DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1973/145

THE BOUNDARY OF THE AUSTRALIAN CONTINENT

(Notes to accompany the BMR 1:10 000 000 map, including an appendix by Division of National Mapping).

by

A. Turpie

THE BOUNDARY OF THE AUSTRALIAN CONTINENT

The Division of National Mapping has drawn lines representing the foot of the continental slope and the foot of the continental rise (edge of the margin) based solely on bathymetry (ocean depth measurements). They have provided accompanying notes (Appendix 1) that point out difficulties met in drawing the lines. The lines have been transferred to a transparent overlay to the BMR 1:10,000,000 map. Also provided is an idealized drawing (Fig. 1) of a simple continental margin which serves to define the terms used.

The Earth's crust, which rests on the denser rocks of the mantle, is 30 to 40 kilometres thick under the continents but only 10 or so kilometres thick under the deep ocean floor. This thinning of the crust from continent to ocean is not abrupt, but takes place across a transition zone beneath the continental margin.

In the simplest case shown in Figure 1, the continental margin consists of :

(1) A prolongation of the continent out to a water depth of about 200 metres, called the continental shelf.

(2) A steep continental slope from the edge of the shelf down to water depths of 2000 to 5000 metres. (Around Australia generally between 4000 and 5000 metres.)

(3) A continental rise sloping downward gradually from the base of the slope to meet the ocean floor (abyssal plain).

The foot of the continental rise is the farthest limit that could be suggested as a continental boundary.

Geologically the continental slope may be thought of as the boundary of the 'continental block'. Sediments that form the rise beyond the foot of the slope, although mainly of continental origin, will have been laid down after a different fashion and in a different (deep sea) environment from sediments on the shelf and slope. They are not expected to have as great a potential for oil, and difficulties of exploitation increase at the greater depth.

Most of the Australian margin is more complex than a simple combination of shelf, slope, and rise. In several places around Australia there is a shelf followed by an upper slope, then a plateau, and then a second slope. These plateaus are largely foundered pieces of the Australian continent except perhaps for the Naturaliste Plateau, which may be an upthrust piece of ocean floor; also some of the sediments on these plateaus have been laid down behind 'dams' at their outer edges. In some places the rise is absent or is not well defined.

Appendix 2 provides notes on the various separate areas of the margin with diagrammatic cross-sections of several of the areas.

The questions that we have set out to answer are :

- what may properly be regarded as the boundary of the Australian continent?
- how is this boundary best indicated?

In trying to answer these questions, lines have been drawn on the map to indicate :

- the 200-metre depth contour
- the 2500-metre depth contour
- the 4000-metre depth contour
- a transition zone (shaded) from continental to oceanic crust (interpreted from gravity measurements - see Appendix 3).

A line 200 miles from the coast is drawn on the map for comparison.

Fairly generally, the National Mapping foot of the slope line coincides with the crustal transition zone as drawn on the BMR 1:10,000,000 map and also with the 4000-metre line except around the Coral Sea Plateau, over the Tasmanian Ridge, and around the Wallaby Plateau.

The foot of the continental slope line circumscribes most of the important sedimentary areas except for the Lord Howe Rise, the Wallaby Plateau, and thick sediments in deep water in the Great Australian Bight and off the west coast between the Wallaby and Naturaliste Plateaus. The full extent and thickness of these deep-water sediments is not known, but they are probably circumscribed by the National Mapping foot of the continental rise line.

Present information indicates that the Lord Howe Rise is separated from the Australian mainland by a zone of igneous rocks that forms the floor of a trough over most of its length. There is less information concerning the Wallaby Plateau, but it is separated from the mainland by a trough about 4000 metres deep.

In summary, there is no single easily and directly measurable parameter that may be used to define the geological boundary of the Australian continental mass. It is contended that the boundary of the continent is best drawn on a basis of crustal thickness and this line is in fair agreement with that drawn by National Mapping as the foot of the continental slope. However, it is to be remembered that the continental slope is not well defined in several places and parts of this line are based on subjective judgment. An alternative boundary is the 4000-metre line, where it is in agreement with the crustal transition zone, supplemented by straight line segments between geographical points as necessary in other areas.

APPENDIX 1

Notes to accompany diagram showing approximate base of continental slope and edge of continental margin around Australia

Figure 1 illustrates the terms used in these notes and provides a very generalized cross-section of the area under study.

Information for this study was taken from the provisional bathymetric plots at 1:1,000,000 scale produced during the BMR margin survey and was supplemented by 1:1,000,000 GEBCO*plot sheets where necessary.

In some areas, particularly for the delineation of the edge of the margin, insufficient data were available for more than an approximation of the position; more detailed study of existing information may vary the positions slightly in some areas, but more data would have to be acquired to improve the delineation in others.

The base of the continental slope is generally quite easily defined except in the following areas :

At the southern extremity of the Coral Sea Plateau a large re-entrant slopes gradually up to the continental shelf with no well defined region of major slope. The line adopted for the foot of the continental slope here is a continuation of the better defined lines for the continental slopes on either side of this feature.

In the Naturaliste Plateau region there are two well defined slopes, each approximately 2500 metres deep; one divides the continental shelf from the plateau while the other forms the outer edge of the plateau where it rises from the deep ocean floor. On present criteria the foot of the slope could be drawn around either of these, but other considerations would probably dictate that the plateau should be included in the area enclosed by the line adopted.

As previously mentioned, the edge of the margin is less easily defined owing to lack of data and to the less obvious demarcation between the gently sloping rise and the flat abyssal plain.

In the area east and south of the Coral Sea Plateau the edge of the margin has been drawn generally through the middle of the numerous saddles and depressions in this area of broken relief.

Structures of the same type occur south of Tasmania where there is no well defined rise or abyssal plain. Again the line has been drawn through the first saddle eastward from the base of the slope, as an attempt to follow the edge of the abyssal plain would result in the inclusion of an extensive area that could hardly be considered part of the continental rise.

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The Wallaby Plateau has been excluded from the continental margin as there are deep re-entrants in the north and south which virtually divide the plateau from the continental mass. There may be some justification in including the plateau by taking the edge of the margin line around its western extremity but this region is very broken, and insufficient data are available to permit a worthwhile attempt at delineation.

It should be noted that this study has been based entirely on the relief of the continental margin area and that geological information has not been considered. The study has, of necessity, been very brief but a more elaborate investigation seems hardly warranted at this stage owing to lack of accurate information in many areas and to the uncertainty that boundaries of this nature will be adopted internationally.

Division of National Mapping

29 June 1973.

APPENDIX 2

Areas of the Australian Continental Margin

Only about 30% of the length of the Australian continental margin is of the simple form of shelf, slope, and rise shown in Figure 1. The remainder of the margin is complex and appears to be greatly affected by horizontal and vertical movements of blocks of continental-type crust, possibly caused by the rifting apart of the continents a few tens of millions of years ago. The margin can be divided into eleven zones, each of which has differing characteristics, and these are best discussed in turn moving clockwise round the continent. The areas where the Australian boundary is or will be determined by political agreement or median line considerations are excluded from this discussion.

