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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Record No. 1969 / 137



A Marine Geophysical Survey
 of the Northwest Continental Shelf
 of Australia, 1968
 (a summary)

by

R. Whitworth

*Paper Presented at Fourth ECAFE Symposium on the
 Development of Petroleum Resources of Asia and the
 Far East, Canberra, October - November 1969*

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources.



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A MARINE GEOPHYSICAL SURVEY OF THE
NORTHWEST CONTINENTAL SHELF OF AUSTRALIA, 1968

by

R. Whitworth

Bureau of Mineral Resources, Geology and Geophysics

SUMMARY

The Bureau of Mineral Resources carried out a marine geophysical survey of the continental shelf of northwestern Australia from Barrow Island to Ashmore Reef in 1968. About 15,000 miles of combined gravity, magnetic and seismic reflection profiling were obtained over a period of 75 days. Navigation was by a combination of satellite doppler, sonar doppler, ships log and V.L.F. radio location.

The seismic results gave information down to about the top of the Cretaceous formations. On a regional scale the offshore Tertiary sediments form a wedge dipping monoclinally to the northwest. Several anticlinal trends were discovered. The trends show parallelism with seismic velocity regimes indicated by refraction soundings. Thirteen main provinces were defined using the gravity and magnetic results. The seismic trends and velocity regimes coincide approximately with larger groupings of the gravity-magnetic provinces.

Based on the correlation between the magnetic and gravity features within each province, and similarity with onshore structural features, the provinces are believed to indicate major tectonic blocks in the area. The seismic anticlinal trends are consistent with vertical movement of these crustal blocks. The tectonic features show continuity with onshore features in the southern part of the survey area and appear to extend to the edge of the continental shelf. A local thickening of the sediments probably occurs in the northern part in the vicinity of Browse Island, but there appears to be little evidence for an offshore basin parallel to the coast.

A MARINE GEOPHYSICAL SURVEY OF THE
NORTHWEST CONTINENTAL SHELF OF AUSTRALIA, 1968

by R. Whitworth*

The Bureau of Mineral Resources has carried out three large-scale marine geophysical surveys over the continental shelf of Australia, covering the Joseph Bonaparte Gulf in 1965, the Timor Sea in 1967, and the Northwest Continental Shelf in 1968. These surveys have been carried out by the Bureau to assist in the exploration of the continental shelf, and to introduce and test geophysical methods not previously used on surveys in Australia.

The number of geophysical disciplines included has increased with time, and the 1968 survey included continuous seismic reflection profiling using a 21 kilojoule sparker as energy source, gravity and magnetic profiling, and seismic refraction shooting using an airgun system for energy source and sonobuoy as receiver. Navigation was by a synthesis of satellite doppler position fixes, sonar doppler, ship's log and gyro for speed and course, and the VLF radio location method.

The seismic data was recorded on multi-channel analogue magnetic tape and monitored by a wet paper facsimile recorder. The results are not usually processed further. The gravity, magnetic and some of the navigation data were recorded digitally on magnetic tape, but some of the systems were recorded in analogue form. Data reduction was carried out by computer, and at least three-quarters of the computations were involved with fixing the position of the ship. The positional accuracy required in these reconnaissance surveys is primarily determined by the accuracy

*Bureau of Mineral Resources, Geology and Geophysics,
Canberra, A.C.T. Australia

requirements for the gravity work. The desired velocity accuracy of 0.1 knot, in particular, is very exacting, hence there is a considerable bias in the time spent on data reduction.

The 1968 marine survey covered about 140,000 square miles of the Northwest Continental Shelf from Barrow Island to Ashmore Reef. The survey consisted of about 15,000 miles of traverse, predominantly along east-west lines roughly ten miles apart with tie lines running parallel to the coast (Plate 1). The positional accuracy varied from about 0.5 mile to 1.0 mile depending upon the degree of control available, while the accuracy of velocity measurement approached 0.2 knot. The overall errors in the gravity work gave a standard deviation of about 2 milligals for the differences at line intersections.

The geology of the Northwest Continental Shelf was poorly known prior to the survey. Because of lack of outcrop, interpretation was based mainly on inference from bathymetric data, previous geophysical surveys, extrapolation from onshore geology, and stratigraphic bores at the northeast and southwest extremities of the survey area. The general picture indicated by this information suggested an offshore basin which paralleled the coast from near Barrow Island to north of Darwin. A basement ridge was thought to underlay a series of shoals and reefs that occurred along the edge of the continental shelf (Plate 3), bounding the outer edge of the basin.

Useful seismic reflections were rarely obtained on this survey at depths greater than 5,000 feet below the sea bottom. In shallow water, ringing and multiples frequently masked any reflections that did exist. Therefore only the near-surface reflections were observable except in deep water.

