DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1974/43

POOLE RANGE SEISMIC SURVEY 1962

Volume 2. Appendixes - plates 5 to 20

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BUREAU OF MINERAL RESOURCES

POOLE RANGE SEISMIC SURVEY

1962

APPENDIXES

APPENDIX I

PERSONNEL

The personnel required by agreement and present on party, for both reflection and refraction, is listed below.

	Reflection		Refraction	
	required	present	required	present
Party leader	1	1	1	1
Senior computer	1	1	1	1
Observer	1	1	1	1
Surveyor	1	1	1	1
Drilling foreman	1	1	1	1
Computer	1	1	1	1
Secretary camp boss	1	1	1	1
Junior observer	1	1	1	1
Shooters	2	2	2	2
Shooter assistant			2	2
Mechanic	1	1	1	1
Driller	2	2	2	2
Drill assistant				
Tanker driver	4	4	4	4
Recorder field hand	4	4	8	8
Surveyor field hand	2	2	2	2
Cook	1	1	1	1
Assistant cook	1	1	2	2
TOTAL	25	25	32	32

In agreement with the B. M. R. Representative on party, one clerk and one assistant mechanic were added to the above list of normal staff.

Also two surveyors trainees were permanently added to the party after the rest leave. Among the above list, five "Key men" were arriving from France. They were:

Party Leader

Senior computer

Observer

Surveyor

Drilling foreman

The rest of the personnel was hired either in Brisbane or in Perth at the beginning of the survey.

The extra personnel required by refraction work was hired either in Perth or in Derby. It arrived on the party at the beginning of refraction operations.

During the course of the survey some men either left the party or were dismissed, they had to be replaced as soon as possible and it was attempted to hire personnel either in Derby or Fitzroy Crossing. In both towns, recruiting was very poor, as well in quality as in quantity. For these reasons it happened sometimes that the total requested personnel was not present on the party for a few days.

APPENDIX 2

EQUIPMENT

1. VEHICLES

The vehicles requested by Agreement and present on party for both reflection and refraction are listed below :

	Reflection		Refraction		Make, Type
Party Leader	1	1	1	1	Land Rover, short wheel base 88"
Recorder	1	1	1	1	Bedford RLHC 4x4
Line cable	1	2	2	3	L.R. Long wheel base 109"
Surveyor	2	1	2	1	L.R. Long wheel 109"
Drill foreman and general purpose	1	1	1	1	L.R. Long wheel 109"
Drills	2	2	2	2	International R 190 4 x 4
Water tankers	5	5	5	5*	Bedford RLHC 4x4
Supply and store	1	1	1	1	Bedford RLHC 4x4

* 4 after the 28th September

While working in reflection, the water tanker was kept as water tanker. When refraction was started, the tank of one water tanker was put off and the flat bed thereby obtained was used as a shooter truck. As a matter of fact, refraction holes were shallower than reflection ones and were drilled with air. Furthermore, the use of nitrate implies that the holes which are to be loaded with the explosive are dry. Also, the shooting trucks equipped with water tanker, though convenient in reflection, had a too small loading capacity when working in refraction, because of the stronger charges used and because of the use of nitrate in sacks. Following the explosion of a shooting truck on September 28th, another water tank was put off and the truck was used as a shooting truck.

Although the Agreement mentioned one Land Rover for the line cable's team, it was thought more convenient and more efficient to have two Land Rovers for the team. It was therefore decided that one of the surveyor's Land Rovers would be permanently used as a line cable's vehicle. When refraction work was started, the addition of an extra Land Rover led to a total of 3 Land Rovers for the line cable's team.

2. SPECIAL EQUIPMENT

2.1. Surveying equipment

-1 Theodolite Wild TO with compass

-1 Theodolite Kern D.K.1

-Staffs with feet and hundreth of feet graduations

-Compass, Binoculars

2.2. Drilling equipment

-Drilling system 2 Mayhew 1,000

-Mud Pump Gardner Denver 5" x 6"

-Air compressor Gardner Denver W.C.G.580

2.3. Recorder equipment

2.3.1. Laboratoire Type C.G.G. 59

(Magnetic pulse width modulation recording)

-equivalent resistance = 1,250 to 1,550 ohms, independent of the frequency

-Maximum input signal = 1. microvolt at 120 ohms

-noise level (reflection = .3 microvolt

(refraction = .1 microvolt

Recording filters - refraction : Hz:56-40 28 20. Slope 18 dB/octave

reflection : Hz:Out-14-20-28. Slope 12 and 24 dB/Octave

The attenuation is 3 dB below maximum for the limit frequencies.

Gains - expander - Initial gain adjustable up to -54 dB of maximum gain, by steps of -3 dB.

- Slope from 40 to 200 dB/second
- Release from 10 to 960 milliseconds after the TB

Suppression - Initial gain adjustable up to -60 dB of maximum gain by steps of 6 dB

Final gain adjustable up to -30 dB of maximum gain by steps of 6 dB.

Release from 40 to 960 milliseconds after the T.B.

A.G.C. Range of action = 70 dB

Minimum level of action = 1 microvolt

Average output level = 3 volts

Three speeds of compression : slow, medium, fast plus one position "out"

Ratio of speed constant and superior to 1

Harmonic distortion : 1% for maximum modulation

Signal to noise ratio : 46 dB between peaks from 1 to 200 Hz.

The information regarding gains and filters is schematically represented on plate 32.

2.3.2. Camera S.I.E. P.R.O. 11,25 traces

2.3.3. Pulse width modulation magnetic recorder Electrotech type M.T.D. with sequential play back facilities in galvanometric presentation by electrical stylus.

2.4. Play-back center

The play back center is an Electro Tech Central M.T.4 intended to process Carter type magnetic tapes. It is equipped with amplifiers CARTER. The final presentation is either oscillographic or variable density and/or area.

2.5. Geophones

2.5.1. reflection : Hall Sears "Junior" Model K 245 Ohms, 20 CPS. Six geophones were connected in parallel on a basic string.

