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AUSTRALIAN AQUITAIN PETROLEUM
PTY. LTD.

PERLANNA
SEISMIC & GRAVITY SURVEY
(APRIL - JUNE, 1966)

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CMPAGNIE GENERALE DE GEOPHYSIQUE
AUSTRALIAN AQUITaine PETROLEUM PTY. LTD.

PERLANNA

SEISMIC AND GRAVITY SURVEY

APRIL - JUNE 1966

OPEN FILE
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>1</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>CHAPTER I Geological and Geophysical data</td>
<td>4</td>
</tr>
<tr>
<td>CHAPTER II Reasons for the survey and programme</td>
<td>10</td>
</tr>
<tr>
<td>CHAPTER III Techniques and operations</td>
<td>12</td>
</tr>
<tr>
<td>CHAPTER IV Interpretation and discussion of the results</td>
<td>21</td>
</tr>
<tr>
<td>PART ONE REFLECTION</td>
<td>21</td>
</tr>
<tr>
<td>PART TWO Refraction</td>
<td>25</td>
</tr>
<tr>
<td>PART THREE SYNTHESIS OF THE RESULTS</td>
<td>27</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>34</td>
</tr>
</tbody>
</table>
# FIGURES

1. Location map scale $1/500,000$
2. Geophysical data
3. Time depth curve Horizon A
4. Time depth curve Horizon B and C
5. Time depth curve Horizon D
6. Velocity determination - Dix method
7. History and statistic

# PLATES

**SURVEYING**

1. Location map scale $1/250,000$
2a. Location map scale $1/100,000$ Northern area
2b. Location map scale $1/100,000$ Southern area
3. Misclosures sketch

**PHOTO REDUCTION OF VARIABLE AREA CROSS-SECTIONS**

4. Line P1
5. Line P2
5 bis. Line P2 (six fold coverage)
6. Line P3
7. Line P4
8. Line P5
9. Line P6
10. Line P7, P11, P9
11. Line P10, P12, P8, P13
12. Offset spreads
REFRACTION
13 Time depth curves
14 Statistic diagram
15 Interpretation diagram
16 Interpretation plate marker 4,200 m/sec

DEPTH CROSS SECTIONS
17 Line P1
18 Line P2
19 Line P3
20 Line P4
21 Line P5
22 Line P6
23 Line P7, P11, P9
24 Line P10, P12, P8, P13

CONTOUR MAPS
25 Depth contour map Horizon "A"
26 Depth contour map Horizon "D"

GRAVITY
27 Gravity bases network
28 Bouguer anomaly contour map

PLATES NOT INCLUDED IN THE PRESENT REPORT:

VARIABLE AREA REFLECTION AND OFFSET CROSS SECTIONS FULL SCALE.
ABSTRACT

In a two and a half month seismic and gravity survey COMPAGNIE GENERALE DE GEOPHYSIQUE carried out a semi detailed programme in OIL PERMIT 36 for AUSTRALIAN AQUITaine PETROLEUM PTY. LTD.

The purpose of the survey was to evaluate the areas of the permit not previously explored by seismic methods to determine the regional structural trends. Some detailed work was done on one structure.

The prospect appears as a regular monocline dipping slightly to the southwest with several smooth undulations and minor structures. Folding and faulting are gentle and increase a little with the age of the sediments.

The gravity results confirm a previous Mines Administration survey. They appear difficult to correlate with the seismic results since most of the anomalies do not correspond to tectonic features of the sedimentary layers.
A seismic and gravity survey, the subject of the present report was carried out by Compagnie Generale de Geophysique on behalf of Australian Aquitaine Petroleum Pty. Ltd. in the area of O.P. 36 Northern Territory, where Australian Aquitaine Petroleum is operator.

The survey followed the Kilpattha seismic survey carried out by the same Company from January to June 1964 and earlier gravity and aeromagnetic surveys in the area.

The party was capable of operating with seismic reflection, short and long distance refraction shooting and gravity methods. The 43 men on the crew included four key Frenchmen. There was also a civil engineering crew for clearing the traverses.

Drilling started on the 22nd April and was completed on the 8th June, 1966.

Seismic operations were carried out between the 22nd April and the 11th June, 1966.

In all 466 new spreads, 8 refraction bases and 83 six fold coverage spreads were recorded.

Gravity readings began on the 22nd April and finished on the 10th June. Readings were made at shot points on all seismic
COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE

lines and bases, and the values at shot points on line K1 and K2 were recorded to tie the survey to the Poeppel Corner Minad base station.

C. ATHIAS headed the party which was supervised from Brisbane by J. TIXERONT.
CHAPTER 1

GEOLOGICAL AND GEOPHYSICAL DATA

1. GEOLOGICAL INFORMATION

Permit OP.36 is situated close to the North-West boundary of the Great Artesian Basin and is a possible easterly extension of the Amadeus Basin. No outcrops occur within the permit which is entirely covered by sand dunes of quaternary age.

Several wells have been drilled within 150 miles of the centre of OP.36.

In the south-west, the Purni 1 and Mokari 1, closest wells to Oil Permit 36, have shown the existence of Permian resting on top of the Upper Proterozoic. Further west and south-west the MacDills 1, Mt. Crispe 1 and Witcherie 1 Wells have proved the Permian to rest on top of Palaeozoic sediments ranging from Cambrian to Devonian.

In the south-east the Putamurdie 1 and Pundieburra 1 Wells have shown Permo-Triassic and Post-Triassic sediments overlying the Ordovician.

The stratigraphy of the north-west tip of the Great Artesian Basin established after the above mentioned wells' results, suggests
a differential erosion of palaeozoic pre-Permian sediments. Folding and faulting must have been initiated mainly during the Middle Proterozoic orogeny. Therefore the occurrence of Lower and Middle Palaeozoic must be considered as uneroded sediments preserved in Sub-basins and their absence in the uplifted areas is probably due to erosion rather than to a lack of deposition on high zones.

Permian seems to have been deposited widely and to date all drilling in the North-Western part of the Great Artesian Basin have penetrated it.

2. GEOPHYSICAL DATA (fig. 2)

The surveyed area has been covered by the following geophysical surveys:

2i. Helicopter Gravity Survey, May 1961

This gravity survey which was carried out over Oil Permit 36 by Mines Administration Pty. Ltd. for Associated Freney Oil Fields N.L., consisted of 255 stations, on a regular 4 mile grid, covering the area. The main object of this survey was to determine the thickness of the sedimentary section.


This survey was carried out by Aeroservices Ltd. for the B.M.R. Only parts of some aeromagnétique flights cross Permit OP.36.
2iii. **Seismic Survey**


This survey represented a first seismic reconnaissance and the main objectives were:

- to study the structural form of the area
- to determine the velocities of any markers present by shooting a refraction probe and to try to correlate the reflection and refraction events by shooting offset spreads
- to check if the gravity and aeromagnetic data were directly related to the structural shape of the sedimentary section or intra-basement contrasts.

The following geophysical surveys have been carried out in neighbouring areas:

**West**

- Seismic Survey of the Simpson Desert for Beach Petroleum November 1960 and August - September 1961,
- Seismic Survey, McDills Anomaly for Beach Petroleum 1963,
- Andado Seismic Survey for Beach Petroleum 1963,
- Dakota Bore Seismic and Gravity Survey for Beach Petroleum 1964,
- Anacoora Bore detailed Seismic and Gravity Survey for Beach Petroleum.
South
- Oodnadatta Aeromagnetic Survey by Aero-Services November 1961 - January 1962 for Santos-Delhi - Reinterpretation by C.G.G.,
- Pedirka Seismic Survey by C.G.G. for FPC(A) March - August 1963,
- Dalhousie Helicopter Gravity Survey by Wongela August - November 1963 for FPC(A),
- Kallakoopah Seismic and Gravity Survey by United for FPC(A) April - June 1964,
- Birdsville Track - Lake Eyre Seismic Survey by the S.A. Department of Mines 1964,

East
- Great Artesian Survey 1960 by the S.A. Department of Mines Preliminary report by B.E. Milton and K.R. Seedsman, report BK 5224,
- Seismic traverse BM (Birdsville - Maree), MK (Mungerannie - Kalamurina) by the S.A. Department of Mines, Great Artesian Basin 1961,
- Innamincka and Goyder's Lagoon, Seismic Survey by Namco for Delhi 1961,
- Clifton Hill Seismic Survey by United for Delhi 1963,
- Annandale Seismic Survey by C.G.G. for FPC(A) August - December 1963,
RESULTS

A summary of the results of these surveys shows:

In the whole area extending from the Simpson Desert to Longreach, the Jurassic formations underlying the shaley Cretaceous formations give a good reflection horizon with a horizontal velocity constant and equal to 3700 m/s.

In the Purni area, the oldest sediments encountered are steeply dipping Proterozoic formations with a refraction velocity of 5,800-6,000 m/s.

These sediments are unconformably overlain by the Devonian Finke Bed detritic formation. Both the overlying Permian and Devonian sediments are characterised by their low density when
compared with the densities of the underlying beds, and by the velocity of the refraction markers in the range of 4,000–4,500 m/s but never as great as 5,000 m/s.

The occurrence of coal measures at the top of the Permian section gives rise to a characteristic reflection marker which facilitates the mapping of these sediments. The mesozoic section conformably overlies the Permian sediments.

In the McDills area, the Permo-Devonian sediments were deposited on the Cambro-Ordovician section. From the sonic log it appears unlikely that the devonian sequence would give rise to reflection markers. The vertical velocity of the lower Cambrian Todd River dolomite is 4,850 m/s, therefore we may expect a horizontal velocity of no more than about 5,350 m/s for this layer. However the refraction velocity of the Ordovician quartzite is about the same.

The Permian basin as confirmed by the McDills well extends to the east and may reach the permit OP.36.

The Kilpattha Survey and FPC(A) Annandale Survey have shown that the limits of the possible extension of the Permian basin seem to correspond to an axis of gravity highs, which cross the northern part of OP.36 in a north-west direction.

The limit of the extension of Pre Permian sediments eastwards from McDills is not known.
1. REASONS FOR THE SURVEY

The purpose of the Perlanna Seismic and Gravity Survey was to complete the first seismic reconnaissance survey carried out in 1964.

The main targets were as follows:

- To investigate whether any interesting structures exist in the area not covered by the previous survey.
- To check if the high axis as shown on Traverse K2 (Kilpattha survey) has structural closure and if so whether it is large enough to be justified as an economical petroleum prospect.
- To find out the possible extension of the Permian basin as known in the Purni and McDills areas, using both reflection and refraction methods (offset spreads, refraction probe).

The gravity readings at each shot point are expected to give an accurate Bouguer anomaly curve which can then be correlated with the seismic events. These readings will complete the gravity network of the previous Minad survey and should aid the interpretation of the results of the survey.
2. **INITIAL PROGRAMME**

The basic initial programme consisted of three lines P1, P2 and P3 designed to complete the previous Kilpattha survey in the western part of the permit.

Then, depending on the results, lines P4 and P5 and either P3 extension or P6 would be shot.

3. **PROGRAMME TIME-TABLE**

From 22nd April to 9th May the first stage of the programme (traverses P1, P2 and P3) was carried out.

From 10th to 13th May a refraction probe and additional refraction shots were recorded on line P1.

From 14th to 30th May traverses P4, P5 and P6 were shot.

From 31st May to 11th June a detailed survey including some six fold CDP shooting was carried out in the area near the intersection of traverses K2 and P2.