The lowest horizons detected over most of the shelf are believed to be somewhat below the base Tertiary level.

On a regional scale the Tertiary horizons show a monoclinial dip to the northwest. The dips are low near the coast, but increase rapidly near the edge of the continental shelf (Plate 1). Continuity into deeper water is uncertain as the seismic sections are greatly disturbed by diffractions and the steeply dipping sea bottom in this zone. Several reflectors can be followed in deep water but correlation with the shelf sediments is not possible.

Three platform-like areas were defined by the seismic reflection work; around Browse Island and Pender map areas and to the west of Broome respectively (Plate 1). These appear to correlate with structural units defined by the gravity and magnetic work (Plate 2). Nine major anticlinal trends were observed within the Tertiary sediments, most of which coincide approximately with the edges of structural units. A correlation between rate of increase of velocity with depth as indicated by the refraction profiles and the structural units also appears to exist (Plate 1).

A series of apparently buried reefs were observed along the outer continental shelf and slope. They look as if they have been engulfed by the continental shelf building outwards (Plate 3). A feature of particular note found in water depths exceeding 500 fathoms to the west of Barrow Island is an anticline of enormous dimensions with a width of 60 miles and a structural relief of about 2000 feet. (Plate 3). This structure is in water deeper than the present limit of economic interest or exploitation.

