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COMPILATION AND REVIEW OF THE GEOPHYSICS OF THE BONAPARTE GULF BASIN, 1962

VOLUME III. CORRELATION BETWEEN GRAVITY PROFILES, GEOLOGY AND SUBSURFACE STRUCTURE AS REVEALED BY SEISMIC REFLECTION AND REFRACTION SURVEYS.

PART 7 of 11

by

A.L. Bigg-Wither

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GRAVITY INTERPRETATION

It is not intended to give a detailed description and interpretation of the anomalies on the Bouguer anomaly maps of the Bonaparte Gulf Basin. This has been adequately carried out by previous writers, extracts and summaries of whose works are given in Volume 1 of this report. Only the broad structural character of the Basin as indicated by the Bouguer anomaly map, will be discussed here (see Vol. IV. Part 3. Plate 55).

Previous writers have pointed out relationships between gravity anomalies and possible basin structures which support the belief that variations in gravity can be related to variations in thickness of the Palaeozoic sediments; that low gravity anomalies represent great thicknesses of sediments and that high gravity anomalies represent areas of shallow basement.

Those anomalies which lie between the (-10) and (-35) milligals contours, representing possible areas of deep sedimentation, are shown on Plate 56, and on Plate 57 are given those anomalies which lie between (+35) and (-10) milligals and which represent areas of possible shallow basement.

The structural picture shown on Plate 56 includes 4 major gravity 'lows'; Carlton, Keep River, Burt Range and Port Keats, with an unusual offshoot to the south-south-west from the Carlton 'low'. The Carlton and Burt Range lows correspond to the 'Carlton Basin' and 'Burt Range Basin' recognised from surface mapping (Traves, 1955). The Keep River 'low' and the Port Keats 'low' have been shown to be areas of deep sedimentation by seismic surveys carried out in these areas (see Volume 2 of this report). The suggestion that these 'lows' could be the expression of deep sedimentary basins was first put forward by Richardson (1955) for the Keep River 'low' and Burbury (1957) for the Port Keats 'low'.

The Keep River gravity 'low' and the Port Keats gravity 'low' are bounded on the east by high Bouguer anomalies which probably represent shallow basement. To the east of the Keep River gravity 'low' the (-10) milligal contour coincides approximately with the Proterozoic - Palaeozoic boundary while further to the N.N.E. it probably marks the boundary between Proterozoic and the pre-Permian Palaeozoic sediments, at a shallow depth below the Permian sediments, (Drummond, 1963). West of the Western Australia - Northern Territory Border the (-10) milligal contour again outlines the Proterozoic outcrops of the Pincombe Range but further north-west it runs a few miles from, but parallel to the Proterozoic-Palaeozoic boundary. This displacement of the (-10) milligal countour to the N.E. is probably caused by the presence at depth of high density material in the Lower Cambrian Antrim Plateau Volcanics. These probably

extend to the north east under younger Palaeozoic rocks. The displacement of the (-10) milligal contour could also be due to a narrow elongate N.E.-S.W. trending horst which brings the Proterozoic rocks close to the surface.

On Plate 57 the positive anomalies between the (+35) and (-10) milligal Bouguer contours are shown.

The strongest anomalies are over PreCambrian rocks with a marked positive anomaly over the Lower Cambrian Antrim Plateau Volcanics west of the Ord River mouth. The large anomaly offshore north of the Keep Inlet in the Queens Channel is believed to be due to the presence of Proterozoic rocks at shallow depths (Burbury, 1957), Thyer et al (1959) also refer to "an isolated gravity 'High' which coincides with the Pincombe Ranges".

The (-10) milligal contour centered over the Weaber Range possibly reflects the extension N.E. of the Proterozoic rocks of the Pincombe Range beneath the Palaeozoic rocks of the Weaber Range.

To the west of the gravity 'High' which coincides with the Pincombe Ranges is a relatively narrow zone of low Bouguer anomalies - the 'Ivanhoe Low.' "The axis of the 'Ivanhoe Low' appears to swing in an arc from Ivanhoe to Pander Ridge and for some distance northwest beyond the Carlton Hill Road". (Thyer et al, op.cit.)

Gravity coverage in the area south west of a line joining Knob Peak and Ninbing H.S. is very poor. Further readings in the area may show that the axis of the 'Ivanhoe low' continues still further to the northwest. If so, this could be the reflection of a possible graben which would be a feature parallel to the suggested elongate horst believed to cause the offsetting N.E. of the (-10) milligal contour.

The interpretation of the gravity results has been based mainly on the known geology of the Bonaparte Gulf Basin. The Bouguer anomaly profiles will now be compared with structural data obtained from seismic reflection and refraction surveys carried out between 1956 and 1962.

CORRELATION BETWEEN BOUGUER ANOMALY PROFILES AND SUBSURFACE STRUCTURES AS INDICATED BY SEISMIC REFLECTION SHOOTING

I. BONAPARTE GULF SEISMIC SURVEY (Robertson, 1957).

(a) Reflection Cross Section.
Traverse A. Ninbing Area
(S.P.'s 127-54 and S.P.'s 1-10)
Plate 20, 21.

Although some fair reflections were obtained along traverse A (Plate 21) very few are continuous over more than ½ a mile. Due to the lack of continuity of the reflections and the presence in some parts of the section of steeply dipping reflections along with flat or very much less steeply dipping reflections the reflection section is very difficult to interpret. If phantom horizons are drawn on the reflection evidence, the dips on the phantom horizons are seen to increase progressively with depth. There is some suggestion that what has been plotted as reflections may in fact be reflected refractions from some point towards the south west end of the traverse. The presence of steeply dipping reflections along with flat lying reflections suggests interference between actual reflections and reflected refractions.

The interpretation, given by Robertson (See Vol. 2 page 1) is only a preliminary one and it is possible that a reinterpretation of the seismic records may yield better results.

Some general observations on the correlation between gravity profiles and the substructure can be made despite the poor seismic evidence.

1. The Bouguer anomalies rise towards the south-west where Proterozoic rocks crop out, thus the anomaly is probably caused by a density contrast between the Proterozoic rocks and the younger rocks above it. Drummond (1963) believes that the Proterozoic rocks underlie the Quaternary rocks at shallow depths below S.P. 116½. The Bouguer anomaly curve also begins to flatten out at about this shot point and thus supports his view.

2. The sudden rise in the Bouguer anomaly curve between S.P.70 and S.P. 60 suggests a fault beneath S.P. 65 with upthrow to the north-east.

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The sudden fall in the Bouguer anomaly curve between S.P.60 and S.P.1 suggests a fault somewhere beneath S.P.56. It is possible therefore that a horst exists somewhere between S.P.65 and S.P.56 Drummond on his interpretative solid geological map shows a repetition of the Border Creek Sandstone and Point Spring Sandstone and the Milligans Formation and the gravity evidence also suggests faulting and repetition of strata.