2.5.2. refraction : E.L.I. GS 13, 610-630 Ohms, 3.5-5 CPS. A single geophone was used in refraction.

The type of connection of the geophone string at a geophone group center is given in the Appendix 6.

2.6. Radios

VHF PYE PTCA (F.M.) 8002 Range 10 watts.

2.7. Cables

Reflection : unit length = 900 feet, with take outs every 150 feet.

refraction : unit length = 900 feet, with plug at each end.

2.8. Bull Dozer

Bell Bros. Caterpillar type D.4

APPENDIX 3

HISTORY AND STATISTICS

All figures concerning the history and the statistics are presented in Plates 28 A, B and C which concern drilling seismic and consumable stores respectively.

1. HISTORY

We recall here the dates of the main events of the survey.

- First drilling : 15th June 1962 Last drilling : 31st October 1962
- First shot : 16th June 1962 Last shot : 2nd November 1962
- Reflection work on Traverse A : From 16th June to 21st July 1962
- Refraction work on Traverse A : from 23rd July to 12th October 1962
- Refraction work on Traverse C : from 15th October to 2nd November 1962.
- The camp move took place on the 13th, 14th, 15th September 1962. This corresponded to a change of working area, when the study of this Poole Range structure was interrupted in order to start the reconnaissance on the Anomaly 16 A.

One rest leave from the 20th August to the 4th September 1962 separated these two periods of the survey. During the duration of the survey, three different working schedules were adopted, according to the method in use (reflection or refraction) and the progress of the work as compared with the date set for the end of the survey.

1.1. Before the rest leave

60 hours per week were to be worked so as to provide :

- Enough work before the rest leave in order to decide a further programme.
- Enough time to allow the rest leave to last for two weeks.

The following working schedule was adopted during reflection work

(Monday to Friday : From 6.30 AM to 6 PM

(Saturday : From 6.30 AM to 11.30 AM

Remark : half an hour was allowed for lunch time.

Since short working days are not worth while in refraction as far as production is concerned, mainly because of the shooter's long trip, the above mentioned schedule was changed into the following one, for the refraction work.

Monday to Friday : From 5.30 AM to 6 PM

Half an hour stop was allowed for lunch time.

1.2. After the rest leave

50 hours per week were to be worked according to the requirement of the Agreement. The following schedule was therefore chosen:

Monday to Friday : From 7 AM to 5.30 PM.

Actually the recording time was a little short of the amount due at the end of the first period, and therefore 10.30 hours a day were worked by the recording team instead of 10 hours in order to make up for that delay.

Noticeable incident

On the 28th September one shooter truck exploded and was completely blown up. This occurred when the engine back-fired and set fire to a wisp of spinifex located right below the petrol tank. Nothing could be done to prevent petrol and distillate to catch fire, and the truck, loaded with explosives and detonators, exploded.

2. STATISTICS

A few definitions of the headings is thought necessary so that no ambiguity be possible regarding the significance of the terms and figures. The reader will be able to reach a full understanding of all figures or comments included in the plates.

2.1. Definitions of the time considered.

Travelling time : is the time necessary to go from the camp to the working site and back to camp at the end of each day. As far as drilling is concerned, the travel was made with the rigs only at the beginning and the end of each week; otherwise it was made with Land Rover and/or water truck.

Drilling time : time of actual drilling

Non production time : includes the travelling along the traverses from SP to SP and/or the travelling between traverses, also any stop for any reason such as break down, waiting for dozer...

Total time : it is the sum of the three previous times, it represents the time elapsed between the departure from the camp and the return back to camp at night.

Time due : it is the working time stipulated in the Agreement. This is to be compared with the total time.

2.2. Drilling Production

The number of shot points drilled per day is significant in reflection, whereas the number of holes drilled per day is significant in refraction. For this reason these two items have been separated and used accordingly. For both shot point per day and holes per day, the number of days which appears in column No. 2 is the number of working days. We consider that the unit "Working day" involves the work of both drills and is then plotted as "one". Whenever one drill only worked during one day, it is therefore plotted as "a half". This is the reason why fractional figures happen to appear for certain periods.

The footage per hour involves exclusively the drilling hours as defined previously, regardless of any non productive and travel times.

2.3. Seismic production

As for the drilling production the "day" used for the computation of the seismic production is the "working day" which appears in column No. 2.

When a base is laid out for the first time and shot from various shot points, the information recorded is new and corresponds, as far as mileage is concerned, with the length of the base. If a base already shot is relaid out and reshot from a NEW shot point the spread and the information recorded are also new and the mileage will correspond with the length of the base. In other cases, the information is not NEW but simply repeated and the mileage is counted as zero.

3. COMMENTS ON DRILLING STATISTICS

3.1. The total drilling time was : 2050 hours 05 minutes. This figure actually includes 39 hours of extra drilling which was requested by the B. M. R. Representative to provide sufficient holes while the party was shooting experimental spreads and shot-point patterns. Consequently the time requested by the Agreement became 2000 + 39 = 2039 hours. The time has been broken to three components whose values are:

Travelling : 487 hours i.e. 23.8% of total time
Production : 1164 hours 50 minutes i.e. 56.8% of total time
Non production: 398 hours 15 minutes i.e. 19.4% of total time.

The travelling time appears as almost one quarter of the total time; this emphasizes the generally bad travelling conditions although the bulldozer improved them greatly. Also fly camps were used when the working site was too far from the main camp.

The non-production time appears as almost one fifth of the total time. It is mainly due to travelling from shot point to shot point or from one traverse to the other one. This last type occurred principally during fortnight No. 8 when the dozer broke down. It was then impossible for the drills to progress on traverse A until the way was cleared and the sand dunes cut off. Hence the drills were sent to traverse C till the dozer resumed work.