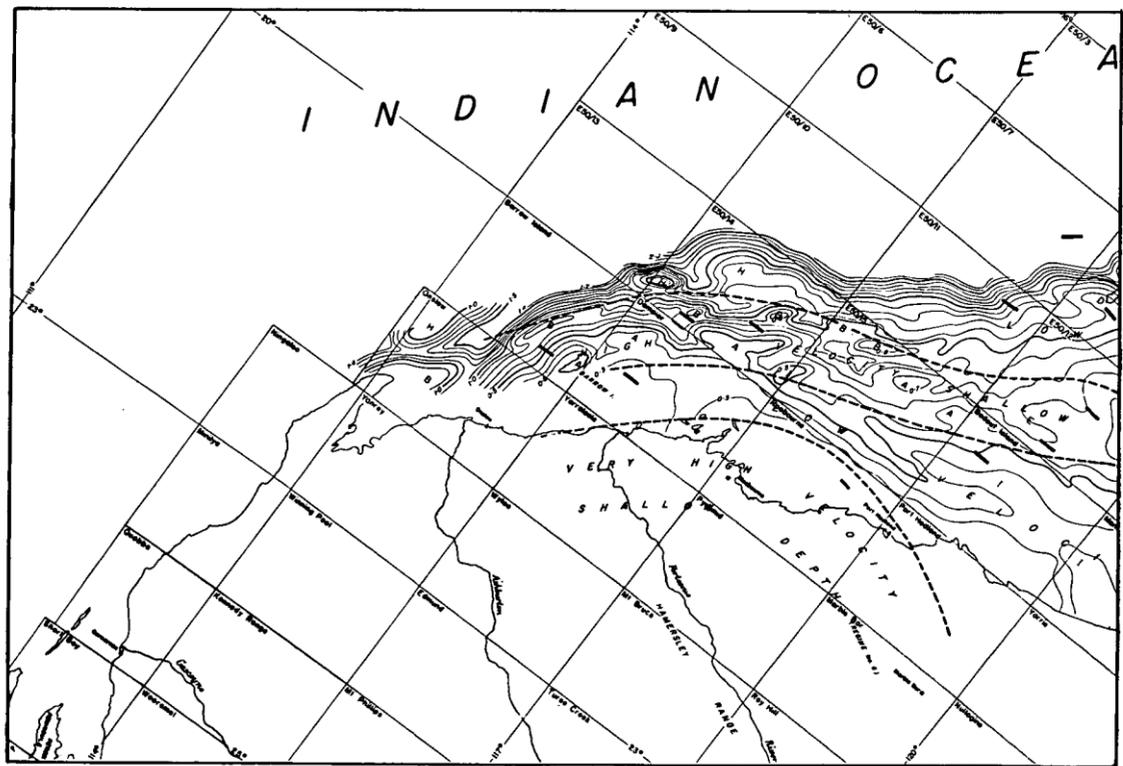
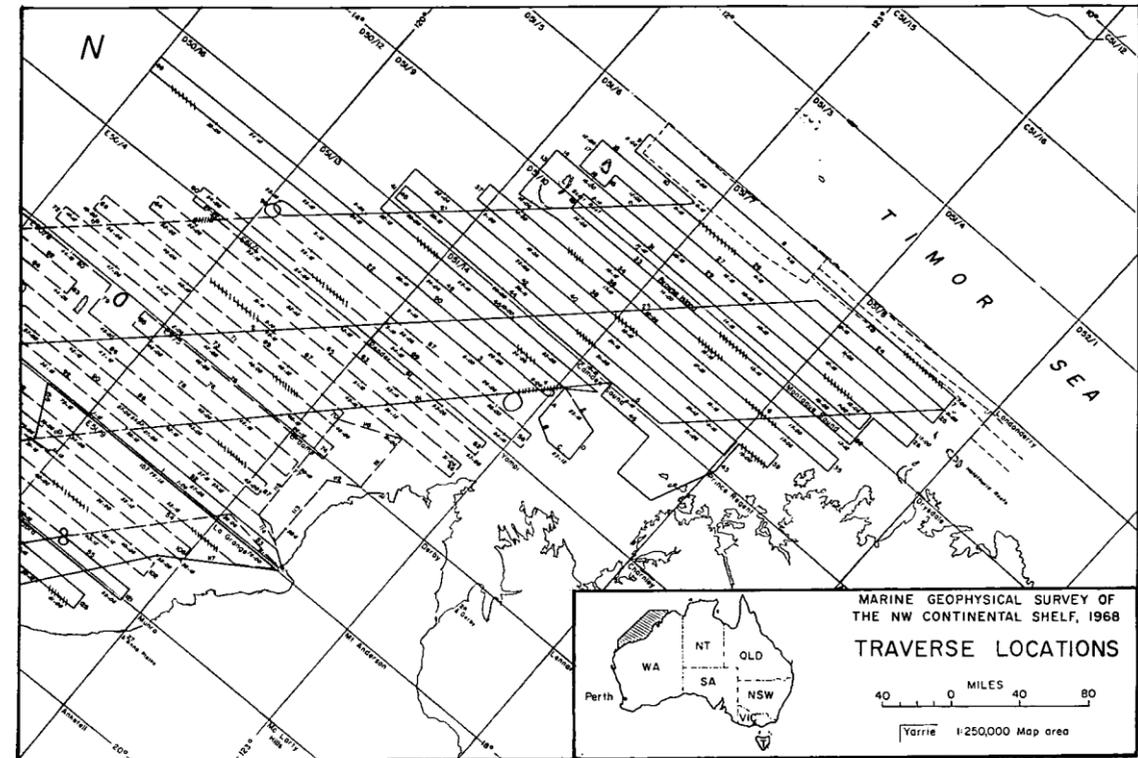
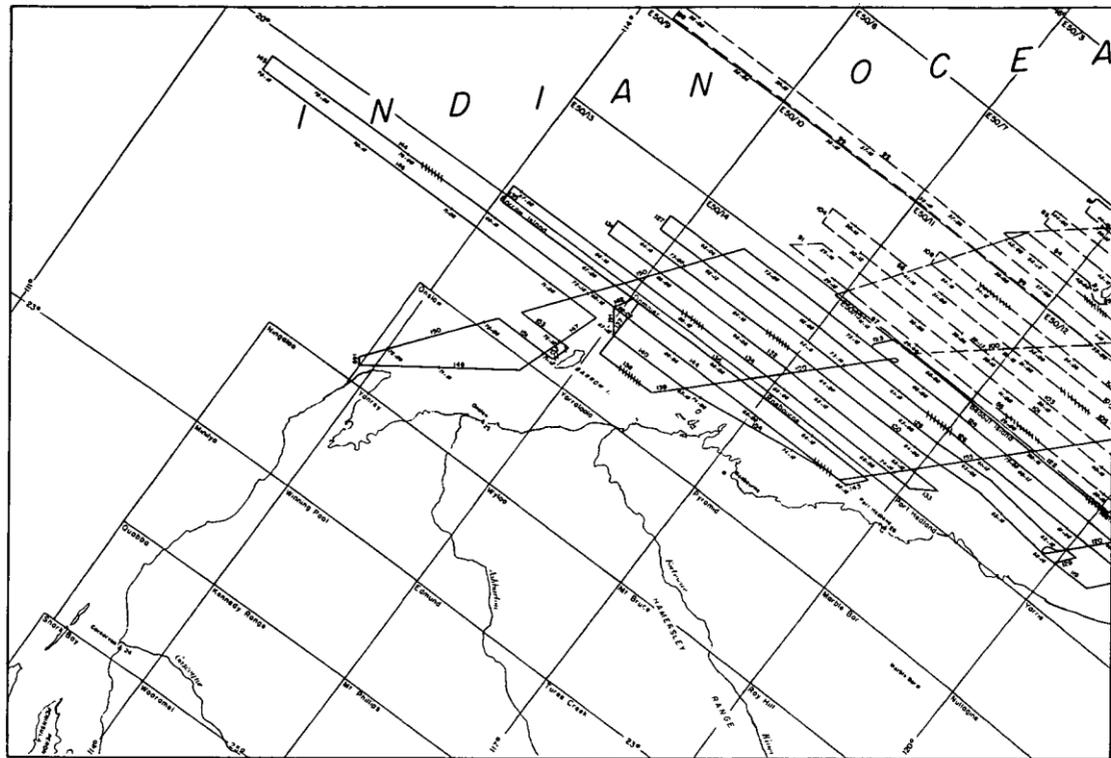
Three major sub-divisions are apparent in the Bouguer anomaly and magnetic anomaly features, which can be further subdivided into thirteen provinces or areas showing common characteristics. In the northeast, there is a zone of broad undulating Bouguer anomalies surrounding a Bouguer anomaly low centred on Browse Island, with only minor associated magnetic anomaly features (Provinces I to III of Plate 2). The data is consistent with a sedimentary depression in the Browse Island area.