1. Coral Sea Plateau (Fig. 2)

An area of crustal thickness 25-30 km with a sedimentary cover 1.0 to 1.5 km thick. The Queensland Trough between the plateau and continent is filled with a large wedge of sediments of likely continental origin. Problems occur in defining the border with the Lord Howe Rise if bathymetry or slope is used, but a crustal transition zone does intervene.

2. Lord Howe Rise (Fig. 3)

A continental feature with crust 25-30 km thick. Thick sediments are believed to occur over much of the Rise. The Tasman Basin almost completely separates the Rise from the Australian mainland. Seismic evidence suggests that the Lord Howe Rise is structurally separated from Australia despite its proximity.

3. Tasmanian Ridge (lat. 44°- 46°S)

A saddle in the bathymetry connects Tasmania to the ridge farther south. The saddle appears deficient in sediments, but farther south metamorphosed sedimentary rocks have been found in a JOIDES drill hole. The saddle falls within the crustal transition zone and this combined with an offset between the ridge and Tasmania suggests a geological break between the two. The standard slope and 4000-m line are not found between the two areas.

4. Victoria, Tasmania, and NSW coasts (Fig. 3)

Closest to the simple type of margin (Fig. 1) with sediments mainly on the shelf and slope. The sediments in the Tasman Basin appear to have been deposited in deep water. The slope, the transition zone, and the 4000-m line almost coincide.

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5. Great Australian Bight (Figs 4 and 5)

There is generally less than 0.5 km of sediments on the continental shelf in this area. The Eyre Plateau (Fig. 5) is a basement terrace overlain by thin sediments and with a low basement ridge on its southern edge. An unusually wide continental rise is an area of thick sediments, in excess of 2 km, extending from the southern edge of the Eyre Plateau to a basement ridge along latitude 35°30'S and possibly beyond. The Ceduna Plateau (Fig. 4) is underlain by probably 4 km of sediments which are dammed behind a basement ridge at their southern edge. South of the Ceduna Plateau the continental rise consists of wedges of sediments 1 to 2 km thick.

6. Naturaliste Plateau (lat. 33°- 36°S) (Fig. 6)

An area of intermediate crustal thickness (20-25 km), but appears to be continuous with the continent. Sediment thickness is generally 1 km or less, but large sedimentary pockets occur, especially near the inner slope. Inner and outer slopes are of about equal steepness and relief. The outer edge of the plateau is closely paralleled by the foot of outer slope, the transition zone, and the 4000-m line.

7. Western Coast (lat. 26°- 33°S)

Closer to the simple form of margin than most, but greatly dissected by canyons. Thick wedges of sediment exist in deep water, but these are of limited extent as shown by JOIDES drilling. The western seaboard is greatly affected by faults with large vertical movements, e.g. in the Perth and Carnarvon Basins, which could extend past the edge of the continental shelf. The foot of the slope, the crustal transition zone, and the 4000-m bathymetric contour are close together in this zone.

8. Wallaby Plateau (lat. 22°- 24°S)

An area of transitional crustal thickness which appears to contain fragments of continental crust within it. A sedimentary sequence of moderate thickness exists on the plateau. Geological affinity with the Australian continent is uncertain. The crustal thickness in a wide zone between the plateau and the continent is transitional. The saddle to the east of the plateau is almost 4000 metres deep, and the continental slope and rise are difficult to define.

9. Exmouth Plateau (lat. 16°- 22°S)(Fig. 7)

An obviously continental block about 30 km thick, covered by thick sediments. These sediments appear to be dammed by a basement ridge along the outer edge of the plateau. Two slopes are discernible along the inner and outer edges respectively. The outer slope is steeper and has greater relief. The outer edge of the block corresponds with the steeper slope, the transition zone from continental to oceanic crust, and in part with the 4000-m bathymetric contour.

..../

10. Northwest Margin (lat. 12°- 16°S)

A region of continental crust covered by about 5 kilometres of sediments, which are known to be petroliferous. There is a poorly defined inner slope and a more pronounced outer slope. Wedges of sediment extend from the mouth of canyons, which disect the outer slope. The transition zone, the foot of the slope and the 4000 metre line roughly coincide.

11. Timor Trough Region (long. 122°- 132°E)

In this region continental crust thickens gradually from the Australian coast to reach 40-50 kilometres beneath Timor. Thick petroliferous sediments occur on the Australian shelf and also within the trough. The 4000 metre isobath is absent in this region.

APPENDIX 3

Notes on depths to the base of the crust as a criterion

It should be pointed out that depths to the base of the crust interpreted from gravity data are not direct measurements as in measured depths to sea bottom, and the interpreted depths are only accurate as an order of magnitude because of various unknown factors. Seismic soundings give more direct and accurate measurements of depths to the base of the crust. Only a few such seismic measurements have yet been made around the margin of the continent. These have been used to control the interpretation of depths from gravity measurements.

It is preferable that the interpreted depths to the base of the crust should not themselves be used as a criterion but that they should be used as a means of justifying a criterion based on a direct measurement, for instance the foot of the slope or the 4000-m contour, each of which is based directly on depth measurements.