3.2. The average footage per drilling hour is 71.66 feet. The fortnightly average footage increased from the beginning to the end of the survey. Besides the normal improvement of the drillers, for a great deal due to a better knowledge of the ground, the fact that tracks and shot point locations were cleaned was predominent. But the changing of methods also influenced the rates. Refraction holes were generally shallower than reflection holes. On the other hand, the work done in reflection was rather experimental with very frequent changes of programme which affected the drilling rate, although the loss of time it could involve was not considered in the computation of the rates. In refraction, the work was always a routine one, which made all proceedings smoother.

4. COMMENTS ON SEISMIC STATISTICS

4.1. The total working time was 1,000 hours 30 minutes. This fulfills the 1,000 hours requirement of the Agreement. One day during which no shot could be recorded because of very strong wind, is not included in this total.
The components of the working time are:
Travelling: 164 hours 40 minutes i.e. 16.46% of total time
Production: 834 hours 50 minutes i.e. 83.48% of total time
Non production: 1 hour i.e. 0.1% of total time

The travelling time appears as approximately one sixth of the total time. This value proportionally to the value of the drilling statistics is smaller. This is due to the fact that travelling with recording truck is faster than with drills, also the recording truck travels always after the drills and the tracks are then better; we have to note also that the recording team has never to travel as far as the extreme shot points.

The amount of reflection and refraction appears as follows:

Reflection: Travelling: 56 hours 45 minutes.
Production: 249 hours 40 minutes

Refraction: Travelling: 107 hours 55 minutes
Production: 585 hours 10 minutes

4.2. The average number of reflection shot points a day was 5.95. This figure included weathering shots and noise tests shot fired during the experimental period. This figure is not representative of a routine exploitation since the whole reflection period consisted of various experiments, either during the first few days or during the exploitation of Traverse A where spreads and shot points patterns were tested almost continuously.

The average number of refraction spreads per day was 4.92 and the average mileage per day 2.73.

APPENDIX 4

EXPERIMENTAL WORK

1. TRAVERSE A

Preliminary tests and experimentation on spreads

The very first shot consisted in a preliminary reflection test intended to give qualitative information regarding the repartition of energy and noise recorded. A series of shot were drilled in a big rectangular pattern allowing for simple and multiple shots at various depths and with various charges. Recording was made on two parallel identical spreads laid 20' apart. With this kind of set up, signal is the same on the two spreads and any difference between corresponding traces is only noise.

A few shallow reflections were obtained with their quality varying from poor to fair. A single shot just below the water level seemed to give the best results. The important fact to be derived from these first tests was the existence of a strong level of noise, both random and organized. This proved that we could not proceed with reflection shooting without a further study of the noise. Though the time imparted did not allow for a complete noise test including a quantitative determination of the signal/noise ratio. So we settled on a simplified test to be carried at two different locations on different outcrops on two initially planned traverses (Plates 5, 6A, 6B, 13A, 13B, 14A and 14B).

The main purpose of the noise tests was a study of the apparent wave length of the organised noises.

The results appear on plates 6A and 6B, a linear spatial filter consisting of 12 or 24 geophones per trace (distance between geophones = 15 feet) was to be adopted for the exploitation.

To point out the difference between these two possible combinations and also to try to determine an approximate value of a better charge, spread experiments were carried out on the same locations where noise tests were recorded (Pl. 15A and 15B). The following conclusions were drawn:

: The quality of the results is better when recording with 24 geophones per trace,

: The quality of the results increases when the charge is loaded deeper,

: This value of the optimum charge varies in both locations and seems to be smaller at SP 100 X (north) than at the south location, although an increase beyond a certain value (80 Lb) does not lead to conclusive improvement.

2. TRAVERSE A

Cross section and addition of two single charges

A traverse was then shot, starting from south (SP 130) and going towards north (SP 101). The geophone and shot point patterns were chosen accordingly to the results of the tests:

: 24 geophones per trace. Distance between geophones = 15 feet

Distance between traces = 150 feet

: Deep holes, the top of the charge being approximately 10 feet below the water table.

On certain points, two holes having same depth and charge were shot separately, while on others two identical holes were shot together (Plate 7).

The study of the cross section obtained shows the following main features (Pl. 16A, 16B, 17A, 17B):

: The existence of a level of energy at .6 - .7 second is clear from SP 112 to SP 107 and from SP 122 to SP 123. Elsewhere, few line-ups indicate the existence of energy. However this horizon cannot be followed continuously.

: The existence of a level of energy at .9 - 1. second, this is particularly well organised from SP 128 to SP 125, SP 123 to SP 118, and SP 110 to SP 107. In between these shot points one can see partial line-ups but, again, this level cannot be picked continuously across the section.

: The existence of a well organised level of energy at 1.6 - 1.8 seconds, mainly on the southern part of the traverse. (120 to 123 and 125 to 126)

: Elsewhere, the arrival of energy when existing is either too poorly organised or hidden by a strong level of noise.

A C.P.O. cross section was built up (SP 101 to 112 and 118 to 124) with the tapes resulting of the addition of the two similar shots recorded on these shot points (Pl. 19A, 19B). This addition does not show any improvement wherever the single holes gave poor results.

One can therefore think that another combination of shot point pattern and geophone pattern would be worth while to experiment in order to find out whether or not reflection can be obtained on this location.

3. TRAVERSE A

Further shot points experiments

On three SP locations (SP 109, SP 115 and SP 118) various shot point patterns were tested and shot into the normal spread (PL 8A). These special patterns consisted of:

- Seven deep holes in one line, top of the charge 10 feet below water table.
- Diamond pattern of 36 shallow holes (10 feet deep)

Generally speaking, these experiments show that a multiplication of holes leads to better records than single holes (Pl. 18A and 18B). The 36 holes pattern gives better results at SP 109 where the improvement as compared to single or 7 deep holes is quite noticeable (level of energy existing below 3 seconds).

On both SP 115 and SP 118, the 7 deep holes pattern gives the best results, although the improvement as compared with the 36 shallow holes pattern is small.

4. TRAVERSE A

High multiplication experiment.

A higher multiplication of geophones and holes was attempted on a few shot points at the end of reflection period. PL 7 shows the location of these experiments and the combination of SP and geophone patterns. Pl. 9 shows the value and depth of charge shot.

Shooting into 96 geophones per trace the shallow holes pattern (36 holes or 81 holes) leads to better results than deep holes although the difference in quality is generally very small.

However, at SP 115, the seven holes in line pattern gives better results than the 81 holes pattern, and the difference there is quite noticeable (Pl. 20A and 20B).
On all these records, line-ups are pickable down to 4 seconds. The study of records made with 48 geophones or 96 geophones and shot from a single deep hole or a pattern of 81 holes shows that the quality generally increases when the number of geophones and holes increases, but the benefit is small.

5. TRAVERSE C

Experiments. Plates 10 and 11

A very simplified and short reflection experiment took place on traverse C on the last day of the survey. Three spreads were recorded, the geophone pattern was the normal one (24 geophones per trace) and the shot points consisted either of a single deep hole or a pattern of 5 deep holes. Heavy charges were used (above 100Lb). The results obtained are very poor, and the records generally show a high noise level. The better records however were obtained with the 5 holes in a line, the energy appears better organised and a few line-ups appear down to 4 seconds (SP 202).

6. CONCLUSIONS

The reflection tests are too few and too much scattered to allow for definite conclusions regarding the best recording procedure. Although one rig was operated two shifts during the high multiplication experiments, more drilling would have been necessary to extend this test.

However, the difference obtained with 48 and 96 geophones is small enough to justify the use of 48 geophones since the use of 96 geophones would raise the cost of the operations to a value which is not worth while in regards to the improvement obtained.

APPENDIX 5

REFRACTION TECHNIQUE

1. FIELD TECHNIQUE

A geophone spread being laid along the traverse, shots are recorded from both in-line directions. One is called direct and the other is the reverse shot. The shooting distances are selected so that energy arrivals from the desired marker be recorded on as many traces as possible. On each successive move, spreads and shot points are shifted along the traverse a same constant distance in the same direction. This distance is called a base and the length of the base is the stepping distance. It is selected so that, with two successive shots from a same direction, energy refracted from the same marker is recorded with a number of common geophones.

2. PRINCIPLES OF THE GARDNER-LAYAT METHOD

2.1. Verifications : a first set of verifications is based upon reciprocal time checks between couples of surface locations occupied by shot points and geophones during direct and reverse shooting :

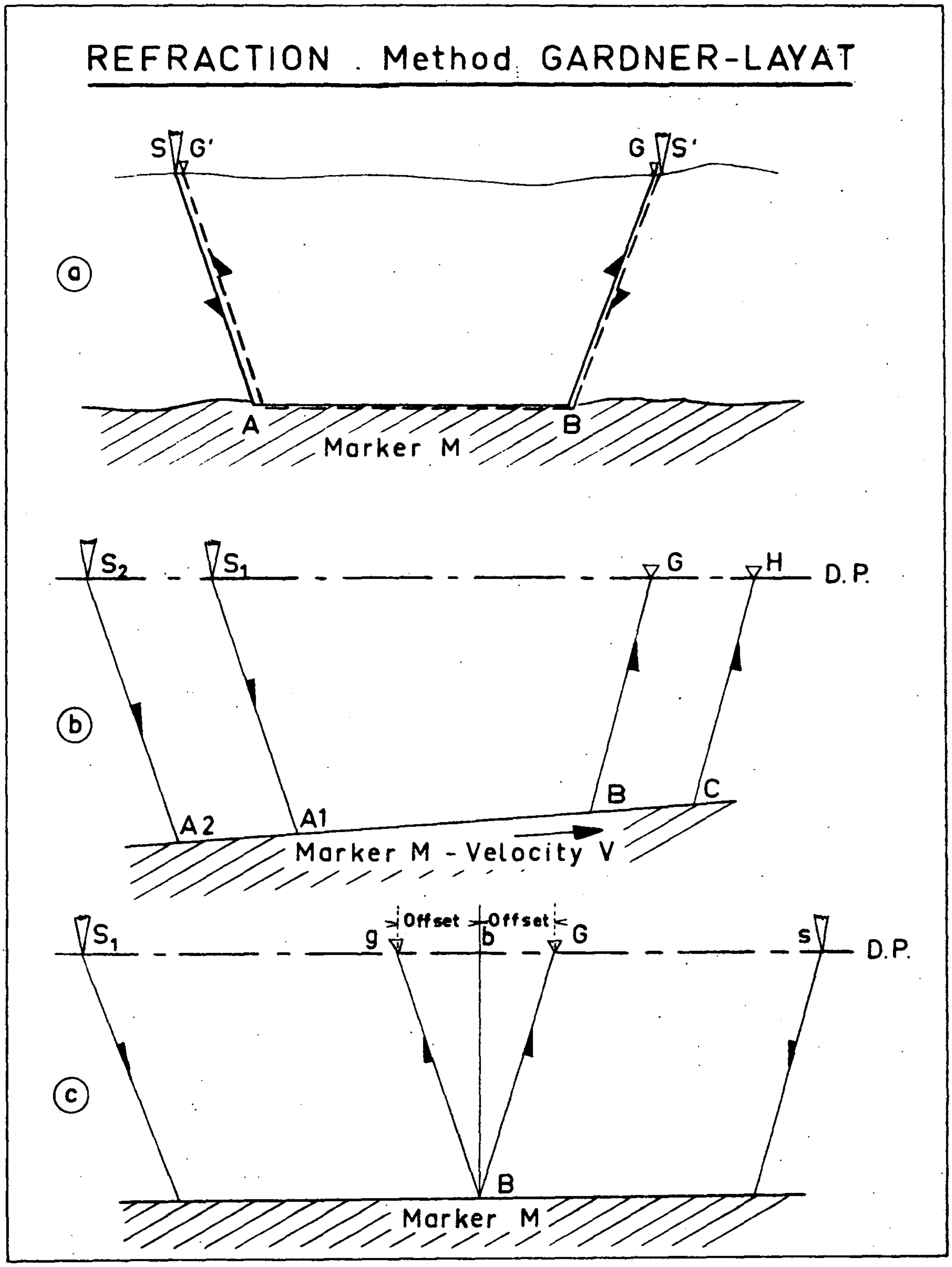
travel time SABG = travel time S'BAG' (see Fig.4a)

Next, the difference of travel times to same geophone locations G, H,... from different shot points S_1, S_2 and along the same marker M must be a constant (Fig.4b) :

$t(S_2A_2CH) - t(S_1A_1CH) = t(S_2A_2BG) - t(S_1A_1BG) = t(S_2A_2A_1) - t(S_1A_1)$

In other words : the time-distance curves relative to a given marker are parallel.

Fig. 4



REFRACTION . Method GARDNER-LAYAT
S
G'
G
S'
a
A
B
Marker M
S2
S1
G
H
D.P.
b
A2
A1
B
C
Marker M - Velocity V
S1
g
Offset
b
Offset
G
s
D.P.
c
B
Marker M

2.2. Construction of relative intercept curves : what is true for travel times is still true for intercept times : $I = t - \frac{X}{V}$, where X is the shot point to geophone distance and V is the horizontal velocity along the marker. So, by shifting in time bits of intercept curves obtained from successive shot points, it is possible to get an only continuous intercept curve as if energy refracted from this marker had been recorded all along the traverse from one same shot point. This shifting is made separately for direct shots and reverse shots. The result is two "Relative Intercept curves", each one relative to a definite shot point.

By definition, the intercept time is the sum of the two delay times corresponding to the shot point and the geophone under consideration. For example, along the wave path S_1A_1BG we have (Fig. 4b) :

$$I = t(S_1A_1BG) - \frac{S_1G}{V} = d_{S1} + d_G$$

So, a relative intercept curve is actually a delay curve to each point of which the delay at the origin shot point has been added.

2.3. Constructing the delay curve : an advantage of the method is to allow to proceed with computations starting from intercept curves plotted with any velocity V. Practically, the computation is made using a velocity as close as possible to the assumed true velocity of the marker. The two relative curves so plotted are parallel only when and if the velocity used for the computations is exactly the true velocity of the marker. If not, the curves either converge or diverge and the amount of convergence allows an a posteriori determination of the true velocity.

Before being compared for convergence, the relative curves must be shifted towards the shot point. The distance of shift is the "offset". For example, the information obtained in G from shot point S_1 and in g from shot point s are both relative to a same point B on the marker (Fig. 4c). The intercept curve relative to a shot point on the left must be shifted towards the left and the amount of the shift is the offset Gb. The intercept curve relative to a shot point on the right must be shifted a quantity gb to the right.

With the two relative offsetted curves, an "Average curve" can be drawn. This last one does not depend on the velocity used for the computation of the intercepts (see next paragraph 4-4). When properly positioned in the time scale, it is the delay curve of the marker M.

The formula relating delays to travel times being of the form $d = 1/2\ I = \frac{1}{2}(t - X/V)$, the delays depend on the velocity of the marker. The time positioning cannot be made without a knowledge of this true velocity. This is derived, as indicated below, from the convergence of the relative curves.

3. PRINCIPLES OF THE CONSTANT DISTANCE CORRELATION METHOD

A method based on the observation of the phenomenon occurring close to the "critical angle" has been used for interpreting the very shallow markers. When the wave path through the overburden reaches this angle, the travel along the marker is very short and the refraction path is practically the same as the reflection path. At this point, experimentation and theory show a considerable increase of the recorded energy. The shot point to geophone distance is then the double of the offset and shot point and geophone correspond both to the same point of the marker. The delay is, therefore, half the intercept time.

All details about this method are given in Geophysical Prospecting 1961, volume IX, page 296.

4. ANALYSIS OF VARIOUS PHASES OF THE GARDNER-LAYAT METHOD

4.1. Delay computing : if we consider a shot point S and a geophone G (Fig. 4 bis), the intercept is :

$$I_G = t - \frac{SG}{V} = d_S + d_G \qquad (1)$$

t : travel time

V : marker M horizontal velocity

d_S and d_G : delay times at points S and G

If the origin shot point of the relative intercept curve is not S, the relative intercept I_{rG} will be : $I_{rG} = I_G + C$ (2), C being a constant applied to all intercepts computed with the shot point S. This constant is zero for the origin shot point and then, is calculated for each shot point of the traverse, comparing the intercepts.

Let us consider the traces G and H recorded from a given shot point. If I_{rG} and I_{rH} are the relative intercepts, applying the formula (1) we have :

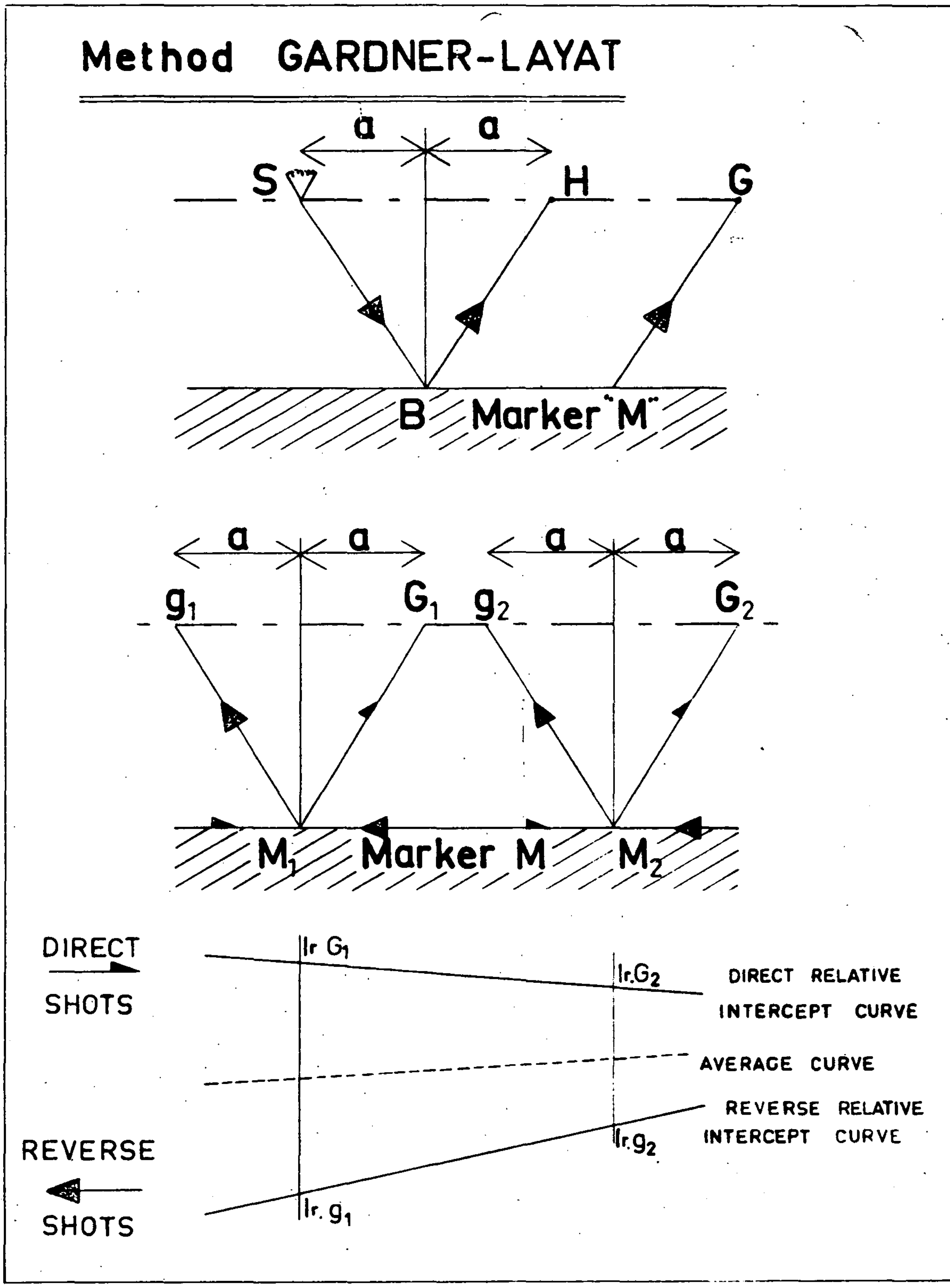
$I_{rH} - I_{rG} = d_H - d_G$ (3), and, from (1) and (2):

$I_{rG} - C = d_S + d_G$ (4); adding (3) and (4):

$I_{rH} - C = d_H + d_S$

The delays d_H and d_S are relative to the same point B of the marker M:

Fig. 4 bis



Method GARDNER-LAYAT
a
a
S
H
G
B
Marker "M"
a
a
a
a
g1
G1
g2
G2
M1
Marker M
M2
DIRECT
SHOTS
REVERSE
SHOTS
Ir G1
Ir.G2
DIRECT RELATIVE
INTERCEPT CURVE
AVERAGE CURVE
REVERSE RELATIVE
INTERCEPT CURVE
Ir.g2
Ir. g1

$d_H = d_S = d_B$; then: $d_B = \frac{1}{2}(I_{rH} - C)$ (5)

Therefore, the delay to one point B of the marker is the difference between the relative intercept plotted at an offset distance a, and the constant relative to the shot point located on the other side, at the same distance a. The formula (5) has been used for computing all delays plotted on the average curve of the different markers (Pl. 24A, 25A and 25B).

4.2. <u>Delay correction when the computing velocity is not the actual velocity</u>

V = actual marker velocity

Vm = approximate marker velocity

In this case the computed intercept is : $I = t - X/Vm$ (6)

Considering the same shot point S and geophone G, we must have :

$$d_S + d_G = t - SG/V$$

The formula (6) gives: $t = I_G + SG/Vm$, or $t = I_{rG} - C + SG/Vm$.

Then : $d_S + d_G = I_{rG} - C - SG.(1/V - 1/Vm)$ (7)

Applying this formula to the geophones G and H shot from the same shot point, we will have :

$$d_H - d_G = I_{rH} - I_{rG} - GH.(1/V - 1/Vm) \quad (8)$$

Adding (7 and (8) :

$$d_S + d_H = I_{rH} - C - SH.(1/V - 1/Vm),$$

but $d_S = d_H = d_B$ and $SH = 2a$:

$$d_B = \frac{1}{2}(I_{rH} - C) - a.(1/V - 1/Vm) \quad (9)$$

Comparing (9) and the above formula (5), it appears that the correction to be applied to delays calculated with Vm instead of V is the expression a. (1/V - 1/Vm). Then, the actual delay curve is but the translated provisory delay curve.

For computing the deeper marker we used Vm = 20,000 ft/sec and Vm = 17,500 ft/sec for the others, the corrections a (1/V - 1/Vm) being applied to each segment of marker after determining the actual velocities.

4.3. Determination of the marker's actual velocity : the formula (8) indicates that the delay curve : points d_H, d_G, ..., is not parallel to the relative intercept curve: points I_{rH}, I_{rG}, ...
There is a convergence :

$$(d_H - I_{rH}) - (d_G - I_{rG}) = GH.\ (1/V - 1/Vm) = K$$

The convergence by unit of length is: K/L = 1/V - 1/Vm (10)
The computing of the convergence allows the determination of the actual marker velocity :

$$1/V = K/L + 1/Vm$$

Changes of the convergence K indicate changes of the marker velocity V as long as the same approximate velocity Vm is used.

4.4. The average curve is parallel to the delay curve : we stated previously that the advantage of the Gardner-Layat method is to permit to proceed with intercepts computed with any velocity Vm.

Let us suppose that M_1 and M_2 points of the marker M have been recorded by geophones G_1 and G_2 (direct shots), g_1 and g_2 (reverse shots). Direct shot points are supposed to be on the left side and reverse shot points to be on the right side: see Fig. 4 bis.

Distances are considered positive in the direction shot point towards geophone.

X_1, X_2, x_1, x_2, being the abscissas of geophones G_1, G_2, g_1, g_2 and K_d, K_r the direct and reverse convergence, we have:

$K_d = (X_2 - X_1). (1/V - 1/Vm)$

$K_r = (x_1 - x_2). (1/V - 1/Vm)$

The couples of geophones are chosen so that $g_1G_1 = g_2G_2 = 2$ a:

$X_1 - x_1 = 2a$ and $X_2 - x_2 = 2a$

Then : $K_d = - K_r$

Let us apply the formula (8) to the couples of geophones G_1, G_2 and g_1, g_2:

$$d_{G1} - d_{G2} + I_{rG1} - I_{rG2} - K_d \qquad (11)$$

$$d_{g1} - d_{g2} = I_{rg1} - I_{rg2} - K_r \qquad (12)$$

But : $d_{G1} = d_{g1} = d_{M1}$ and $d_{G2} = d_{g2} = d_{M2}$, then, adding (11) and (12) :

$$2\, d_{M1} - 2d_{M2} = I_{rG1} + I_{rg1} - I_{rG2} - I_{rG2}, \text{ or}$$

$$d_{M1} - d_{M2} = \tfrac{1}{2}(I_{rG1} + I_{rg1}) - \tfrac{1}{2}(I_{rG2} - I_{rg2})$$

Therefore, if we draw the curve $I = \frac{1}{2} (I_{rG} + I_{rg})$ we obtain an average curve parallel to the delay curve.

Practically, a deviation curve is plotted corresponding to the time interval between the relative intercept curves in marker position. Its slope is the double convergence used for the marker's velocity determination. The average curve is transformed into a delay curve by plotting calculated and corrected delays (see "Exploitation plate" 24A, 24B, 25A, 25B).

APPENDIX 6

FIELD OPERATIONS

1. NATURAL CONDITIONS (Accessibility Map Plate 4)

The accessibility was generally bad. The access from Christmas Creek Homestead to camp No. 1 was a very old track which had to be cut across spinifex.

The track leading to camp No. 2 was slightly better, although the average time required to travel from Christmas Creek Homestead to camp No. 2 (30 miles) was closer to one and a half hours. The surveyed area was mainly spinifex covered area. A few cleared zones (Moorland) allowed a slightly faster travelling but this occurred very seldom. The crossing of creeks (Christmas Creek and others) was always difficult. The vehicles were often "bogged" and this was the cause of important losses of time. The southern part of traverse A and the western part of traverse C were covered with sand dunes which had to be cut across.

Travelling along the unaltered surface was very slow and imposed great fatigue on both personnel and equipment. The amount of time lost in displacements was very important during the first weeks. So, it was decided to hire a bull dozer in order to clear the traverses, to cut the river banks and dune crests and to improve other bad spots. This additional expense was compensated by a decrease of time lost and more efficient operations (see paragraph 9 here below).

The nearest homestead was at Christmas Creek approximately 10 miles away from camp No. 1 and 30 miles from camp No. 2. The nearest supply spot was Fitzroy Crossing at 50 miles distance from Christmas Creek Homestead. The nearest city was Derby, 170 miles west of Fitzroy Crossing (3000 residents).

The days were hot (up to 95^{O}F) but nights rather cool during the first period (June to August). After the rest leave, the temperature increased to reach 110^{O}F with rather hot nights. During the whole duration of the survey, the conditions varied from windy to very windy, hence affecting the operations. A few storms occurred as from mid-October, none of them very serious.

2. LOGISTICS

2.1. Water supply

The water was taken from bores, located at one mile from camp No. 1 and sixteen miles from camp No. 2. Transportation from bore to camp was made with a 400 gallons water truck into a 800 gallons storage in camp.

2.2. Food supply

The food was mainly "tinned food" supplied from Fitzroy Crossing. A limited amount of fresh vegetables and fruits was supplied from Fitzroy Crossing and/or Derby and/or Perth. The meat and bread were generally available at Christmas Creek Homestead and some extra meat and fish supplies came from Derby.

2.3. Lubricants and motor fuels supply

They were supplied from Fitzroy Crossing, and were transported to Christmas Creek Homestead. The nearest depot, when needed for an emergency case, was located in Derby. No supplier had a truck capable of crossing the Christmas Creek, and therefore the supplies had to be picked up at the homestead by the trucks and men of the party.

2.4. Explosives and detonators supply

They were supplied by ICI and transported by Geotools from one of their depots (generally Alice Springs). Explosives and detonators were brought by road to Christmas Creek Homestead where they were unloaded. From thereon transportation was made with the Party trucks.

2.5. Organisation of transports

Regular and occasional transports were therefore to be organised.

Regular transports: From the camp to Fitzroy Crossing, twice a week, for the mail and food supply (camp boss with a Land Rover). An average of one trip a day for the camp water supply.

Occasional transports: After each delivery of lubricants or explosives unloaded at Christmas Creek Homestead, the transportation had to be organised in order to pick up these items and bring them to the camp. The reader will find further information in paragraph 9 of the same appendix.

3. COMMUNICATIONS

3.1. Radio

4 daily sessions were existing with the Flying Doctor Service in Derby with the main purpose of transmitting and receiving telegrams.

- One daily session exclusively medical.
- In case of emergency, possibility of communication with

Wyndham Air Radio which is in permanent listening 24 hours a day.

3.2. Road transportation

They were organised, when needed, by the party. No road transportation exists between Fitzroy Crossing and Derby.

3.3. Air transportation

One fortnightly flight was landing at Christmas Creek Homestead. Two weekly flights were landing at Fitzroy Crossing and several were existing from Derby.

4. SURVEYING OPERATIONS (For the Equipment see Appendix 2)

While working in reflection "pegging" and levelling operations were made simultaneously. While working in refraction, these two operations were distinct and a compass was used to line up the traverses during the "pegging".

The levelling was made :

- With the theodolite Kern DKI on reflection traverse A and on refraction traverse A from base 100 to 104. It was used also for the tying to Mt. Hutton and Mt. Amy.
- With the theodolite Wild T.O. during all further operations.

The instrumental declination was measured by sun observations. The results of several measurements led us to use during all survey an average value of $2^{o}40'$ as instrumental declination.

Ties were made with the following markers:

- Mount Amy. Army trigonometrical station
- Mount Campbell. Army trigonometrical station
- B.M.R.'s Gravity Survey 1954, but these ties only concerned the elevation values.

4.1. Elevations

Traverse A was tied from base 102/3 to Mount Amy and from SP 86 to Mount Campbell. The length of traversing from Mount Amy to Mount Campbell along traverse A is approximately 38 miles, and the closure is (- 11) feet. One must note that it is not known whether Mount Amy and Mount Hutton have been tied together and if they have the same origin of heights. On the other hand, a control was made with B. M. R.'s Gravity Survey 1954 elevations values. Since no marks of these traverses could be found these controls were made only in level areas. The results are as follows:

Point of control	Difference with B. M. R's values
95/6	- 13 feet
99/5	- 15 feet
100/6	- 13 feet
103/3	- 14 feet
108/10	- 20 feet
113/6	- 16 feet

These figures show a systematic difference between the values of both elevations and the average value of this difference is - 15 feet. It is very likely that the difference is due to different origin of elevation between the B. M. R's and our measurements.

However a comparison between the original values and "first order values" for certain points shows the following results:

Mount Synott : difference of - 23 feet
G 2 (R.008) : " - 15 feet

Mount Campbell : no difference

Outcrop Hill : "

It is therefore possible that the difference of - 15 feet in Mount Amy elevations is relative to the first order. If on all elevations were added 15 feet, the closure to Mount Campbell and to B. M. R's gravity survey values would be smaller and within reasonable values. However, since the only data regarding Mount Amy were in original value, we could not compensate for the observed discrepancies and the values of the elevations are given uncorrected.

The rest of the survey (extreme shot points, northern part of traverse A, southern part of traverse A and traverse C) is untied. The origin of the elevation of traverse C is located at its crossing with traverse A : geophone 10, base 115.

A list of all elevations is given at the end of the present Appendix 6.

4.2. Rectangular co-ordinates

The origin of traverse A is Mount Hutton (A. T. S.) and a tie was made with Mount Campbell (ATS). The closures are as follows : X = - 79 yards and Y = + 12 yards.

No compensation was made and the values of the co-ordinates given are uncorrected.

The origin of traverse C is located at its crossing with traverse A: Geophone 10, base 115.

4.3. Documents kept by the surveyors

The surveyors kept records of all measurements in their "surveyor Book" on which computations are made and final results appear (elevation, rectangular co-ordinates).

5. DRILLING OPERATIONS (equipment appendix 2)

Although the drills were equipped to work either with air (air compressor) or mud (water pump) the totality of the holes were drilled with air with one exception when a test was made on a deep reflection shot point (shot point 106).
The size of the bits used was either 4" ¼ or 5"5/8. The latter were mainly used when working in refraction, during the second period of the survey.

5.1. Drilling for reflection work

The depth of reflection holes was very variable, from 30 feet to 130 feet. The drills had to drill depth such that the top of the charge be located approximately 10 feet below the water table. However, the drilling operations involved almost exclusively the use of the air compressor, and the holes were loaded immediately after completion of the drilling. The explosives used was waterproof gelignite.

When working in reflection, the holes were systematically pre loaded by the drillers. This, added to the fact that the charges used were generally small (compared with those used in refraction) did not lead us to attempt to any "bulling" of these holes.

5.2. Drilling for refraction work

Refraction holes were shallower (maximum depth 45 feet) and they were drilled with air. Nitrate explosive was

used during most of the second period of the survey and such explosive requires dry holes.
On the other hand, with intent to reduce the number of holes to be drilled, 5"5/8 diameter bits were used ; the loading capacity of holes drilled with such bits is approximately 1.7 time the capacity of holes drilled with 4"¼ diameter bits.

In refraction work, since the value of the charge cannot be calculated but at the very moment of the shot, the number of holes to be drilled was computed referring to the worse conditions (wind) so that the shooter had always enough holes. In an attempt to reduce this number "bulling" the holes as soon as they were completed was attempted. The various experiments did not lead to conclusive results and very often, the holes collapsed. As a result, extra holes had to be drilled and since the depths of these refraction holes were rather shallow (Kelly depth or two Kellies depths) this type of operation was possible with our drilling capacity without slowing down the recorder production.

The drillers did not encounter great difficulties in the drilling of holes during the whole survey.
The main problems were due to bad travelling conditions, from camp to traverse and from shot point to shot point along the traverse. Troubles occurred on the shot points due to fire damage caused by the contact of hot exhaust and spinifex. These causes of difficulties were partly reduced when a bulldozer cleared the tracks, traverses and shot point locations on traverse C. However, the problem of crossing the sand dunes located on the southern end of traverse A and western end of

traverse C was not solved, even after the work done by the dozer D 4 (probably too small).

5.3 All informations regarding the drilled holes (depth, simplified log) and the charges used when holes were pre-loaded were recorded on the Driller's daily report (annexe VI)

6. SHOOTING OPERATIONS IN REFRACTION

The shooter team consisted of one shooter and one shooter assistant. