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COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE

AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD.

PEARCE POINT SURVEY

August - November, 1963 O.P.2.

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SUMMARY

A two-and-a-half month survey has been carried out in the PORT KEATS area of the O P 2 Lease in Northern Territory, by the COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE (Australian Branch) on behalf of AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD.

The party experimented the seismic (reflection and refraction), gravimetric and magnetic methods.

In reflection two horizons, presumably Paleozoic, were mapped. They show an important regional North-West dip. Their depth ranges respectively from 450 to 1,750 metres and from 1,200 to 3,250 metres.

Two structural anomalies were revealed in the southern part of the survey.

A refraction probe showed the existence of several markers with apparent velocities ranging from 3,500 to 7,000 m/sec.

This latter might represent the basement and a rough approximation leads to a 7,700 metres depth for the Basin.

A 4,500 - 5,000 m/sec marker was exploited. It is conformable with the first reflection horizon and could be of Devonian age.

None of the main features of the seismic horizons appears to correspond to a gravity anomaly.

It is probable, therefore, that the density contrasts inside the sedimentary formations are insignificant compared to the contrast sediments-basement.

Most of the magnetic measurements are questionable because of a defective working of the magnetometer under the tropical conditions of the area.

INTRODUCTION

Following the signing of a contract between the AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD. on one hand and the COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE (Australian brand) on the other, the latter carried out a geophysical survey in the area of PORT KEATS - PEARCE POINT (Lease O P 2) in Northern Territory, where Australian Aquitaine Petroleum is operator.

The party including 42 men (6 key men being from France), was capable of operating either with the reflection, refraction, gravimetric or magnetic methods. This survey, following the Fermoy survey (A.T.P. 86 P, Queensland) was performed with the same equipment.

The drilling began on the 23rd of August and was completed on the 4th of November, 1963.

The seismic recording began on the 24th of August and was stopped on the 9th of November, 1963.

Gravimetric and magnetic measurements were taken between the 25th of August and the 8th of November.

The initial programme, consisting of approximately 100 miles of reflection traverse and a refraction probe has not been completed. The commencing of the wet period obliged the party to withdraw from the Port Keats area before the middle of November.

117.6 km (73 miles) of reflection traverses and 58.8 km (36.5 miles) of refraction traverses were carried out.

Mr. M. POULAT, Engineer Geophysicist, headed the party.

Mr. C. DIKOFF, Engineer Geophysicist, supervised the survey.

CHAPTER I

GEOLOGY AND GEOPHYSICS

1. GEOLOGY (Pl. 2)

The area to be investigated is located in the north eastern part of the Bonaparte Gulf Basin (Fig. 1). It is mainly covered by large outcrops of Permian and possibly Jurassic age, extending all along the eastern coast of the Basin (see plate 2).

The Permian has a minimum thickness of 1,500 ft., as shown by the old coal bore at Port Keats.

Older formations are cropping out southwards; carboniferous sediments of the Keep River area and the Proterozoic Kimberley Range.

Eastwards, the basin is bordered by a non-metamorphic upper Proterozoic and, near the Moyle River, by a granite basement.

There is a possibility of the existence of a pre-Permian Basin near Port Keats which could be deep enough to offer good possibilities for oil exploration, and could show the same section as exposed in the southern part of the Bonaparte Basin. In that area (Spirit Hill area), a thick Palaeozoic section exists limited by a big fault system (Cockatoo fault system), and underlying the Carboniferous - Permian below an unconformity.

The section in that area is as follows:

AGE	LITHOLOGY	THICKNESS
Permian	sandstones, shales and limestones	> 1,500 ft.
	regional unconformity	
Carboniferous	sandstones, limestones, sandstones (Weaber group)	> 3,400 ft.
	unconformity	
	limestones, shales, sandstones	> 1,600 ft.
	regional unconformity	
Devonian	limestones, sandstones	> 7,000 ft.
	unconformity - transgression	
Cambro-Ordovician	sandstones and limestones, shales sandstones	4,500 ft.
	unconformity	
Upper Proterozoic	sandstones, shales, dolomite	> 12,000 ft.
	unconformity	
Middle and Lower Proterozoic Archean	metamorphic complex - granite	Basement

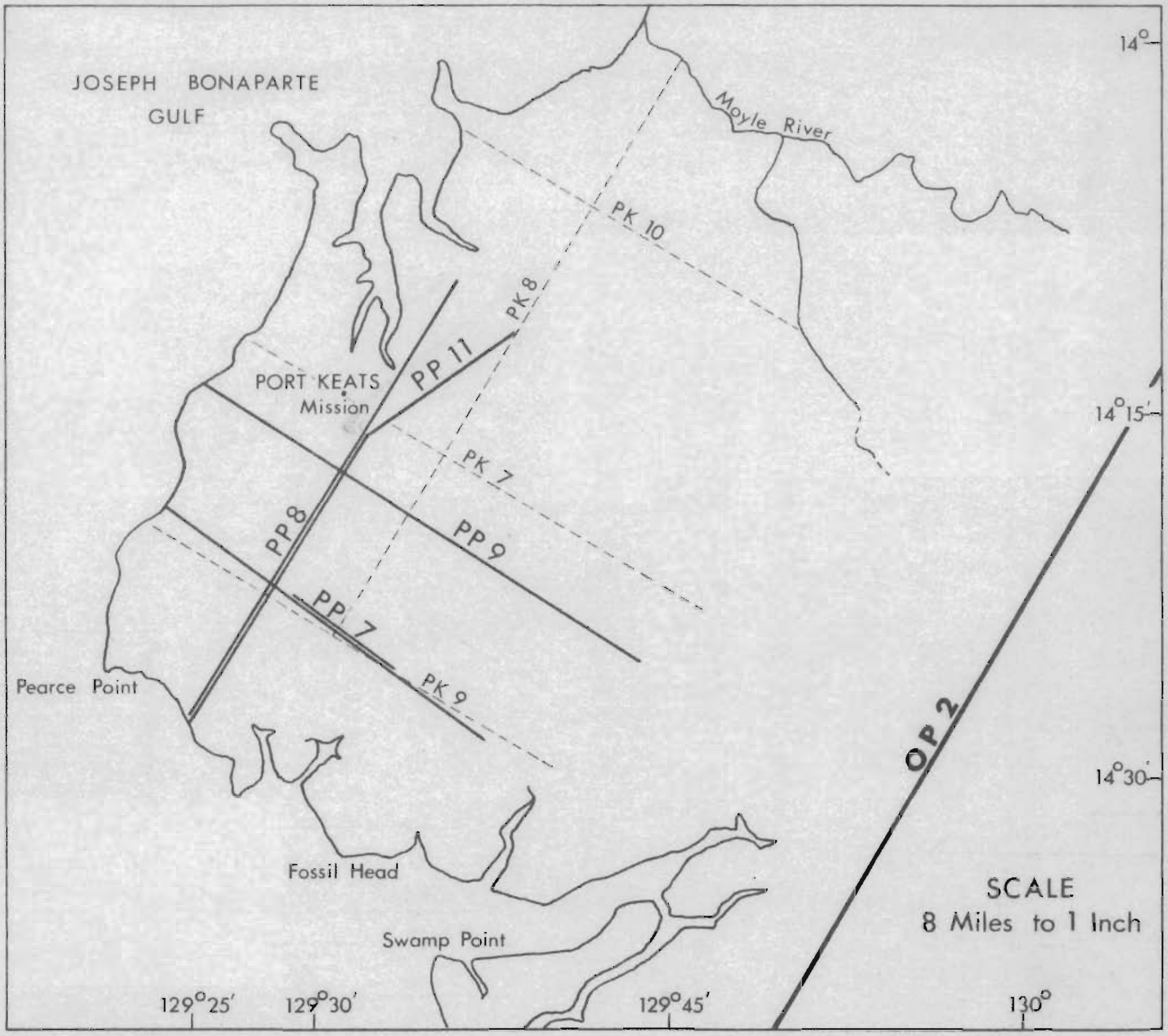
2. GEOPHYSICS

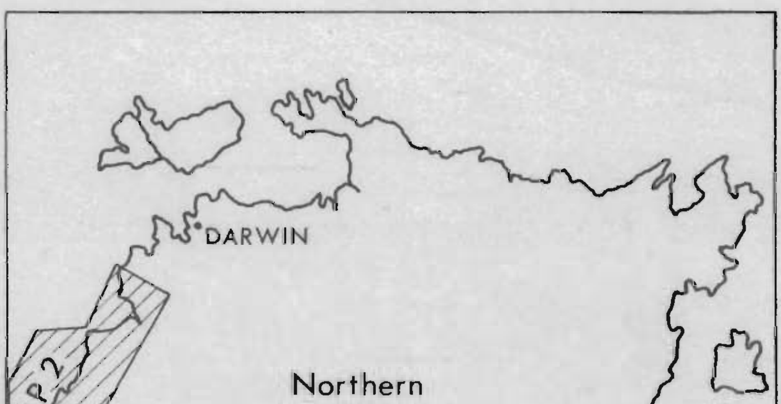
2.1 - Gravity

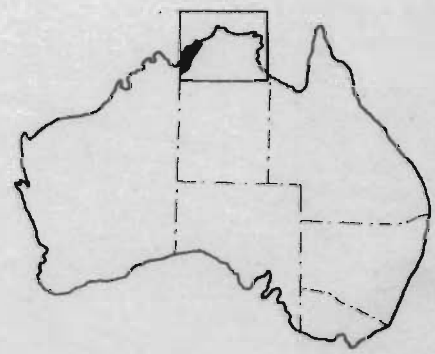
A gravity survey was carried out on behalf of Associated Australian Oilfields N.L. by Mines Administration Pty. Ltd. in 1957. (Regional gravity survey on Bonaparte Gulf Basin - North Western Australia - 1957).

Copies of the final report of this survey are on file at the

FIG. 1







LOCATION
MAP

Bureau of Mineral Resources.

The Bouguer anomaly contour map shows a regional high situated at 24 miles east of Port Keats. This high is probably in relation with the presence of a basement ridge at shallow depth below the Permian cover.

The pronounced gravity low around the Port Keats Mission could indicate a considerable thickness of sediment above the lower Proterozoic rocks.

2.2 - Seismic

The previous seismic coverage of the area, was carried out in late 1960 by Associated Australian Oilfields N.L. between Port Keats and the Queen's Channel. Only a small part of the survey gave reliable results.

In the better part of the area, a good marker was recorded and it seems to originate from unidentified Palaeozoic.

In poor record areas, it was possible to improve the results by using three hole patterns; but in nil record areas, it was impossible to improve the reflection quality by pattern shooting.

The disappearance of reflections in the eastern part of the survey is probably related to the proximity of the edge of the Palaeozoic basin.

The contour map of an unidentified Palaeozoic marker shows a north-west resultant dip.

The seismic results indicate the presence of approximately 12,500 ft. of Palaeozoic section in the central part of the area. This is in accordance with gravity results.

An offshore seismic survey, between the Moyle River and the Queen's Channel in 1962 has recorded only shallow reflections deepening to the north-west from .5 second to 1.5 seconds two-way time. These arrivals presumably belong to Permo-Carboniferous formations too close to the surface to be recorded east of Port Keats.

South of the investigated area, the Keep River survey (1962) consisted of seismic reflection and refraction. The reflection cross-sections show, near the southern limit of the Basin about 7,000 feet thick, almost horizontal Paleozoic formations overlying the unconformable Proterozoic.

To the north, the Basin dips steeply and results became very poor. The refraction shooting which followed, secured the exploitation of a Devonian age refractor, the depth of which increases from 700 ft. to 7,500 ft. near the seashore.

CHAPTER II

OBJECTIVES AND PROGRAMME

1. REASONS FOR THE SURVEY

1.1 - Technical reasons: It was planned to carry out at the same time gravity, magnetic and seismic work in order to compare as quickly and as well as possible, the results given by those different methods. This would indicate whether or not they could be used later on in the area to be defined as well as how to apply these techniques.

1.2 - Geological reasons: The programme was designed as a semi-detailed cover of a part of the Bonaparte Gulf Basin in which the results of previous seismic surveys were generally very poor and which corresponds to a regional gravity low. A pre-Permian basin could exist and it was planned to investigate it because it is possible that a convenient lithological sequence exists here, with possibilities of oil accumulation, either by structural or stratigraphic traps.

2. OBJECTIVES

The previous survey carried out in 1960 by Austral Geoprospectors for MINAD, has shown reliable reflection results only on the area situated near the eastern boundary of the basin. On the whole western part of the survey, where the elevation is higher, the results were practically nil in spite of some attempts to improve by using multiple holes. It must be noted that the crew has operated with only four geophones per trace.