During the complete survey:

- 466 new reflection spreads were recorded, representing 332,760 kilometres of lines (207 miles).
- three offset locations were surveyed, and a total of 18 spreads were shot.
- 36 refraction spreads were recorded on 8 bases corresponding to 23 kilometres of line.
- 584 gravity readings were made for 522 new stations.
I. TECHNIQUES

(I.1.) Reflection

The reflection method was the conventional split spread continuous profiling. A test of six fold C.D.P. coverage was carried out on line P2.

(I.1.a) Single Coverage

Twenty-four recording traces, were laid out and the shot was fired midway between traces 12 and 13.

The shot point interval was 720 metres with 60 metres between traces.

Thirty-six Hall Sears Junior Geophones were used per trace; they were laid out in three lines of 12 geophones, parallel to the traverse and 20 metres apart. The distance between geophones was 5 metres.

The shot points consisted of 24 holes in two symmetrical patterns of twelve holes on each side of the traverse. Each pattern consisted of 3 lines of 4 holes parallel to the seismic line, the distance between holes was 10 metres and between lines was 20 metres. The shot holes were 15 feet deep.

The charge was generally 100 lbs per shot point.
(I.1.b) Six Fold Coverage

The geophones spread was the same as for the single coverage.

The shot point consisted of a square pattern of 9 holes in three lines of three holes, 10 metres apart, with the diagonal of this square on the traverse. The charge was 50lbs per shot.

A roll along technique was used. For each 24 trace spread the shot points were located between traces 10 and 11, 12 and 13, 14 and 15. Then, 6 traces were shifted forward for the following spreads.

(I.2.) Refraction

One refraction probe and complementary shots were recorded on the line P1. This enabled the Gardner-Layat method of interpretation to be used.

Twelve Hall Sears Geophones per trace were laid out in two symmetrical lines of 6 geophones, perpendicular to the traverse. The distance between geophones was 10 metres and 15 metres between lines. The refraction shots were recorded on the 24 traces of the base from different shot points on either side of the spread. The distance between traces was 240 metres. After the shots for any one base were finished, twelve traces of the spread were shifted forward.
The results of the interpretation and subsequent computations is presented as a delay curve. The delay is then converted to depth by using the formula:

\[
\text{Depth} = K \cdot \text{delay} \frac{V}{\cos i}
\]

with 
- \( K \) = anisotropy factor
- \( V \) = overburden velocity
- \( \sin i \) = overburden velocity/marker velocity

(1.3.) Offset Spreads

Three offset spreads were recorded during the course of the survey.

The total length of each offset recorded depended mainly on the expected depth of the "b" horizon. This shooting distance was 9.5 km on line P2 and 8 km on line P5.

(1.4.) Gravity

Gravity readings were made at each seismic shot point. Base stations were established so that the time elapsed between tying to the base station was less than two hours.

II. OPERATIONS

(II.1.) Natural Conditions

The weather was fine throughout the survey and the temperatures averaged about 80 to 90 degrees Fahrenheit during the day.
(II.2.) Accessibility

The only economical access to O.P. 36 was the track bulldozed two years ago from Cowarie to Poeppel Corner. About ten days work was necessary to open it again to four wheel drive vehicles. Progress was slowed by the recent rains which flooded the Diamantina River crossing between Cowarie and Mona Downs. Also several clay pans were still wet and detours had to be made.

From Poeppel Corner, the dozed access track followed line K1 to camp A and across the sand dunes on line K2 to the crossing with P1. Although travelling was very slow, no major difficulties were encountered, thanks to the Michelin sand tyres fitted to most of the vehicles.

(II.3.) Camps

The main camp was located at camp D about 35 miles west from the Kilpattha native well (camp A) near SP 441 of line P1.

Six fly camps were used along the seismic lines to keep the field teams as close as possible to the working area.

(II.4.) Logistics

(II.4.a) Food

Fresh food was flown once a week from Charleville by a Cessna 185 chartered from Western Air to camp A and then to an airstrip located 9 miles north of camp D.
Fresh meat and other tinned food was supplied by an additional flight from Birdsville.

(II.4.b.) Water Supply

Fresh water was taken from the Kilpattha native well.

(II.4.c.) Explosives, Fuel and Lubricants

Deliveries were made to Cowarie, and then brought in by the party's supply trucks. The distance between Cowarie and camp D was about 220 miles. The round trip took two days on an average.

(II.5.) Communications

Once a week the light plane brought mail to and from Birdsville or Charleville.

Daily radio services for telegrams and medical advice were arranged with the Flying Doctor Service based at Alice Springs.

Daily contact with A.A.P. Brisbane was maintained with an SSB radio transmitter.

(II.6.) Surveying Operations

(II.6.a.) Alignment and Pegging

All traverses were first laid out by compass. Pegging operations were carried out with a 60 metre cable.

(II.6.b) Levelling.

All coordinates and elevations were calculated in metres.
Elevations:

The origins chosen were

SP  50 Line K1
SP  240, 270 and 295 Line K2

The misclosures of the loops made between lines of the previous Kilpattha survey and the new seismic lines with the points of origin are small (Pl.3).

Coordinates: (Pl.3)

The origins chosen were

SP  50 Line K1 Kilpattha survey
SP  240, 270 and 295 Line K2
SP  1870 FPC(A) Poolowanna survey

Misclosures of the loops made with the seismic lines and the points of origin were small apart from the loop P5, P6, K1, K2. After checking line K1, it was found that better closures were obtained by changing the instrumental declination of 1° on line K1.

The magnetic declination was checked twice by sun sightings.

The adopted values were:

6° east on line P1 and westwards
5° 30, east of line P1

(II.6.c) Permanent Markers

Permanent markers were placed at every tenth shot point.

These points are indicated on the location maps (Pl. 1, 2, 3).
They consist of iron pipes 6 feet long and 1½" diameter showing the traverse and shot point numbers, driven into the ground.

A list of these markers with their corresponding elevations and coordinates follows the appendices of this report.

(II.6.d.) Documents Used
- 1/250,000 maps as published by the division of National Mapping
- Aerial Photo mosaics (scale 1/63,000)
- All documents on the Kilpattha survey.

(II.7.) Drilling Operations
Two drilling shifts per day were sufficient to provide the necessary number of daily shot points for the recording crew. At the shot points used for shooting offset spreads or refraction shots, additional 30 foot holes were drilled.

All holes were loaded by the drilling crew.

Only air drilling was used. In most of the region nothing more than sand was encountered.

(II.8.) Recording Operations
(II.8.a.) Field Procedure
Thirty-six geophones per trace were used from the beginning of the survey.

For the offset shots from 720 to 2160 metres, a 24 hole pattern was loaded with about 100 lbs.
Beyond 2160 metres buried charges of either nitrate or ligdyn were used. The charges ranged from 50 to 250 lbs and were laid down in lines perpendicular to the traverse in holes 30 feet deep.

In refraction shooting, both surface shots and charges buried in 30' holes were used.

(II.8.b.) Instrument Setting

**Reflection - recording**

Filters 14 - 160 (band pass of the AS 626 amplifier

Level of common gain 0.18 to 0.56 - microvolts

Individual gain Initial gain - 25 db to a maximum at 200 to 300 milliseconds

Common A.G.C. Initial gain - 60 db

Final gain maximum

Delay 400 milliseconds

**Reflection - playbacks**

Filters 20/56 c.p.s. slope : 120 db/oct

A.G.C. on

Pen gain -10 db

Initial amplifier gain -15 to 20 db

(II.8.c.) Offset Recording

Filters out - 160

Level common gain -0.18 microvolts
Individual A.G.C. off
Common gain -25 to -40 db
Offset playbacks A.G.C. : on
Amplifier -15 to -25 db

(II.8.d.) Refraction Recording
Filters out -40
Gain -6 db to -40 db (For close shots)
The gain was adjustable per group of 3 traces.

(II.9.) Gravity Operations

Bases were established at permanent markers of the seismic survey locations, within less than one hour travel by Land Rover from each other which meant an average separation of 20 S.P.s.

The calibration coefficient of the Worden gravimeter No. 708 was $K = 0.8316$.

After the completion of the survey it was checked between the Mount Coot-tha and the Brisbane University pendulum stations. A value of $K = 0.8315$ was found. The coefficient $K = 0.8316$ was adopted for the survey.

The benchmark chosen as the origin for the survey was the Poeppel Corner Minad base station.

A tie was made to the FPC(A) Poolowanna survey. A discrepancy of 0.79 milligal was found at shot point 1850 line B. This is due to the different origins chosen; the origin of the Poolowanna survey being the base station located at DAKOTA BORE.
1. EXPERIMENTS

Only a few experiments were carried out during the survey, since the previous Kilpattha survey in 1964 showed that a pattern of 24 shallow holes together with 36 geophones per trace gave the best and most constant results. Also, the C.G.G. AS 626 X transistorized amplifier system was used. This equipment shows the value of the gain at all times during recording by means of a calibrated galvonometric trace transposed to a logarithmic scale on the play backs. The record of the gain enables the relative importance of various energy arrivals (noise and reflections) to be determined, and therefore provides further control in checking the recording parameters. The best recording settings can then be found after shooting only a few shots.

From SP 361 to 374, charges of 75 and 120 lbs per shot point were used alternately: the 120 lb charge proved slightly better than the 75 lbs.

From SP 417 to 471, 36 and 48 geophones per trace were laid out alternately: no significant improvement was noticed when comparing the records.
2. SIX FOLD COVERAGE

A test of six fold CDP coverage was carried out between SP 706 and 370 of line P2, in order to check whether deep events could be improved.

Results are shown on a variable area stacked cross section (Pl.5 bis). The reflections corresponding to the A and C horizons are more energetic than on the single coverage cross section. The B horizon is slightly improved but the D reflector is about the same and no deeper event can be picked on the stacked cross section.

In conclusion, it can be said that the improvement in the stacked cross section was too slight to warrant the extra cost involved in using this method.

3. QUALITY OF THE RESULTS

Results are generally good in quality especially for the A and C horizons which are continuous and have a reliable character throughout the prospect.

No continuous events were followed beneath the D horizon. Some scattered steeply dipping reflections could be picked, but their significance is not known. As far as deep events are concerned, the results appear to be better than the previous Kilpattha surveys. This could be due to the recording equipment's programmed gain, which does not decrease even after strong energy arrivals.
4. **VARIABLE AREA CROSS SECTIONS**

The photo-reductions of the variable area cross sections are included in this report (Pl. 4 to 11) and show the horizons picked.

The horizons show a general NE - SW gentle dip with several faults numbered F1 to F5.

The "A" horizon was easily followed throughout the survey. It was the most constant in character and energy of all the horizons picked. It appears as a first high frequency cycle followed by two lower frequency phases. It enables reliable correlation across faults.

The "B" horizon was plotted immediately below the two low frequency phases of the "A" reflection. It is generally conformable with the upper level.

The "C" reflector is a strong and persistent one and is almost as characteristic as the "A" reflection. The first of two low frequency phases, was picked.

The "D" horizon corresponds to a reflection which is difficult to pick since it is not continuous and its energy is variable from one record to the next. One way to follow it was to calibrate the sections by shooting offset spreads. This technique enables a characteristic fast velocity refractor (about 6,000 m/sec) to be tied to a reflection event by following the refracted first breaks back in second events through the critical point to the associated reflected events. This was then checked by computation.
of the vertical time of the refraction marker from the velocity information available on the offset spread section.

Another characteristic of the "D" reflection is the presence of scattered steep line-ups and diffractions which suggest that the "D" is the envelope of an eroded surface.

5. TIES WITH THE KILPATTHA SURVEY

A comparison of the times read on the variable area cross sections of the Perlanna survey and on lines K2 and K3 of Kilpattha shows on the average a general discrepancy of 5 milliseconds (one way time) at the intersection of the old and new traverses. The static corrections are the same to within two or three milliseconds so it seems that the discrepancy must be due to the use of different recording equipment. At the intersection of lines P6 and K1 a discrepancy of 20 milliseconds was found, 13 of which are due to the different corrections used in the two surveys. Since the same system of corrections was used throughout the Perlanna survey, it has been assumed that there was a change during the previous Kilpattha survey. The corrections were recomputed on line K1 from SP 30 to SP 170 in order to integrate the results into the new survey.
A refraction probe of eight bases (23 kms) was carried out along the northern part of traverse Pl. Additional shots were recorded in order to study a 4,200 m/sec marker.

The time-distance curves are shown on Pl 13. Results are good although events interfere with one another in places. Low velocity arrivals (1,900 to 2,000 m/sec) were recorded from shooting distances up to 4 km.

- From 4 km to 5.5 km, interfered arrivals appeared with velocities ranging from 3,200 to 3,400 m/sec.
- Beyond 5.5 km, a high velocity marker (5,700 m/sec) was recorded as a first arrival after a characteristic break with the previous marker. The velocity remained constant up to 21 km.
- Between 5.5 km and 9 km, a 4,200 m/sec arrival appeared as a second or late arrival. Since it was recorded on 8 to 12 traces it was possible to use the Gardner-Layat method of computation by shooting at an interval of 6 traces along the traverse.

The information with regard to the records is indicated on the statistical and interpretation diagrams. (Pl. 14 and 15)

4,200 m/sec Marker

The interpretation plate (Pl. 16) shows the results of the computation by the Gardner-Layat method.

The convergence curve gives an actual velocity of 4,200 m/sec for the marker.
The calibration of the delay curve was good. Since no change of velocity was expected at either end of the probe, the delay curve was extrapolated from one integrated intercept curve and the convergence curve.

The offset chosen was 960 metres, this value was obtained from the formula:

\[ \text{offset} = p \cdot t \cdot g \cdot i \]

were \( p \) is the depth of the marker (about 1,550 metres)

\( i \) is defined by \( \sin i = \frac{\text{overburden velocity}}{\text{marker velocity}} \)

In this case a value of 2300 m/sec was adopted for overburden velocity. This gave a theoretical offset value of about 1,000 metres.

**5,700 m/sec Marker**

The high velocity marker was computed by the "Constant Distance Correlation" method only. This method gives the delay at each shot point, where the value of the delay is assumed to be half the intercept time for that shot point.

The parameters used were:

- distance of correlation : 6,800 m
- computation velocity : 5,700 m/sec

The velocity used for computation was that given by the time-distance curves.
PART THREE SYNTHESIS OF THE RESULTS

The synthesis of the results is shown on the depth cross sections Pl. 17 to 24 and on the contour maps (Pl. 25-26-28).

1. TIME TO DEPTH CALCULATIONS

The average vertical velocities from the D.P. to the A, B, C and D horizons were determined by a statistical study of the velocity surveys carried out in the following wells:


The corresponding time depth curves are shown on Fig. 3, 4, 5.

A velocity survey was carried out in conjunction with the offset spreads on line P5. It was computed using the DIX method. Results are shown on Fig. 6. They are slightly different from those given by the well velocity surveys:

A Horizon : 2,100 m/sec (DIX method)  
2,180 m/sec (Fig. 3)

C Horizon : 2,550 m/sec (DIX method)  
2,450 m/sec (Fig. 4)

These discrepancies in the velocities would correspond to differences of about 50 metres in the calculated depths. It is believed that the general accuracy of the depths is ± 50 metres.
FIG. 3

TIME-DEPTH CURVE
'A' HORIZON

DOUBLE-WAY TIME IN MILLISECONDS

DEPTH IN METRES

Poonarunga
Putamurdie
Innaminka
Witcherrie
Merrimelia
Dullingsari
Rendibura

D.P.: Ground Level
FIG. 4

TIME-DEPTH CURVE 'B' & 'C' HORIZONS

DOUBLE WAY TIME IN MILLISECONDS

DEPTH IN METRES

D.P.: Ground Level
Time-Depth Curve 'D' Horizon

Depth in Metres

Double-way Time in Milliseconds

FIG. 5

Ground Level

Purni +
+ Putamurdie
+ Poonarunna
+ Witcherie
+ Pandieburra
+ Orientos
+ Gidsealpa
+ Dullingari

Marduroo
The Brothers + †
VELOCITY DETERMINATIONS
DIX METHOD

LINE P5  S.P. 587-589

\[ V = 2,550 \text{ m/sec.} \]

\[ V = 2,100 \text{ m/sec.} \]

'C' HORIZON

'A' HORIZON
It must be noted that the reflection picked for each of the marker horizons is possibly not the first cycle of the reflection. Therefore, the depths have probably been a little over-estimated by about 50 metres if the second cycle has been picked.

The 4,200 m/sec refraction marker was converted to a depth value by using the following parameters:

- anisotropy factor : $K = 1$
- overburden velocity : $V = 2,300$ m/sec

For the 5,700 m/sec marker the parameters were:

- anisotropy factor : $K = 1$
- overburden velocity : $V = 2,650$ m/sec

2. IDENTIFICATION OF HORIZONS

No well enables a direct identification of the various horizons picked in the prospect. Therefore it was necessary to tie the markers to known sections in adjacent areas.

The "A" horizon is the same as the "A" of the previous Kilpattha survey which was assumed to originate from the Upper Jurassic formations (Mooga of Blythesdale Group). The tie between line P2 and line B of the FPC(A) Poolowanna survey shows the "A" horizon corresponds to the Poolowanna "C" which was tied to the transition beds of lower Cretaceous age. The latter correlation
is believed to be more reliable since it has been checked in several wells drilled in this region.