(b) Spirit Hill Area. Reflection Cross Sections. Traverse 'A' S.P.'s 338-301 and 329-350 Plates 20 and 22.

There are insufficient reflections on which to draw a phantom horizon with any degree of certainty: however an attempt will be made to find out the nature of the correlations which may exist between the Bouguer profiles and the substructures as indicated by phantom horizons.

The reflection evidence is sufficient to indicate a broad syncline with its axis near S.P.307 and reflection horizons rising to the W.N.W. and to the S.E. The Bouguer values also increase to the W.N.W. and S.E. and suggest a broad syncline. Between S.P's 310 and 340 there is a wide but small gravity positive feature, the highest values being centred at S.P.329. The reflection evidence however is very poor and it is not possible to say if the subsurface reflects this gravity 'high' or not although there is some suggestion in the shallower reflections that it does. Thus the correlation between the Bouguer anomalies and substructures appears to be normal* over the whole of the traverse. While this is probably true the reflection evidence by itself is insufficient to show where, in the section, the density discontinuity surface (or surfaces) exists.

By analogy with the Keep River traverses (Plate37 and38) a few miles to the north it is possible that the main contrast is between Palaeozoic and Pre-Cambrian rocks. On Plate 38 a major unconformity can be seen within the Pre-Cambrian?, and the younger Pre-Cambrian? and succeeding strata are roughly conformable. If a similar tectonic history is applicable to the area of traverse 'A' the possible unconformity at Horizon B between S.P's 313 and 308 at about 6500 feet beneath S.P.310 (Robertson, 1957) probably represents the unconformity within the Pre-Cambrian? since the dips on the beds below

* Generally gravity lows are expressions of sedimentary basins and gravity highs the expression of basement highs. When this is the case I refer to the correlation between the Bouguer anomalies and substructures as being normal. If the reverse situation holds I then refer to the correlation between Bouguer anomalies and substructures as being reversed.

horizon B change very much more than do the dips on the horizon above.

In fact, the reflections between horizon A and B appear to be as flat lying as those above phantom horizon A.

If the shallow continuous reflection between S.P.317 and S.P.323 (horizon A) is extrapolated to the W.N.W. it will intersect the surface at S.P.330 where Proterozoic rocks outcrop. On Lines A and B (Plates 37 and 38 respectively) there did not appear to be a density discontinuity surface within the Pre-Cambrian. If this is true and applicable to traverse 'A' Spirit Hill area, the gravity anomaly will be expected to be due to the difference in density between the Palaeozoics and the younger Pre-Cambrian rocks (i.e.) possibly at horizon A which is about 2500 feet below S.P.315 rising gently towards S.P.330.

By analogy with Line A (Plate 37) and Line B (Plate 38) it is likely that Palaeozoic rocks do not extend down to 14,000 feet as suggested by Robertson (op cit.) The phantom horizon shown by Robertson at a depth of 11,000 feet below S.P.309 (horizon C) is likely to be within the Lower Pre-Cambrian rocks.

When the increase in depth of Phantom horizon 'A' between S.P's 330 and S.P.312 (2400 feet) is compared with the decrease in the Bouguer values between these points (11.3 milligals) it is calculated that a density contrast of .37 grams per cc must exist between sediments above and below horizon A to account for the Bouguer anomaly, assuming that horizon A is the only density discontinuity surface present in the section. If we assume that horizon B is the only density discontinuity surface in the section, by comparing the drop in the Bouguer values between S.P.'s 330 and 312 (11.3 milligals) and the drop in horizon B between these points (6400 feet) a density contrast of .14 grams per c.c. must exist between sediments above and below the B. horizon to account for the Bouguer anomaly. On Lines A and B (Plates 37 and 38) in the Keep River area a few miles to the north it was found (see pages 26-30) that a density contrast of .33 grams per c.c. between the Palaeozoic? and Precambrian? rocks must exist to account for the Bouguer anomalies, assuming that the refractor is the only density discontinuity present in the section. This correspondence in the density contrast lends support to the view that horizon A is probably the top of the Precambrian rocks. If this is correct the rocks of the Pincombe Range must be lower Precambrian; slight metamorphism of the rocks was reported by Drummond (1963). The flat lying upper Precambrian(?) appears to wedge out onto the lower Precambrian and to be overlapped by the Palaeozoic rocks.

The validity of the above interpretation rests upon the following important observations and assumptions.

(1) That on Plates 37 and 38 the 18,500 feet/sec to 19,000 feet per sec. refractor does in fact represent the top of the Precambrian rocks. The reason given for this assumption will be found on page 15.

(2) That the major unconformity at a two way time of 1 sec. between shot points 47 and 55 on Plate 37 is <u>within</u> the Pre-Cambrian.

(3) That above the major unconformity within the Pre-Cambrian section the sediments are roughly conformable all the way to the surface.

(4) That if similar subsurface conditions prevail in the area of Traverse A (Plate 22) as were present in the Keep River Area, (Lines A and B - Plates 37 and 38) a few miles to the north, then horizon B probably represents the unconformity within the Pre-Cambrian as the sediments between phantom horizon A and B are roughly conformable with the sediments above horizon A, whereas the dips below horizon B increase rapidly and suggest an unconformity.

(5) The extrapolation of the shallow horizon A to the W.N.W. would probably reach the surface at S.P.330 where Proterozoic rocks crop out. However, as horizons A and B converge to the W.N.W. this is uncertain.

(c) Spirit Hill Area Reflection Cross Sections
Traverse <u>B, C, D, E</u> Plate 22.

The reflection evidence is not good enough to be able to determine the nature of the correlation which may exist between the Bouguer anomalies and the substructure. There is evidence of an unconformity at depths ranging from 9,000 to 10,000 feet but similar reasons to those given for Traverse A (see above) suggest that this unconformity is within the Pre-Cambrian, and in all probability the Precambrian-Palaeozoic boundary is at very shallow depth. However, the much lower Bouguer values across these traverses suggest that the Palaeozoic rocks are of greater thickness than they are believed to be on traverse A (Plate 22). There is some suggestion that there may be a qualitative correlation between the Bouguer anomalies and the structure as indicated by the shallow horizons especially on traverse C and E where the reflections have a north-westerly component of dip and the Bouguer values decrease to the north west, and on traverse D where the shallow reflections show a S.W. component of dip and Bouguer values decrease to the south-west.