The general purpose of the present survey was to get a general tectonic picture of the area of Port Keats; this is why 4 traverses covering the whole region were proposed.

However, before starting the coverage, the method of prospection had to be determined. Experiments had to be carried out and the subsequent programme was depending on the test's results. Therefore it was impossible to say what would be the final percentage of reflection and refraction.

The general forecast was:-

" - to conduct reflection work on all parts where experiments indicate the possibility of obtaining reliable results;

- to conduct refraction work on the parts where reflection was unable to give reliable results. Anyway, a refraction sounding was to be carried out on the Traverse PK8. "

It was not known whether or not the results of the Keep River Survey, 1962, could be extrapolated over the Port Keats area but in the affirmative, it seemed that it would be possible to follow the Devonian Burt Range limestone with refraction when the reflection ceases to yield adequate results.

Another target of the present work was to check the ability of gravity and magnetism to give adequate information on the shape of the basin.

3. PROGRAMME

3.1 - Initial Programme

With this purpose in mind, a gravity-magnetism operation was coupled with the seismic work, in the same manner as on the previous 86 P Fermoy survey.

The gravity and magnetic survey was to consist of 3 parallel lines, one or two miles distant from each other, depending on topographic difficulties. The seismic line would be used as one of those three parallel lines to take advantage of the seismic surveying that would be conducted with the accuracy necessary for a gravity survey. The three traverses would be surveyed both by gravity and magnetism, each line with about 3 stations per mile.

The seismic programme is shown on Fig. 1; the four forecast lines being PK 7, 8, 9 and PK 10.

3.2 - Modification of the programme (Fig. 1)

The initial programme was modified as follows:-

- PK 7 was moved southwards (PP 9) in order to avoid the Sugarloaf Range;
- PK 8 was shifted westwards, lined as well as possible between the Sugarloaf Range and the swamps of Port Keats;
- the northern part of this line and traverse PK 10 were abandoned because of the inaccessibility of the area.

3.3 - Realization of the programme (Fig. 1)

August : reflection experiments on traverse PP 7.

September : refraction probe and refraction line PPR 8;
reflection experiments on traverses PP 8 - PP 7;
eastern parts of traverses PP 7 - PP 9.

October : central part of traverse PP 9,
traverses PP 7 and PP 8,
refraction traverse PPR 7.

November : southern end of PP 8,
traverse PP 11,
western end of traverse PP 9.

CHAPTER III

TECHNIQUES AND OPERATIONS

1. TECHNIQUES

1.1 - The reflection method used throughout the survey is the conventional split-spread recording technique.

At the beginning of the survey 24 recording traces were laid down and the shot was fired between traces 12 and 13.

Following numerous experiments we were led to increase the number of geophones per trace from 24 to 60 and consequently to lay down only 12 traces, the distance between shot points remaining of 600 metres.

The recording equipment was a pulse-width modulation magnetic assembly MTD-CGG 59 equipped with an Electrotech MTD sequential play-back system and an SIE-PRO 11 galvanometric camera.

1.2 - The refraction method is the Gardner-Layat technique of continuous profiling, used by CGG since 1952 and adapted from L.W. Gardner refraction method described in geophysics, 1947 - volume XII, page 221.

1.3 - The gravity survey was carried out with a Worden gravity meter, type Pioneer. A network of base stations was established so as to prevent the total duration of the measurements at intermediate stations between two base stations from exceeding four hours.

1.4 - The <u>magnetic survey</u> was performed with an Elsec Proton magnetometer (from Littlemore Scientific Engineering Co.). The method was the same as above for the gravity work.

2. OPERATIONS

2.1 - Travelling conditions

A track was cleared by a bulldozer between Daly River and Port Keats but the travelling conditions remained precarious.

The surveyed area is covered by a thick vegetation and cut by swamps. The accessibility was improved by the dozer working for the seismic crew and later on by a second dozer added to the gravity-magnetism crew. (An accessibility map at a scale of 1/50,000 has been drawn. It has been forwarded to Aquitaine Australian Petroleum but is not included in the present report.)

2.2 - Weather and local conditions

The weather was hot and humid with a temperature rising during the course of the survey. Living conditions were worsened by the numerous mosquitoes and sandflies.

The first rainfalls occurred in early October.

The Catholic mission of Port Keats was the only populated spot.

2.3 - The camp consisted of individual and collective canvas tents and three trailers (kitchen, office and workshop). Two main camps were used for the survey.

2.4 - Supplies were received from Darwin; by air for the perishables; by barges or by trucks using the cleared track for the rest of the supplies.

2.5 - Personnel: To the basic crew of 29 were added 13 persons for the refraction and gravity-magnetic surveys and as additional means.

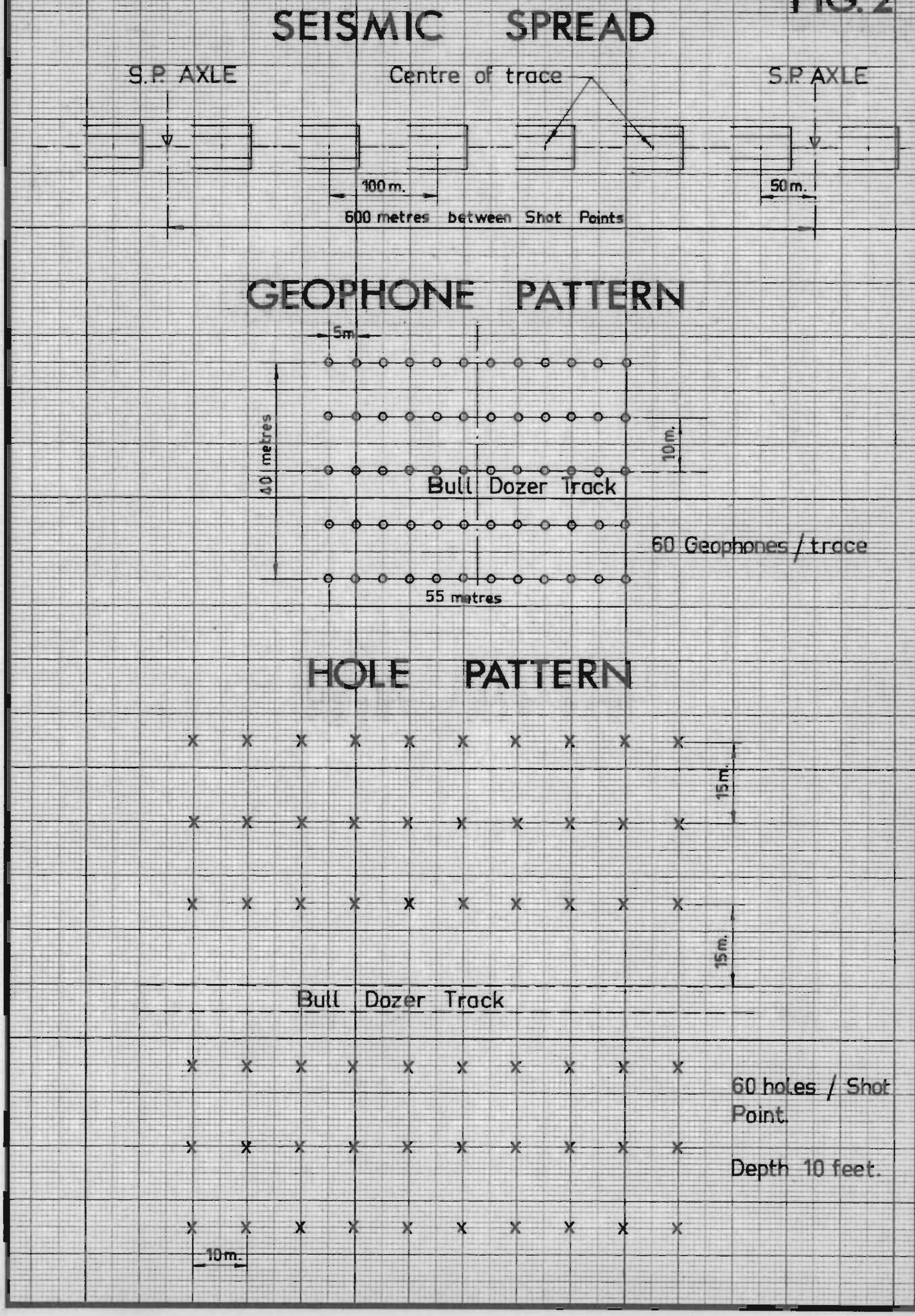
2.6 - Vehicles: 7 Land Rovers, 2 International R 190, and 7 Bedford RLHC3 were attached to the party. All are four wheel drive vehicles.

Two bulldozers and two Chevrolet 4 x 4 were used by the dozing crew.

2.7 - The surveying operations were conducted with a theodolite Wild To. The metric system was adopted and elevations referred to the sea level.

The co-ordinates were tied to the Astronomical station JB7 of the Australian Survey Corps.

FIG. 2


SEISMIC SPREAD
S.P. AXLE
Centre of trace
S.P. AXLE
100 m.
50 m.
600 metres between Shot Points
GEOPHONE PATTERN
5m
40 metres
10 m.
Bull Dozer Track
60 Geophones / trace
55 metres
HOLE PATTERN
15 m.
15 m.
Bull Dozer Track
60 holes / Shot Point.
Depth 10 feet.
10 m.

The projection system was the Universal Transverse Mercator grid, zone 4.

2.8 - Drilling was conducted with two air/water Mayhew 1,000 drills. Two shifts were generally insufficient so a third one was added.

Air drilling was satisfactory and water drilling used only on the eastern part of traverse PP 7 and for boring out deep holes (experiments).

The average footage per effective drilling hour was 107 feet with holes being generally 10 to 15 ft. deep.

2.9 - Seismic operations were carried out using a reflection spread with 12 geophone traces, 100 metres apart. Each trace consisted of 60 geophones laid down in five parallel lines connected in series. On each line, 12 geophones were connected in parallel.

The shot point consisted of two patterns of 30 holes drilled to a 10 ft. depth.

All patterns are illustrated on Fig. 2.

The recording was done using the AGC and the expander with a low-cut filter of 14 c.p.s.

In refraction 24 traces were recorded. They were 200 metres apart on traverse PPR 8 and 100 metres apart on traverse PPR 7. Each trace was equipped with a single GS 13 geophone. The shooting distance ranged from 0 to 36 kilometres (22 miles).

A high-cut filter of 40 c.p.s. was used.

The recording equipment was a pulse-width modulation magnetic assembly with "C.G.G. 59" amplifiers.

2.10 - Play-back operations were conducted using the CGG's specially designed corrector allowing for elevation, weathering and move-out corrections. The variable area play-backs were manually assembled into cross-sections.

In addition to the above field documents, another set of magnetic sections were made available by the A.A.P. after a somewhat more elaborate processing on the MT4 central processing office of the company in France. These sections were produced with two filter settings: 14-40 c.p.s. and 28-80 c.p.s., whilst the field play-back setting was 28-56 c.p.s.

2.11 - Gravimetric operations: The base stations were established along the seismic traverses with an average spacing of 5 miles. Readings were taken at intermediate stations spaced 600 metres along the seismic traverses where they coincided with the seismic shot points. Readings were also taken with the same station spacing on two lateral lines located on each side of the seismic traverses, at approximately two miles distance.

27% of these stations had to be reached on foot and in these areas, the station spacing was 300 metres.

The Bouguer anomaly was computed after correcting for the instrument drift, for the latitude and after applying the "Bouguer" and the tidal corrections. No correction was applied for the mass effect of the relief.

2.12 - Magnetic operations: Field operations were conducted in the same general manner as for the gravimetric operations. However, after a few working days, the readings appeared doubtful, presumably because of the high humidity rate in the Port Keats area.

NOTE: Techniques and operations are discussed at length in the Appendixes 4 and 5.

CHAPTER IV

RESULTS

1. REFLECTION

Numerous experiments were carried out which led to a shot hole and geophone multiplication. For the routine exploitation 60 holes at 10 ft. depth were shot and the geophone trace consisted of 60 geophones laid down in 5 parallel lines (see Fig. 2).

Results were generally fair to good.

Two reflections are continuously pickable over the whole of the traverses, the first one at 300 to 1,200 milliseconds two-way time, the second at 900 to 2,050 milliseconds.

Shallow reflections are noticed in the eastern part of the survey and a deep horizon, although scattered, appears between 1.5 and 2.5 seconds t.w.t. on the southern PP 7 traverse.

Migrated depth cross-sections were established for the two continuous reflectors (horizons 2 and 3), assuming vertical velocities of 2,800 and 3,200 m/sec. (9,180 and 10,500 ft. sec.)