The "B" horizon reflection corresponds to the 4,200 m/sec refraction marker on line P1. This velocity can be correlated with the horizontal velocity of Jurassic, Triassic, Permian or Devonian sediments. However, the "B" reflection is very close to the "A" and it is believed to originate from the Upper Jurassic formations.

The "C" horizon may correspond with the "P2" horizon of the Poolowanna survey. It could originate from Lower Jurassic or possible Triassic sediments which were drilled in the Pandieburra and Putamurdie wells. This correlation is questionable since the survey is not tied to either well.

Also, it is possible to tie the "C" to the Permian sediments encountered in the Mac Dills, Purni and Mokari wells, since the limit of the extension of the Permian east of these wells is not known with certainty.

The "D" horizon represents an angular unconformity between Mesozoic or Paleozoic sediments and an old proterozoic plateau. It is the same horizon as the "D-D1" followed on the Kilpattha survey. Although the "D" is one or two phases lower than the "Z" of the Poolowanna survey both horizons are believed to correspond to the same marker. The discrepancy may be due to a lack of accuracy on the eastern part of line B.
3. **DEPTH CROSS SECTIONS**

These sections show the seismic reflection and refraction results as well as the Bouguer anomaly curves and hence enable a comparison of the results of the various methods.

Folding and faulting are very gentle on all lines. The prospect shows a general southwest dip which increases slightly with the age of the formations. All horizons have the same minor features and are roughly conformable. The increase in the thickness of the sediments between the "A" and "D" horizons is about 5 metres per kilometre (5%) from the eastern end of line P6 to the southern end of line P2.

Faults are of two types:

- F1 and F2 are down thrown to the south at all levels.
- F3 appears as a flexure on the upper horizons ("A" and "B") and the increasing throw results in a fault on the lower reflectors "C" and "D". Its existence on SP's 592 - 593 of line P5 is quite doubtful.

The reflection and refraction results can be compared on line P1. The "B" horizon corresponds to the 4,200 m/sec marker with great accuracy, both methods showing the same dip.

The "D" horizon is slightly deeper (by 100 m) than the 5700 m/sec refractor. This discrepancy is probably due to the fact that refracted times are computed from the first breaks whilst the reflection picked is possibly not the first cycle of the event.
The apparent horizontal velocities of refracted events recorded on the offset spreads are indicated on the plates. Their values depend on the dip of the corresponding marker and could be over-estimated on line P5.

The gravity results appear difficult to correlate with the seismic features since the shape of the Bouguer anomaly curves are different to the seismic horizons.

The faults do not show on the Bouguer anomaly curves but F1 on line P6 corresponds to a steep gradient of the gravity curve within a regional anomaly.

4. CONTOUR MAPS

Since all seismic horizons are nearly conformable, they were drawn for the "A" and "D" horizons only. Both maps show the gentle tectonics of the area.

Correlation of faults may be questionable in several cases:

The fault on line K1 SP 94 could be tied to either F1 or F2. F1 was chosen because this direction corresponds to a magnetic fault. This correlation leads to the assumption that F2 dies out between lines P5 and K1.

Correlation of F3 from P1 to P5 is quite doubtful since the existence of F3 on line P5 is not reliable.
Faults F4 and F5 were not tied to any other events and could be minor local faults.

4. i. **"A" HORIZON** (Pl. 25)

This map shows an overall southwest dip with gentle folding more marked close to the faults.

The contour spacing is 25 metres.

Several high zones were found, but no actual structure with a reliable closure. The high axis of line K2 continues northwards through lines P5 and P4 but no structural closure appears to the north.

The small structure detailed near the crossing K2 - P2 is closed against fault F3 with a closure of about 15 metres to the north.

Another small high zone seems to exist between fault F5 and line P1. Although it seems closed to the south, the lack of information to the north limits the closure to the realm of conjecture.

4. ii. **"D" HORIZON** (Pl. 26)

This map shows the same overall features as the "A" horizon map.

The contour spacing is 50 metres.

The high zone of the K2 - K3 crossing is a long nose since it is not closed to the north. Its development to the south is not known.
The structure delineated by traverses K2, P2 and fault F3 has a closure of about 40 metres to the north.

4. iii. BOUGUER ANOMALY CONTOUR MAP (P1,27)

The contour map confirms the main features of the previous Mines Administration Helicopter Gravity Survey.

Some minor differences are due to the greater density of readings and greater accuracy in the measurement of elevations.

The Bouguer anomaly values vary over the permit from a maximum of -6.4 milligals in the north western part of the prospect to a minimum of -32.7 milligals on line P2 ext.

The major features of the map are:
- a strong negative anomaly (about 20 milligals with a steep gradient in the south western part of the survey to the south of a relatively smooth area.
- several smaller positive or negative anomalies ranging from 2 to 7 milligals.
CONCLUSIONS

The two and a half month Perlanna seismic and gravity survey furthered the regional understanding of the structural features of the sediments in OP 36.

The traverses shot during the survey revealed only minor structures with small closures.

The high axis on traverse K2 (Kilpattha survey) extends to the north and probably southwards. It looks like a long nose with a good closure to the southwest. It is closed to the east against fault F2; closure to the north may exist but does not show on the traverses.

Nothing has been found with regard to a possible limit of a Permian basin in the prospect. The results of the Poolowanna survey do not indicate a reliable eastern limits of the Permian basin. The methods used during this survey did not allow to draw any conclusion with regard to the existence or the non existence of the Permian sediments.

The refraction method showed the existence of a 4,200 m/sec marker which could be tied to Upper Jurassic or Permian formations.