A zone of high Bouguer anomaly gradients (Provinces IV to VII) occurs along the edge of the continental shelf with few significant features within it. Very little magnetic feature occurs within the zone. The high gradients are almost certainly caused by isostatic thinning of the crust towards the ocean. There appears to be little indication of a basement ridge along the edge of the shelf.

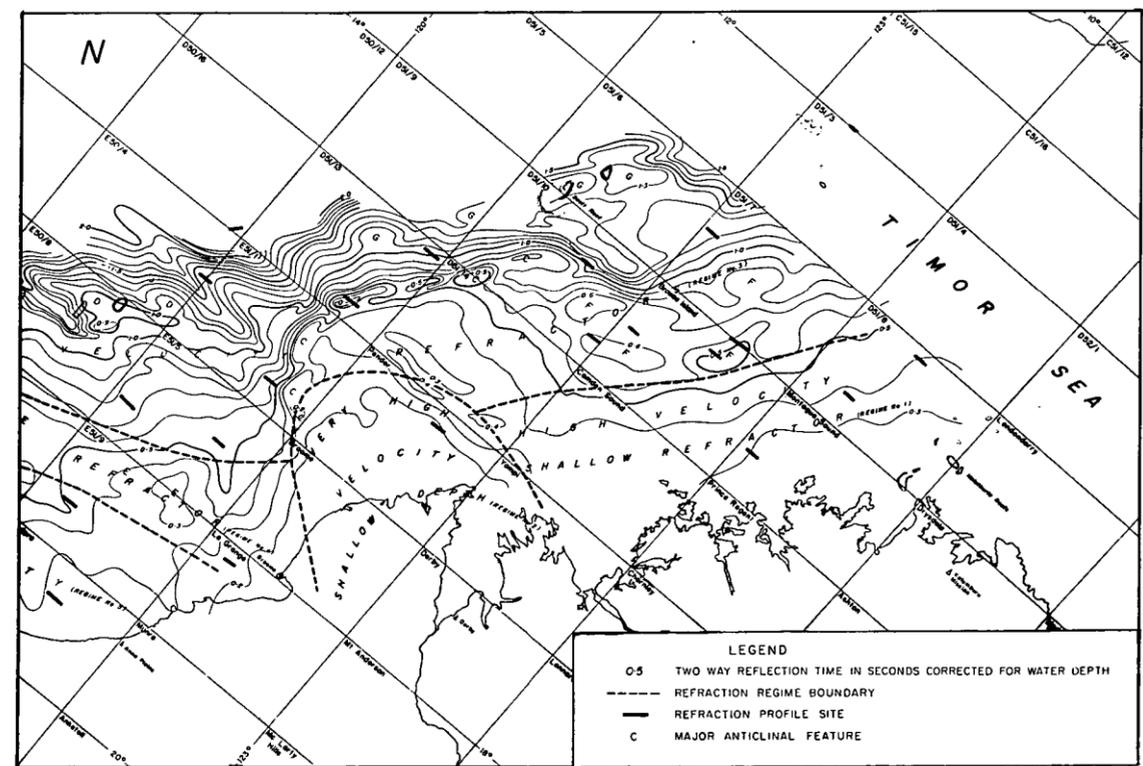
The southwesterly third zone is one of intense Bouguer anomaly and magnetic anomaly features (Provinces VIII to XIII) with a generally northwesterly trend. In the far southwest, the trend gradually shifts to southwesterly around the edge of the Pilbara Block. There appears to be an intimate correlation between gravity and magnetic features in this zone, as would occur if the cause of the features were metamorphic or intrusive rocks within the basement. The features appear continuous with features of similar association and trend in the Canning Basin.