Time contour maps of these horizons are presented at a scale of 1/100,000. For this purpose, cross sections of the previous Port

Keats Survey were reinterpreted.

The main feature of the surveyed area is an important regional north-west dip, steeper in the eastern part.

Major faults were crossed with two probable prevailing directions; north-west and north-east.

Structural anomalies were detected in the central and southern parts of the survey. The first one has a questionable closure to the south. The second one, suggested by the southern extension of traverse PP 8, presents a vital interest because of the outstanding south dip revealed by this traverse.

Horizons 2 and 3 are of a probable Paleozoic origin.

2. REFRACTION

One refraction probe completed as a continuous line and one short refraction line were carried out.

The refraction probe showed the existence of several markers:

- a shallow 3,500 m/sec. refractor,
- a 5,000 m/sec. marker,
- a 5,150 m/sec. marker,
- a deep refractor with apparent velocities ranging from 5,200 to 5,900 m/sec.

A 7,000 m/sec. event recorded at the longest distance: 35 to 37 km., could represent the basement. The hypothesis of a 4,000 m/sec. average vertical velocity leads to a questionable depth of 7,740 metres below the sea level.

The Gardner-Layat continuous profiling method allowed the exploitation of the 5,000 m/sec. arrivals: the marker's actual velocity is of 4,980 m/sec. whilst on the second refraction line a horizontal velocity of 4,550 m/sec. was found.

These markers are conformable with the reflection horizon 2 and underlie it by 200 to 400 metres.

They might be related to Devonian formations.

3. GRAVIMETRY AND MAGNETISM

A Bouguer anomaly map at a scale of 1/100,000 is included in the present report.

This survey does not bring any noticeable contribution to the knowledge of the Port Keats area, since the B.M.R.'s gravity reconnaissance survey has already defined a very important light anomaly in this zone.

The secondary indications are questionable because of the possible influence of the topographical relief.

The density contrasts inside the sedimentary section appear to be insignificant compared to those of the contact sediments-basement since none of the main features of the mapped horizons has affected undoubtedly the gravity results.

The magnetic results are unreliable and only one magnetic cross section (traverse PP 7) is accompanying this report.

CHAPTER V

DISCUSSION OF RESULTS AND INTERPRETATION

First part: reflection results

1. EXPERIMENTS

The numerous experiments listed on Fig. 10a. to 10w. led to the following conclusions:

- increasing the hole depth generally does not improve the quality of the records.
- a high multiplication of holes drilled at shallow depth: 60 holes at 10 feet, improves greatly the results. These appeared to be the most important parameters.
- increasing the number of geophones per trace is also beneficial.
- in certain areas (Permian outcrop zones) the influence of the charge of explosive is also important. Relatively heavy charges, until 120 lbs. per shot point had to be used.

The analysis of the experiments is detailed in Appendix 4.

A few experiments are illustrated by Pl. 5 and 6.

2. QUALITY OF RESULTS

The quality of results, although variable along the traverses, is generally fair to good.

Variable surface conditions might explain these changes in quality. In particular, in the south-eastern part of the survey overlaid by alluviums, results were good when a light shot point is used (traverse PP 7).

The various shot point parameters (number of holes, charge, distance between holes) were adjusted according to the surface conditions and, finally, the quality of records was maintained at as good a level as possible.

Two generally reliable horizons were followed on the whole of the traverses: A shallower level (horizon 1) appears in places and some indications of reflected events at depth (down to 2.5 seconds two-way time) were noticed. Fault indications are frequent.

Along traverse PP 7, except in the vicinity of the faults where unfavourable tectonic conditions may explain the lack of quality, results are good.

They are also good on the south of traverse PP 8 but as from SP 108 only horizon 2 is reliable (see Pl. 19).

Several reflectors are seen on the eastern part of traverse PP 9 (SP 114 to 130). The central part is poor (SP 133 to 155): noisy records lacking of energy. Results improve and become good along the western part of this line.

Results are fair to good on traverse PP 11 with the appearance of shallow reflectors down to horizon 2.

3. INTERPRETATION DOCUMENTS

The variable area cross-sections at a scale of 1/8054 or 1/16,108 were supplied during the course of the survey and are not included in the present report; migrated cross-sections of traverses PP 7 and PP 9 were established (Pl. 7 and 8). Only the continuous horizons 2 and 3 were migrated using the overburden velocities of respectively 2,800 m/sec. and 3,200 m/sec. deduced from the study of the curvature of the reflections.

A depth cross-section AA' tying the traverses PP 7 and PP 9 is also presented (Pl. 9).

Reflections recorded along traverses PP 8 and PP 11 have not been migrated because of the particular position of this line, which follows the flank of a large structure. The time cross-section of horizons 2 and 3 is included as Pl. 10. Time contour maps of horizons 2 and 3 were drawn at a scale of 1/100,000 after including the results of the previous Port Keats survey (Pl. 11-12).

4. EXAMINATION OF THE DEPTH AND TIME CROSS-SECTIONS (Pl. 7 to 10)

4.1 - Traverse PP 7 (Pl. 7): The depth cross-section shows a general westward dip. This feature is interrupted by the existence of a high zone between SP 10 and 30.

The culmination is affected by a major fault F2, which has a south-eastern throw of approximately 150 metres.

A second fault between SP 8 and SP 12 marks the area of dip reversal. It seems to have two components which limit a narrow and deeper compartment.

The western part of the section shows a dip increasing with the depth of the horizons: slope of 2.3% for horizon 2 and 3.9% for horizon 3.

4.2 - Traverse PP 9 (Pl. 8): Similar features are revealed by this cross-section parallel to the previous one. However -

- the top area of SP 136 to 146 is bordered westwards by a fault with a down-throw to the west
- eastwards, the culmination is limited by an important fault which affects horizon 3 and which appears only as a flexure on horizon 2 (F2).
- to the south-east this traverse extends near the edge of the basin and shows steep dips of 4.5% for horizon 2 and 7.6% for horizon 3.

4.3 - Depth Cross-Section AA' (Pl. 9): The direction of AA' cross-section corresponds to the orientation of the basin near Port Keats. Pl. 9 points out steep dips of 3.6% and 6.1% for horizons 2 and 3 between traverses PP 7 and PP 8 and dips of 1.1% and 2.1% between traverses PP 8 and PP 9.

NOTE: Pl. 9 was migrated after a time cross-section AA' was taken from contour maps of horizons 2 and 3 (Pl. 11 and 12).

4.4 - Time Cross-section of traverses PP 8 - PP 11 (Pl. 10)

Along almost the whole of the two traverses (as from SP 108) horizons 2 and 3 dip gently northwards. The only anomalies are a steeper zone at the beginning of traverse PP 11 (SP 179 to 182) and a possible faulted zone at the northern end of PP 11: very poor recordings as from SP 195.

At the southern end of traverse PP 8:

- F4 is an important fault with a north downthrow of about 80 milliseconds one-way time;
- south of F4 a reliable dip of both horizons might secure the southern closure of a structure, the northern closure of which would be given by fault F4.

5. CONTOUR MAPS (Pl. 11-12)

As mentioned above (paragraph 3) horizon 1 has not been mapped. On traverse PP 7 it appears 300 to 340 milliseconds to-way time above horizon 2. It is not pickable in the summit zone: SP 14 to

28, and remains fair to good along the rest of the line.

It is not continuously pickable on the other traverses.

A deep horizon, although not continuous, is visible on traverse PP 7. It dips westwards from 1.5 to 2.5 seconds two-way time. It is the deepest reflection event noticed on the surveyed traverses.

Cross-sections of the previous Port Keats Survey by Austral Geo-prospectors were reinterpreted but only the south-eastern part of the survey provided reliable results.

5.1 - Correlation of faults

The main faults are represented on the depth and time cross-sections. Correlation from traverse to traverse is delicate because of the distances involved and of the tectonic complexity of the area. The correlations shown on Pl. 11 and 12 are not secured and could be deeply changed by further work.

F4 is approximately parallel to the direction of traverse PP 7 since this major feature does not appear on line PP 7. It could be corre-lated with a faulted zone seen south of lines 3 and 5 (MINAD survey).

The north-east direction of F2 has been determined assuming that the major faults downthrown to the east crossed by the parallel traverses PP 7 and PP 9 belong to the same fault system. Consequently, the less important faults F1 and F3, each of them affecting only one traverse are supposed to be nearly parallel to the direction given by F2.

Nevertheless, a second hypothesis could be made. F1 might be associated with F2 of traverse PP 9, these faults having the same net slip. But this would lead to associate F2 of traverse PP 7 with F3 and to admit the existence of an important reverse fault (see P. Pl. 11 and 12).

5.2 - Contour map of Horizon 3 (Pl. 12)

Picking of this horizon is not secured everywhere since it is characterized by energetic arrivals rather than by a continuous line-up. In particular, correlation across faults is delicate.

This map shows a regional north-west dip of the horizon which from 900 milliseconds two-way time deepens to 2,050 milliseconds in 34 km.

The gradient is very steep eastwards: when commenting on the migrated cross-sections, we pointed out a slope of 7.6% on the eastern part of traverse PP 9.

In this direction we are approaching the Proterozoic outcrops and the limit of the Paleozoic Basin.

Beside the main trend constituted by the north-west dip, the important features are as follows:

- a large positive anomaly oriented SW-NE which culminates around

SP 22-23 of traverse PP 7. This high zone appears to be split by fault F2 the throw of which would be increasing to the north.

The dip reversal between the anomaly and the rising eastern zone is underlined by a minor fault F1 and, northwards, by a narrow syncline noticed on traverse PP 9 (SP 130 to 135). Nothing is known about the possible closure southwards.

- a major fault F4 crossed by traverse PP 8. As explained in paragraph 5.1 its direction is allegedly parallel to that of traverse PP 7. Correlation of horizons is good on traverse PP 8. Therefore, the downthrow to the north of 160 milliseconds two-way time is reliable.

- a possible structure south of fault F4 suggested by the outstanding south dip on SP 105 to 99 of traverse PP 8. Although little information is available south of traverse PP 7 there is a probable closure for this structure due to the north-west general dip, to the presence of fault F4 and to the south dip observed.

As a conclusion it must be noted that very interesting structural information was obtained in the southern part of the survey but it has to be studied southwards and detailed by further seismic investigation.

5.3 - Contour map of horizon 2 (Pl. 11)

The contour map of horizon 2 is described after that of horizon 3 since it is less interesting because of its shallower depth (300 to 1,200 milliseconds two-way time).

It is more reliable and confirms the structural shape of the deeper horizon. Features are the same and, due to the lower dips, the only difference is the smoothed amplitude of all tectonic elements.

Second part: refraction results

The refraction survey commenced on traverse PP 8. A refraction probe: S1 PPR8 and a continuous profile PPR8 were carried out.

Later on, a short continuous profile was shot along the central part of traverse PP 7, it was called PPR 7.

1. REFRACTION PROBE S1PPR8 (Pl. 13, 14)

The probe was recorded on sixteen bases (the first one, to the south, being only partly laid down). Each base consisted of 12 traces, 200 metres apart. The distance between the extreme shot points was 31.6 km and two time-distance curves were recorded from 0 to a maximum shooting distance of 36.4 km.

Complementary shots were performed on the two central bases using various shot points situated on each side of this spread.

All information concerning the shooting process appear on Plate 14: "Exploitation diagram".

All recorded and timed arrivals are plotted on Pl.13: "Time-distance curves".

1.1 - Results of the analysis of the records are condensed hereafter:

Distance in km.	Velocity in m/sec.	Remarks
0 to 4	2,500 to 3,100	First refracted arrivals which correspond to the base of the weathered zone. A slightly faster event (2,800 m/sec. at SP112 and 3,100 m/sec. at SP99) represents a very shallow layer.
4 to 9	3,320 to 3,750	High frequency arrivals. Energy decreasing rapidly with the shooting distance. Very neat break with the following marker between 8 and 10 km.
9 to 23	4,750 to 5,150	Slow decrease of the energetic level. Pure arrivals recorded from SP112. From SP99 records show a second top which comes very close to the first one until picking becomes difficult (interfered zone of bases 107-108).
23 to 30	5,000 to 5,300	Visible as a second arrival as from 18 km. Replaces the previous refracted arrivals after an interfered area. Weak, similar to the previous refractor, disappears by loss of energy.
30 to 35	5,200 to 5,900	From SP99, similar to the 5,000 m/sec. worker. From SP112, low frequency suggesting an interfered signal.
35 to 37	7,000	Record made from SP112 only: sudden disappearance of the previous arrivals replaced by a weak, interfered but very fast arrival.