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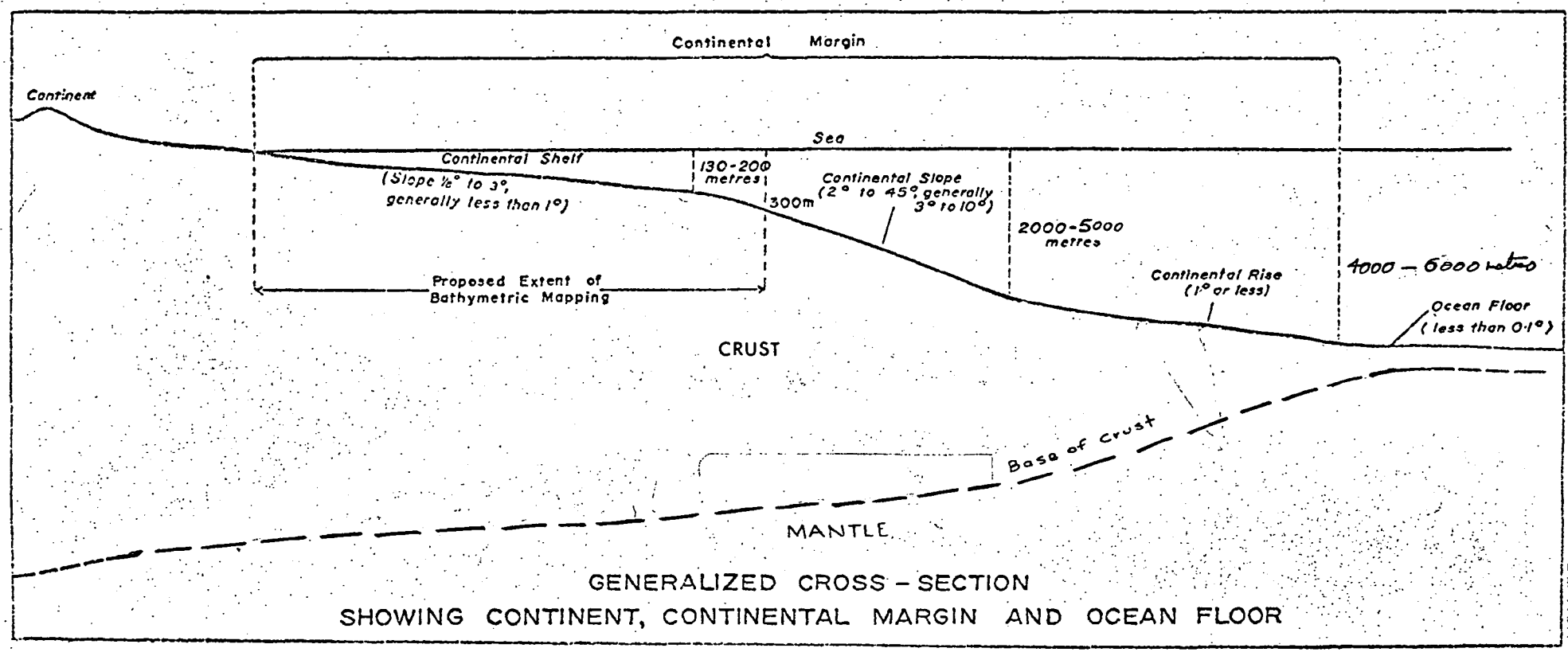
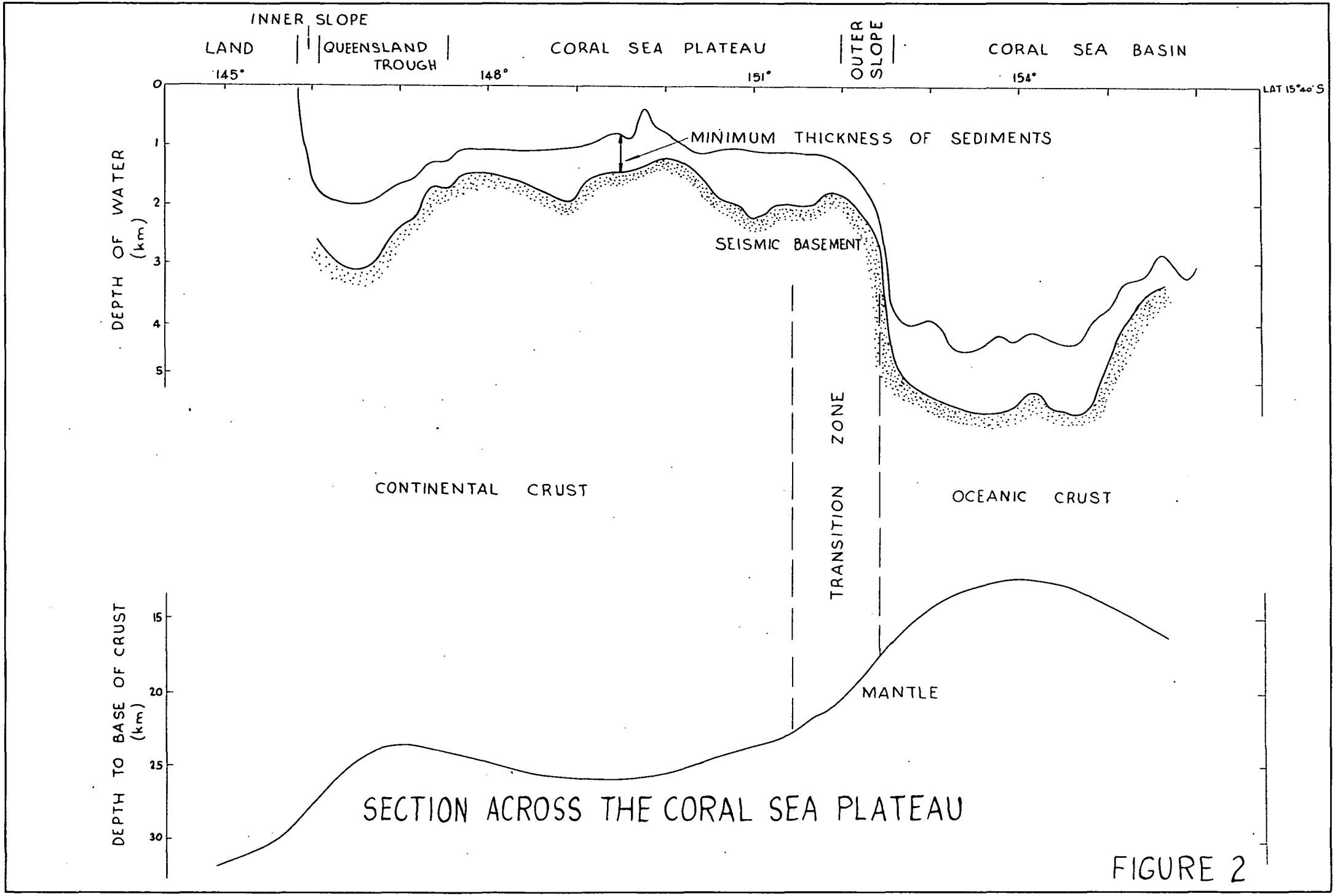