The regional geology indicated by this survey is considerably at variance with previous interpretations. The tectonic trends north and south of the King Leopold mobile belt appear entirely different. In the south the onshore Canning Basin trends appear to continue almost to the edge of the continental shelf and are gradually buried by a thickening

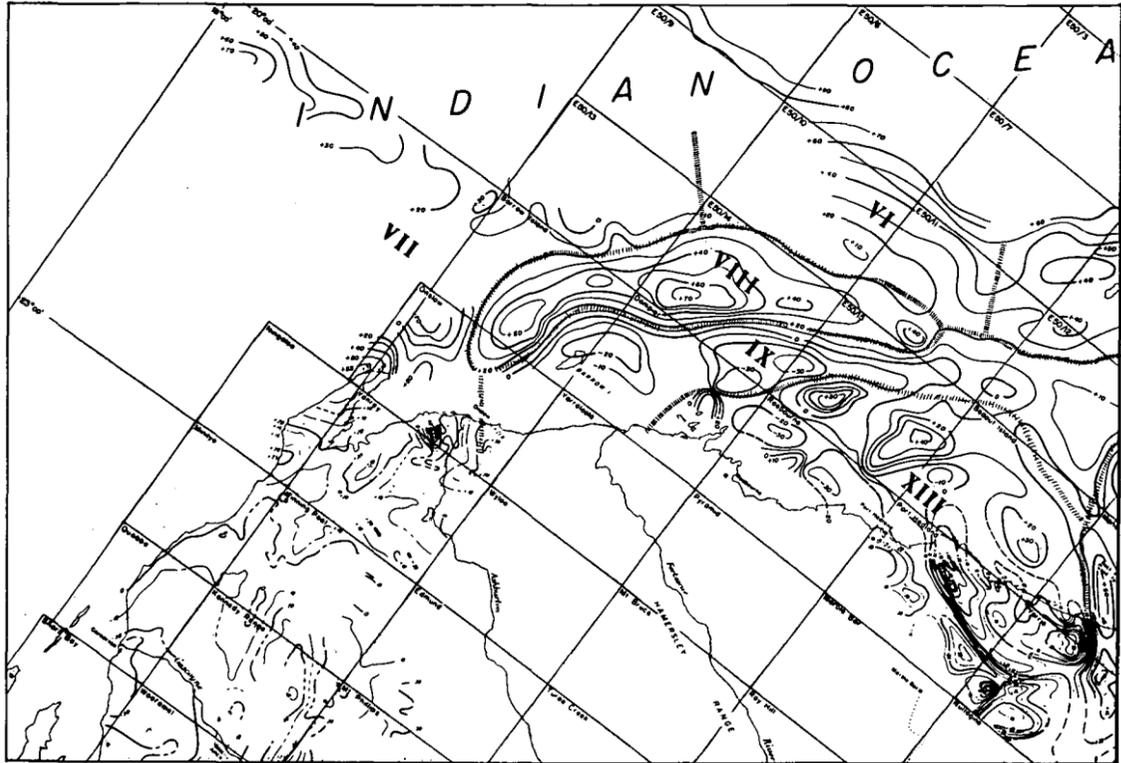
wedge of Tertiary sediments. Near Barrow Island, the structures tend to parallel the edge of the Pilbara Block and may be relics of old geosynclinal belts formed around the periphery of the Block. In the northeast there is an indication of a basinal structure which may continue northeastwards. However, there does not appear to be much evidence in favour of a basement ridge along its outer edge. The correlation between major anticlinal trends and the structural units suggested by the gravity and magnetic work indicate that most of the offshore structures are probably caused by differential vertical movement of crustal blocks.



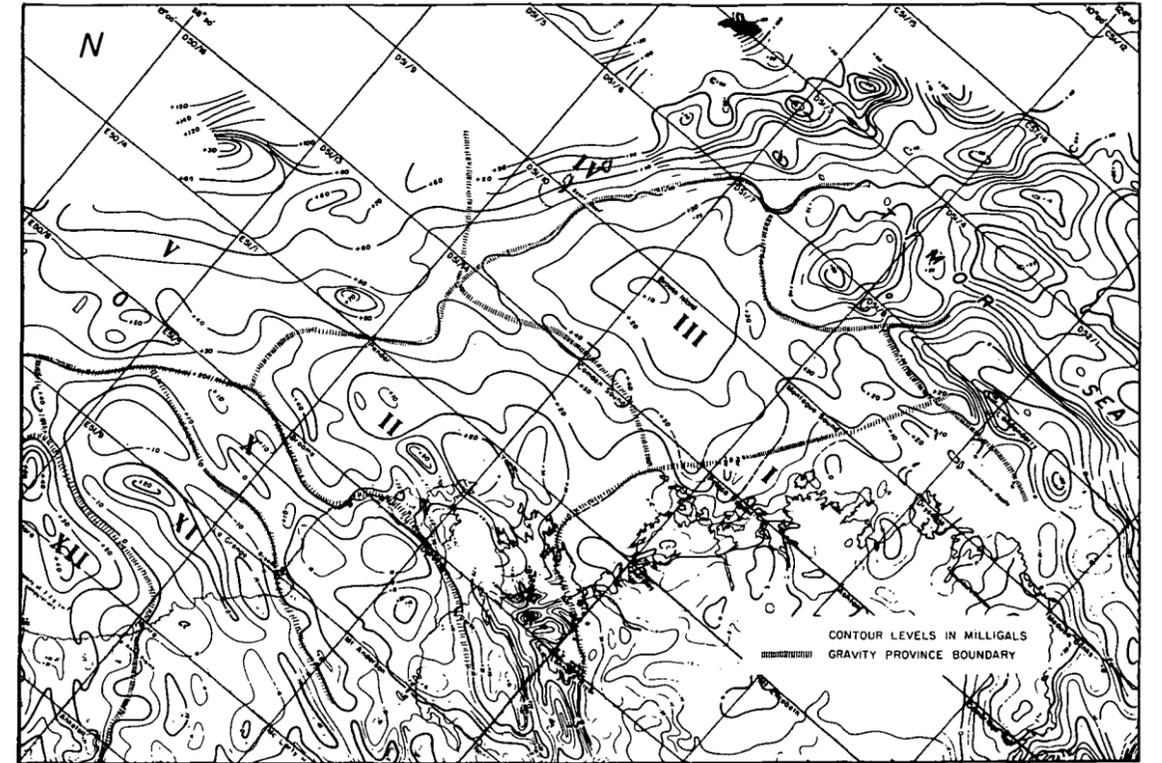
TWO WAY REFLECTION TIMES TO NEAR BASE TERTIARY HORIZON



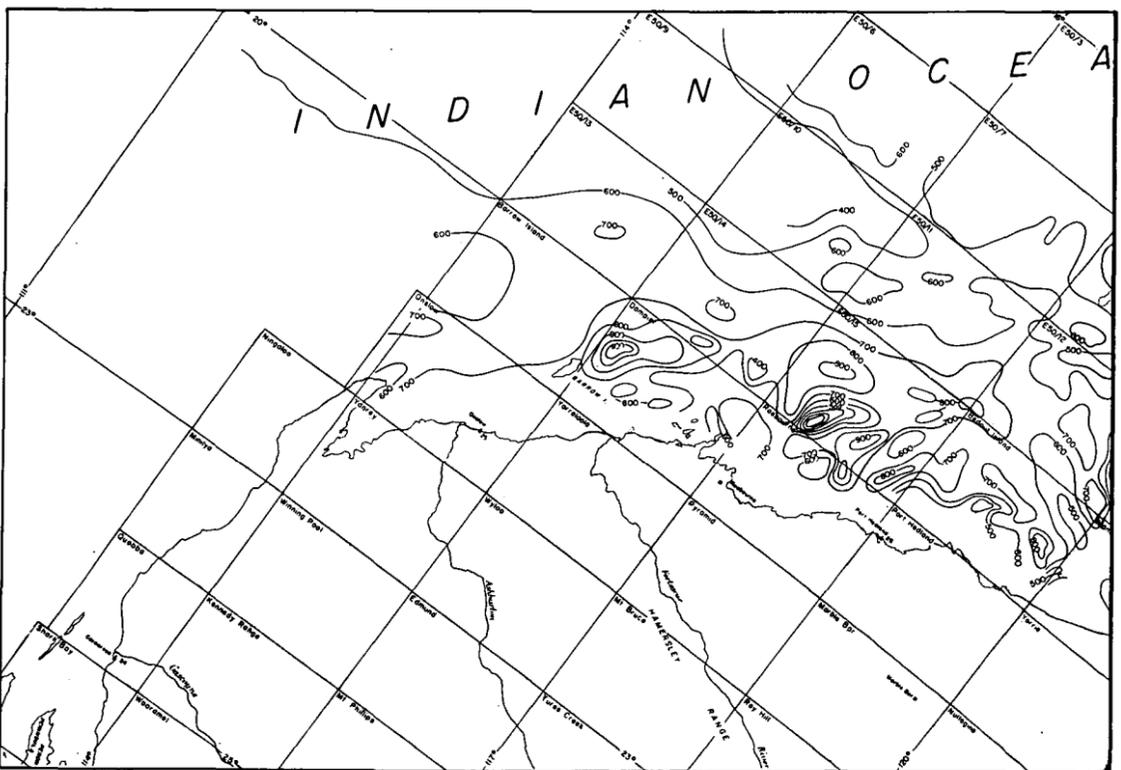
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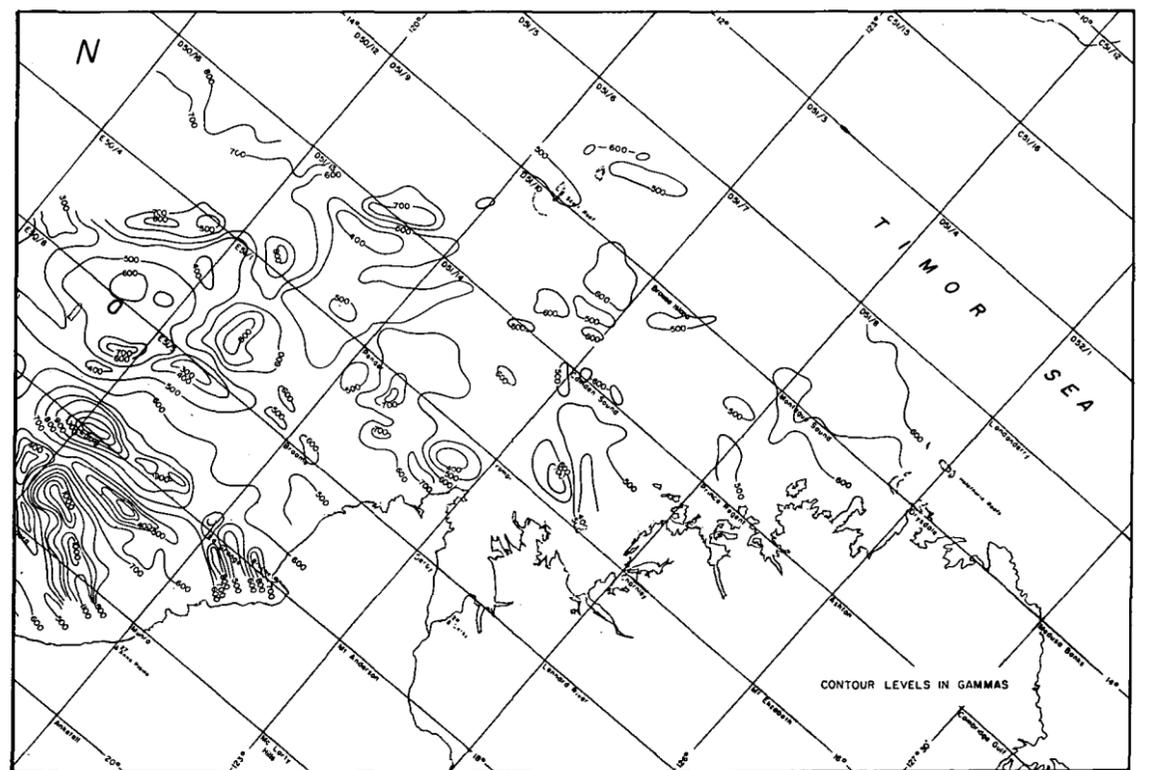
BOUGUER ANOMALIES