1.2 - Interpretation

Correlation of arrivals recorded from the south (SP99) and the north (SP112) shows a general north dip and the probable existence of the following markers:

- a shallow "3,500 m/sec." refractor, with an intercept-time increasing from 180 milliseconds (SP99) to 340 milliseconds (SP112). Assuming an overburden velocity of 2,800 m/sec. the depths are 420 and 790 m. (1.2% north dip) below the sea level;

- a "5,000 m/sec." refractor, the north dip leading to apparent velocities which differ from the actual velocity by 150 to 200 m/sec. The intercepts are 905 and 1,220 milliseconds below SP 99 and 112. If we assume an overburden velocity of 3,000 m/sec., the corresponding depths are 1,700 and 2,280 m., i.e. a northward slope of 1.85%;

- a "5,150 m/sec." refractor with intercept times of 1,040 and 1,400 milliseconds respectively below SP 99 and 112.

Correlation of the 5,200 m/sec. with the 5,500-5,900 m/sec. arrivals is questionable because of the long distance involved (31.6 km. between both SP) and the dispersion of the apparent velocities and intercept-times.

If the 7,000 m/sec. arrival is an actual refracted event it probably represents the basement but is recorded on a very short distance and therefore could be a diffraction or another anomalic phenomenon.

Considering it to be the basement, the intercept-time is 3,180 milliseconds. With the hypothesis of a 4,000 m/sec. average vertical velocity, the double-way vertical time is of 3,870 milliseconds and the depth of 7,740 metres below the mean sea level. It must be pointed out that, in the absence of more recordings (determination of the accurate marker's actual velocity and intercept-time) and of information concerning the vertical velocities, these values are not reliable and correspond to a rough approximation.

2. REFRACTION LINE PPR 8 (Pl. 15)

A Gardner-Layat continuous exploitation of the "5,000 m/sec." marker was carried out using shots performed at a distance of 10 to 15 km. and some of the refraction probe's recordings.

Results of this exploitation are shown on Pl. 15.

The actual marker's velocity is of 4,980 m/sec. (16,300 ft/sec.) and there is a gentle north dip with delays increasing regularly from 450 to 630 milliseconds.

3. REFRACTION LINE PPR 7

Eight bases were laid down in the middle part of traverse PP 7 and recorded from shot points located on both sides. The distance between geophone traces was reduced to 100 metres and the shooting distance ranged from 2.4 to 9.6 km. (see Pl. 16 "Exploitation diagram" for the recording and shooting particulars).

3.1 - Results

The main features of the records are summarized on the "Interpretation diagram" of Pl. 17.

Slow velocity arrivals ranging from 3,000 to 3,850 m/sec. are recorded as from 2.4 km.

A neat break at about 6 km. separates these arrivals from a consistent marker recorded up to 9 km. (shooting distance). The critical distance as far as shots from western shot points are concerned is shifting, suggesting a rise of the marker eastwards.

The first arrivals are generally weak but there is an evidence of the presence of a 300 m/sec. faster refractor recorded as from 9 km. from the eastern shot points.

3.2 - Interpretation

The arrivals recorded between 6 and 9.6 km were exploited by the Gardner-Layat method. The relative intercept curves were compared using different offset values, from 200 to 3,200 metres. The most satisfactory is the smallest although the calculated offset is of the order of one kilometre.

This is easily understandable when the following conditions are met: conformable or almost conformable formations underlaying a low velocity overburden. In this case, indeed, the intercept time concerning one of the formations is the sum of two terms: the first corresponds to the travel time through the overburden and the second to a travel time between parallel layers. This second term being unvariable the intercept time for each of the formations considered varies according to the depth variations of the first one. Consequently, the structural shape is correctly interpreted only when the smallest value of the offset is taken into account. This offset is the true offset of the first high velocity formation.

We consider this to be the situation along line PPR 7 and the exploitation plate (Pl. 18) was completed after adopting an offset value of 200 metres.

The actual marker's velocity is of 4,550 m/sec. (14,900 ft/sec.). The delay curve outlines a wide structure with a possible fault in the summit zone. Delays vary from 290 to 390 milliseconds, the gradient being steeper towards the West.

4. COMPARISON OF LINES PPR 7 AND PPR 8

On line PPR 8 a 4,980 m/sec. refractor was exploited between 11 and 14 km. shooting distance.

On line PPR 7 the 4,550 m/sec. refractor was exploited between 6 and 9.5 km.

On Pl. 17 the crossing of lines PPR 7 and PPR 8 has been marked as well as the arrivals recorded on line PPR 8 close to this crossing: a 3,320 m/sec. arrival separated by a break at 8 km. from a 4,860 m/sec. arrival.

This fits with the 3,200 m/sec. and 4,900 m/sec. arrivals recorded on bases 206-207 shot from SP 214. Besides, the films involved are absolutely similar.

Therefore, it seems that the same marker has been exploited along these perpendicular lines, the difference of velocity being due to an anisotropic effect and/or to a shortening of the shooting distance on line PPR 7.

It must also be noted that the marker lies deeper on line PPR 8 than on PPR 7.

The conversion of delay times into depths (see the "Fourth part") confirms this assumption.

Third part: gravimetry and magnetism

Some of the documents established during the course of the survey and supplied to Australian Aquitaine Petroleum are not included in the present report. This applies to the location maps and to the Bouguer anomaly maps drawn at a scale of 1/50,000 (Pl. A6 to A11).

Reduction of the Bouguer anomaly (scale 1/100,000) is presented under No.23.

In magnetism the cross-section PP 7 is the only one presented but even these results are questionable.

GRAVITY

It seems that the Bouguer anomaly map (Pl. 23) brings no contribution to the knowledge of the Port Keats area, since the B.M.R.'s gravity reconnaissance survey has already revealed the very important light anomaly.

Even a careful examination cannot provide secondary indications. These, because of the possible influence of the topographical relief, are not secured.

However, two indications are given by the cross-sections (Pl. 7 and 8) where the Bouguer anomaly may be compared to the seismic results:

- on traverse PP 7 the adoption of a regular regional anomaly would lead to a positive residual anomaly corresponding to the faulted culmination of horizons 2 and 3 between SP 19 and 25;

- on traverse PP 9 the eastern flank of the light anomaly shows a slope break suggesting the existence of a North-South fault affecting even the shallow horizons (fault F2).

One is led to believe that such a density of measurements does not enable the gravity method to provide a better interpretation of the seismic results, if this interpretation is to be limited to the mapped horizons 2 and 3. None of the main features of these horizons; faults or structures, seems to have been significantly expressed by the gravity data.

The obvious conclusion is that the density contrasts inside the sedimentary formations are insignificant compared to those of the contact sediments-basement on one hand and the composition of the basement on the other.

Fourth part

1. COMPARISON BETWEEN THE DIFFERENT METHODS

1.1 - In order to compare the reflection and refraction results a delay to depth transformation was done, using the formula :

$$\text{depth} = \text{delay} \times \frac{V}{\cos \theta},$$

With V = vertical velocity from the sea level down to the marker and

$\sin \theta = \frac{V}{Vm}$, Vm being the actual velocity of the marker.

Values of V : V = 3,000 m/sec. on line PPR 8
and V = 2,900 m/sec. on line PPR 7,
considering the shallower depth of the marker.

The calculation with a 3,000 m/sec. value for V on line PPR 7 leads to an interval between the horizon 2 and the marker 4,550 m/sec. equal to the interval separating horizon 2 from the refraction marker along line PPR 8. This is backing the assumption made in the "Second part", paragraph 4, after which the same marker was followed on lines PPR 8 and PPR 7.

The comparison reflection-refraction is good along traverse PP 8; the refractor is conformable with the overlaying reflection horizon 2.

On traverse PP 7 the position of the fault is confirmed (F2) and the refractor and reflection horizon 2 are parallel. However, the distance between them is different on each side of fault F2; 250 to 350 metres separate horizon 2 and the refractor to the west of F2 and the depth interval is of 175 to 200 metres east of F2.

1.2 - For the comparison <u>seismic-gravimetry</u> please consult the previous "Third part".

2. IDENTIFICATION OF THE SEISMIC HORIZONS

The first marker with a velocity of 3,500 to 3,700 m/sec. and a depth not exceeding 600 metres (2,000 ft.) could represent the limit between Permian and Carboniferous sediments.

Reflection horizon 2 might be Carboniferous, representing for instance the unconformity noted in Chapter I - Geology.

There is a good possibility for the refraction marker 4,550 - 4,980 m/sec. (14,900 - 16,300 ft/sec.) to be related to Devonian formations.

The refraction marker 5,000 - 5,300 m/sec. and horizon 3 could be of Cambro-Ordovician and the fast markers: 5,200 to 5,900 m/sec. of Proterozoic age.

We already noted that the 7,000 m/sec. events might be originating from the basement, the depth of the Basin reaching in this case 7,700 metres (25,000 ft.).

All these assumptions are questionable, based only upon data obtained in the Keep River area, 150 kilometres south of the surveyed area.

3. ACHIEVEMENT OF OBJECTIVES

Objectives defined in Chapter II have been met in a satisfactory way.

3.1 - A heavy experimentation led to the adoption of a high multiplication for the shot point and geophone patterns. Reflection results were appreciably improved.

3.2 - The main tectonic features of the Port Keats area, as far as Paleozoic layers are concerned, were outlined.

3.3 - Two structural anomalies appeared to be of prime importance in the southern part of the survey.

3.4 - The refraction profiling allowed an easy exploitation of a 4,500 to 5,000 m/sec. marker, rising from a probably Devonian formation.

3.5 - The existence of other markers was pointed out. Their apparent velocities range from 3,400 to 7,000 m/sec.

3.6 - There was no contribution of the gravimetry to the knowledge of the Paleozoic formations. The contrasts of density are probably very weak inside the sedimentary formations and only a dense network of gravity stations could improve the interpretation of the seismic results.

3.7 - Under the tropical conditions of the area the magnetometer did not work satisfactorily and the readings were considered to be unreliable.

CONCLUSIONS

The Pearce Point survey consisted of 117.6 km. of reflection traverses, 58.8 km. of refraction probe and continuous profiling, of 993 gravity and 284 magnetic measurements.

Compared to previous results, the reflection records were noticeably improved in areas of very poor or nil results.

A high shot point and geophone multiplication had to be used.

Two main reflectors were followed in continuity on the whole of the traverses. Migrated cross sections were established as well as time contour maps.

An important north-west dip of the Paleozoic formations appeared with the eastern part of the survey, not far away from the Proterozoic outcrops, showing the steepest slope.

In the central and southern part of the survey two structural anomalies of utmost interest were outlined.

The area appeared to be of a great tectonic complexity and, therefore, the network of traverses is too loose to provide an accurate and detailed picture of the structural shape of the Basin.

Further seismic work is necessary, in particular for the determination of the south-western closures of the structures.

A refraction probe permitted an inventory of the markers, which show apparent velocities ranging from 3,000 to 7,000 m/sec.

4,550 to 5,000 m/sec. refractors at depths of 1,100 to 2,100 m. are conformable with the first mapped seismic horizon and are easily followed by refraction shooting. They might arise from Devonian formations.

A 7,000 m/sec. arrival recorded between 35 and 37 km. shooting distance, could originate from the basement. The alleged depth is of 7,700 metres.

The gravimetric measurements did not contribute to a better knowledge of the Port Keats area which is a known negative anomaly. The density of stations was not tight enough to provide some reliable supplementary information especially with the possible influence of the relief.

The magnetometer failed to work satisfactorily, due to the tropical conditions and the measurements are considered to be unreliable.

Brisbane, April, 1964

C. DIKOFF
Seismic Supervisor

S. LEMONDE
Australian Branch Manager

A P P E N D I X E S

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APPENDIX I

PERSONNEL

The personnel required by agreement and present in the party is listed below:

	Basic Crew	Refraction	Gravity Magnetism
Party Leader	1		
Seismologist	1		
Computer	1		
Administrative Assistant	1		
Surveyor	1		
Rodmen	2		
Driller - Mechanics	4		
Driller - Helpers	6		
Observer	1		
Junior Observer	1		
Shooter	1		
Helpers	5	2	
Geophysicist			1
Operator - computer			1
Surveyors			2
Helpers			4
Camp Boss	1		
Cook	1		
Helpers	2		
TOTAL	29	2	8

In agreement with Australian Aquitaine Petroleum, the following personnel was added to the above basic composition :

2 Rodmen - for lining and pegging operations as from the 15th of September, 1963

1 Mechanic Helper - as from the 13th of October, 1963

2 Crews - each consisting of 1 bulldozer operator and 1 driver engaged by AAP directly, which were independent of the mission.

The party leader, the seismologist, the geophysicist, the observer and the two surveyors were expatriated from France. The rest of the personnel were hired in Brisbane.

