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RECORDS:

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

Volume II Seismic Compilation

PART 6 of 11

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

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VOLUME II SEISMIC COMPILATION

by

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INTRODUCTION

The purpose of Volume II of this report is to enable the reader to assess the structural information obtained by Seismic Surveys in the Bonaparte Gulf Basin to the end of 1962. Cross-sections have been given at scales suitable for such assessment. Bouguer anomalies, topography, Geological surface outcrop and interpretative solid geology are also given in profile with the cross-sections to facilitate the correlation with the sub-structures revealed by seismic reflection and refraction methods.

SEISMIC

Seven seismic surveys have been carried out in the Bonaparte Gulf Basin between the years 1956 and 1962. The areas in which the seismic surveys have been carried out are shown on Plate 19. The location of all seismic traverses will be found also on Plates 2 and 3 along with the Bouguer anomaly contours.

Locality maps showing traverses and shot points of each survey in more detail accompany this compilation. (Vol 4 Part 2)

1. BONAPARTE GULF SEISMIC SURVEY

The first seismic survey in the Bonaparte Gulf Basin was carried out by the Bureau of Mineral Resources (B.M.R.) in the Spirit Hill, Milligan's Lagoon area and in the Ninbing area between June and October, 1956. The location of these traverses on a scale of 1:250,000 is given on Plate 20.

This survey has been described in the B.M.R. Record 1957/46: Preliminary Report on a Seismic Survey in the Bonaparte Gulf area June-October, 1956, by C.S. Robertson.

All cross-sections from this survey are given on Plates 21 and 22 on a scale of 1" = 1 mile along with the Bouguer anomaly profiles except for traverses B and C (Ninbing Area).* The original scale of the cross sections presented in Robertson's record was 1" - 1000 feet.

Extracts and summaries from the report are given below.

According to Robertson the seismic results indicate a maximum thickness of sediments of about 20,000 feet in the "Carlton Basin" and 14,000 feet in the "Burt Range Basin". (The basin subdivisions after Traves, 1955). The rocks in both areas have been folded to a considerable extent and seismic reflections suggest unconformities within both basins.

"CARLTON BASIN"

Traverse A Ninbing Area (Plate 20 & 21)

No reflections were obtained north-east of S.P.9 and surveying was stopped at S.P.48. Pattern holes of 13 and 36 holes were fired at S.P.33 and 28 respectively, but no reflections were obtained. Refraction surveying of this portion of the traverse was also unsuccessful.

"To the south-west of S.P.9, several reflections of fair quality were obtained as far as S.P.90. Most of these showed a north-easterly component of dip of about 30° and a few shallow horizontal reflections were also obtained. South-west of S.P.90, fewer reflections were recorded, and none were obtained south-west of S.P.100 while shooting on Cambrian rocks. Definite reflected energy was recorded at S.P's 122

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* Traverses B and C, (Ninbing Area) each a mile long, were shot at right angles to traverse A (Ninbing Area) through S.P's 57 and 71 (Plate 19). The reflections? obtained on these two short traverses were very few and of a questionable nature hence they have not been included in this report.

and 126 on the Proterozoic rocks, but it was impossible to make any calculations of dip.

Between S.P.9 and S.P.55 there is evidence of an unconformity which, below S.P.6, is at a depth of 7,000 feet, but below S.P. 55, is probably at 2,000 feet. The components of dip above the unconformity are to the north-east but are less steep than those below it. From S.P. 65 to S.P.71 shallow reflections were recorded which show a north-east component of dip of about 4°. There is thus a suggestion of another unconformity, [redacted] a depth of about 4,000 feet.

The results of the traverse across the 'Carlton Basin' indicate the existence of a thick section of some 20,000 feet of sedimentary rocks with a general north-easterly dip, extending at least as far east as the outcropping Weaber Sandstone east of Ninbing. The major problem which remains unsolved is whether such a section exists beneath the Weaber Sandstone and alluvium to the north-east. Following the traverse to the north-east, the reflections cease near the western margin of a large fault zone. It is not known whether the absence of reflections north-east from there is due to adverse surface shooting conditions or to the absence of a section favourable to the production of reflections. From consideration of both seismic and geological evidence (Traves, 1955, pp.131, 132) it is possible that the Weaber Sandstone overlies basement at shallow depth.

The results of the seismic traverse across the 'Carlton Basin' do not indicate the existence of anticlinal structures. The best possibilities for the accumulation of oil indicated by the dip-plotted section would be in any fault traps near the above mentioned fault zone and in any stratigraphic traps above the unconformities referred to".

"BURT RANGE BASIN"

RESULTS AND INTERPRETATION

Traverse A Spirit Hill

A preliminary cross section of Traverse A, Spirit Hill, is given on Plate 22. The reflections were migrated and plotted in their apparent correct positions.*

"Reflections, mostly of poor quality, were obtained over the greater part of the traverse, from S.P. 324 to S.P. 334, and the deeper reflections indicate a broad syncline with its axis near S.P.307. Reflections were obtained to a depth of about 20,000 feet. Between S.P. 313 and S.P.308 there is evidence of an unconformity at 6,000 feet which probably extends to the eastern margin of the basin. Below the unconformity, the reflections indicate a dip of about 25° towards the axis of the basin, but the dip appears to be considerably less above the unconformity.

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* The velocity function used is not mentioned in the report.

Unfortunately, the reflections gradually decreased in number easterly towards the crest of the Spirit Hill Anticline and none was obtained to the east of the crest. Therefore the anticline was neither proved nor disproved, but westerly dips on the western flank were indicated.

Near both ends of the traverse, deep reflections were obtained which indicated dips of up to 40° towards the axis of the syncline. The layers producing these reflections, if produced to the surface, coincide with outcropping Proterozoic rocks. If produced down into the syncline, these layers would occupy at the axis the portion of the section below about 14,000 feet. However, very few reflections were recorded below this depth near the axis.

The sudden decrease with depth in the number of reflections recorded from below 14,000 feet over the greater portion of the traverse, together with the steeply dipping reflections near the margins of the basin, suggest that Proterozoic rocks occur beneath an unconformity which occurs at depths ranging up to about 14,000 feet. Reflections from above the indicated unconformity show moderate dips such as are encountered in the known Palaeozoic rocks of the area. It appears likely, therefore, that the Palaeozoic section may be about 14,000 feet thick at the centre of the basin."

RESULTS AND INTERPRETATION

(Traverses B, C, D, E and F Spirit Hill) Plate 22

"Reflections recorded along the 5 miles of traverse D were generally horizontal down to about 10,000 feet, below which the dip components were variable in direction and magnitude. On traverses, B, C, E and F, across the strike, reflections were obtained except where the traverses approach the sandstone hills to the east. The southernmost traverse, B, indicates at its north-western end and at shallow depths a south-easterly component of dip; otherwise the four traverses indicate north-westerly components of dip. There is evidence on each of these traverses of an unconformity at depths ranging from 9,000 to 10,000 feet, the dips being considerably less above the unconformity than below it.