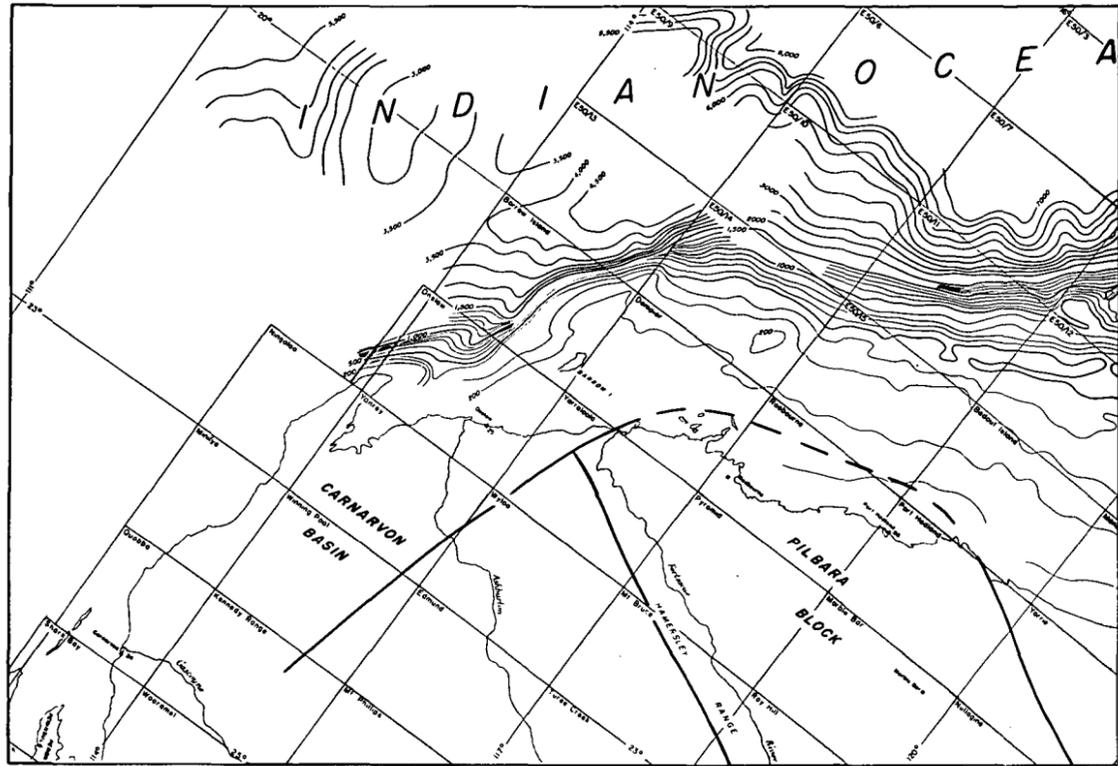
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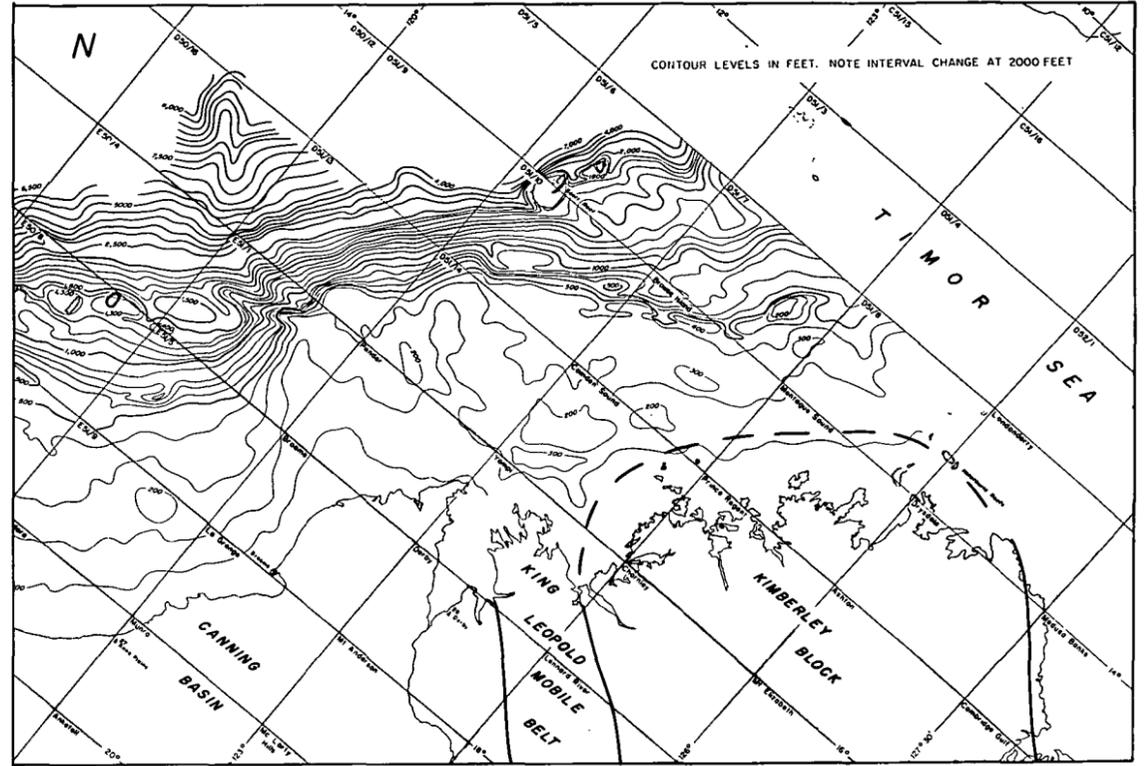
MAGNETIC ANOMALIES



MAGNETIC ANOMALIES



WATER DEPTH AND GEOLOGICAL UNIT BOUNDARIES



WATER DEPTH AND GEOLOGICAL UNIT BOUNDARIES