Most of the personnel had already worked with the mission, during the previous "Fermoy" survey (on lease 86P in Queensland).

A few helpers were also hired in Darwin, during this survey, to replace personnel who had left.

On two occasions we had to call in a "native men's crew" (obtained through the Catholic Mission of Port Keats) for the clearance of lagoons with choppers, in places which were not accessible to the bulldozers. (Passage of creeks and mangrove areas).

APPENDIX II

EQUIPMENT

1. VEHICLES

Office	:	1 Land Rover (long wheel base, 109 inches)	
Surveying	:	1 Land Rover (long wheel base, 109 inches)	
Drilling	:	2 International R190,	4 x 4 trucks
		2 Bedford RLHC3,	4 x 4 water trucks
		1 Land Rover,	(88 inches)
Recording	:	1 Bedford RLHC3,	4 x 4 recording truck
		1 Bedford RLHC3,	4 x 4 shooting truck
		2 Land Rovers,	(109 inches)
Gravity	:	2 Land Rovers,	(109 inches)
Camp	:	1 Bedford RLHC3,	4 x 4 supply truck
Refraction	:	1 Bedford RLHC3,	4 x 4 shooting truck
		1 Bedford RLHC3,	4 x 4 explosives transportation truck

2. CAMP

The camp consisted of canvas tents with the exception of a kitchen trailer, an office trailer, and a workshop trailer. The trailers were transported from Winton to Daly River on the truck of a contractor, and they were then towed in by the party's trucks to Port Keats.

The necessary power was supplied by two Diesel plants: one KVA 18 and one KVA 3 power plant.

3. SPECIAL EQUIPMENT

3.1 - Surveying Equipment

2 Theodolites Wild To
4 Staffs with metres and centimetres graduations,
compasses, binoculars

3.2 - Drilling Equipment

Drilling system: 2 Mayhew 1,000 equipped for air/water drilling.
Mud pump: Gardner-Denver, 5" x 6", 895 p.s.i.
Air compressor: Gardner-Denver, WCG type, Kelly length 18 ft.
One 800-gals. water tank was mounted on each of the water trucks (vacuum filling system).
Drilling pipes: 48 (15' stems)

3.3 - Recording Equipment

One recorder type "C.G.G.59" with pulse-width modulation magnetic recording. Field play back facility with the C.G.G. MTD corrector allowing for variable area or wiggle lines reproductions.

One SIE-PRO 11, 25 traces photographic recorder.

Two SBT 1,000 automatic blasting boxes, 1,000V output.

3.4 - Geophones

Reflection 600 Hall Sears "Junior" geophones, model K.245 ohms, 20 c.p.s. 12 geophones are connected in parallel on a basic string.

Refraction 28 ELI-GS13, 610 ohms, 5 c.p.s. geophones.

300 Hall Sears refraction, 215 ohms, 4.5 c.p.s. geophones. Three Hall Sears geophones are connected in parallel on jumper.

3.5 - Cables

Reflection 5 cables, unit length 400 metres, with 12 take-outs at 33m. intervals.

8 cables, unit length 300 metres, with three take-outs by cable .

Refraction 25 cables, unit length 300 metres, with one take-out by cable.

3.6 - Radios

Four VHF "PYE" PTCA 8002 type, frequency modulation, for the radio transmission of the time breaks.

Two "PYE" HF 20A for communication with the Flying Doctor Base.

3.7 - Gravimetry and Magnetism

1 Worden gravitymeter, Pioneer type, No. 41.

1 Littlemore Magnetometer, Elsec type, No. 168.

3.8 - Engineering

2 Caterpillar D8,

2 Chevrolet 4 x 4 trucks for transportation of operators.

APPENDIX III

HISTORY & STATISTICS

All figures concerning the history and statistics are presented in Figure 4.

1. HISTORY

This survey followed the FERMOY survey (lease 86P Queensland) and was carried out by the same crew.

The drilling crew left Fermoy on the 12th August, and arrived at Port Keats, on the 22nd August, 1963.

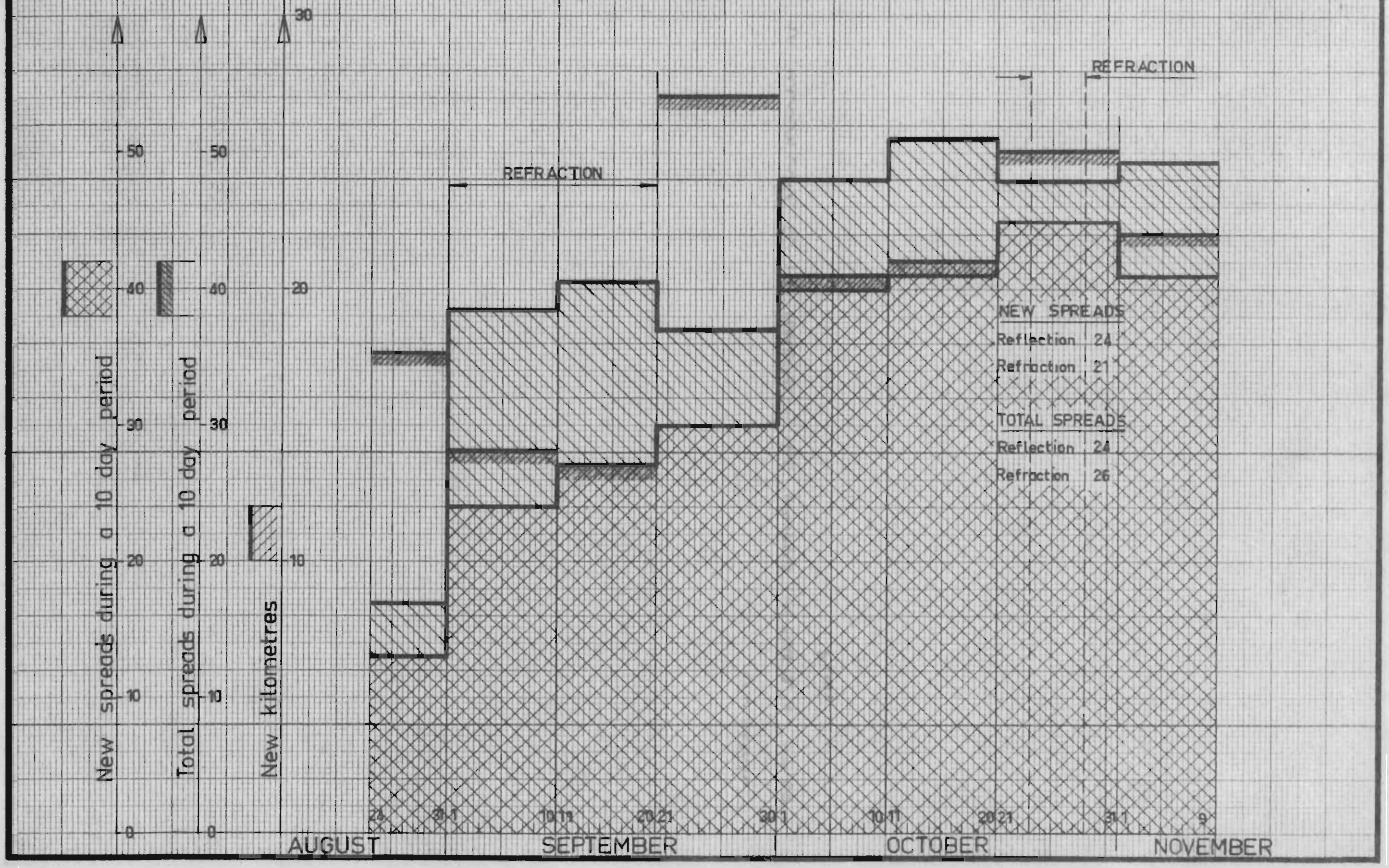
The move was effected in good conditions between Winton and Daly River but, on the other hand, many road difficulties were encountered between Daly River and Port Keats.

The track had been insufficiently ripped by a bulldozer in order to be accessible to the trucks of the various suppliers. These vehicles, carrying trailers, fuel and dynamite had to unload on the track, shortly after leaving Daly River. This resulted in a great loss of time, together with numerous mechanical incidents occurring in the crew's vehicles which had to carry the supplies to the camp.

The main events of the survey are recorded hereunder:

SEISMIC STATISTICS

FIG. 5



1st drilling	23rd August, 1963
Last drilling	4th November, 1963
1st seismic shot	24th August, 1963
Last shot	9th November, 1963
First and Last Gravity measurements:	24th August to 8th November, 1963.

The working schedule was the same all along the survey. The working day consisted of 10 hours field work, including the travelling time. The crews left the camp at 7 a.m. and returned at 5.30 p.m. A half-hour break was allowed at lunch time.

This schedule was in force from Monday to Saturday, the extra hours allowing the party to take a two weeks' leave after ten weeks' field work.

2. STATISTICS

2.1 - Seismic Statistics (See figures 4 - 5)

In reflection, the average production was of 5.2 spreads and 2.6 km. of traverse per working day. The great number of the reshot spreads (48) i.e. 20% of the total shots is explained by the various and numerous tests which had to be made to determine the best spread. The minimum charge used during the exploitation (not counting the tests) was 120 lbs. per shot.

In refraction 51 spreads were exploited. It is difficult to establish an average refraction production as the majority of the programme consisted in carrying out a refraction probe on line PPR 8.

With an average of 26 working days per month, the monthly reflection production is 66.5 km. of traverse and 134 spreads.

2.2 - Gravity-Magnetism

The gravimetry crew achieved a monthly production of 11 base connections and 320 newly measured stations.

From September 4th we reported several breakdowns to the magnetometer. After numerous checks on the base network, the behaviour of the magnetometer appeared anomalic after the exploitation of the first PP 7 line.

2.3 - Drilling Statistics (see figures 4 - 6))

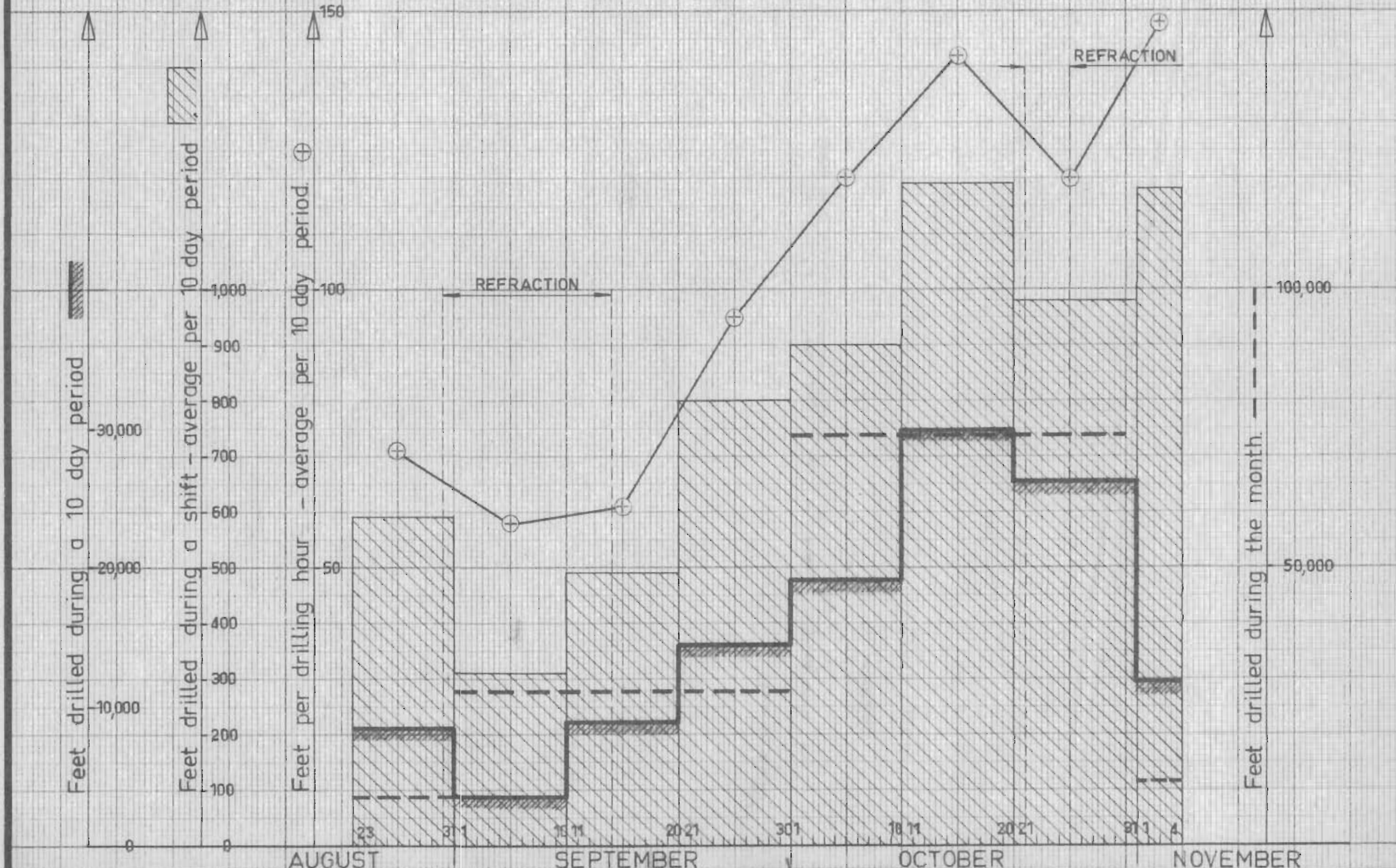
Whereas for the seismic crew the travelling hours correspond to 14% of the total hours, this percentage is much higher and reaches 22% for the drilling crews. The explanation for this much higher percentage is given hereunder:

- drilling machines were moved to test bases on various traverses,
- the moves were long and difficult for the drilling of extreme shot points, in seismic refraction.

The average production realised during the survey was as

DRILLING STATISTICS

FIG. 6



follows: 107.3 feet per drilling hour

83.1 feet per total hour

The production increased during the survey (figure 6) and the best results were obtained in the last weeks :

127.3 feet per drilling hour in October

149 feet per drilling hour in November.

<u>REMARK</u>: One of the drills was destroyed by fire on the 3rd September, 1963. Two and, when necessary, three shifts were worked on the second drill until a new drill was available on the field, the 6th October, 1963.

APPENDIX IV

EXPERIMENTAL WORK

1. REFLECTION EXPERIMENTS

The party commenced operations with a series of tests on traverse PP 7. These tests had to be interrupted following the failure of the shots made with the DUPONT detonators. Only a small proportion of the detonators placed in series on a line, exploded. The party then carried out the exploitation of a refraction probe on traverse PPR 8, and after receiving new detonators (I.C.I.) the reflection tests were resumed.

In the surveyed area two zones are to be distinguished:

- one which is fairly well restrained (in particular the area situated to the south east), covered by alluviums and where good results were obtained during the previous survey of Port Keats,
- the other, representing the majority of the surface of the lease, which is covered by Permian outcrops and where no results were previously obtained.

From the outset of the survey testing bases were established in two zones, in an endeavour to obtain even better results in the first zone and some results in the second one.

The results of the above tests have been noted in the attached experiment sheets. (Figures 10a to 10w).

The following parameters were surveyed:

1.1 - Hole Depth

During the first tests on the eastern side of traverse PP 7, which is an alluvium area - (tests 6, 8, 9) the best results were obtained with holes of shallow depth.

The results were in any case confirmed by tests 11 and 13 where shots at 13 and 22 m. gave poor results.

At the test base 22 situated on a Permian outcrop area (tests 14, 15, 16, 17) holes were successively shot at 72, 54, 34 and 23m. with the same charge.

The four recordings were very poor, the shot at 23m. being slightly better.

Depth shots were resumed as follows:

At SP 68 of traverse PP 8 - tests 27 to 33 (Depth 88.5 to 15m.)
At SP 41 of traverse PP 7 - tests 42 to 48 (Depth 67.5 to 13m.) see plate 6.
At SP 67 of traverse PP 8 - tests 58, 59, 60 (35 holes at 22.5 - 15 and 3m.)

The tests only confirmed the first conclusions: shots, at greater depths, do not improve the records and in most cases give much poorer results, often disturbed by high frequency noises.

1.2 - Charge

The few tests carried out to determine the optimum charge showed that:

- on the area covered by alluviums, relatively weak charges (i.e. 5 to 10 lbs.) were sufficient in obtaining good results. The charges were placed in terrain composed of clay alluviums which constituted an excellent shooting medium, transmitting the energy in a satisfactory manner.

On the other hand, in the Permian outcrop area it is necessary to place fairly big charges. During the exploitation of the multiple shot points it was found necessary to use 120 lbs. per shot point.

1.3 - Number of shot holes

Numerous tests were made regarding this parameter.

From the very first tests, the longitudinal increase of the number of holes resulted in important improvement (tests 7, 9).

The hole multiplication tests were made with holes of shallow depth (3m.) and on holes of greater depth - 35 holes at 22.5 m. at point 67 of traverse PP 8 (tests 58, 59, 60), 24 holes at 16 m. at point 31 of traverse PP 7 (test 74).

The latter test, however, may be compared to test 73 (66 holes at 3m.) which gives better results. It was soon obvious that a high increase of the number of holes at shallow depth represented the most economical method of exploitation with regard to drilling, and the most efficient with regard to the quality of the results.

A depth of 3m. was adopted. At this depth it is possible to use individual charges relatively strong (2 lbs. per hole) without the danger of the hole to blow out.

So as to determine the optimum values of distances between the holes and the surface of the pattern, two testing bases were established:

SP 41 of PP 7 (tests 49, 50, 51)

SP 68 of PP 8 (tests 34, 35, 36)

3 patterns of 24 holes were drilled on each base:

2 patterns situated on the same side of the traverse, with their lines interlaced,

1 pattern situated on the other side of the traverse.

In successively shooting the two first patterns and comparing the two recordings it was observed that they differed slightly, which consequently proved the nearness of the optimum hole density.

The corresponding recordings of the two patterns situated on each side of the traverse were quite different and showed that it would prove beneficial to increase the surface of the hole pattern.

1.4 - <u>"Stretched" hole pattern</u>

A test was made at point 67.

The shot point comprised a hole in the centre of the spread and one hole at each of the twelve central traces.

The depth of the holes was 22.5m.

The test was not conclusive, the recording being very poor.

1.5 - Geophone Patterns

24 geophones in two lines parallel to the traverse (length of each line: 55m.) were compared with 24 geophones in a single line parallel to the traverse (length of the line: 115 m.).

These two recordings were of equal quality.

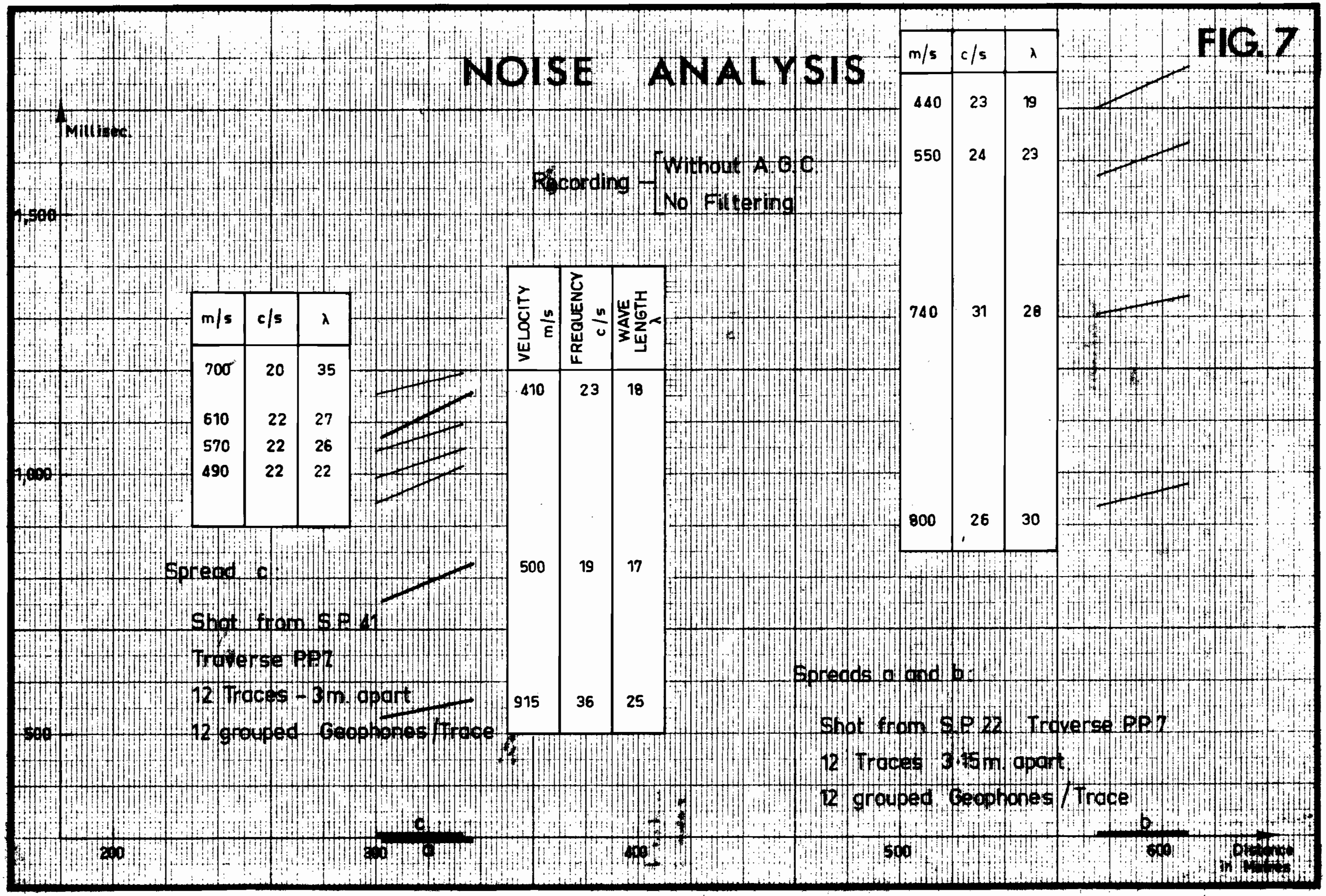
In certain parts of the survey, the dips being very steep, such extended traces, parallel to the traverse, could lead to the deterioration of the results. Therefore, a spread of 2 lines of geophones was adopted.

1.6 - Number of Geophones

Recordings with 60 geophones per trace having been carried out on several spreads, in particular SP 69, on traverse PP 8, SP 35 on traverse PP 7 (tests 71, 72) and having given much better results, patterns of 60 geophones per trace arranged in 5 lines parallel to the traverse were adopted for the exploitation of the remainder of the programme.

FIG. 7

NOISE ANALYSIS



m/s	c/s	λ
700	20	35
610	22	27
570	22	26
490	22	22

VELOCITY m/s	FREQUENCY c/s	WAVE LENGTH λ
410	23	18
500	19	17
915	36	25

m/s	c/s	λ
440	23	19
550	24	23
740	31	28
800	26	30

1.7 - Noise Tests (Figure 7)

Three noise tests were performed:

On SP 68 of traverse PP 8 (tests 38, 39, 40)

OnSSP 22 and 41 of traverse PP 7 (tests 24, 25, 26, and 53, 54)

On SP 68 tests were made shooting at great depths (up to 54m.)

Not much organised noise was recorded with a high frequency one.

The results recorded on traverse PP 7 are shown on figure 7.

It is to be noted that :

- the dominating noise moves at a velocity of 400 to 800 m/sec.
- the wave length of the noise ranges from 17 to 30 metres.
- the geophone spread, when it is used in the course of normal exploitation, strongly reduces the noise but does not eliminate the noise from the very emission of energy.

2. REFRACTION EXPERIMENTS

These experiments refer only to the comparison between 12 Hall Sears refraction geophones per trace and 1 GS13 geophone. The results being almost identical and, on the other hand, the local terrain conditions (abundant vegetation) lending themselves better to the use of the GS13, the exploitation continued with these geophones.

During the refraction exploitation on traverse PPR 8, it was often difficult to assess the optimum charges. The charges used had to be very strong and it was necessary to use multiple hole shot points. The failure of the Dupont detonators gave us further trouble.

3. DETONATOR TESTS

From the start of the multiple shot point reflection tests, we noticed that a large amount of the detonators, placed in series, had not exploded. Systematic tests were made and results are noted hereunder. On receipt of each delivery of detonators, tests were made to determine the delay. These tests showed for all detonators an approximate delay of 7 to 9 milliseconds. A constant value of 8 milliseconds in the computing of corrections was used.

TESTS OF DUPONT DETONATORS

30/8/63

Tests of detonators grouped in series.

Shots carried out with two different blasting boxes.

(1) Lot No. 18.875 — Detonators with 80' stems

24 detonators in series	1st shot : 2 detonators exploded
22 " " "	2nd " 1 " "
21 " " "	3rd " 16 " "
5 " " "	4th " none "

(2) Lot No. 2.784 — Detonators with 120' stems

24 detonators in series	1st shot : 3 detonators exploded
21 " " "	2nd " 2 " "
19 " " "	3rd " 16 " "
3 " " "	4th " 3 " "

(3) Lot No. 8.858 — Detonators with 120' stems

48 detonators in series	1st shot : 10 detonators exploded
38 " " "	2nd " : 17 " "
21 " " "	3rd " 16 " "
5 " " "	4th " 4 " "
1 " " "	5th " 1 " "

(4) Samples taken from different boxes of detonators with stems of 80'.

24 detonators in series	1st shot : 6 detonators exploded
18 " " "	2nd " 16 " "
2 " " "	3rd " 2 " "

(5) Samples taken from different boxes of detonators with 120' stems.

24 detonators in series	1st shot : 7 detonators exploded
17 " " "	2nd " 6 " "
11 " " "	3rd " 10 " "
1 " " "	4th " 1 " "

APPENDIX V

FIELD OPERATIONS

1. NATURAL CONDITIONS

In the surveyed area, where the rainy season is of long duration (November to June) accessibility is only possible, if at all, during a few months of the year: mid-July to the beginning of November.

Operations started in August and some areas, particularly the south west of the survey, were not practicable.

Access to Port Keats was only made possible with a bull dozer clearing the track. Work started late, unfortunately, and despite the 200 working hours put in between Daly River and Port Keats, the track was not ripped very satisfactorily and the crew's vehicles met great difficulties.

The area is covered with tropical bush vegetation and big trees. The lower areas, located along the seashore, are almost covered with marsh and crossed by creeks, along which are dwarf mangroves which hamper progress.

The use of a bulldozer was indispensable for the opening up of the track to the seismic crew. Later on it was found necessary to get another bulldozer, attached more particularly to the gravity-magnetism crew. On two occasions it was found imperative to call in the services of a "native" crew to cut down trees and vegetation surrounding the creeks.

A rodman was included in the bulldozer set up for the purpose of lining the traverse.

The population of this region comprised only "natives" - grouped around the Catholic Mission at Port Keats.

The weather was hot and humid. The temperature rose sharply at the end of the survey and heavy showers fell locally.

2. CAMP MOVES

Two main camps were established during the survey. The first one was installed on the north side of traverse PP 7, near the KULSHILL CREEK (gravity point A10).

The second one was installed near the Catholic Mission, on the N.W. side of the crossing of traverses PP 8 and PP 9.

This latter camp had the advantage of being placed in such a good position as to give quick access to the various traverses and make it easy to reach the embarkment zone, in the case of sudden and premature storms.

3. LOGISTICS

3.1 - Water Supply

Water was taken from the creeks and transported in an 800 gallon water truck, equipped with a vacuum filling system.

3.2 - Food Supplies

Meat and bread were purchased from the Catholic Mission. The other foodstuffs were forwarded from Darwin.

Two road liaisons were made during the survey for the delivery of non-perishable foodstuffs. Other goods were sent by barge together with fuel and equipment. Perishable foodstuffs were forwarded through the weekly plane, or by chartered plane.

3.3 - Fuel and Lubricants

At the start of operations the supply of fuel and lubricants was a big problem.

Despite the clauses in the contract signed with Mobiloil, arranging for deliveries to be made at Port Keats, supplies were deposited on the track shortly after Daly River. These have to be picked up in the crew's own vehicles and in a 6-wheel drive GMC truck which was hired from Darwin, to provide replenishment until a barge became available for transport by sea.

These deliveries were made in 44 gallon drums. One 1,000 gallon mobile tank was also used at the camp.

3.4 - Supply of Explosives

The same problem as above arose with regard to the supply of explosives and detonators. It was also found necessary, in this case, to recover the loads of the various trucks, which were left on the side of the road between Daly River and Port Keats.

Dupont de Nemours detonators were used. These were found to be faulty and were, therefore, replaced by I.C.I. detonators. The explosives used were also manufactured by Dupont and were presented in 1 lb. "Nitramon" waterproof cartridges, which necessitated the use of a primer.

4. COMMUNICATIONS

4.1 - Radio

Daily sessions with the Flying Doctor service base of Darwin were secured for telegram transmission purposes and medical advice.

4.2 - Mail

The mail was forwarded from Darwin to Port Keats by air, road, or sea service.

5. SURVEYING OPERATIONS

5.1 - Alignment and Pegging

Alignment was done with the use of a compass, a rodman being in permanent attendance with the bulldozer.

The pegging was effected link by link, with the aid of a 50 m. cable.

In using a multiple shot point it was found necessary to use a bulldozer on the traverse for the purpose of clearing the shot point locations. Indeed, the shrubs being so thick in places, it would have been too long and difficult a job for the drilling crew to shift on the shot point to drill 60 holes, without pre-arranged service paths.

5.2 - Levelling

The levelling, made with two theodolites To, required a knowledge of the instrumental declination.

For that purpose 8 sun observations were conducted, the determination ranging from 3° to 3°20' (declination identical for the 2 theodolites To. See Pl. 3).

5.3 - Documents used

Map:	"Port Keats"	Scale:	4 miles to the inch.
Aerial Photographies		Scale:	Approximately 1/50,000.

Location maps of previous seismic and gravimetric surveys
Scale: 1/63,000 and 1/253,440.

5.4 - Tie of the Survey

Elevation: There were no bench marks of any kind. On the other hand, it was not possible to identify, with certainty, the few shot points which were available from the previous surveys. It was, therefore, necessary to adopt as a point of departure, the sea level bottom readings taken on the 27th August, 1963, at 4.15 p.m. on the western extremity of traverse PP 7.

This level calculated with the aid of local tide tables was : +2,65m. The levels shown on the tide tables being given in relation to a Darwin Bench Mark, our datum level should not differ more than 0.50m. from the state level. With regard to the previous surveys the differences in tie are approximately the following:

+ 5 m. compared to the altitudes of the MINAD survey

+ 6 m. compared to the altitudes of AUSTRAL GEOPROSPECTORS' survey.

Planimetry

Two astronomical stations were found, which were represented by the landmarks AWI andAW2, but the co-ordinates were not available and could not be found. It was, however, possible to obtain geographical co-ordinates of point AW3, which could not be found on the terrain.

After 3 weeks the crew still did not have a departure base for the co-ordinates and the adoption of a graphically measured station was envisaged on Map 1/253,440. Finally a 1944 documentation of the Australian Survey Corps was received. With the aid of a location sketch it was possible to establish the astronomical station JB7, situated at the Catholic Mission, Port Keats. The estimated value of this station is ± 100 m.

5.5 - Closure of Loops (Pl. 3 - 4)

The seismic and gravimetric lines formed a network, which allowed a permanent check of the altimetric and planimetric closures by allowing a link up of the polygons.

On the whole, the closures are good, certain small discrepancies being easily explained by the diurnal variations of the declination.

5.6 - Projection system

The projection system adopted is the U.T.M. Australian zone 4. The connecting co-ordinates were converted to enable the metric system to be used. (Location Map Pl. 1, scale 1/250,000, location maps 1/100,000 and 1/50,000, not included in this report)

5.7 - Permanent markers

10 feet long iron pipes, on which the name of the traverse and the number of the shot point, are carved, were placed approximately every 6 km. and at each crossing of a line.

These markers, with corresponding co-ordinates and elevations are given at the end of the appendix.

6. DRILLING OPERATIONS

The drilling was conducted by rotation with two MAYHEW air water drill trucks (for details see Appendix 2). On most of the shot points air drilling was carried out. Water drilling was used on the western side of traverse PP 7 and to drill deep holes.

During the reflection survey test holes were drilled at different depths, sometimes as deep as 300 feet. (Later on, exploitations was effected with multiple shot points (60 holes per shot point at a depth of 10 ft.)

In refraction, 4 to 5 holes were drilled per shot point at a depth of 50 feet.

Following the destruction by fire of one of our drill trucks on the 3/9/63 it was necessary to work two and sometimes three shifts on the same machine. After the arrival of a new drill truck on the 6th October, three daily shifts were regularly carried out. The three shifts were essential, in view of the big amount of holes to be drilled by shot point. Drilling was quite easy as the formations encountered were composed of clay, sand and fairly soft sandstone.

7. SHOOTING OPERATIONS

The holes were loaded just before shooting since some of them were used several times in order to carry out charge and depth experiments.

In reflection the loading of multiple holes took a long time and the shooter had to be helped by the recording crew.

1 lb. dynamite cartridge and a 1 lb. primer were assembled and constituted one charge for each hole.

In refraction, the shooting operations were the classical ones involving two teams of 1 shooter and 1 helper. The loading operations were tedious as 1 lb. dynamite cartridges, in metal tins, were used. The two shooting crews operated on each side of the laid down spread, moving from one shot point to another, according to the radio instructions transmitted by the observer.

8. RECORDING OPERATIONS

The field techniques applied in both reflection and refraction were the classical methods, split spread recording in reflection, continuous profiling in refraction.

In reflection, at the start of the survey, 24 holes were used, the shot point being in the centre of the spread.

Following the survey it was necessary to increase the number of geophones per hole, 60 instead of 24, and to lay out 12 traces only, the distance between the traces having doubled: 100 m. instead of 50.

The shot point was also in the centre of the spread and the spread itself was shifted 6 traces. The characteristics of the spread were:

Distance between holes: 600 m.

12 traces - 100 m. between traces.

60 geophones per trace in 6 lines, 10 m. distant, parallel to the traverse.

5 metres between geophones.

The shot point was made up of 60 holes, divided into two patterns. Each pattern consisted of 3 lines of 10 holes parallel to the traverse.

Distance between lines: 15 m.

Distance between holes: 10 m.

Depth of holes: 10 feet.

The shot point and geophone set ups are illustrated on Fig. 2.

In refraction, 24 holes were recorded. The spread was displaced by 12 traces, after completion of recordings (one or several shots on the same spread).

Each trace consisted of a geophone GS13. The distance between traces for the probe and exploitation of traverse PPR 8 was of 200 m.

On traverse PPR 7 where the dips were steep and the marker followed on shorter distances, the chosen distance was of 100 m. between traces.

8.1 - Instrument settings

8.1.1 - Reflection

The settings used for recording in reflection varied only slightly after the experiments allowed to determine the appropriate ones.

Filters : 1/14	-	Out
A.G.C. :	-	Medium
Suppressor	-	Initial gain : -30 to -36 db Delay : 280 to 400 milliseconds Final gain ; maximum
Expander	-	Initial gain : -24 to -36 db Slope : 80 to 160 db/sec. Delay : 400 to 980 milliseconds

Play-back settings

Play-backs were systematically made on the field after each shot:

one with a	:	1/28 - 1/56 filter
another with a	:	1/20 - 2/40 filter
Initial gain	:	-27 to -30 db
A.G.C.	:	Medium

8.1.2 - Refraction

The main parameters used for recording in refraction are the filter and the gain. The A.G.C. was not used and the filter setting was : out - 1/40.

No figure can be given regarding the input gain, as this is a parameter, which may vary in quite a large proportion according to the noise conditions, the shooting distance and the charge.

Values of gain actually used for each shot are shown on the exploitation diagrams. (Pl, 14 -16).

8.2 - Vehicle of Information

For both reflection and refraction the recording was made on magnetic tapes. A galvanometric monitor was recorded at the same time in refraction.

The raw tapes were processed immediately after recording and gave a field play-back on electro sensitive support.

In reflection such a play-back is used for exploitation purposes, computations of static corrections, analysis of the curvature of the reflections.

The filter setting was usually 1/28 - 1/56.

In refraction the play-back is mainly made so as to check that the magnetic tape is correctly recorded.

Whenever data regarding corrections was available the magnetic tapes were processed with the "MTD corrector". The final result was a galvanometric variable area cross section which is the final interpretative document.

9. GRAVITY OPERATIONS

The spacing between measured stations was chosen as being equal to the reflection shot point interval : 600 m.

Along the seismic traverses, therefore, every shot point corresponds to a gravity station.

Parallel to the seismic traverses and two miles apart were lined two other gravity lines called traverse A to the north, and traverse B to the south.

The second bulldozer, mainly attached to the gravity-magnetism crew had to work a few days on the opening of the shot points for the seismic crew. Certain gravimetric lines had to be exploited on tracks not cleared by the dozers. The gravity crew then took measurements on all existing tracks :

- the traverses of the previous Port Keats survey (line 1 and 6),
- tracks going from Port Keats to Daly River,
- tracks connecting Port Keats with the northern part of the survey.

At the end of the survey some parts were exploited on foot.

So as to render this operation more beneficial and bearing in mind that the Bouguer anomaly gradient is steep, stations were placed every 300 m.

These stations were of help in locating the orientation of the anomalies.

The operator's programme, i.e. the readings made at a base, at the intermediate stations and at the next base did not exceed 4 hours. The base connections were repeated.

10. MAGNETIC OPERATIONS

The measurements were taken with an ELSEC PROTON magnetometer. It evaluates the earth's magnetic field by measurement of the free precession frequency.

The magnetometer consists of a detector bottle, which was placed at the measuring station and is connected by a 100 feet cable to the instrument itself. This instrument uses transistorized plug-in units and is powered by miniature accumulators. Upon pressing a button the answer is displayed digitally on 5 meters graduated 0 to 9.

The sensitivity is of the order of 1 gamma and its calibration being governed by a crystal controlled oscillator cannot drift.

It was intended to exploit the same programme as that for the gravity, the bases and traverses being the same. The only difference was that every magnetic reading was the average value of 4 to 6 measurements which were taken around the station in question, at approximately 10 m. distance.

Unfortunately, the magnetometer started to give aberrant measurements and broke down.

The central lines of traverses PP 7, PP 8 (until crossing with PP 9), and a lateral southern line, on the eastern part of PP 7, were the only places exploited. These results are rather doubtful and have to be considered with care.

LIST OF PERMANENT MARKERS

Line	Shot Point	Longitude	Latitude	Elevation
PP 7	SP 1	216,585	2,893,865	8.7
	SP 11	211,645	2,897,300	8.8
	SP 20	207,230	2,900,360	49.8
	SP 34	200,530	2,905,325	40.7
	SP 45	195,260	2,909,215	41.4
	SP 50	192,860	2,911,010	17.8
PP 8	SP 98	195,435	2,897,185	11.4
	SP 107	198,310	2,901,760	36.4
	SP 60	203,370	2,909,925	52.6
	SP 68	205,915	2,913,990	50.5
	SP 76	208,510	2,918,025	20.3
	SP 84	211,165	2,921,995	6.8
	SP 97	215,205	2,928,405	7.2
PP 9	SP 114	228,794	2,899,557	67.5
	SP 120	225,730	2,901,460	52.6
	SP 128	221,650	2,904,000	40.0
	SP 136	217,560	2,906,515	62.2
	SP 148	211,440	2,910,405	59.9
	SP 169	200,920	2,917,300	41.4
	SP 178	196,390	2,920,205	13.5
PP 11	SP 188	213,605	2,920,160	21.3
	SP 198	218,715	2,924,270	25.3
	SP 211	225,595	2,928,380	66.2
	A 26	207,500	2,907,070	69.4
	A 113	224,130	2,929,160	56.7
	A 143	227,875	2,915,400	51.8
	B 93	221,855	2,897,435	14.1
	B 128	232,360	2,905,510	35.1
	B 143	240,030	2,908,365	26.6
	C 190	229,320	2,923,500	44.9
Astronomical Stations:				
(small bottle tree)	JB7	205,893	2,919,962	23.5 (ground)
(guard stone)	AW2	205,760	2,919,200	22.2 (top)
(guard stone)	AW1	211,976	2,899,175	13.5 (top)

NOTE: PROJECTION - TRANSVERSE MERCATOR AUSTRALIAN BELT ZONE 4.
ORIGIN OF COORDINATES: ASTRONOMICAL STATION JB7 (METRIC SYSTEM).
ELEVATIONS: IN METRES ABOVE THE MEAN SEA LEVEL.

APPENDIX VI

REDUCTION OF DATA

1. REFLECTION

1.1 - Corrections

The reference plane is the mean sea level. The elevation correction merely consists in fictitiously transferring geophones and shot points on the datum plane. Calculations of the time thus involved implies the knowledge of elevations (surveying data) and of the sub-weathering layer's velocity, which is the correction velocity.

The weathered zone correction consists in replacing the travel time of the path in the weathered zone by a fictitious path which would travel the same way with a velocity corresponding to that of the sub-weathered layer.

The computations of field corrections necessitated the knowledge of the depth and velocity of the weathered layer and velocity of the underlaying layer. The velocity of the weathered zone varies from 500 m/sec. to 1,000 m/sec. and its thickness from 4 to 22 metres. The horizontal velocity below the weathered zone ranges from 1,900 to 2,600 m/sec. with an average value of 2,000 m/sec. This last value was used for the elevation corrections.

On part of traverse PP 7 the weathered zone consisted of two media:

- the first layer with a very slow velocity of 400 to 600 m/sec., and
- the second layer with a velocity of 1,000 to 1,400 m/sec.

1.2 - Reflection cross-sections

The tapes were processed at the camp and assembled in variable area cross-sections (vertical scale : 1 cm. for 26 milliseconds one way time, horizon scale : 1/8,054 for the 24 first films of the survey. 1/16,108 for the other recordings).

Such processing necessitates the calculation of static and move-out corrections.

The static corrections were determined for each trace using a method based on the comparison of templates recorded on a spread shot from two adjacent shot points. It is derived from the "Plus minus method of interpreting seismic refraction sections" by J.G. Hagedoorn ("Geophysical Prospecting" Volume 7 No. 2).

The move-out corrections were deduced from the analysis of the reflections which was carried out for each traverse. The C.G.G. designed MTD corrector allows corrections up to 200 milliseconds with any desired velocity function. The move-out corrections are applied by steps of one millisecond.

2. REFRACTION

2.1 - Correction

A similar principle of reduction of data is applied to the refraction measurements (same datum plane and same velocity values were chosen). On line PPR 8 where reflection spreads were shot after the refraction survey, special weathered shots were recorded in order to provide the necessary information (velocity and thickness of the weathered layer). For the refraction line PPR 7 reflection results were used to calculate the corrections.

2.2 - Interpretation documents

The following documents are included in the report:

- Time distance curves of refraction probe S1 PPR8 (Pl. 13)
- Exploitation diagrams of refraction traverses PPR8 and PPR7 (Pl. 14 - 16)
- Interpretation diagram - Traverse PPR7 (Pl. 17)
- Exploitation plates - Traverse PPR8 and PPR7 (Pl.15 - 18)

These plates are self-explanatory and it should be noted that on the diagrams, in order to represent both direct and reverse spreads, two slant lines are drawn on which are reported the bases actually shot.

The depth cross-sections of traverses PP7 and PP9 and the time cross-section of traverses PP8-PP11 allow a comparison of the reflection and the refraction results.

3. GRAVIMETRY

3.1 - Calibration

The Worden No. 41 gravimeter was calibrated on the 1st August, 1963, by tying the bases of the Brisbane University and of Mount Coot'Tha (Fig.8).

In order to be sure that the coefficient determined in Brisbane (K = 0.986 mgls/division) did not vary a calibration base was established between the stations AW1 and A26. A check made on the 11th November, showed a small variation : K = 0.9869 mgls/division, but this could be partly due to the bad condition of the track connecting the stations by the end of the survey.

3.2 - Values of G.

A value of the gravity was arbitrarily given to the first base, SP1 of traverse PP7, at the beginning of the operations : 978,500.00 milligals.

However, all calculations were made according to the gravity value given for the station No. 128 of the 1958 MINAD survey, which corresponds to our A53 station g= 978,341.69 milligals. (See. Pl. 22).

Some other supposed stations of the MINAD survey were measured, their values are indicated in the computation books : stations No. 108 - 110 - 112 - 113 - 114 - 115.

3.3 - Network of gravity bases.

The base values were determined after a series of measurements done in succession at two bases for eliminating the drift influence.

During the survey four loops were obtained showing very small closures: 0 to .03 milligals. Location of the bases, gravity values and closures are indicated on Pl. 22.

3.4 -- Density - Computation of the Bouguer Anomaly

Two Nettleton lines were carried out at locations selected because of their topographic irregularity: SP 22 - 23 - 24 of traverse PP 7 and SP 135 - 136 - 137 of traverse PP9. It appears that a density comprised between 2.0 and 2.1 answers Nettleton's requirements. (See Pl. 20 and 21).

Calculations were done with a density value of 2.1.

No surface correction was applied since stations were located so that short distance corrections are minimized. Normal gravity values were computed after tables giving the theoretical value of the gravity along the international ellipsoid.

The other corrections applied were the tidal correction and a linear gravimeter drift correction.

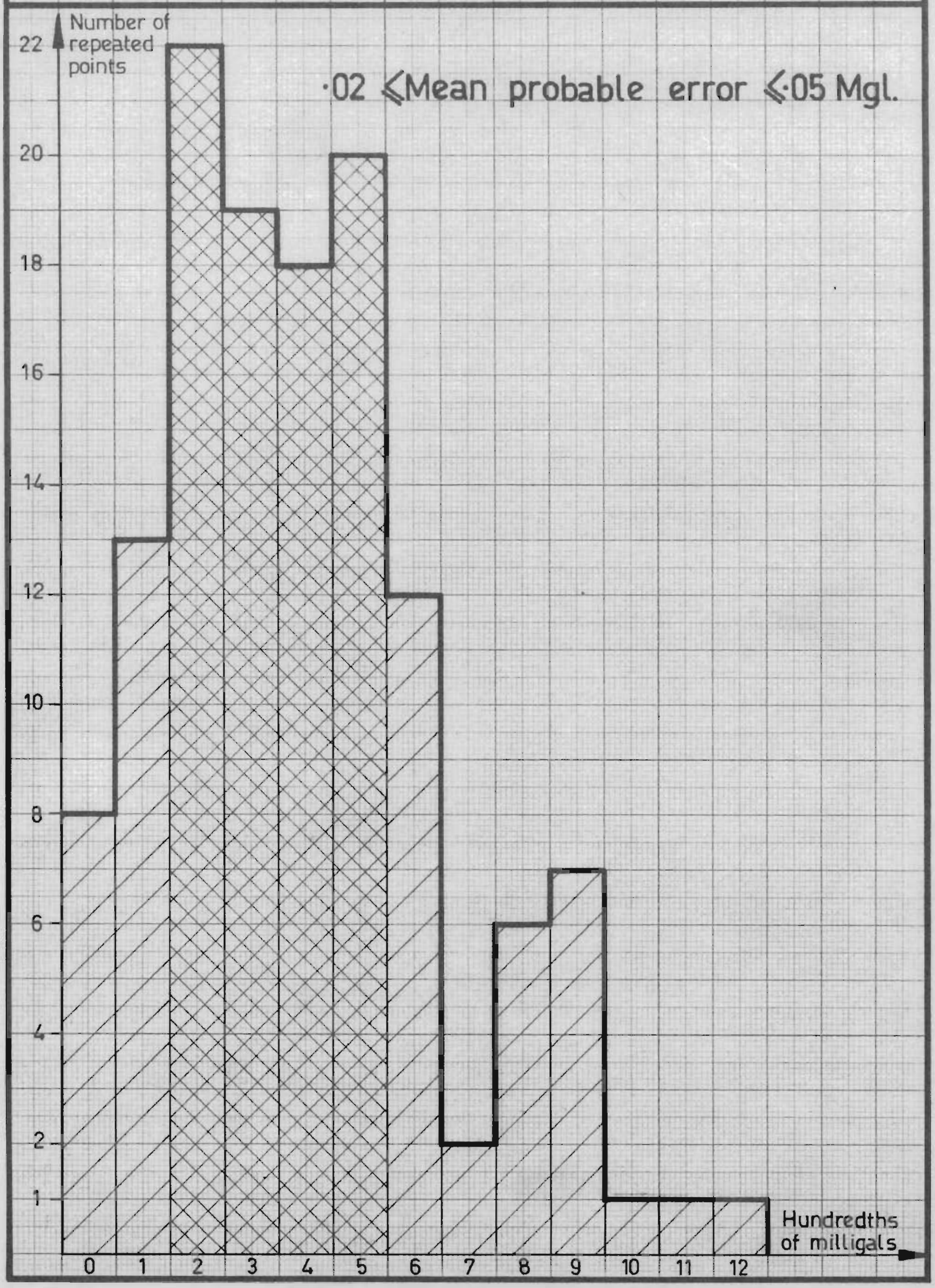
3.5 - Accuracy

Base connections were made according to the specifications of the

Gravimetry

STATISTIC of REPEATED POINTS

FIG. 9



contract : less than .1 milligal error.

The gauss function calculated with the discrepancies observed at repeated stations gives a mean probable error of $\pm$ .02 to $\pm$ .05 milligal (Fig. 9).

4. MAGNETISM

For an accurate correction of the magnetic field's daily variations it would have been necessary to use an additional recording magnetometer.

With only one apparatus, these variations were determined after the repeated station values and assuming that they are a linear function of the time. However, occasional studies of these daily variations showed an error up to $\pm$ 5 gammas when proceeding in this way.

Anyway, except for a few measurements, the magnetometer did not work satisfactorily which we supposed to be due to the tropical conditions encountered during the whole of the survey.