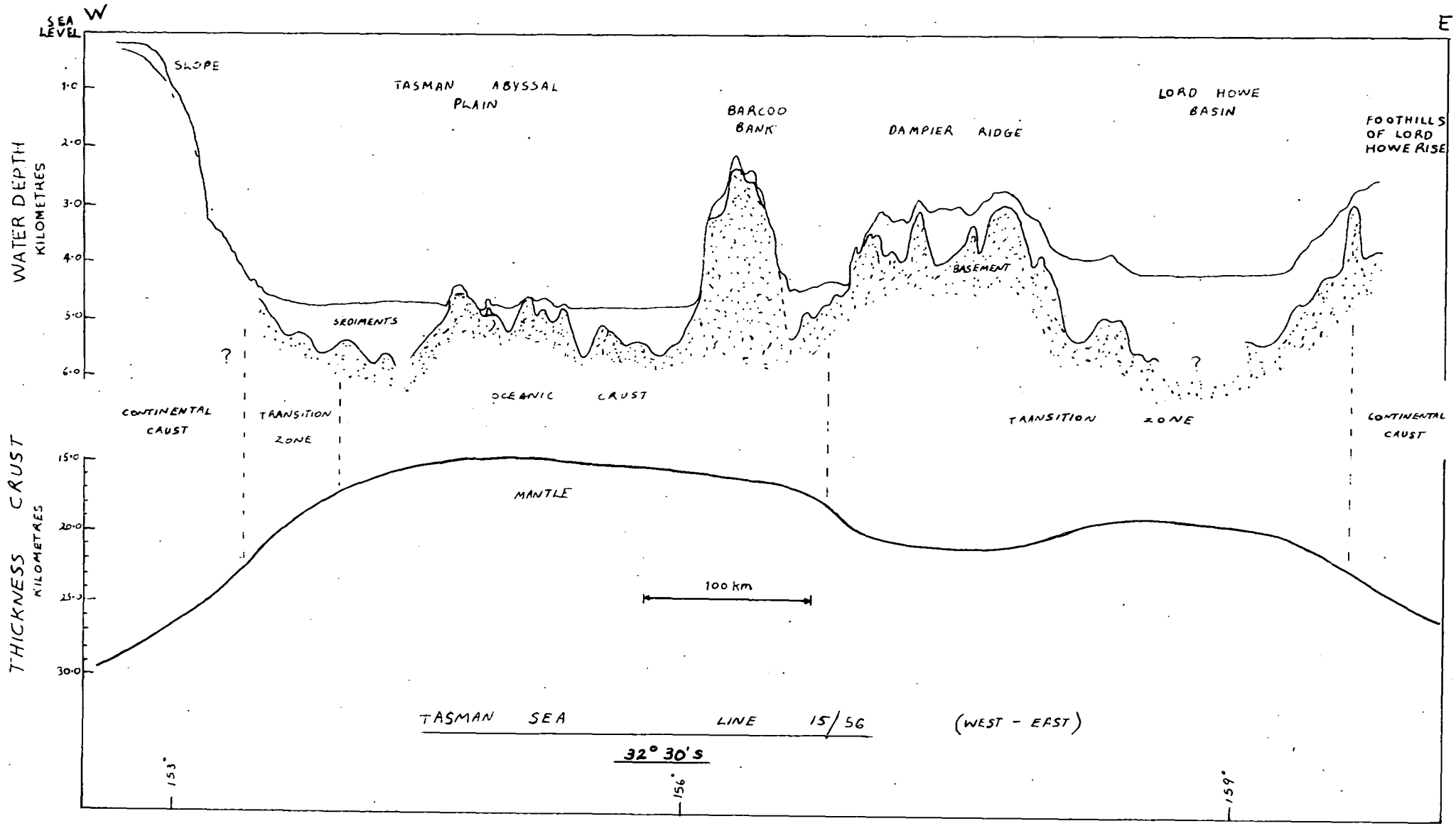
GENERALIZED CROSS – SECTION
SHOWING CONTINENT, CONTINENTAL MARGIN AND OCEAN FLOOR