The gravity results are difficult to correlate with the seismic events due to several local anomalies. Since they are not related to the tectonics of the known geological formations but possibly
are due to local changes in densities, further study of these anomalies would be necessary before it would be possible to make any reliable correlation with the seismic horizons.

Respectfully submitted

COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE

C. ATHIAS
Party Chief

J. TIXERONT
Supervisor
<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Personnel</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>Equipment</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>History and Statistics</td>
<td>6</td>
</tr>
<tr>
<td>IV</td>
<td>Reduction and Presentation of Data</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>List of Permanent Markers with Elevations and</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Coordinates</td>
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APPENDIX I

PERSONNEL

The personnel required by the agreement and present on the party are listed below.

<table>
<thead>
<tr>
<th>Position</th>
<th>Basic Crew</th>
<th>Additional Facilities</th>
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<tr>
<td>Party Chief</td>
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<tr>
<td>Chief Computer</td>
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<tr>
<td>Computer</td>
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<tr>
<td>Administrative Assistant</td>
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<tr>
<td>Observer</td>
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<td>Shooter</td>
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<td>Surveyor</td>
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<td>Drillers</td>
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<tr>
<td>Drillers Helpers</td>
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<tr>
<td>Mechanics</td>
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<td>Mechanic Helper</td>
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</tr>
<tr>
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<tr>
<td>Cooks Helpers</td>
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<tr>
<td>Camp Drivers</td>
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<tr>
<td>Drivers Helpers</td>
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<td></td>
</tr>
<tr>
<td>Gravity Operator</td>
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<td></td>
</tr>
</tbody>
</table>

**TOTAL**                                **38**  **4**  **1**  **43**
Additional facilities

1 Surveyor Helper for the Civil Engineering Crew as from 26/3/66.

Civil Engineering Crew

The bulldozing crew of 5 operators was supplied by "Seismic Dozing" Brisbane. They handled the civil engineering equipment as a self-contained party.
APPENDIX II

EQUIPMENT

VEHICLES

A) Land Rovers

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<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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<td>Office</td>
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<tr>
<td>* Surveying</td>
<td>1</td>
</tr>
<tr>
<td>* Recording</td>
<td>3</td>
</tr>
<tr>
<td>Field Manager</td>
<td>1</td>
</tr>
<tr>
<td>* Gravity</td>
<td>1</td>
</tr>
<tr>
<td>Shooter</td>
<td>1</td>
</tr>
<tr>
<td>Drilling</td>
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<tr>
<td>A.A.P.</td>
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Total 10

Additional facilities

Civil Engineering : 1

B) 4 x 4 Trucks all wheel drive

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<tbody>
<tr>
<td>* Recording Truck International AB 160</td>
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</tr>
<tr>
<td>* Supply - Truck International AB 160</td>
<td>2</td>
</tr>
<tr>
<td>* Supply - Truck Bedford</td>
<td>1</td>
</tr>
<tr>
<td>* Water - Truck International AB 160 (equipped with one 800 gal. water tank)</td>
<td>1</td>
</tr>
<tr>
<td>* Water - Truck International R 190 (equipped with two 800 gal. water tanks)</td>
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</tr>
<tr>
<td>Drill - Truck International R 190 (with DC3 tyres)</td>
<td>2</td>
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</tbody>
</table>

CIVIL ENGINEERING EQUIPMENT (supplied by Seismic Dozing)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Caterpillar D6</td>
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</tr>
<tr>
<td>Caterpillar D8</td>
<td>1</td>
</tr>
<tr>
<td>Land Rover</td>
<td>1</td>
</tr>
<tr>
<td>Supply Truck</td>
<td>1</td>
</tr>
</tbody>
</table>

* with Michelin sand tyres
COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE

DRILLING EQUIPMENT

2 Mayhew 1000 air-water drills
2 Air Compressor Gardner Denver WCG type
2 Mud-pump Gardner Denver 5" x 6" 895 psi
2 Kelly 3/4" diameter and 18 foot long
2 x 6 drilling pipes (15 ft. stems)

RECORDING EQUIPMENT

1 C.G.G. reflection seismic transistorized amplifier system type AS 626 X
1 C.G.G. transistorized modulator system type D.M. 605
1 25 trace SIE PRO II photographic recorder
1 C.G.G. magnetic recorder Electrotech MTD equipped for corrected variable area playbacks with V.A. camera
2 SBT 1000 Automatic shooting boxes, 1000 volt output
1 Manual shooting box
3 VHF radio transmitters with attachments for time-break transmission (PYE PTCA 8002)
1 604 R Refraction unit as a complementary facility

GEOPHONES AND CABLES

1400 Hall Sears Junior Reflection Geophones 20 cps 245 ohms, on jumpers of 12 with a 15 feet interval between geophones
300 Hall Sears Refraction Geophones 4, 5 cps on jumpers of 3 with a 30 feet interval between geophones, as complementary facilities.
4 Reflection cables 6 traces
4 Reflection cables 3 traces
27 Portable refraction cables, one take out per cable, 800 foot long
1 WZ Cable with 24 Hall Sears Junior Geophones

GRAVITY EQUIPMENT
1 Worden "Pioneer" type gravimeter No. 708.

