEATURE
LEGEND
Modern Reefs
Shallow Basement
Faults
AURE/MORESBY TROUGH GEOSYNCLINE
15 to 20 KM
SUBMERGED PLATEAU
20 to 25 KM
(EASTERN PLATEAU)
EMBAYMENT SLOPE (PANDORA BASIN)
CONTINENTAL SHELF >30 KM
CONTINENTAL SLOPE 25 to 30 KM
MARGINAL TROUGH (PORTLOCK TROUGH)
INTER PLATEAU REGION 15 to 20 KM
Kilometres
PNG
QLD
Fly River
Based on PNG/B8-50

STRUCTURE



CRUSTAL SECTIONS
DERIVED FROM GRAVITY RESULTS

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