FIGURE 1



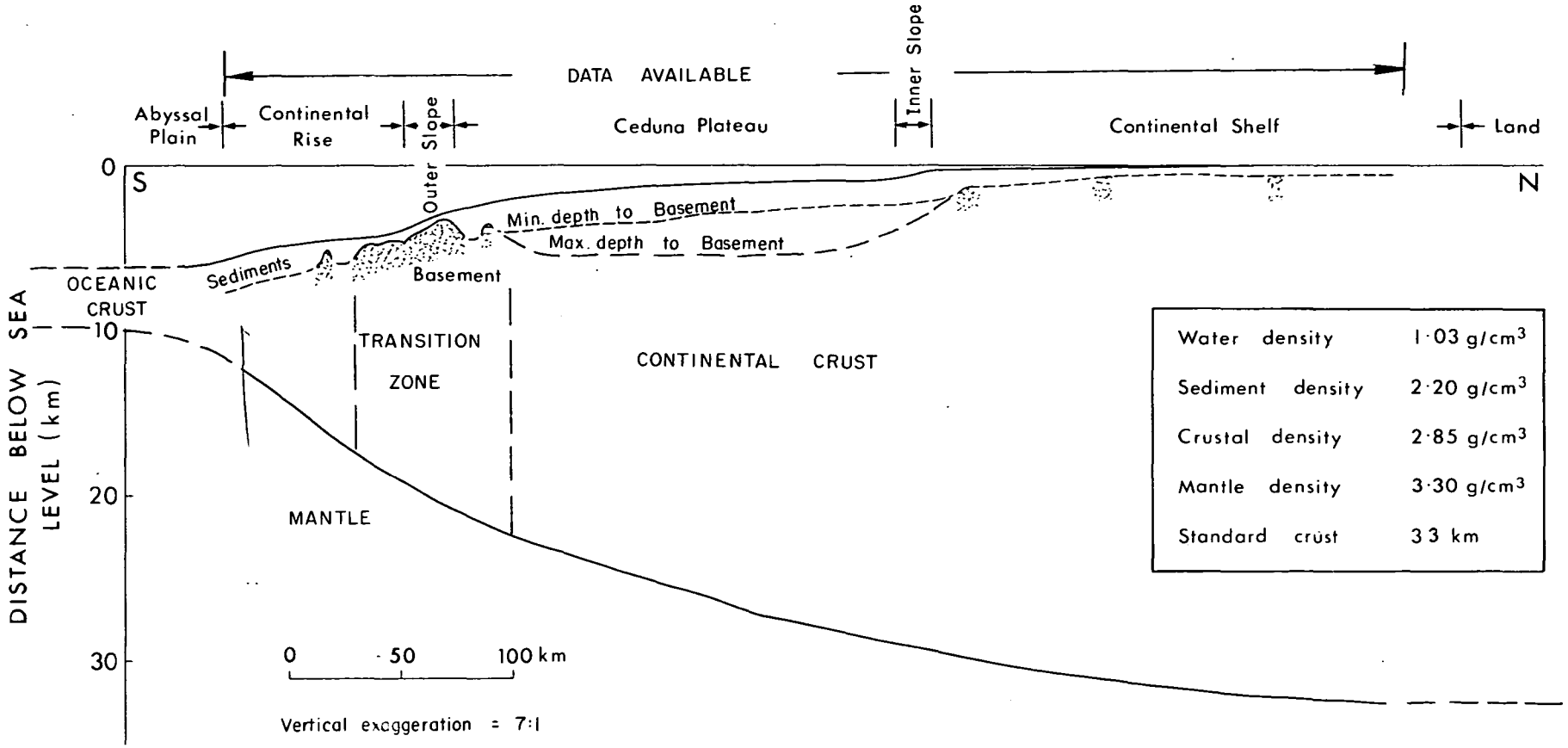
SECTION ACROSS THE CORAL SEA PLATEAU

FIGURE 2



SECTION ACROSS THE TASMAN BASIN

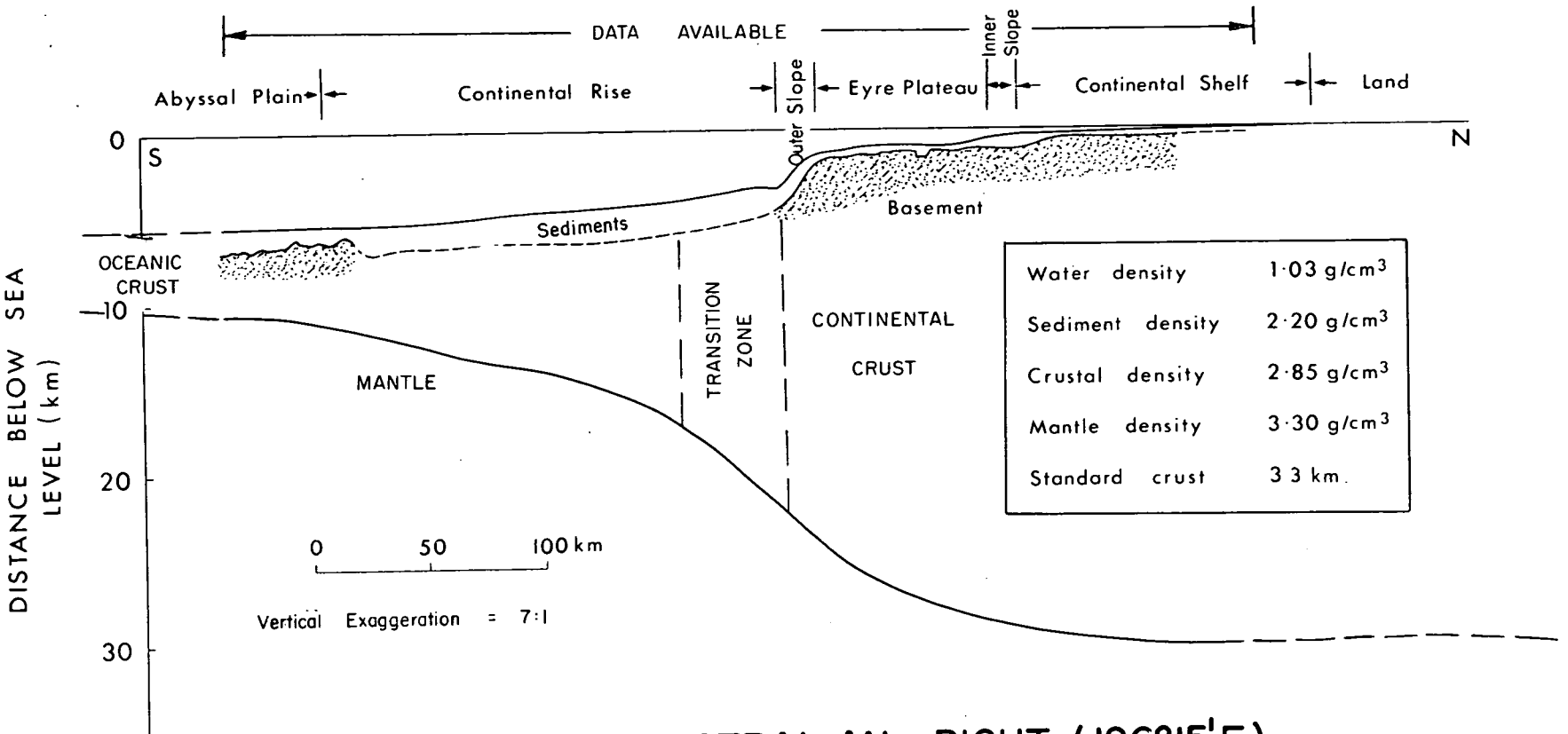
FIGURE 3



GREAT AUSTRALIAN BIGHT (130°35'E)

SECTION THROUGH THE CEDUNA PLATEAU

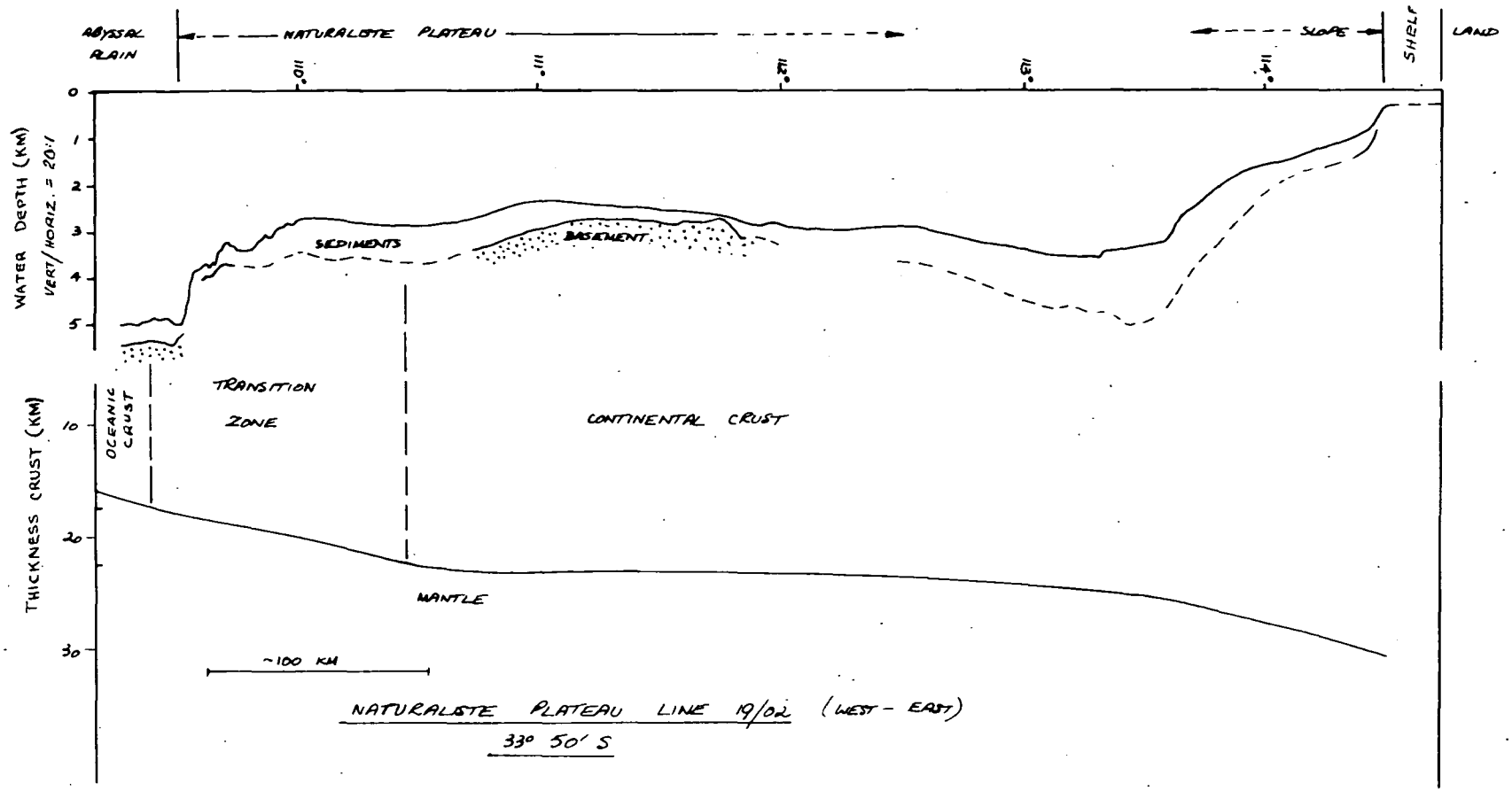
FIGURE 4



GREAT AUSTRALIAN BIGHT (126°15'E)