CAMP EQUIPMENT
1 Office trailer
1 Kitchen trailer
1 Workshop trailer
2 18 KVA Diesel Power Plants
1 5 KVA Diesel Power Plant
1 Cabin kitchen portable for the fly camp
All necessary tents for accommodation of
the crew
2 HF 20 radio transmitter PYE.
### APPENDIX III

**HISTORY AND STATISTICS**

#### HISTORY

The main dates of the survey are as follows:

<table>
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<tr>
<th>Recording</th>
<th>Date</th>
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<td>- first reflection shot</td>
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<tr>
<td>- seismic refraction</td>
<td>10th - 13th May, 1966</td>
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<tr>
<td>- multiple coverage</td>
<td>9th &amp; 10th June, 1966</td>
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<td>- last shot</td>
<td>11th June, 1966</td>
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<table>
<thead>
<tr>
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<th>Date</th>
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</thead>
<tbody>
<tr>
<td>- first hole drilled</td>
<td>22nd April, 1966</td>
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<tr>
<td>- last hole drilled</td>
<td>8th June, 1966</td>
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<table>
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<th>Gravity</th>
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</tr>
<tr>
<td>- last reading</td>
<td>10th June, 1966</td>
</tr>
<tr>
<td>SEISMIC</td>
<td>Month</td>
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<tr>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>APRIL</td>
<td></td>
</tr>
<tr>
<td>MAY</td>
<td></td>
</tr>
<tr>
<td>JUNE</td>
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</tr>
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<table>
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<th>CONSUMABLE STORES</th>
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<td>Explosives (lbs)</td>
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<tr>
<td><strong>Month</strong></td>
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<tr>
<td>APRIL</td>
</tr>
<tr>
<td>MAY</td>
</tr>
<tr>
<td>JUNE</td>
</tr>
<tr>
<td>TOTAL</td>
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<table>
<thead>
<tr>
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<tbody>
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<td><strong>Month</strong></td>
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<td>APRIL</td>
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<tr>
<td>MAY</td>
</tr>
<tr>
<td>JUNE</td>
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<td>TOTAL</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Month</strong></td>
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<td>MAY</td>
</tr>
<tr>
<td>JUNE</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>
APPENDIX 4

REDUCTION AND PRESENTATION OF DATA

The Datum plane is 100 metres above mean sea level Port Augusta.

Part one REFLECTION

1/i  Static Corrections

Weathering corrections: At each shot point the depth of the weathering zone was determined by an analysis of the first breaks on the seismic records. Also an average of two weathering shots were carried out each day, i.e. shallow refraction shots made along the traverses using a special cable.

Static corrections were then computed for each trace using a method based on the comparison of templates recorded on a spread shot from two adjacent shot points.

Velocities used for the corrections were:

\[ V_0 = 700 \text{ m/sec in the weathering zone} \]
\[ V_1 = 2000 \text{ m/sec below the weathering zone} \]

1/ii  Normal Move Out Corrections

The normal move out corrections were deduced from the T-Delta T values plotted for each traverse, and recorded manually on a magnetic tape.
Date Processing

After the daily field work, the magnetic tapes of each shot were corrected for both static and normal move out corrections on the crew, using the C.G.G. optical "MTD corrector" which has a dynamic correction range from 0 to 255 milliseconds which can be applied in steps of one millisecond.

The playbacks were then assembled as variable area cross sections of about 10 or 11 corrected films.

The offset spreads were corrected for static corrections only.

Documents Used for Interpretation

The computation of the static corrections and the T-Delta T statistics were compiled from the teledelto playbacks.

The settings were: Filter: 1/20 1/56

AGC: on

The first interpretation of the results was made on the assembled variable area record cross sections (pl. 4 to 12)

The depth cross sections were established for each traverse (pl. 13 to 16) using the time depth curves shown on figure 3, 4, 5. These curves were deduced from the results of several wells located in the same basin.
The Bouguer anomaly values were also plotted on the depth sections.

Scales are: horizontal \( \frac{1}{100,000} \)
.vertical \( \frac{1}{20,000} \)

All variable area cross sections (including offset shots) were photo reduced in order to provide documents of a more convenient size. They are included in the report (pl. 4 to 12).

Horizontal Scale: approx. \( \frac{1}{30,000} \)

Vertical Scale: 5 cm per 1 sec double way time

Part two REFRACTION

2/i Corrections

Information was obtained from the results of the reflection survey. The same values for the parameters were used.

2/ii Data Processing

Interpretation was carried out from the field records using the Gardner-Layat method for the 4/200 m/s marker.

Documents produced
- Statistic and interpretation diagrams
- Interpretation plates
- Time distance curves
Part three GRAVITY

The computations were made in the field office by the gravity operator when not taking readings on the seismic traverses.

The preliminary gravity corrections included tidal and instrumental drift corrections - then latitude and elevation corrections were made to compute the Bouguer anomaly values. The rock density used for the elevation correction was 1.9 g/cm³.

Topographic corrections: these corrections, taking into account the topographic anomalies close to the stations, were computed on line P4 using Hammer tables. Since they are all less than 0.03 milligal they were not included in the computation of the Bouguer values.

The origin of the survey was the Minad Peoppel Corner base station. The value of the gravity was

\[ g = 979.014.03 \text{ cm/sec}^2 \]

The documents forwarded to the BMR are:

- Gravity computation sheets ) Not included
- Bouguer anomaly computation sheets ) in
- Bouguer anomaly values on a \( 1/100,000 \) map ) this report
- Network of base ties (pl. 27)
- Bouguer anomaly contour map at scale \( 1/250,000 \) (pl. 28)

Note: the Bouguer anomaly curves are plotted on the depth cross sections.
- LIST OF PERMANENT MARKERS -

<table>
<thead>
<tr>
<th>Line</th>
<th>Shot Point</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Elevation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( x )</td>
<td>( y )</td>
<td>( z )</td>
</tr>
<tr>
<td>P2</td>
<td>370</td>
<td>505,526</td>
<td>1,632,226</td>
<td>61.98</td>
</tr>
<tr>
<td></td>
<td>380</td>
<td>507,934</td>
<td>1,625,454</td>
<td>54.58</td>
</tr>
<tr>
<td></td>
<td>390</td>
<td>510,315</td>
<td>1,618,711</td>
<td>53.44</td>
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<tr>
<td></td>
<td>400</td>
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<td>1,611,870</td>
<td>45.08</td>
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<tr>
<td>P2 ext.</td>
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### LIST OF PERMANENT MARKERS

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<tr>
<th>Line</th>
<th>Shot Point</th>
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