As in the case of traverse A, north of Spirit Hill, no reflections were obtained east of the crest of the Spirit Hill Anticline; consequently, the dips on the eastern side were not determined. There is strong evidence of north-westerly dip on the north-western flank of the anticline but otherwise the seismic results give no proof that a closed structure exists".

TOPOGRAPHIC SURVEY:-

The Bureau of Mineral Resources also carried out gravity observations at shot points along the B.M.R. seismic traverses in the Ninbing and Spirit Hill areas during September - October, 1956.

(A full account of the method of survey is given in Volume I Part 2 of this record. The elevations of all stations are given in Appendix D.)

2. PORT KEATS (LAND) SEISMIC SURVEY

In late 1960, a reflection seismic survey was carried out in an area which lies south of the Port Keats Mission Station. See Plate 23.

This survey is described in the report entitled "Seismic Survey Report for the Port Keats Area O.P. No. 2, Northern Territory", submitted to Mines Administration by Douglas F. Warner of Austral Geo Prospectors Pty. Ltd., July, 1961. All cross-sections from this survey are shown on plates 24 to 27 at a horizontal scale of 1" = 1 mile.

Extracts and summaries from the report are given below.

PURPOSE OF SURVEY

The primary aim of the survey was to determine the thickness and structural configuration of the Palaeozoic sediments south of the Port Keats Mission.

RECORDING;- "Reflection quality was good on some profiles, but, in many instances no reflections were recorded at all. Two factors were recognised which contributed to the spotty results. First, reflection quality generally deteriorated with elevation; that is, the higher the elevation the greater the probability of finding thick sandstone and the faster the velocity of this sandstone the poorer its properties as a shooting medium. Second, abrupt changes occurred in the subsurface with presumably a complete loss of the reflecting Palaeozoic section".

INTERPRETATION METHODS

A constant velocity of 15,000 feet per second was used to migrate for dip. "Therefore the depth scale shown on the cross-sections would greatly exaggerate the depths of the shallow reflectors."

"Only one reflection could be carried over enough of the area to be useful in map presentation. For this reason only one subsurface contour map the "Unidentified Palaeozoic" was prepared". See Plate 23.

An approximate outline of the Palaeozoic basin is also shown on Plate 23.

DETAILED DISCUSSION OF RESULTS

"Best results were obtained on the segment of Line 1 (Plate 24) which lies between Shotpoints 121 and 61. An examination of this segment reveals the following significant geological considerations.

1) A persistent reflection having fair character stands out. It occurs at 1.248 seconds at Shotpoint 3, is downthrown to the east at Shotpoint 10, then rises gently eastward. This reflection is identified as "P" and heavy-lined on the enclosed sections.
A deeper and less persistent reflection (1.653 seconds at Shotpoint 3) is also heavy-lined on the cross-sections.

Following the two horizons westward, we find that they stop abruptly at Shotpoints 2 and 3 - just as if they 'ran into a wall'. Upper events persist farther to the west. We take this to mean that the horizons have 'bumped into' a Precambrian island or peninsula in the Palaeozoic sea.

One might discredit the above hypothesis by saying that the gap in reflections is caused by shooting problems associated with sandstone found at higher elevations. However, one would be hard pressed to explain why the two strong, fairly persistent deeper reflections disappear abruptly while the more shallow reflectors continue farther to the west.

No more coherent reflections are noted to the west until the western extremity of the line, where one mile of reflection continuity at an intermediate depth suggests the return of basin conditions.

East of Shotpoint 54, we assume that we have again encountered a Precambrian island or northward projecting peninsula of the Palaeozoic sea. The cross-section suggests that the island or peninsula here has a west-dipping flank. Since reflections in this locality were poor and also indicated that the Precambrian section was getting very close to the surface, the field crew skipped approximately 3 miles to Shotpoint 74. Recording at this point was performed under conditions which ordinarily would have yielded reflections, but no line-ups were obtained - possibly indicating that Shotpoint 74 is near the culmination of the Precambrian peninsula or island. Another skip approximately 3 miles was made to shotpoint 90. There was a return to basin conditions and a semi-persistent reflection vaguely correlatable with the "P" horizon was noted on the eastern end of Line 1. (Plate 24).

2) Between Shotpoints 24 and 37 there are some sharply west-dipping partial reflections which define an angular unconformity. At Shotpoint 37 (Plate 24) the line makes a right angle bend to the north. Here, to the north of Shotpoint 37, where the traverse is on strike with the beds beneath the angular unconformity, we see our only segments of Precambrian' continuity. We would logically associate this angular unconformity with the most drastic change in the section which would be the break-over between the Palaeozoic and the Precambrian. Accepting this at face value, we thus have a means of estimating the thickness of the Palaeozoic section. Projecting the angular unconformity westward along the line of section to its deepest point, we got a value at Shotpoint 12 of about 1.9 seconds. If we assume a 'linear increase with depth' velocity distribution, take an initial instantaneous velocity (Vo) of 7500 feet per second (the sub-weathering horizontal velocity given by the first breaks) and take the refraction velocity (Vz) for the Precambrian as 21,000 feet per second (the limiting instantaneous velocity at depth), we can compute a thickness of 12,500 feet of Palaeozoic section. This is roughly commesurate with the thickness of the Palaeozoic measured across the outcrop in the Keep River Area, 100 miles to the south-west

No cross-section was prepared for Line 2 since no reflections were obtained. Data on Line 3 Plate 26 were very poor. Lines 4, 5, and 6 (Plates 25, 26, 27) add to the picture as follows:-

1) The northern ends of Lines 4 and 6 carry very little information. This is quite likely due to surface conditions of high topography and sandstone. However, if we accept the few reflections present at face value, we must conclude that the Palaeozoic basin deepens slightly to the north.

2) The southern portion of Line 6 shows the upper horizon (P) lapping on the lower semi-persistent horizon at Shotpoint 116. This defines the approximate boundary of the Palaeozoic basin at that point. Lines 3 and 5 show no such on-lappings: so, we conclude the southern limits of the basin lie somewhere south of the southern ends of these traverses.

As shown by the reflection contour map (Plate 23) we have now outlined a north-south striking arm of the Palaeozoic sea, bounded by two northward projecting Precambrian peninsulas. Reconnaissance gravity observations by Mines Administration Pty. Ltd. define a gravity minimum roughly coincident with the basin visualized. No support for the hypothesis of the westernmost Precambrian peninsula is provided by the scattered gravity data, however".

CONCLUSIONS AND RECOMMENDATIONS

".....,it is logical to presume that a commercially interesting thickness of marine Palaeozoic extends north and west from the area worked. Consequently, within the confines of Permit No. 2, a sufficiently extensive distribution of marine Palaeozoic may exist to justify a large scale exploration program".

An offshore reconnaissance seismic program coupled with additional gravity control was recommended to attempt to determine the areal extent of the Palaeozoic basin.