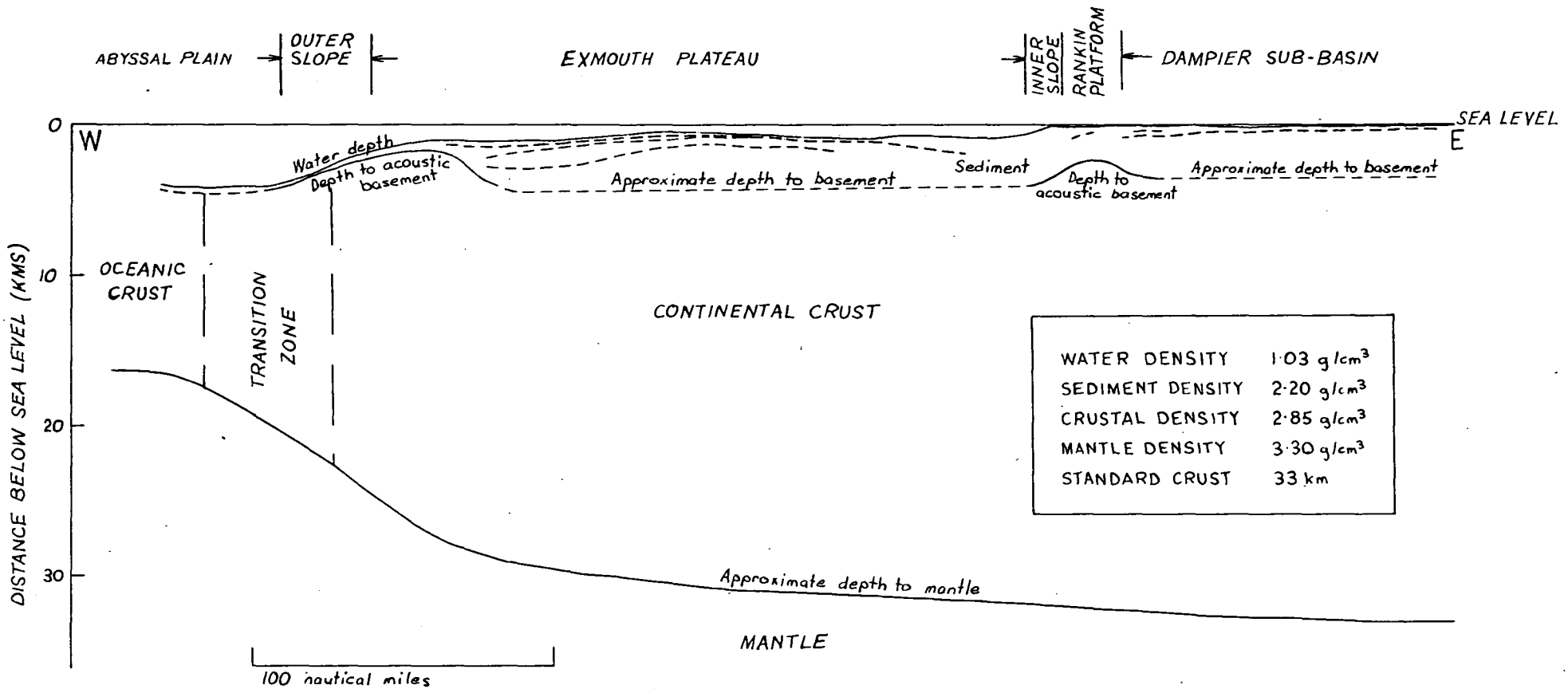
SECTION THROUGH THE EYRE PLATEAU

FIGURE 5



SECTION THROUGH THE NATURALISTE PLATEAU

FIGURE 6



SECTION THROUGH THE EXMOUTH PLATEAU (20°S)

LINE 67 (WEST-EAST)

FIGURE 7

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1973/145 (Addendum)

THE BOUNDARY OF THE AUSTRALIAN CONTINENT
(Notes to accompany BMR 1:10 000 000 map)

ADDENDUM No. 1

by

A. Turpie

THE BOUNDARY OF THE AUSTRALIAN CONTINENT

In this addendum further analyses of Bureau and other data have been used to clarify concepts of areas where connexions with the Australian continent were less clear and areas outside the 200 nautical mile line.

Additional sections have been provided: across the southern Coral Sea, from Rockhampton east to the northern extension of the Lord Howe Rise (Fig. 8); through the Tasmania Ridge (Fig. 9); and through the Wallaby Plateau (Fig. 10).

Contours have been added to the BMR 1:10 000 000 map in the areas of the Tasmania Ridge and the Wallaby Plateau.

A second overlay to the BMR 1:10 000 000 map has been provided titled "Sedimentary Thicknesses on the Australian Continental Margin."

Positions of JOIDES drill sites have been marked on the second overlay. Appendix 4 gives comments on the findings of the JOIDES holes.

The section across the southern Coral Sea shows that the Marion Plateau, a prolongation of the Australian continent, is separated from the Lord Howe Rise by the 3000 metre deep Cato Trough and the Kenn Plateau, the latter an area of submarine igneous basement covered by a thin layer of sediments. It is not thought that the Lord Howe Rise or Bellona Plateau can be claimed as part of the Australian continent although it probably was in past geological time. On the other hand the Lord Howe Rise is joined to New Zealand on a broad front at water depths less than 2000 metres.

The major feature of the Tasmania Ridge is seen on the 1:10 000 000 map to be the South Tasman Rise which rises to a depth of 1000 m at a point 380 km south of Tasmania. The topography of the ridge makes it appear to be a southern extension of the Tasmanian mainland although there is a trough more than 2500 metres deep separating the South Tasman Rise from Tasmania. The additional evidence of continental type mica schist breccia in JOIDES hole No. 281 would make it likely that the Tasmania Ridge is a part of the Australia continent. 277 000 sq km of the Tasmania Ridge lies outside the 200 nautical mile line. On present evidence the petroleum prospects of the Tasmania Ridge would be rated low; there is little information with regard to other mineral prospects. More information is needed.

The Wallaby Plateau is very different from the Exmouth Plateau to the north. It is a complex ridge-like feature rising to a maximum height at 2000 metres below sea level and connected to the base of the continental slope but also separated from it by a trough 4000 metres deep, the whole including the trough being elevated above the surrounding abyssal plain. Rifting and intrusion has taken place at both the inner

and outer boundaries of the plateau. Wedges of sediments up to one and a half kilometres thick appear on top of the plateau. While the tectonic origin of the feature is not clear, it must surely be regarded as part of a complex continental margin.

Parts of the margin indicated on the map fall outside the 200 nautical mile line in the following areas: the Lord Howe Rise, the Tasmania Ridge, and the Wallaby Plateau which have been discussed and the Coral Sea Plateau, the rise on a part of the Great Australian Bight, the Naturaliste Plateau, and the Exmouth Plateau.

About 150 000 sq km, of the Coral Sea and Marion Plateaus lie outside the 200 nautical mile line. The petroleum and mineral prospects of the relatively thin cover of Tertiary marine sediments over the Coral Sea Plateau would be rated low. Little is known of the pre-Tertiary sedimentary pile and further information is necessary to assess its potential. The thickness, nature, and prospectivity of the sediments in the trough separating the Coral Sea Plateau and the Marion Plateau are unknown.

An area covering about 30 000 sq km on the southern margin of the Ceduna Plateau in the Great Australian Bight is outside the line. The thick sequence of Upper Mesozoic and Tertiary sediments in this area may be prospective for petroleum, but the sedimentary structures of possible interest are in deep water.

On the Naturaliste Plateau about 59 000 sq km lie outside the line. The sedimentary pile is over 1.0 km thick on the western margin of the Plateau. Upper Cretaceous marine sediments were penetrated at the JOIDES site but nothing is known of the deeper sediments. Faulting on the eastern end of the plateau obscures the relation of the sediments to those in the east. More information is required to establish the mineral and petroleum prospects of the area.

An area of about 115 000 sq km of the Exmouth Plateau lies outside the line. The major part of the sedimentary sequence of probable Palaeozoic age, is overlain by a thin Mesozoic cover. The sediments are moderately folded. On present evidence the petroleum prospects would be rated low.

The BMR geophysical survey results provided the main source of information used in the compilation of the overlay showing sedimentary thicknesses. No distinction is made between deep-sea and shallow-water sediments. The contours indicate the minimum thicknesses of sediments, and further studies are required to establish maximum thicknesses.

APPENDIX 4

JOIDES HOLES

Hole Number	Co-ordinates S	E	Water Depth (m)	Penetration (m)	Comment
206	32°01'	165°27'	3196	734	Bottomed in mid-Eocene sediment. Basement probably not much deeper.
207	36°58'	165°26'	1389	513	359 m of sediment; oldest is late Cretaceous; basal 154 m is rhyolite which may be subaerial extrusive
208	26°07'	161°13'	1545	594	Bottomed in late Cretaceous sediment (chalk).
209	15°56'	152°11'	1428	344	Bottomed in mid Eocene shallow-water terrigenous sediment.
210	13°46'	152°54'	4643	711	Bottomed in mid Eocene chalk. Basement estimated to be over 1 km.
257	30°59'	108°21'	5278	326	Basaltic basement met at 262 m. Oldest sediment is mid Albian (lower Cretaceous)
258	33°48'	112°29'	2793	525	Bottomed in glauconitic sand (lower Cretaceous). Deep water turbidites believed to be a deep sea feature since lower Cretaceous.
259	29°37'	112°42'	4712	346	Basaltic basement met at 308 m. Oldest sediment is lower Cretaceous clay.
260	16°09'	110°18'	5709	331	Basaltic basement met at 322 m. Oldest sediment is lower Cretaceous ooze.
261	12°57'	117°54'	5687	579	Basaltic basement met at 532 m. Oldest sediment is ?Tithonian (upper Jurassic).
263	23°20'	110°58'	5065	756	Bottomed in lower Cretaceous glauconitic clay. Basement believed to be not much deeper.
264	34°58'	112°03'	2873	216	Bottomed in volcanic conglomerate. Basement may be either continental or oceanic. Oldest sediment is upper Cretaceous.
280	48°57'	147°14'	4181	524	Basaltic basement at 519 m (dolerite intrusion). Oldest sediment is mid to late Eocene glauconitic silty clay.
281	48°00'	147°46'	1591	169	Bottomed in late Eocene mica schist breccia. Continental basement must be very close.
282	42°15'	143°29'	4207	310	Basaltic basement met at 295 m. Oldest sediment is late Eocene.
283	43°55'	154°17'	4756	592	Basaltic basement met at 585 m. Oldest sediment is upper Cretaceous.
284	40°30'	167°41'	1068	208	Bottomed in late Miocene calcareous ooze. No evidence of basement depth.

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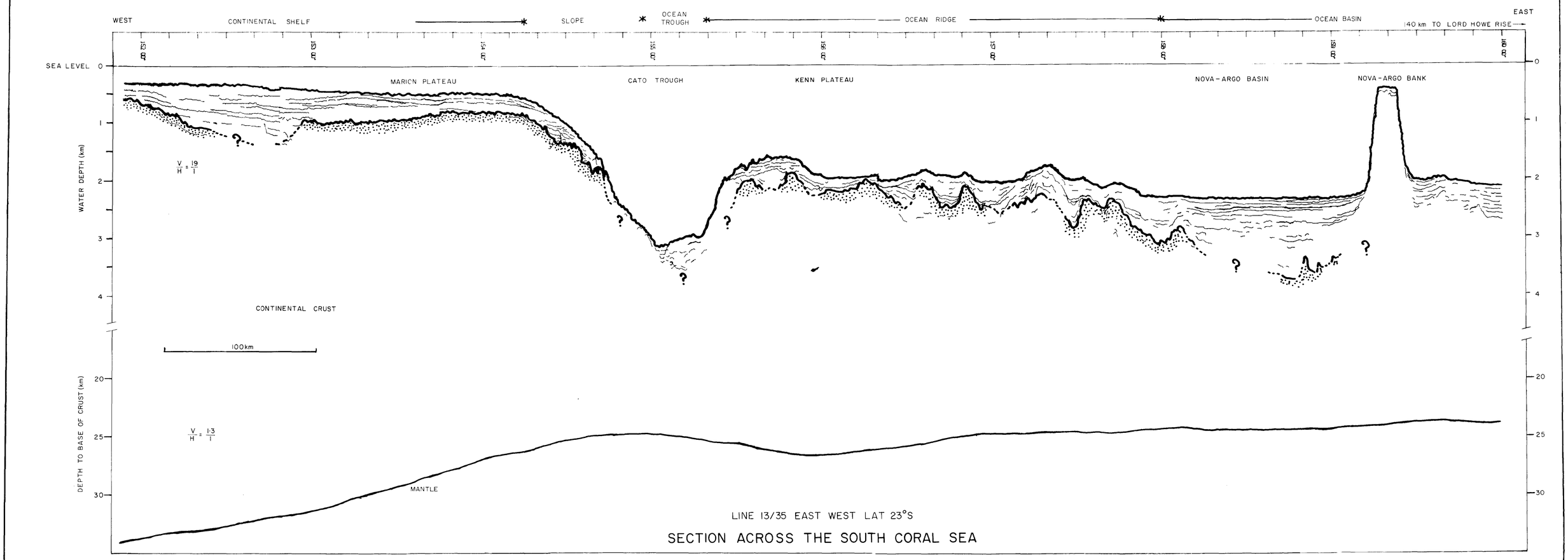
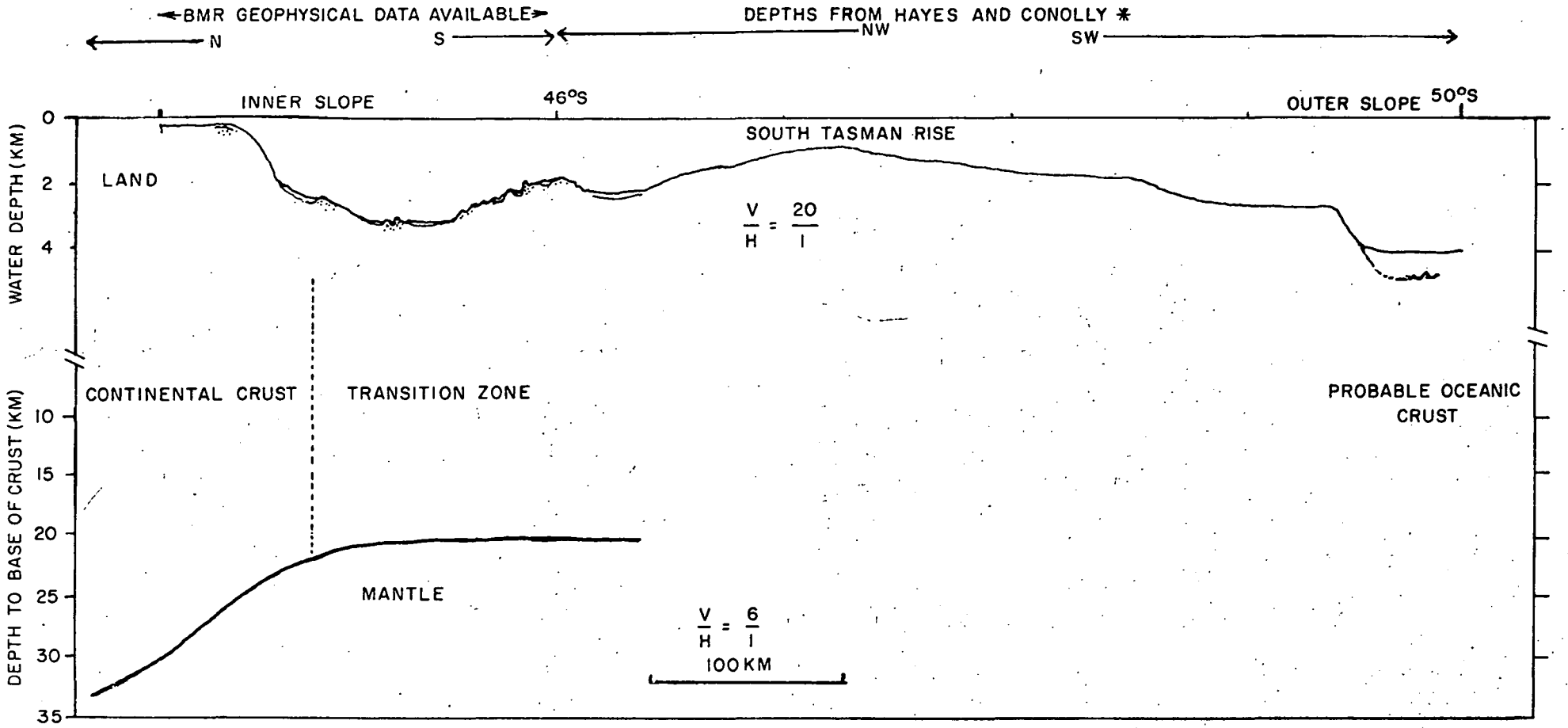
FIGURE 8