CORRELATION BETWEEN BOUGUER ANOMALY PROFILES AND SUBSTRUCTURES AS INDICATED BY SEISMIC REFLECTION AND REFRACTION SURVEYS

II PORT KEATS (LAND) SEISMIC SURVEY. (Warner, 1961)

a) Reflection Cross Section.
Line 1. S.P.'s 170-117,
1-37, 105-107 and 32-100.
Plate 24.

The correlation between Bouguer profiles and the substructure between S.P.40 and S.P.56 is normal. To the east of S.P.56 it is not clear what the correlation is as no reflections were obtained, and S.P's 62 to 90 were not shot.

If the interpretation given by Warner (1961) is correct, and that the 'P' horizon between S.P.'s 40 and 56 correlates with the 'P' horizon beneath S.P.90 the correlation between the Bouguer profiles and the substructure is reversed. However, the following discussion shows that the interpretation given by Warner (1961) may not be correct.

SEMI QUANTITATIVE

For this discussion I assume that the 'P' horizon under S.P's 36 to 56 correlates with the shallowest continuous horizon under S.P.'s 90 to 98 and that this horizon is the only density discontinuity surface present in the section. By comparing the drop in the Bouguer values between S.P.90 and S.P.40 (23.5 milligals) with the drop in what has been assumed to be the 'P' horizon between these shot points (5,500 feet assuming an average velocity of 10,000'/sec. or 7,700 feet assuming an average velocity of 14,000 feet per second to the 'P' horizon), a density contrast of .335 grams per c.c. must exist between sediments above and below the 'P' horizon if the average velocity is 10,000 feet per sec. to the 'P' horizon and .239 grams per c.c. if the average velocity is 14,000 feet per second. This correspondence in the density contrast to those in the Keep River area lends support to the view that the 'P' horizon under S.P's 36 to 56 correlates with the shallowest continuous horizon under S.P's 90 to 98. The correlation between the Bouguer profiles and the substructures appears to be normal up to about S.P.8.

The 1963 surveys by the Australian Aquitaine Petroleum Pty Ltd (see Volume 2 P.30) parallel to and only 1 mile north of the traverse between S.P's 8 and 170 show that the sediments begin to deepen rapidly

towards the west while the Bouguer values begin to increase and hence west of about S.P.8 the correlation between Bouguer profiles and the substructure is definitely reversed.

Further reasons why I do not favour Warner's (1961) interpretation are given below:-

(1) Proterozoic rocks outcrop a few miles to the east of S.P. 100 on the eastern end of the traverse and the 'P' horizon is expected to rise towards the east.

(2) It is not possible to correlate horizons 7 miles apart with any degree of confidence.

(3) The Bouguer profiles can be correlated with subsurface structures between S.P.40 and S.P.56 and can be expected to correlate still further to the east of S.P.56, as Proterozoic rocks outcrop towards that direction. It is probable that horizon 'P' is much shallower than it is shown to be.

(In the correlation between Bouguer profiles and the substructures elsewhere in the Bonaparte Gulf Basin, the Bouguer values rose where approaching the Proterozoic outcrops).

(4) Warner's contention that the 'P' horizon has "bumped into" a Precambrian island or peninsula in the Palaeozoic Sea is doubtful. A survey in 1963 by Australian Aquitaine Petroleum Pty Ltd (see Volume 2 page 30) has shown that reflections occur at great depths between S.P. 121 and S.P.170 (Plate 54) where no reflections were obtained in this survey.

As was the case on the western part of the traverse the lack of reflections in the eastern part is probably due to faulting. If the correlation is normal between Bouguer profiles and subsurface structures east of S.P.54 the 'P' horizon between S.P's 40 and 54 is more likely to correlate with the two shallow horizons shown beneath S.P. 90 and 98.

b) Port Keats Seismic (Land) Survey.
Reflection Cross-Section Line 6,
Shot Points 116-254. Plate 25.

Good qualitative correlation occurs between the subsurface structure and the Bouguer anomaly profiles. A density contrast above and below the continuous reflection horizon is probably responsible for the Bouguer anomaly profile. If similar correlation continues to the north of S.P. 240, the section thickens towards the north and the sudden increase in the gradient of the Bouguer anomaly curve suggests that the section is probably intersected by faulting with blocks downthrown towards the centre of the basin. The density contrast required to account for the Bouguer anomalies in this section cannot be calculated because the Bouguer profile and subsurface reflections do not level out together at any point.

To the south of S.P.116, the Bouguer profile has the same gradient as between S.P's 110 and 116; 4 miles south of S.P.116 the gradient increases sharply, but levels off 2 miles farther south. The sharp increase in gradient may be due to a fault.

c) Port Keats (Land) Seismic Survey.
Reflection Cross-Section. Line 3,
S.P. 208-7A. Plate 26.

The reflections are poor and present over only about 4½ miles and it is doubtful if any significance should be placed in the apparent lack of correlation between the subsurface which appears flat, and the Bouguer anomalies which decrease rapidly to the N.N.E.

d) Port Keats (Land) Seismic Survey.
Reflection Cross-Section. Line 4,
S.P's 14A-216. Plate 26.

The correlation between the Bouguer anomalies and the sub-structure is reversed across this traverse.

c) Port Keats (Land) Seismic Survey.
Line 5, S.P's 195-182
Line 1, S.P's 22-35
Line 6, S.P's 108-248
Plate 27.

There is a good qualitative correlation between the 'P' horizon and the Bouguer profiles across these traverses. The rise in the 'P' horizon between S.P's 22 and 35 being reflected by a rise in the Bouguer values and the drop in the 'P' horizon between S.P's 35 and 240 being again reflected by the fall in the Bouguer values.

CORRELATION BETWEEN BOUGUER ANOMALY PROFILES AND SUBSTRUCTURES AS INDICATED BY SEISMIC REFLECTION SHOOTING.

III PORT KEATS (MARINE) SEISMIC SURVEY (Traves & Burbury, 1961)

a) Reflection Cross-Section
Line 5, S.P's 514-569 and 570-610
Line 6, S.P's 611-650 Plate 30.

Due to the very poor reflections on this traverse it is not possible to derive much information regarding the correlation between Bouguer profiles and the subsurface apart from the following:

(1) Between S.P.540 and 562 the dips on the reflections are to the S.S.W. and the Bouguer anomaly rises to the S.S.W. hence the correlation between the Bouguer anomaly and the subsurface is reversed.

(2) Between S.P.590 and 562 the dips on the scattered reflections are very shallow to the N.N.E. and the Bouguer values decrease to the N.N.E. hence the correlation appears to be normal.

(3) Between S.P.567 and S.P.630 there is no gravity control and hardly any reflection data and nothing can be said about either the structure or the correlation between these points.

(4) Between S.P.645 and 615 there is sufficient reflection evidence to show that the beds dip to the north while the Bouguer values decrease to the south. Once again the correlation between the Bouguer profile and the structure is reversed.

On gravity evidence the Queens Channel high could be a reflection of shallow basement. However, evidence is accumulating which suggests that this may not be true due to the reversal of correlation between the Bouguer profiles and the substructures. It cannot be over emphasized that the contours in the Gulf are based on very few control points. They are shown with a question mark on plate 4 implying that the actual shape of the anomalies is questionable.

Evidence given above points to some reversal of correlation between Bouguer profile and the substructures across the Queens Channel high and it is the author's opinion that the contouring in the Gulf should be ignored except at points where control is available as, despite the fact that they are queried, there is a tendency to regard them as an accurate representation of the Bouguer anomaly. This can lead to a wrong assessment of the structure of the Bonaparte Gulf Basin.

The interpretation on pages 1 & 2 was made on the simple assumption that the gravity lows represented basins and the gravity highs areas of high basement. This assumption was reasonable at the time as the position and shape of the gravity lows conformed closely to the geological mapping of the basins and all regions of high gravity surrounding the lows correspond to areas mapped as Proterozoic basement rocks. From the reversal of correlations which were found to exist in the Port Keats Land and Marine Surveys and the Pearce Point Surveys (see later, page 20) it is now realised that such a simple assumption cannot be applied over the whole area of the Bonaparte Gulf Basin. The Bouguer gravity map, while still useful in giving a first approximation of the structure of the Basin, cannot in certain areas be relied upon to give an accurate idea of the structures, due probably to the increase in density of the sediments or to a change in density of the basement which results in a reversal of correlation between the Bouguer profiles and the substructures.

b) Port Keats (Marine) Seismic Survey
Reflection Cross-Sections.
Line 3, S.P's 216-271, 416-515
Plate 31.

There is very little control for the Bouguer profile on this traverse and it is impossible to find out if any correlation exists between the Bouguer profiles and the subsurface. Between S.P.513 and S.P.230 the traverse crosses only two contours and between the two there is no control. Any attempt at correlation on the available Bouguer data can lead to very wrong conclusions.

c) Port Keats (Marine) Seismic Survey
Reflection Cross-Section
Line 1, S.P.'s 0 - 90, Plate 32.

The gravity coverage in the area of the traverse is insufficient to determine the exact shape of the anomalies. This is especially the case between the 30 milligal contour at S.P.28 and the 30 milligal contour at S.P.73. It is possible that the gravity values decrease between these two contours. Further to the North of S.P.73 there is no gravity control and although the gravity low north of Port Keats is shown to have closure to the north, it is quite possible that more detailed work will show that it does not. On available evidence it is not possible to be sure of the nature of the correlation which may exist between the Bouguer profiles and the subsurface although there are indications that it is normal. Further to the south on the Port Keats Land traverse Line 6 S.P.'s 116-254 (Plate 25), good correlation

exists between the Bouguer profile and the substructure and it is possible that this good correlation continues to the north towards the marine traverse Line 1 S.P. 50-90.

Deep reflection evidence is poor across this traverse, but there are a sufficient [redacted] reflections at depth to suggest the possibility of reflecting horizons on Line 1 deeper than the shallow continuous horizons.

Some interesting features of this traverse are:-

(1) The sudden increase in thickness of sediments to the north of S.P.40 and once again to the north of S.P.73.

(2) The possibility of sediments shelving to the south which would indicate an unconformity within the Palaeozoic.

(3) If the shallower horizons are extrapolated to the south they will probably reach the surface somewhere to the south of about S.P.30 where Permian rocks probably crop out at the sea bed.

(4) To the north of S.P.73 the sediments are seen to increase rapidly to the north and it is possible that Triassic and even younger rocks may be present to the north of S.P.73.

d) Port Keats (Marine) Seismic Survey
Reflection Cross-Section.
Line 2, S.P's 215-186, 185-132 and 91-131. Plate 33.

The sedimentary section increases in thickness from east to west. The dips are mainly to the west except across an anticline with its axis approximately over S.P.170. The correlation between the Bouguer anomaly profile and the reflection horizons is normal between S.P.'s 131 and S.P. 155. It also appears normal over the anticline, the rise in the subsurface being reflected by a rise in the Bouguer values. However, the increase in the Bouguer values over the anticline appears to be far in excess of what is expected for a very small rise in the subsurface

With the available seismic evidence it is not possible to determine where the density discontinuity surface lies. However, the reflection evidence suggests that the sediments from the shallowest to the deepest are conformable except over the anticline and at the eastern end of the traverse. Thus no matter where the density discontinuity surface is assumed to be, calculations based on the 2nd shallowest horizon which is almost continuous across the traverse will give almost the same result.

By comparing the rise in the Bouguer values between S.P.95 and S.P.131 ($6\frac{1}{4}$ milligals) with the rise in the 2nd horizon between these shot points (1250 feet*) it is found that a density contrast of .39 grams per c.c. must exist between the sediments above and below the density discontinuity surface which may be at the 2nd horizon or lower down the section.

By comparing the drop in the Bouguer values between S.P.170 and S.P.49 (6 milligals) with the drop in the second shallowest horizon between these shot points (400 feet*), it is found that a density difference of 1.174 gms per c.c. must exist between sediments above and below the density discontinuity surface which could be at the 2nd shallowest horizon or lower down in the section.

This density contrast of 1.174 gms per c.c. is far in excess of what is expected if subsurface conditions across the anticline are the same as those which exist between S.P.93 and S.P.131. It is possible therefore that the density of the sediments increases rapidly to the west of S.P.150 or that there is a considerable change in basement type. The fairly continuous nature of the deeper reflections does not suggest that changes in lithology occur from east to west. Also, it does not appear plausable that the sedimentary rock types could change so radically by as much as .78 gms per c.c. in density in such a short distance. For a density contrast of 1.174 grams per c.c. to exist at the density discontinuity surface strongly suggests a complete change in basement to a basic type or the intrusion of volcanics.

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* Assuming an average velocity of 10,000 feet per sec. for the sediments above the density discontinuity surface.

e) Port Keats (Marine) Seismic Survey.
Reflection Cross Section.
Line 4 shot points 374-415
and 272-372.
Plate 34.

The control for the Bouguer profile shown on plate 34 is very poor, hence no attempt will be made to compare the seismic horizons with it.

f) Port Keats (Marine) Seismic Survey.
Reflection Cross Section.
Line 7 S.P.'s 651-742.
Plate 35.

The seismic evidence is very poor across this traverse and the control for the Bouguer anomaly profile is also poor hence it is not possible to find out what the nature of the correlation between the subsurface and the Bouguer profile is.

CORRELATION BETWEEN BOUGUER ANOMALY PROFILES AND SUBSURFACE STRUCTURES AS INDICATED BY SEISMIC REFLECTION AND REFRACTION SHOOTING.

IV KEEP RIVER SEISMIC SURVEY, (Associated Group)

a) Refraction Line A, Spreads (10-27)
Reflection Line G3, S.P.'s 40-49.
Plates 36, 37.

A. Qualitative

This reflection and refraction cross-section is an east-west traverse across the southern margin of the Keep Inlet gravity 'low' area.

A very good qualitative correlation exists between the 18,900 feet per second refractor and the Bouguer anomaly between S.P.'s 316 and S.P. 100. The refractor rises to the east of S.P. 338 then levels off at 400' between S.P.'s 144 and 100. The Bouguer profile also follows the refractor's change in depth over this range. East of S.P. 100 there is a sudden rise in the Bouguer values which suggests a fault upthrown to the east. Proterozoic rocks outcrop to the east of S.P. 100 at S.P. 56. From the above correlations it is concluded that:-

(1) a density discontinuity surface probably exists between sediments above and below the 18,900 feet per sec. refractor.

(2) This discontinuity surface probably represents the top of the Proterozoic rocks.

The reflections obtained between S.P.'s 40 and 49 on line G.3 are mainly parallel, and are slightly diverse from the dip of the main refractor, they may be due to sediments onlapping over the basement.

To the west of S.P. 40, there is a marked reversal in correlation between the gravity profile and the 18,900 ft/sec refractor.

B. Semi-Quantitative

Assume that a density discontinuity surface which probably exists between the sediments above and below the 18,900 feet per second refractor is the only one present in the section. By comparing the amount of thickening of the section above the refractor between S.P.'s 122 and S.P. 316 with the amount of decrease in the Bouguer values between these shot points, it is found that a density contrast of approximately .3 grams per c.c is required to account for the Bouguer anomaly.

A. QUALITATIVE

b) Keep River Seismic Survey
Refraction Line B, Spread 10-22
Reflection Line G5, S.P.'s 43-124.
Plates 36, 38.

This reflection and refraction cross-section is a north-south traverse across the eastern margin of the Keep Inlet gravity 'low'. Reflections, where present, support the structure of the area as shown by refraction evidence.

A very good qualitative correlation exists between an 18,500 - 19,000 feet per second refractor and Bouguer anomalies and this suggests that a density discontinuity surface exists at the refractor surface. This is apparently the only major discontinuity surface. If the refractor is extrapolated to the south on gravity evidence it would probably reach the surface at about S.P. 54. Proterozoic rocks outcrop to the south of S.P.43 at the southern end of the traverse and it is obvious from the surface geology that they occur very near the surface further to the north where they are overlain by thin Quaternary sediments. The evidence suggests that the 18,500-19,000 feet per second refractor represents the top of the Pre-Cambrian.

Reflection evidence between S.P.46 and S.P.58 shows an unconformity which rises to the south, more or less parallel to the refractor, at a two-way time of about one second under S.P.52.

B. SEMI-QUANTITATIVE

Assume that the 18,500-19,000 feet per second refraction horizon is the discontinuity surface which gives rise to the Bouguer anomalies and that no other density discontinuity surface exists at other depths. By comparing the drop in Bouguer values between S.P.50 and S.P.106 where they level off, with the increase in depth of the refractor between S.P.50, (where the refractor probably reaches the surface) and S.P.106, a density difference of approximately .3 is required between rocks above and below the assumed density discontinuity surface to account for the drop in Bouguer values.

From the above, the following conclusions can be reached.

(1) That a density discontinuity surface probably exists between sediments above and below the 18,500-19,000 feet per sec. refractor.

(2) That this density discontinuity surface probably represents the top of the Precambrian.

(3) That the unconformity shown by reflection methods is within the Precambrian.

Similar conclusions to 1 and 2 above were reached for the east-west traverse across the southern margin of the Keep Inlet gravity 'low'.

INTERPRETATION OF CROSS-SECTION

The section shows the unconformity within the Precambrian between S.P.46 and S.P.58, and, above this, a conformable sequence of well-marked reflecting horizons with the 18,500-19,000 feet per second refractor at the top. The reflection evidence does not appear to be sufficient to trace the unconformity further to the north of S.P.58 although this has been attempted by the company (Geophysical Service International, 1962).

The dip of the deep semi-continuous reflection from 1.0 to 1.2 seconds between S.P.109 and S.P.122 suggests that the 18,500-19,000 feet per second refractor may continue its dip to the north.

Another possible unconformity is shown between S.P.104 and S.P.110, but its significance is not clear.

On the Bouguer anomaly map the lowest Bouguer values are shown between S.P.110 and S.P.122 with the values rising to the north of S.P.122. If the correlation which was shown to exist between the Bouguer profile and the subsurface structures on this cross-section continues to the north the deepest part of the Basin is expected to be centered somewhere between S.P.112 and S.P. 122, yet we have clear evidence of north dip from the reflections. Thus either there is a reversal of correlation towards the northern end of the traverse or the contouring, which is based on very limited gravity control is incorrect.

c) Keep River Seismic Survey.
Cross-Sections.
Refraction Line C, Spreads 16-23.
Reflection Line G4, S.P.'s 50-83.
Plate 36,39.

There is a qualitative correlation between the Bouguer profiles and the subsurface structures between S.P.59 and S.P.88.

The density discontinuity surface is probably at the 18,000 ft per second refractor, and similar to the discontinuity surfaces on lines A and B.

If this correlation continues to the north the refractor should reach its maximum depth below about S.P.300. The slope of the Bouguer profile decreases to the north of S.P.82 which suggests that the dip on the 18,000'/sec refractor probably decreases north of S.P.82. It is not possible to carry out a quantitative calculation to obtain the probable density contrasts which could account for the Bouguer profiles, as there are no two points at which both the gravity profile and the refractor level off.

A fault, with an upthrow of 600 ft to the south is reflected by a sudden increase in the gradient of the Bouguer anomaly curve across S.P.70. The considerably greater increase in the gradient across S.P.58 could be the reflection of a fault with a much greater throw than 600 ft.

d) Keep River Area.
Reflection Cross Section.
Traverse G1 S.P.'s 46-49 (West) and S.P. 50-73 (East).
Plates 36, 40.

The correlation between Bouguer profiles and the substructures appear to be normal. Proterozoic rocks are believed to exist at a shallow depth a few miles east of S.P.73 and the Bouguer anomaly between S.P.59 and 73 reflects this rise.

e) Keep River Area.
Reflection Cross-Section
Traverse G2 S.P.'s 50-80.
Plates 36, 40.

The reflection evidence particularly to the north of S.P. 64 is much too poor to find out what the nature of the correlation is between Bouguer profiles and the substructures.

f) Keep River Area.
Traverse G6 S.P. 50-67
Plates 36, 40.

Reflection evidence is too poor to attempt a correlation between Bouguer profiles and the substructure.

g) Keep River Area,
Traverse G7, S.P.'s 58-50.
Plates 36, 40.

The reflections show east dip from the shallowest to the deepest reflections; Bouguer anomalies, however, show a slight rise to the east. This traverse, although very short, is important for the following reasons:

(1) It has already been shown that Bouguer anomalies were probably caused by density contrast between Proterozoic and Palaeozoic rocks and not within the Proterozoic. The fact that the steeply dipping reflections on this traverse produce little or no effect on Bouguer anomalies suggests that the reflections are from within the Proterozoic.

(2) There is a suggestion that a structure exists in the deeper Proterozoic beds just west of S.P.50, or the beds may be dipping into a basin to the east.

V. SPIRIT HILL SEISMIC SURVEY (Oil Development N.L.)
(Plates 41-44)

The correlation between Bouguer Profiles and substructures will not be attempted for the Spirit Hill Survey traverses. The reflection evidence is not sufficient to indicate substructure and it is not even possible to draw a phantom horizon on the very poor and scarce reflections.

CORRELATION BETWEEN BOUGUER ANOMALY PROFILES AND SUBSTRUCTURES AS INDICATED BY SEISMIC REFLECTION AND REFRACTION SHOOTING

VI CARLTON SEISMIC SURVEY (Oil Development N.L.)

a) Reflection Cross-Section
Traverse NG S.P.'s 1-108
Plates 45, 48.

A. Qualitative

Only traverse NG S.P.'s 1-108 has sufficient reflection evidence on which to draw a phantom horizon and the correlation between Bouguer profiles and substructures will be attempted for Line NG only.

Between S.P.1 and 35 there is evidence of a gradual deepening of the sediments to the NNW. If we commence at a time of 1 sec. under S.P. 2 and draw a phantom horizon on the reflection evidence this phantom deepens to a time of 1.5 secs under S.P. 35. A deepening of 0.5 seconds or 2500 ft if we assume an average velocity of 10,000'/sec. or 3500' if the average velocity is 14,000'/sec for the sediments above the phantom horizon. The Bouguer values decrease between S.P.1 and 35 by 11 milligals and hence the direction of the slope of the Bouguer profile corresponds to that of the substructure.

Between S.P.41 and 108 the reflection evidence is poor and it is not possible to draw a phantom horizon except on the shallowest semi-continuous reflection which indicates a gradual rise to the north-north-west. If the deeper horizons are conformable with the shallower horizon the direction of slope of the Bouguer profiles and substructure will correspond.

If we assume that the phantom horizon between S.P.'s 1 and 35 is the only discontinuity surface present in the section, it is calculated that a density contrast of approximately .34 gms per c c is required to exist between sediments above and below the phantom horizon, assuming an average velocity of 10,000 ft per sec for the rocks above the phantom, and .25 gms per c c if the velocity is 14,000 ft/sec.

CORRELATION BETWEEN BOUGUER ANOMALY PROFILES AND SUBSTRUCTURES AS REVEALED BY SEISMIC REFLECTION SHOOTING

VII PEARCE POINT SEISMIC SURVEY (Australian Aquitaine Petroleum Pty Ltd).

a) Reflection Cross Section
Traverse PP7, S.P.'s 0-50
Plates 52, 53.

A. Qualitative

The cross-section between S.P.'s 0 and 50 is an enlarged reproduction of the interpretative cross-section Plate PP7 submitted by Australian Aquitaine Petroleum Pty Ltd as part of the monthly progress report. The section is extrapolated west to intersect the Port Keats Marine traverse Line 3 at S.P.509.

The direction of slope of the Bouguer anomaly and the subsurface structures corresponds between S.P. 0 and S.P.8, but further west the correlation is reversed and between S.P.22 and S.P.50 there is over 12 milligals rise in the Bouguer values despite the fact that the sediments are increasing in thickness to the west. As in traverse PP9 (Plate 54, see page 21) there must be either a considerable change in the density of the sediments to the west or a change in basement type.

Two different types of reversal of correlation between Bouguer profiles and substructures are noted on this traverse. Between S.P.'s 10 and 20 despite the rise in the substructures the Bouguer values drop, whereas between S.P. 20 and S.P.50 despite the rapid increase in the sediments, the Bouguer values begin to increase.

This suggests that a graben exists between S.P.10 and 20 which gives rise to a gravity low despite the rise in the substructures.

Between S.P.'s 20 and 50, the high Bouguer values could be due to:

1. An increase in density of the sediments or the presence of volcanics in the sedimentary section.
2. A change to a denser basement west of the fault under S.P.20. However, if the basement type remains the same between S.P.20 and S.P.50 this should give rise to a gravity low after an initial rise past S.P.20.

b) Pearce Point Seismic Survey
Reflection Cross Section
Traverse PP9 Shot Points 115-178.
Plates 52,54.

A. Qualitative

The cross-section between S.P.115 and 160 is an enlarged reproduction of the interpretative cross section of traverse PP9 submitted by

Australian Aquitaine Petroleum Pty Ltd. The cross section between S.P.160 and 178 for the 1st and 2nd horizons was obtained by the author from an interpretation of the variable area seismic records submitted by the company. There was some reflection evidence for the 3rd horizon also, but it was poor.

The 1st and 2nd horizons between S.P. 178 to the western end of the section shown in Plate 54 and the 3rd horizon from S.P.160 to the western end are extrapolations to intersect the Port Keats marine traverse Line 3 at S.P.480.

Between S.P.'s 115 and about S.P. 135, there is good correlation between the substructure and the Bouguer anomaly profile. Between S.P.'s 135 and 150 the correlation appears to be fairly good, whereas west of S.P.150 the correlation is reversed if my interpretation and extrapolation are correct.

This reversal could be caused by:

(1) change in basement type to a higher density, e.g. Antrim Plateau Volcanics,
(2) change in facies of the rocks towards the west to higher density rocks. As the beds dip towards the west this change must be very great to enable the Bouguer values to rise despite the increase in thickness of the rocks to the west,
(3) intrusion of volcanics into sediments in the basin.

CORRELATION BETWEEN PORT KEATS (LAND) SEISMIC SURVEY (LINE 6) AND PORT KEATS (MARINE) SEISMIC SURVEY LINE 1

In discussing the correlations which exist between the Bouguer anomalies and substructure on Line 6 (see page 8 and plate 25) good qualitative correlation was shown between the substructure and the Bouguer anomaly profiles. It was pointed out that if similar correlations continued to the north of S.P.240 the section continues to thicken to the north. It is not possible to carry out a quantitative analysis of the correlation as there are no two points at which both the Bouguer profile and the substructures level out. However, if the close qualitative correlation which exists between the Bouguer profile and substructure continues to the north, the sediments are expected to reach their maximum thickness beneath a point $5\frac{3}{4}$ miles north of S.P.254. Also, the sudden increase in the gradient of the Bouguer profile at about S.P.240 suggests a fault downthrown to the north. Extrapolation of the continuous horizon to the north on gravity evidence should therefore give reflections in excess of at least 1.7 secs beneath the point $5\frac{3}{4}$ miles north of S.P.254.

The 1963 results by Australian Aquitaine Petroleum Pty Ltd confirm this suggestion and extrapolation of these contours for Horizon 3 (Plate 52) gives a time of 2.1 sec. to the subsurface beneath that point.

The rise in the Bouguer profile between a point $5\frac{3}{4}$ miles north of S.P.254 on Line 6 (land) and S.P.$12\frac{1}{2}$ on Line 1 (Marine) is small compared to the drop in the Bouguer values between S.P.236 and that point. Hence the reflector on Line 6 (Land) extrapolated to be at 2.1 secs. at its deepest point is expected to be not much less than 2.1 secs. under S.P.$12\frac{1}{2}$ and probably correlate with the deepest horizons of Line 1 (Marine).

On page 23 an attempt is made to correlate the Pearce Point traverses P.P.7 and P.P.9 (Plates 53 and 54) with the Port Keats (Marine) seismic traverses. A value of 1.9 secs. was obtained beneath shot point $12\frac{1}{2}$ of Line 1 (Marine) by extrapolating Horizon 3 on P.P.7 and P.P.9 first to Line 3 (Marine) then around the marine traverses back to Line 1. This suggests that the continuous horizon on Line 6 (Plate 25) of the Port Keats (Land) traverse is the same as Horizon 3 of the Pearce Point traverses (Plates 53 and 54). This horizon is thought to represent the base of the Palaeozoic section. The tie between the surveys has allowed the extension of the contours (Horizon 3 of Plate 52) to the north of Port Keats - see Plate 59.

To the south of S.P.116 on Line 6 (Land) the Bouguer profile has the same gradient as between S.P.'s 110 and 116 see Plate 2; 4 miles south of S.P. 116 the gradient increases sharply but levels off 2 miles further south. If the good correlation between the gravity profile and the subsurface on Line 6 continues to the south, the Bouguer profile suggests that the continuous subsurface horizon rises to a point 4 miles south of S.P.116 where it is intersected by a fault, upthrown to the south. Further extrapolation of the continuous horizon to the south on gravity evidence suggests that it reaches the surface approximately 11 miles south of S.P.116 where Drummond (1963) has interpreted the Proterozoic rocks to be present at very shallow depth. The continuous reflection on Plate 6 could therefore represent the top of the pre-Cambrian.

On Plate 58 it is seen that the continuous reflection on Line 6 has a north component of dip and on Line 1 all horizons also have a north component of dip. Thus between these two traverses, there must either be a turn over of the continuous horizon on Line 6 or the section must be faulted.

CORRELATION BETWEEN THE PORT KEATS (MARINE) SEISMIC SURVEY, PEARCE POINT (LAND SEISMIC SURVEY AND PORT KEATS (LAND) SEISMIC SURVEY

A contour map produced by correlating the Port Keats Marine Survey with the land surveys is given on Plate 59.

If the correlation is correct a considerable thickness of sediments must exist in the north-west. A two way time of 3.4 secs. to the reflector was obtained beneath S.P.215 (Line 2, Marine Survey). Assuming an average velocity of 14,000 ft per sec. this will give a depth of 23,800 feet of Palaeozoic rocks. The identification of Horizon 3 on traverse P.P.7 and P.P.9 (Plates 53 and 54) as the top of the Proterozoics is only very tentative and should Horizon 4 be the top of the Proterozoics the thickness of the Palaeozoic rocks could be as much as 29,000 feet.

The correlation between the marine and land surveys was carried out in the following manner:

(1) Horizon 3 on traverse P.P.7 (Plate 53) of the Pearce Point Survey was extrapolated to the north-west to intersect the Port Keats Marine traverse Line 3 at S.P. 509. The extrapolated time under S.P. 509 Line 3 was 1.95 secs.

(2) Horizon 3 on traverse P.P.9 (Plate 54) was extrapolated to the north-west to intersect the Port Keats Marine traverse Line 3 at S.P.480. The extrapolated value of the 3rd horizon under S.P.480 was 2.25 seconds.

(3) The extrapolated Horizon 3 was then carried as a phantom horizon using as a guide the deep reflections wherever present and shallower ones when no deep reflections were present.* This phantom horizon was carried through all the traverses and back to Line 1 of the Port Keats Land Survey its value being 1.9 seconds under S.P. 12½.

As mentioned earlier, the point of lowest gravity values (and probable greatest thickness of sediments) is at 5¾ miles north of S.P. 254 on Line 6 (Plate 58). By extrapolation from the Pearce Point Survey (Australian Aquitaine Petroleum Pty Ltd, 1963), a two way time of 2.1 secs has been estimated to the main reflecting horizon from Line 6 at that point. If this horizon is further extrapolated to S.P. 12½ on Line 1, the two way time should not be much less than 2.1 secs for the following reasons:

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* The validity of the correlation will depend on whether or not the discontinuous deep reflections on the Marine Survey are multiples; from the corrected variable area records it is not possible to decide.

The rise in the Bouguer values to the east from the point $5\frac{3}{4}$ miles north of S.P. 254 to S.P. $12\frac{1}{2}$ on Line 1 is only 7 milligals compared with a drop of 26 milligals between S.P. 116 on Line 6 and the point $5\frac{3}{4}$ miles north of S.P. 254. The 26 milligals drop corresponds to a fall in the subsurface equal to 1.25 secs in two way time hence a rise of 7 milligals to the east is not expected to correspond to a rise of more than .34 secs.

This is in close agreement with the figure of 1.9 sec obtained by extrapolation of Horizon 3 along the Marine traverses.

POSSIBLE CAUSE OF THE REVERSAL OF CORRELATION BETWEEN BOUGUER PROFILES AND SUBSURFACE STRUCTURES

Strong belts of basic igneous rocks occur along the eastern margin of the Kimberley Basin, south-west of the Bonaparte Gulf Basin (Tectonic Map of Australia, 1960). These have a north-easterly trend and could possibly extend below the eastern side of the Bonaparte Gulf Basin. Their presence in the basement would explain reversals in correlations between subsurface structure and gravity profile in the western parts of the Keep River and Port Keats Surveys (Land and Marine).

On Port Keats (Marine) Seismic traverse Line 6 (Plates 29, 30) there is sufficient reflection evidence between S.P.'s 650 and 615 to show that the sediments dip to the north, (i.e. there is a reversal of correlation between the Bouguer profiles and the substructure). On Pearce Point traverses P.P.7 and P.P.9 (Plates 53 and 54) a similar reversal is seen. Hence although the Queens Channel gravity 'high' tends to be regarded as an area of shallow basement the sediments could deepen across it.

Also, the Keep Inlet gravity 'low' which on gravity evidence appears to be bounded to the north north-east and west by shallow basement, need not necessarily be so. The Keep Inlet Basin could easily extend to the north, north-east and west and perhaps even deepen towards these directions. Evidence for the deepening of the Basin to the north is clearly seen on Line B Plate 38). Although it is not possible to correlate the Keep River Refraction Line A (Plate 37) with the Carlton traverse Line NG (Plate 48) there is sufficient reflection evidence on Line NG to show that sediments exist down to a time of about 2.5 seconds.

On Plate 37 it is seen that the dip on the 18,900 ft/sec refractor increases suddenly to the north of S.P.338 reaching a two way time of approximately 1.2 seconds under S.P.396. On Line NG (Carlton Survey) the time to the deepest reflections under S.P.20, where traverse A intersects it, just three miles to the west of S.P.396, is over 2.4 seconds. Thus, in all probability, the sediments continue to deepen towards the west, despite the fact that the Bouguer values are rising.

For reasons given above it appears that the Keep Inlet and the Port

Keats basins are not isolated from one another. It is possible that they form an integral part of a major basin deepening to the north west.

GRAVITY INTERPRETATION

The study of the correlations which exist between sub-surface structures as indicated by seismic surveys and the Bouguer anomaly profiles have shown:-

(1) That over the eastern half of the Keep Inlet gravity 'low' the correlation between gravity profiles and the substructures is normal and the low gravity values do reflect a great thickness of sediments.

No seismic work has been carried out across the western half of this low except for Line NG, of the Carlton Seismic Survey (See Plate 48, page 36) which runs from the edge of the Pincombe Range across the south western portion of the Keep Inlet gravity 'low'. Correlation between Bouguer profiles and substructures appears to be normal over this traverse, but the seismic evidence is very poor and the correlation is by no means certain.

(2) The land and marine surveys in the Port Keats area show that the correlation between gravity profiles and subsurface structure is normal over the eastern half of the Port Keats gravity 'low', but reversed towards the western part, the sediments continuing to deepen while the Bouguer anomalies are seen to <u>increase</u> in value.

The gravity anomaly 'high' of large extent in the Joseph Bonaparte Gulf, which was thought to represent a high structural block bounding the Keep Inlet basin to the north and the Port Keats basin to the west, is now seen to be the reflection of a great thickness of sediments west of the Port Keats gravity 'low' and may yet be proved to represent an increase in thickness of the sediments of the Keep River basin to the north. The information on the Port Keats (Marine) Seismic traverse Line 7 (Plate 35) which crosses the southern margin of this gravity high was unfortunately very poor, although on Line 6 (Plate 30) there is sufficient evidence to show that

the correlation between Bouguer profiles and substructure is reversed as it is west of the Port Keats gravity low.

From the above it is clear that while a gravity reconnaissance survey helps in the understanding of the major structural features of the basin, it is only a first approximation and too much confidence should not be placed on the assumption that gravity lows represent areas of deep sedimentation and gravity highs areas of shallow basement. Every anomaly of importance shown on the gravity map must be tested by seismic reflection or refraction shooting before any confidence can be placed in the interpretation of the Bouguer anomaly map.

AEROMAGNETIC SURVEYS

A record on the aeromagnetic survey carried out by the B.M.R. in June and September 1958 has been written by J.H. Quilty but has not yet been edited. Since the B.M.R.'s survey two other surveys have been carried out in the Bonaparte Gulf Basin. The surveys were subsidized operations , one was by Aero Service Ltd in 1964 over the Northwest Continental Shelf of Australia. The survey was carried out for Woodside (Lakes Entrance) Oil Co. Ltd, and Mid Eastern Oil N.L.

The other was in Anson Bay O.P.83N.T. by Adastra Hunting Geophysics Pty Ltd, for Mines Administration Pty Ltd.

Mr. Quilty has dealt fully with the interpretation of the B.M.R.'s aeromagnetic survey in his record (in preparation).

The following comments were offered by him with respect to the aeromagnetic interpretation for inclusion in this compilation.

"The aeromagnetic pattern shows that shallow magnetic basement rock exists in the Moyle River area extending south to latitude $14^{\circ}30'S$

There is no evidence, however, of this shallow basement through Queens Channel, where estimates of depth to magnetic rocks are of the order of 10,000 feet below sea level.

The northern edge of the sedimentary basin postulated from aeromagnetic and, in part gravity evidence is as shown in the Bonaparte Gulf maps. (See Volume IV, Part 3, plates 60 and 61).

The Ivanhoe Graben on the south-west of the basin is not well defined by the aeromagnetic contours. In the vicinity of Kimberley Research Station, there is a correlation between the magnetic anomalies and outcrops of Cambrian volcanics, but the more intense anomalies to the south-west are ascribed to basement metamorphics and/or gabbro intrusives. The general south-western edge of the basin is indicated in the above mentioned maps."

ACKNOWLEDGEMENTS

The co-operation of Oil Development N.L., Mines Administration Pty Ltd, and Westralian Oil Ltd, in supplying data from private geophysical reports, is gratefully acknowledged.

This report is based on the work of many geophysicists and others. Data from their reports are acknowledged in the body of the report.

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The following bibliography lists sources of data under two headings.

(i) Unpublished reports.

(ii) Private Company Reports - indicated by an asterisk.

The unpublished reports include

(a) Bureau of Mineral Resources Records.

(b) Completion Reports on subsidized geophysical or drilling operations which may eventually be published.

(a) Reports in this category may be examined at the Bureau's Canberra and Melbourne offices. The Bureau of Mineral Resources Records are sometimes obtainable on loan from the Bureau - upon request.

(a) Completion Reports on subsidized geophysical or drilling operations cannot however be obtained on loan from the Bureau. Most of these reports eventually become available as P.S.S.A. Publications and may be purchased from the Bureau. Unedited copies of these reports may however be obtained from the following sources:-

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Geophoto Resources Consultants,
Millaquin House,
30-36 Herschel Street,
BRISBANE. Qld. Phone 2-7320

(ii) Private Company Reports are on unsubsidized geophysical operations of which the majority were carried out before the Petroleum Search Subsidy Act covering geophysical surveys came into operation in 1959. These reports are the property of the companies concerned and can be inspected at the Bureau's Canberra office only if a letter of authorisation from the company is first obtained.

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