TOPOGRAPHIC SURVEY DETAILS:-

Previous geophysical surveys* provided horizontal and vertical control. A plane-table and alidade were used for reflection lines and transit for refraction lines. All distances were chained. Permanent markers, iron ports imbedded in cement

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* Geological and Geophysical Report on Keep River Area - Mines Administration Pty. Ltd. Private Report No. NT/BG/200 (See Volume 1, Part 1 of this report)

and identified by line and shot point numbers, were placed at line intersections, refraction shotpoints, and 10 mile intervals on reflection lines.

PORT KEATS (MARINE) SEISMIC SURVEY

Between 15th and 20th September, 1961, a marine reflection survey was carried out in the Joseph Bonaparte Gulf by Seismograph Services Limited of London, under contract to Mines Administration Pty Limited, for the "Associated Group".

185 miles of traverse were shot at ¼ mile intervals. The area surveyed covered the Port Keats Entrance and Eastern coastal waters of the Joseph Bonaparte Gulf from Cape Dombey in the north towards Turtle Point in the south. (Plates 28 and 29).

This seismic survey is described in "Report on a Marine Seismograph Survey in the Port Keats Area O.P. 2 Northern Territory", by Mines Administration Pty Ltd. (D.M. Traves and J.M. Burbury, 1961).

Summaries and extracts from this report are given below.

PURPOSE OF SURVEY

Previous seismic work south of the Port Keats Mission indicated that the sedimentary section was thickening to the north (Warner, 1961, p.8). Gravity surveys in the Bonaparte Gulf Basin also indicated that sedimentary thickening occurs in the Port Keats area.

The survey was designed to determine the thickness and structural configuration of the Palaeozoic sedimentary section in the Port Keats sub-basin and also to find out if the Carboniferous, Devonian and Cambrian rocks of the Keep River area extend northwards below the Permian in the Port Keats sub-basin.

RESULTS

Two strong shallow reflections, A and B were fairly continuous over the greater part of the area surveyed. Contours on horizon A and B are given on Plates 28 and 29 respectively.

"The reflection quality was, in general, good although there was some deterioration towards the south on lines 6 and 7.

The regional north-west dip is interrupted, in the north of the prospect area, at the junction of Lines 2 and 3, by a major anticlinal feature. No definite closure is shown on the contour maps. However, the greater part of this feature appears to lie to the north of Line 2, (Plates 28 and 29) outside the area covered by the survey, where critical north-east dip may occur.

Immediately to the south of this anticline faulting, upthrown on the south, is postulated on Line 3.

The regional north-west dip persists over the southern portion of the prospect area with the exception of two prominent anticlinal folds centred about shot points 515 and 597 on Line 5".

Variable area time sections corrected for move-out were presented in the above report, but these have been reinterpreted and are presented in Plates 30 to 35 of this report as plotted time cross-sections. Features shown in Plates 30 to 35 agree very well with those described from the variable area time sections by Traves and Burbury (see "Interpretation" below).

In assessing these time cross-sections it must be borne in mind that no corrections were made either for water depth (which varied from 20 feet to 90 feet with an average of 60 feet) or for the depth of the charge and geophones which were always less than 15 feet. Undue weight should therefore not be attached to slight features of small extent.

INTERPRETATION

Horizon 'A'

"Over the whole northern area the sections are characterised by two shallow reflections which show excellent continuity and can be readily correlated throughout the area, with the exception of the portion of the fault zone on Line 3 between shot points 246 and 258.

Horizon 'A' was chosen to coincide with the deeper of these two reflections which are separated by a time interval of approximately 250 milliseconds.

In the southern area these reflections can still be followed until they become so shallow that interference occurs between the reflected energy and the water transmitted energy; for this reason, Horizon 'A' was discontinued at shot point 639 on Line 6 (Plate 28) at a reflection time to 250 milliseconds below datum.

The contour map shows north-west regional dip interrupted by a prominent anticlinal feature situated immediately north and east of the intersection of Lines 2 and 3. (see Plate 28).

This feature shows a sharp reversal on Line 3 with 0.150 second of north dip mapped to the northern extremity of the Line at shot point 216, and 0.170 second of south dip against the fault at shot point 239.

On Line 2, (Plate 33) the west flank is well developed and shows 0.370 second of regional dip to the end of the line at shot point 215 with the possibility of minor faulting at about shot point 182, which would be upthrown the east. East of the intersection of Lines 2 and 3, the horizon is virtually flat along Line 2 except for minor undulations

and remains at the minimum reflection time of 0.710 second below datum as far as shot point 163 where the eastern flank develops and exhibits 0.100 second of east dip into the synclinal reversal at shot point 151.

This feature has been mapped as a nose plunging south-west and no definite closure is shown on the contour map; (see Plates28and 29) however, since it would appear that the greater part of this anticline lies to the north of Line 2 and outside the area surveyed, it is possible that some closure does exist further to the north-east.

The syncline which is centred at shot point 151 has been contoured as extending in a south-westerly direction into the fault zone on Line 3.

This faulting has been postulated because of the marked change of character on Line 3 between shot point 239 and shot point 259 on the two strong shallow reflections which elsewhere show persistently good character and continuity. These two reflections can be readily correlated between shot point 239 and shot point 259; however, although two weak events of similar time interval can be distinguished between shot point 241 and shot point 245, no such events can be recognised on the section between shot point 246 and shot point 258.

Correlation between these two weak reflections and the stronger reflections snorth of shot point 239 indicates a fault upthrown to the south at shot point 239. Similar faulting has also been postulated at shot point 259 south of which point the two strong reflections can again be readily distinguished; the throw of this southerly fault cannot be accurately determined due to the total loss of correlatable reflections north of shot point 259 and, similarly, the contouring within the zone of faulting must be considered conjectural only.

Elsewhere within the northern prospect area, the map (see Plates 28 and 29) shows uniform regional north-west dip with minor terracing on Line 1 (Plate 32) between shot points 55-57 and a small anticlinal fold on Line 4 (Plate 34) at shot point 298.

South of Line 4, the programme consisted of long reconnaissance lines and no closed loops were surveyed; Horizon 'A' in general rises to the south consistent with the north-west regional dip mapped further north; however, folding results in the formation of two prominent anticlinal reversals centred about shot points 515 and 597 on Line 5* (see Plate 30).

The reversal at shot point 515 exhibits 0.300 second of south-west dip into the major synclinal reversal mapped at shot point 550; the reversal at shot point 597 shows 0.170 second of north-east dip into the same syncline and 0.060 second of south-west dip into the flanking syncline at shot point 604".

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* My interpretation of the variable area records does not appear to give much evidence for the anticlinal reversals.

Horizon 'B'

"Horizon 'B' was chosen as a deeper phantom horizon which generally maps the structure of the deepest reflection alignments which can be observed on the sections. This horizon does not follow any readily identifiable event but the reflection quality in the vicinity of the phantom is generally fair over the greater part of the northern area; to the south, the reflection events do not persist at depth and the quality and continuity deteriorates. Due to this discontinuous nature of the deeper results, the contour map of Horizon 'B' is of a lower order of reliability than Horizon 'A' which continuously maps an identifiable event.