LINE 13/35 EAST WEST LAT 23°S

SECTION ACROSS THE SOUTH CORAL SEA

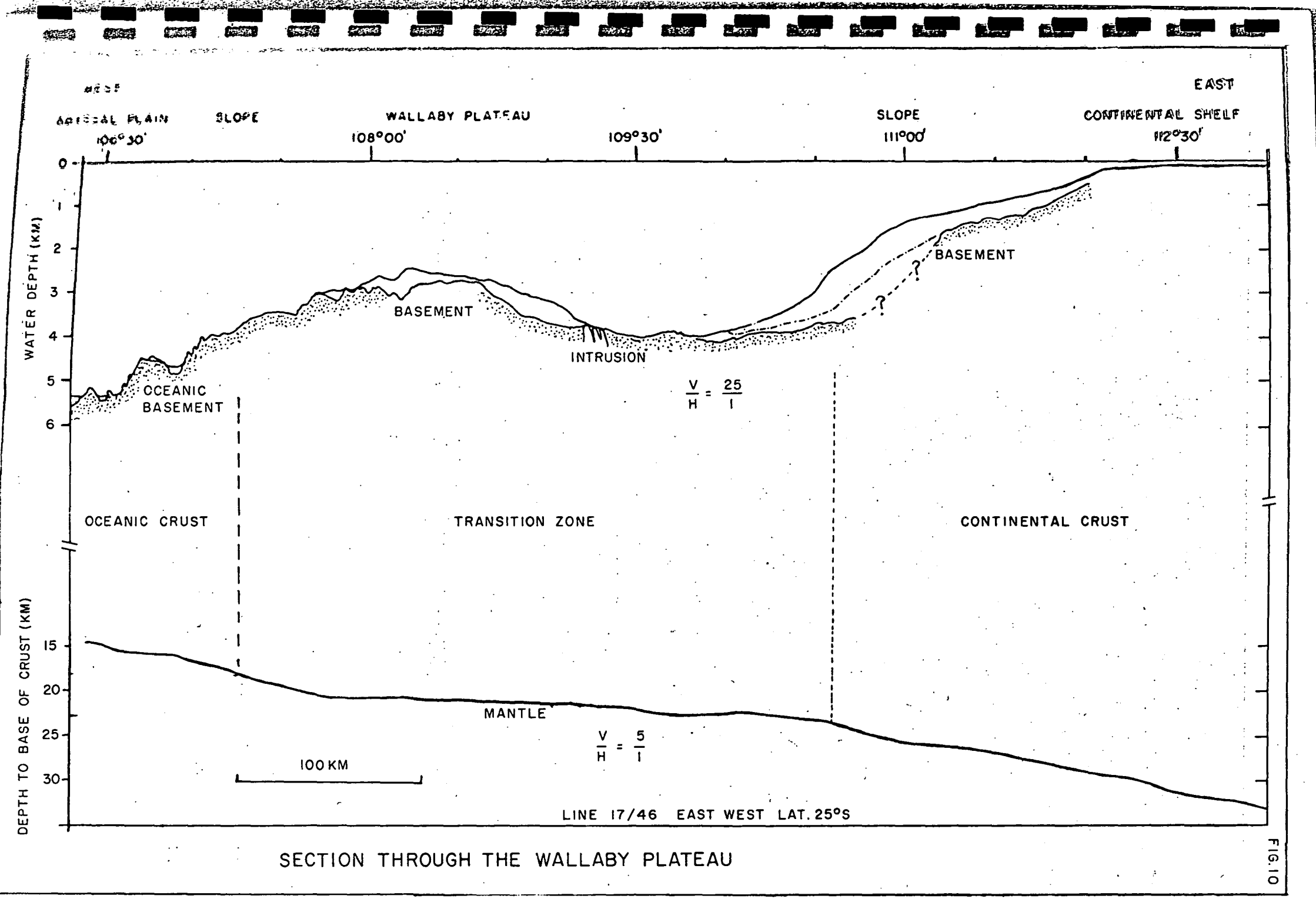


* HAYES AND CONOLLY (1972)

° AMERICAN GEOPHYSICAL UNION, ANTARCTIC RESEARCH SERIES, VOL. 19

SECTION THROUGH THE TASMANIA RIDGE

FIG. 9



SECTION THROUGH THE WALLABY PLATEAU

FIG. 10