The contour map of Horizon 'B' shows identical structural features to that of Horizon 'A' but, at this depth, the relief is considerably greater. Over the northern area for example, the overall north-west dip on Horizon 'B' is 1.400 seconds as compared to 0.720 second on Horizon 'A'. It is worth noting that this amount of dip on Horizon 'B' is approximately twice that of Horizon 'A' and the possibility of multiple reflections influencing the deeper horizon cannot therefore be completely eliminated.*

To the south of the point on Line 6 where horizon 'A' was discontinued, Horizon 'B' is featureless and continues to demonstrate the north-west regional dip trend".

GEOLOGICAL INTERPRETATION:

"The results of the marine seismic survey in the Port Keats and Keep River areas have shown that the sedimentary section increases in thickness seawards over the whole of the area investigated, that is, from Cape Dombey in the north of Quion Island in the Queen's Channel. The general trend in increase of section is north-westerly. This trend is clearly indicated in the northern part of the survey area and although little directional control of trend is afforded by the regional lines to the south appears to conform with the observed data.

In the northern part of the survey area both seismic horizons mapped show a major irregularity in the north-west trend. This occurs near the junction of Lines 2 and 3 where a reversal of dip of approximately .150 seconds indicates an anticlinal structure extending to the north-east. West of the junction of Lines 2 and 3 the north-west dip increases and the lower horizon, Horizon 'B' shows a maximum reflection time of 2.560 seconds at the end of Line 2, and is seen to be still dipping to the west. The depth to Horizon 'B' would be approximately 12,000 feet in this area.

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* Several other record sections in the northern part of the survey strongly suggest the presence of multiple reflections.
e.g. line 3 - S.P.435 - 460, line 4, S.P. 295 - 315, line 4 - S.P.333-350.

Along Line 4 both horizons show a continuous increase in depth to the west apart from a very small reversal near shot point 297, which could be due to surface reef development in this area; and a sharp reversal of the west dip on the extreme western end of the line.*

The reflection results in the northern area indicate that the sedimentary section increases in thickness to the west and that the major basin development must occur west of the surveyed area. The sharp reversal of west dip on the end of Line 4 (Plate 34) could be the start of the west flank of the basin, however, because of the very abrupt change in dip observed it is considered more likely that the reversal is due to faulting, possibly related to the faulting observed on Line 3 (Plate 31).

The results of gravity surveying over this northern area had indicated that the axis of sedimentation in the Port Keats Basin extended north through the Port Keats Harbour and that the basin broadened to the north. As shown above, the seismic surveying does not confirm the conclusions drawn from the results of the gravity surveying. More detailed gravity surveying may indicate a relationship between seismic and gravity results, but at present the gravity results cannot be relied upon to indicate basin trends in the Port Keats area.

Throughout the whole of the survey area some reflection events occur below Horizon 'B', however, their continuity is poor and they appear on a few consecutive records only. It is possible that these sporadic reflection events could be originating from the same section that gave rise to the numerous deep partial reflections mapped by Austral Geo Prospectors Pty Ltd, during the land seismic survey (1960). These deep partial reflections showed angular unconformity to the overlying section and it was considered that the unconformity was the base of the Palaeozoic section. The deeper reflections mapped during the marine survey appear to be conformable with the overlying section and hence no suggestion of the base of the Palaeozoic is indicated.

Shot point 515 line 3 (see Pl.28) of the marine survey is approximately 1 mile west of shot point 170 of the Austral Geo Prospectors Pty Ltd land survey. Reflections at times approximately 1.300 and 2,000 seconds appear on both records. The record quality at shot point 170 is very poor however, and the numerous reflections observed at shot point 515 are not seen on the record of shot point 170. East of shot point 170 very poor records make it impossible to correlate the reflections of the marine survey with those observed in the good record area of the land survey approximately 12 miles inland. Intervals between reflection events observed in good record areas of both surveys are difficult to correlate and hence correlation of horizons mapped is not possible.

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* Some evidence of this reversal is shown in the author's interpretation. However, a more prominent reversal occurs near S.P.335.

Lines 5 and 6 of the marine survey traversed the large gravity high anomaly in the Queen's Channel, which was mapped by the Bureau of Mineral Resources sub-marine gravity survey as being centred at about shot point 610.

The gravity survey showed positive reversal of Bouguer gravity values approximately 25 milligals between Pearce Point in the Port Keats area and the Keep River Inlet to the south. It had been postulated that the large gravity anomaly represented a basement high that could have formed a barrier to Palaeozoic deposition in the Bonaparte Gulf Basin between the Keep River and Port Keats areas. The Bouguer gravity values over the high were similar to those observed over Proterozoic basement around the margin of the basin, and it was considered likely that similar basement rocks would occur at or near the surface in the area of the gravity high.

South-west from Pearce Point along Line 5 both horizons mapped show a continuous rise to shot point 600, where the lower horizon still shows a reflection time of approximately 1.300 seconds. The lower horizon Horizon 'B', rises approximately .300 seconds from shot point 550 to shot point 600. Between shot points 600 and 620, Horizon 'B' shows reversal of approximately .080 seconds and then rises again to the south-east to the end of Line 6. Horizon 'A' shows similar trends. Although this structural reversal near shot point 600 coincides with the crest of the gravity high, its magnitude is insufficient to account for the observed gravity reversal. Some scattered reflections occur in the section below the Horizon 'B' level in this area which appear to be conformable with the shallower section. No indication of a more pronounced structure at depth or any change in the general character of the reflection section that could explain the gravity anomaly is evidenced on the results of Lines 5 and 6.

It must be concluded that although the small reversal shown on Lines 5 and 6 may well be related to the gravity high anomaly, the major cause of the gravity anomaly must occur below the section mapped and that sedimentation, at least in part, was continuous across Queen's Channel and it is likely that the Palaeozoic section occurring in the Keep River area would also occur in the Port Keats area".

LOCATION OF SHIP'S POSITION AND DETERMINATION OF SHOT POINT POSITIONS: (Summary)

Within the sight of land the ship's position was fixed at each shot point by two or more magnetic bearings measured from the recording boat's standard compass to prominent topographic features. Further to seaward the lines were shot from a previously fixed buoy position within sight of land, or from the motor launch the M.V. Laakanuki anchored to act as a back sight, on a time cycle and compass course.

Buoys were dropped to position accurately the ties at all line intersections and to mark the position of a line at the end of a day's shooting. For further details see Traves and Burbury (op cit. p.7).

CONCLUSIONS:

"The results have shown that the sedimentary section increases in thickness to the north-west and that the major basin development must occur west and north of the surveyed area.

The contour maps have defined a major anticlinal structure near the intersection of Lines 2 and 3 (Plates 33 and 31) which may well show considerable closure further north-east outside the area covered by this survey.

Structural reversal was mapped near Shot Point 600 in Queen's Channel which coincides with the crest of a large gravity high; however, the magnitude of the reversal is insufficient to account for the observed gravity anomaly and it is concluded that the major cause of the large gravity anomaly must occur below the section mapped.

Complete loss of sedimentary section across Queen's Channel was not observed and hence it appears that sedimentation, at least in part, was continuous between the Keep River and Port Keats areas".

4. KEEP RIVER SEISMIC SURVEY

Between July and September, 1962, reconnaissance reflection and refraction surveys were carried out in the Keep River Area by Geophysical Service International, on behalf of the Associated Group,* under the supervision of Mines Administration Pty Ltd.

The location of the traverses and the form lines on the 18,500-19,000'/sec refractor is shown on plate 36. Approximately 43 miles of reflection and 48 miles of refraction shooting were carried out.

Reflection and refraction time sections from this survey on a scale of 1" = 1 mile (horizontal) are given on plates 37 to 40 along with the Bouguer anomaly profiles. They are reduced copies of the cross-sections presented in the above report in the Keep River area.

This survey is described in the Seismic Report:-

"Keep River Area
Oil Permit 2,
Northern Territory".

by J.L. Harris of Geophysical Service Internation.

Extracts from this report are given below.

I Objective

The survey was carried out to determine the thickness and structural configuration of the Palaeozoic sedimentary section in the Keep River Area of the Bonaparte Gulf Basin.

II Discussion of Results

RECORD QUALITY - REFLECTION

"There were several NR and questionable data segments and no reliable continuous data were recorded on any one line.

A "skip" technique was used on Lines G 1 to G 4 (Plates 40, 39, 37) when record quality deteriorated. Record quality varied from NR to fair on continuous shooting of Line G 5 (Plate 38).

The lack of reliable reflections is probably due to different factors in separate areas; e.g.

1. Extremely variable near-surface lithology and sub-weathering conditions.
2. Ground filtering and damping of reflection energy by loose surface sand.

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* Associated Australian Oilfields N.L.
Associated Freney Oilfields N.L.
Associated Continental Petroleum N.L.
The Papuan Apinaipi Petroleum Company Ltd.
Interstate Oil Limited.
Sleigh Exploration N.L.

3. Subsurface structural and lithological variations."

RECORD QUALITY - REFRACTION

"Record quality varied from fair to good. There were some first breaks timed but trough times were used for velocity determinations."

III IDENTIFICATION OF REFLECTORS AND REFRACTORS

"REFLECTORS: No wells have been drilled in this area and the lack of reliable continuous data makes identification of reflections very questionable. Reflection bands to a two-way time of 1.0-1.2 seconds on Lines G 1 to G 4 (Plates 40, 39, 37) are considered to be from within Permian and Carboniferous sediments. Deeper reflections on these lines are probably from within the Palaeozoic.

A strong unconformity occurs at approximately 1.0 second at the southern end of Line G 5 (Plate 38). Reflections above the unconformity are flat or show minor north dip. It is thought that they originate from below the unconformity and are possibly from disturbed Proterozoic sediments which show similar steep dips in outcrop approximately one mile south of Line G 5* (Plate 38).

REFRACTORS: One refractor, with a horizontal velocity 18,500-19,000 feet per second was mapped continuously on each line. Identification of this refractor is not definite. The high velocity recorded is indicative of a limestone or basement refractor. The refractor occurs at less than 1000 feet on the southern end of reflection Line 5 (Plate 38) where a minimum of 5000 feet of Palaeozoic section is postulated from reflection data. It appears likely that refractions are from the Burt Range Limestone (Devonian). The velocity is considered too high for a sandstone refractor.

Indications of a shllower refractor occur on some profiles. The velocity is 14,500-15,000 feet per second. It is possibly from within the Carboniferous section."

IV REFLECTION RESULTS

"Similar results were obtained on Lines G 1 and G 2 (see Plate 40).

There are flat conformable dips recorded to 1.2 seconds (two-way time) on Line G 1 Shot Points 51-59, and Line G 2 Shot Points 56-72. A possible unconformity is indicated below this time. Scattered deeper reflections occur to a time of 2.0 seconds. Thickness of section is considered from reflection data as a minimum 6000' with a possible thickness of 10,000 feet.

From very poor data on Line G 3, (Plate 37) two conformable bands at two-way times 0.4 seconds and 0.75 seconds show east dip between Shot Points 40-49.

On Line G 4, (Plate 39) Shot Points 66-84, north dip from poor data at 0.7 seconds is not considered reliable. Scattered dip segments above this time suggest a conformable section to this time at least.

A strong unconformity is clearly defined at a time of 1.0 second between Shot Points 44-60 on Line G 5 (Plate 38). Reflections to this time have minor north dip, below the unconformity strong north dip is evident. The unconformity is considered to occur at the base of the Palaeozoic. Proterozoic sediments outcrop approximately one mile south of this line. Reflections recorded at times of 2.7 seconds may be multiples. Two apparently conformable bands from Shot Points 108-122 also show north dip. It is not possible to correlate across the interval from Shot Points 60-71 where an abrupt change in reflection quality occurs. This may indicate (1) faulting of early Palaeozoic sediments or (2) loss of Palaeozoic section against a basement high. No faulting is apparent on the 18,500-19,000 feet per second refractor (possible Devonian) on Line B (Plate 38).

On Line G 6 (Plate 40) only a few scattered discontinuous reflections were recorded.

A probable unconformity occurs at about 2.0 seconds on Line G 7 (Plate 40). Data from 0.9 seconds to 1.6 seconds is generally conformable. Minor east dip is shown from Shot Points 57-53 and strong east dip from Shot Points 53-50; data is reliable.

Depth to an unconformity was about 5000-6000 feet where reliable reflectors were recorded; exceptions are on Lines G 5 and G 7. Reflection data below this depth is poor; scattered deeper dip segments on these lines indicate that section thickness may be a minimum 10,000 feet. Depth to the top of the Devonian is a minimum 7000 feet on the western margin of the prospect if identification of the 18,500-19,000 foot per second refractor is correct."

V REFRACTION RESULTS

"18,500-19,000 foot per second refractor was recorded on the three lines. There is broad structurally high area centered about the intersection of Lines A and B. Depth values range from 700 feet on the crest of this structural high to 7000 feet on the west end of Line A (near the Western Australian border) (see Plate 37) and 4500 feet at the north end of Line B (Plate 38). The basin deepens rapidly to the north-west.

Towards the eastern end of Line A strong west dip has been mapped on Spreads 15-22. The section continues to thicken towards the west end of the line.

Line B shows strong north dip off the structural high. Dip is flat on the south end of the line over the broad structural high and some dip reversal is shown at shallow depth on Spread 13. This is coincident with minor reversal shown on reflection Line 5 (Plate 38) and Shot Point 71.

Some minor south dip is indicated on the north extremity of Line C (Plate 39). Most of the north dip on this line occurs on Spreads 19 and 20.

There is evidence of a shallow discontinuous refractor with velocity in the range of 13,000-15,000 feet per second. Reverse subsurface coverage obtained on Line C, Spreads 16 and 17, indicated a velocity of 14,750 feet. One Lines A and B no reverse subsurface coverage was obtained on this refractor which precluded positive velocity identification. No attempt was made to map this horizon.

Salt marshes in the north and ranges in the south limited extension of the north-south trending Lines B and C".

CONCLUSIONS

VI "No closed structures are indicated. A structurally high area is shown on an 18,500-19,000 foot per second refractor mapped in the southeast of the area. Depth is less than 1000 feet and the refractor is considered to be massive Devonian Burt Range Limestone. Plunge to the northwest from the high agrees with regional gravity results* which show a continuous decrease in gravity in this direction to a major low over Keep Inlet.

An inferred unconformity at a depth 5000-6000 feet in the central and southern part of the prospect may be within the Carboniferous.

Faulting within the Palaeozoic is possible from reflection results obtained on Line 5.

Experimental work indicates that more complex arrays of shot holes and seismometers, plus the possible use of velocity filtering, may be necessary to obtain reliable continuous reflection data in this area. The refraction technique can be used successfully for mapping in this area although some operational difficulties were experienced".

VII TOPOGRAPHIC SURVEY

"Previous geophysical surveys**provided horizontal and vertical control. A plane table and alidade were used for reflection lines and transit for refraction lines. All distances were chained Permanent markers, iron posts embedded in cement and identified by line and shot point number, were placed at (a) line intersections (b) refraction shot points (c) 10 mile intervals on reflection lines."

** Geological and Geophysical Report on Keep River Area Mines Administration Pty Ltd Private Report No.N.T/B.G/20. See Part 1 page for a summary of this report.

* "Regional Gravity Survey - Bonaparte Gulf Basin 1957" - J.E. Burbury, Mines Administration Report No. NT/2/46.

For a summary of the above report see Vol.I, Part 3 of this compilation.

5. SPIRIT HILL SEISMIC SURVEY

Between July and September 1962, General Geophysical Company (Bahamas) Limited carried out a survey for Oil Development N.L.

The survey was located in O.P. - 3 situated in the north-western part of the Northern Territory close to the border between the Northern Territory and Western Australia near the headwaters of the Keep River (Plate 41). The survey area is approximately 40 mls. north-east of the Kimberley Research Station.

This survey is described in the report entitled:-

"Final Report Spirit Hill Seismic Survey"
by F.J. Tinline.

Summaries and extracts from this report are given below.

OBJECTIVE OF SURVEY:

"The purpose of this survey was to discover and delineate structure suitable for the accumulation of oil or gas and also if possible to obtain data on the thickness of the sedimentary section and altitude of the basement".

SURVEY DETAILS

TOPOGRAPHIC

HORIZONTAL CONTROL: Established by ties to Northern - Territory - Western Australia pegs SS-20 and SS-28. Horizontal distances were measured using a surveyor's chain and checked by stadia readings. Horizontal angles were measured by a theodolite. The border pegs were located on the map according to information furnished by the Department of Lands and Survey, Perth.

VERTICAL CONTROL: Established from elevations of Geoseismic points from their seismic survey in 1960. Levelling was carried out using a Zeiss automatic level.

PERMANENT MARKERS: Located at numerous shot points. The markers consist of star pickets with aluminium tags on which the line number, the shot point number and elevation of the shot points are given. A list of the location of the permanent markers is given on page 23 .

MAGNETIC DECLINATION: N 3°30' E of true north (1962).

RESULTS:

The results of the survey are presented in the form of a contour map of the proposed Palaeozoic reflection (Plate 41), and plotted time cross-sections (Plate 42).

"Record quality varies from fair to unusable with the majority of records being of a very poor quality. The best record quality was in

the north-west portion of the surveyed area with the quality deteriorating as the survey continued south and east.

Record quality is though to depend mainly on the soft sand over-burden masking energy return, however, records shot over black soil showed no improvement over those shot over soft sand. Also, the poor record results may be attributed in part to the fact that this area is a flood plain and the surface varies considerably due to the presence of a multitude of old drainage channels.

The 3-hole pattern normally employed, appeared to give better results where record quality was poor but showed no improvement over a single 80 foot hole where record quality was fair. Shot depths did not appear to be critical where record quality was fair, but were critical where record quality was poor.

The data used in the construction of the subsurface contour map is considered to be poor but generally reliable.* Record quality precludes continuous correlation, and a phantom horizon has been employed over much of the area. Continuous correlation was attempted but was not considered reliable.

The phantom horizon mapped is believed to be of Upper Devonian or Lower Carboniferous in age. This phantom horizon indicates a seismic high at the north end of line ND trending south-south-east towards the high indicated on line EC. A syncline trending south-south-west at the north end of line NB appears to saddle across the southward trending high at the junction of the EA and ND lines. A small fault is postulated at shot point 32 line EC, but could not be well defined. Regional dip appears to be to the northwest".

CONCLUSIONS:

"There appears to be a problem of multiple reflections in this area as well as a problem of poor energy return. Changes in the shothole depths and single and pattern shot holes did not appear to change the multiple reflection bands. Pattern holes appear to help energy return where record quality was poor. Several diffractions are apparent notably on the east and west ends of the line EC. With more extensive shooting the origins of the diffractions could possibly be determined.

The results of this survey are considered generally reliable as to attitude of the sedimentary section near the horizon mapped, however, no data could be obtained as to depth or attitude of the basement. There are some indications of reefing, notably secondary phasing between the refleqtion mapped and the phase below it, however, poor record quality precluded an out line of this proposed reefing.

The results of the survey indicate several interesting features which will require additional seismic work, to delinate any possible drilling.

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* The author's view is that the data used is unreliable.

The most interesting feature appears to be the seismic ridge trending south-south-east from the north end of line ND and the possible continuation of this high ridge south on line EC.

This ridge is possibly due to the draping of sediments over a basement high or due to thickening within the sedimentary section. Also, it may be the result of the draping sediments over a reef formation, however this is though unlikely as the relief does not appear great enough for this possibility. The premise that the high ridge was formed as a result of the draping of the sediments over a basement high is thought the most probable reason for its formation".

COMMENTS ON LIZ STRIKE HILL SEISMIC SURVEY

Most of the reflections shown on the 3" record sections and corrected 3" variable area record sections submitted to the Bureau of Mineral Resources appeared to be questionable and were considered to be too poor for reliable interpretation. The method used by the operator to produce a phantom horizon is illustrated on Plate 44. Individual traces were picked and timed, and, regardless of the alignment of the time plots of individual traces, the interpreter drew in a straight line nearly always horizontal. The straight lines only pass through very few of the time plots of individual traces, and sometimes through none of the points.

These records have been reinterpreted by the author and cross-sections are shown in Plate 43. They were so poor that little or no structural information could be obtained from them.

Perhaps the only conclusions which can be drawn from these plotted time sections - and ~~these~~ this too with some reservation - is that on line EC between SPs 49 and 30 reflections occur to a time of over 2.5 seconds. Assuming an average velocity of 10,000 feet per second this gives a depth of sediments of over 12,000 feet. Also, beneath S.P.32 there is some evidence of a fault. This is also supported by the steep gravity gradient across S.P.32.

Footnote

Another set of records was supplied to the B.M.R. after I had made the above re-interpretation. Their quality was better, but they still did not appear to contain sufficiently good reflections for reliable interpretation.

SPIRIT HILL SEISMIC SURVEY
PERMANENT MARKER LOCATIONS

(Star pickets, aluminium tag with shot point number, line number and elevation stamped thereon).

Line EA

S.P.	0
"	10
"	16
"	23-2
"	28-2

Line EC

S.P.	29
"	34
"	39
"	44
"	49

Line ND

S.P.	0
"	5
"	10

Line NE

S.P.	5
"	10
"	15

Line NB

S.P.	0
"	10
"	15
"	20
"	25
"	29

Line NF

S.P.	0
"	5
"	10

6. CARLTON SEISMIC SURVEY

General Geophysical Company (Bahamas) Limited carried out a survey in the Carlton Sub-basin for Oil Development N.L. between September and November, 1962. The survey was located in P.E. 127H in the north-eastern part of Western Australia, approximately 45 miles north-east of the Kimberley Research station.

An account of this survey is given in the report
"Final Report Carlton Basin Seismic Survey"
by R.J. Tinline and John S. Fife.

Summaries and extracts from this report are given below.

I OBJECTIVE OF SURVEY:

"To obtain data on the subsurface attitude of the sedimentary section present, with the objective of outlining and delineating a structure suitable for the accumulation of oil and gas".

SURVEY DETAILS

II TOPOGRAPHIC:

HORIZONTAL CONTROL: Established by a traverse from the adjoining Spirit Hill Survey traverse and later by a tie to the Western Australia - Northern Territory border peg M.N.74. The border peg was established on the map from information supplied by the Department of Lands and Survey, Perth. Horizontal distances were measured using a Surveyor's chain and later checked with stadia readings. Vertical and horizontal angles were measured using a theodolite.

VERTICAL CONTROL: Vertical control was established from levels at shot points previously determined in the adjoining Spirit Hill seismic survey.

PERMANENT MARKERS: Located at numerous shot points. The markers consist of star pickets with aluminium tags on which the line number, the shot point number and elevation of the shot points are given. A list of the location of the permanent markers is given on page 29.

MAGNETIC DECLINATION: N3°30' E of true North (1962).

III RESULTS - REFLECTION

"The results of the survey are presented in the form of a contour map of the proposed Palaeozoic horizon, (Plate 45, and plotted cross-sections (Plates 46 and 47).

Record quality varied from fair to unusable with the majority of records being of very poor quality. The best record quality was from holes shot in blue shale approximately one mile south of the mud flats in the north-east position of the survey. Record quality deteriorated west, south and north of this locale.

Poor quality is thought to be influenced by the soft sand overburden masking energy return, however, shots recorded on the mud flats showed no improvement over those recorded on soft sand. Another attributable factor may be that this area is a flood plain and the surface formations vary laterally due to the presence of varying drainage channels.

The data used in the construction of the subsurface contour map is based on a phantom horizon at a time of approximately 0.959 seconds (corrected 2-way time). Depths to the phantom horizon were obtained using the velocity function Va = 9560'/sec + .32Z, where Va is the average velocity down to depth, Z. This corresponds with the Lower Carboniferous or Upper Devonian horizon as contoured in the adjoining Spirit Hill Seismic Survey. The data used in the subsurface contour map construction is considered generally reliable, however, a phantom horizon has limitations.*

The phantom horizon indicates a 125 foot high closure** in the north-west corner of the survey, trending north east - south west, and a high nose trending north-west. There appears to be a low trend south-east of the closure, possibly saddling across the southern flank of this feature to another low trend to the west. A small open high is indicated in the south-western part of the surveyed area that is possibly an extension of the closed high. There appears to be a seismic low in the north-east corner of the surveyed area trending south and south-west. A small open high is indicated at Shot Point 42 Line NG. The strongly dipping open high at the south-east corner of the surveyed area indicates the beginning of the Weaber Mountain Range.

Regional dip is indicated to be north-east. The deepest portion of the basin appears to be near the West-Australia-Northern Territory border in the central part of the surveyed area and possibly even deeper in the extreme north-eastern corner of the area".

IV RESULTS - REFRACTION

One refraction was completed to determine the amount of section existing in the area.

Some refraction records were without time breaks but by use of reverse time ties and adjacent record time ties it was possible to establish a theoretical time break on those records which were without one.

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* The data used in the construction of the survey subsurface map Plate 45 are unreliable in the author's opinion.

** With the very poor reflection data available, a closure of 125', which is equal to 25 milliseconds closure in two-way time, is probably within the limits of error of the survey, and is also unreliable. With the very poor reflections recorded mis-ties up to 5 or 10 milliseconds can occur across two records only ½ mile apart.

The time distance plot of the refraction survey is given on Plate 50.

Using an average velocity of 14,000 feet/second down to the 18,800'/sec. refractor intercept times of 1.240 and 1.158 seconds were obtained at S.P.1 and S.P.9 respectively. Tinline using "multiple layer formula" obtained depths of 12,220 feet and 12,863 feet respectively below S.P.1 and S.P.9, a dip of 643 feet towards S.P.9 (i.e.) to the N.N.E.

Calculations by Tinline of the depth of the 18,800'/sec. refractor using the "critical distance formula" and an average velocity of 14,000 feet down to the 18,800'/sec. refractor gave depths of 11,000 feet below S.P.1 and 11,500 feet below S.P.9, a dip of 500 feet towards S.P.9 (to the N.N.E.).

Calculations by the author using the intercept times and an average velocity of 14,000 feet sec. down to the 18,800 feet/sec. refractor gave depths of 13,380 feet and 12,880 feet* below S.P.1 and S.P.9 (i.e.) a dip of 500 feet towards S.P.1 (to the S.S.W.). However, over a distance of 72,000 feet this indicates that the refractor is virtually flat.

On the time distance plot (Plate 50) a velocity of 15,620 feet/sec. was obtained in the shooting from S.P.7 into spreads 7 and 8. Shooting from S.P.9 into spreads 3 and 2 a velocity of 14,750 feet/sec. was obtained.

Reciprocal time ties at S.P.1 and S.P.9 are both 5.035 secs. While the intercept times at S.P.1 and S.P.9 were .558 and .292 secs. respectively. This would make the refractor under S.P.1 almost twice as deep as the refractor under S.P.9.

It is felt that the straight line drawn through the time distance plots obtained by shooting from S.P.9 into Spreads 3 - 2 is not the best possible one. This could have resulted from Tinline trying to get a reciprocal time tie. An agreement in reciprocal times to the nearest millisecond over 72,000 feet is seldom obtained in fact an agreement to within 25 milliseconds over this range is considered a good tie.

Further reasons why it is felt that a best possible straight line has not been drawn through points obtained by shooting from S.P.9 into Spreads 3-2 and are given below (see Plate 51).

(1) If the 15,620'/sec. refractor obtained by shooting from S.P.1 into Spreads (7-8) is matched with the 15,700'/sec refractor obtained by shooting from S.P.7 into Spreads 2-1 the reciprocal time ties at S.P.1 and S.P.7 agree very well and are both 3.940 seconds and the intercept times are .555 secs. at S.P.7 and .558 secs. at S.P.1. This indicates that 15,620'/sec. refractor is more or less flat

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* The formula Va = 9560'/sec. + .32Z was used by Tinline to calculate depths to the phantom horizons. (Va = average velocity, Z = depth).

The average depth of 13,130 feet calculated for the refractor when substituted in the above formula gives an average velocity of 13,762 feet/sec. for the rocks above the 18,800 feet/sec. refractor and agrees well with the 14,000 feet/sec. used in the depth calculations.

as was the deeper 18,800'/sec refractor.

(2) By drawing what the author believes to be the best straight line through points obtained by shooting from S.P.9 into Spreads 3-2 a velocity of 15,680'/sec. is obtained (as against 14,750'/sec. obtained by Tinline). This velocity is close to the 15,620'/sec. refractor obtained by shooting from S.P.1 into Spreads (7-8) and the 15,700'/sec. refractor obtained by shooting from S.P.7 into Spreads (2-1). The reciprocal time ties at S.P.1 now becomes 5.005 secs. just 35 milliseconds different from the reciprocal time tie at S.P.9.

This slight mis-tie in the reciprocal time tie results in an increase in the intercept time at S.P.9 from 290 milliseconds to 475 milliseconds. This figure of 475 milliseconds agrees much more closely to the intercept times of the 15,610'/sec. refractor of .558 and .555 seconds at S.P.1 and S.P.7.

Assuming an average velocity of 11,000'/sec* for the section above the 15,610'/sec. refractor we get depths to the refractor of 4360' and 4 330' beneath S.P.1 and S.P.7 respectively.

By matching the 15,620'/sec. velocity from S.P.1 into Spreads (7 and 8) with the 15,680'/sec. velocity from S.P.9 into Spreads (3 and 2) and again assuming an average velocity of 11,000'/sec. for the section above the refractor we get depths to the 15,610'/sec refractor of 4360' under S.P.1 and 3704 feet under S.P.9. The 15,610'/sec. refractor like the 18,800'/sec. refractor dips to the S.S.W. The average depth is 4131 feet.

The velocity function used by Tinline for the phantom horizon was Va = 9560'/sec. + .32 Z . Substituting the average depth to the 15,610'/sec. refractor in this equation we get an average velocity for the rocks above the refractor of 10,882'/sec. which is close enough to the 11,000'/sec. which was assumed in calculating the depths.

COMMENTS ON THE CARLTON SEISMIC SURVEY

Most of the reflections shown on the 3" record sections and corrected 3" variable area record sections submitted to the Bureau of Mineral Resources appeared to be questionable and were considered to be too poor for reliable interpretation. The method used by the operator to produce a phantom horizon is illustrated on Plate 44. **

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* The average depth of the 15,610'/sec. refractor is 4345 feet when this depth is substituted in the formula:

Va = 9560'/sec. + .32Z

(average velocity) = (Depth)

An average velocity of 10,950 feet/sec. is obtained which agrees well with the velocity of 11,000'/sec. taken to be the velocity of the rocks down to the 15,610 feet/sec. refractor.

** The method used by the operator to produce a phantom horizon in the Carlton Seismic Survey is the same as that employed in the Spirit Hill Survey.

Individual traces were picked and timed and regardless of the alignment of the time plots of individual traces the interpreter drew in a straight line nearly always horizontal. However, some lines passed through only one or two of the time plots of individual traces, and some through none of the points.

The records submitted were reinterpreted by the author. The time cross-sections are shown in Plates 48 and 49. Perhaps the most conclusions that can be drawn from these plottedtime sections is that on line NG, shot points 1-108, reflections occur to a time of over 1.5 seconds.

On line NG between shot points 1 and 35 there are indications of a deepening of sediments to the N.N.W. which is supported by the Bouguer anomaly profile. A rise of a shallow horizon to the N.W. is indicated between S.P.53 and S.P.83; this rise is also supported by the rise in the Bouguer values to the north-west.

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* Subsequent to the above reinterpretation, General Geophysical Company submitted another set of records; their quality was better, but they still did not appear to contain sufficiently good reflections for reliable interpretation.

PERMANENT MARKER LOCATIONS

(Star picket, line numbers, shot point and shot point elevation stamped on aluminium tag).

Line NE

S.P. 15
S.P. 20

Line NG

S.P. 1
" 5
" 10
" 15
" 20
" 25
" 30
" 35
" 40
" 45
" 50
" 55
" 60
" 65
" 70
" 75
" 80
" 85
" 90
" 95
" 100

Line EI

S.P. 0
" 5
" 10
" 15

Line NJ

S.P. 35
" 30
" 25
" 20
" 15
" 10
" 0
" 5 } extension
" 10 }
" 15 }

Line EH

S.P. 0
S.P. 5
S.P. 10
S.P. 15

Line NK

S.P. 5 } extension
S.P. 0 }
" 35
" 30
" 25
" 20
" 0
" 5
" 10
" 15

Line EN

S.P. 0
" 5
" 10
" 15
" 20
" 25
" 30

Line NR

S.P. 0
" 5

Diagonal Line 0

S.P. 0
" 5
" 10

Line NO

S.P. 15
" 10
" 5

POINT PEARCE SEISMIC SURVEY

It was not originally intended, in this compilation to discuss the seismic surveys carried out after the end of the field season 1962. Since then two seismic surveys have been carried out in the Bonaparte Gulf area. The first survey was the Ninbing - Burt Range Seismic Survey by United Geophysical Corporation for Alliance Oil Development N.L. carried out between May and September 1963. The second survey was the Point Pearce Seismic Survey carried out by Compagnie Generale De Geophysique for Australian Aquitaine Pty Ltd. Drilling commenced on the 12th August 1963 and the seismic crews followed on the 15th August. The results of the second survey are so important that three provisional plates submitted along with the progress reports from the field have been included.

(1) Reflection time contour map Horizon (3) - Plate 52. (Includes traverse locations).

(2) Interpretative cross-section Traverse PP7. - Plate 53.

(3) Interpretative cross-section Traverse PP9. - Plate 54.

The interpretative cross-section for Traverse PP8 was not included in the progress reports submitted on 25.10.63, although the reflection information from this traverse appears to have been used in the construction of the contour map of Horizon (3), Plate 52.

The Point Pearce Seismic Survey was completed on 9.11.63 and the Final Report was open to public inspection on 9/5/64.

The author did not have time to critically examine the progress reports submitted up to 25.10.63 and only the information given on the three provisional plates submitted by Compagnie Generale De Geophysique have been used in this report. In volume III of this report an attempt has been made to correlate the third horizon from the Point Pearce and Port Keats Land Surveys with the Port Keats Marine Survey, and overall contours of what is believed to be the top of the Proterozoic rocks are given for the Marine and Land Surveys.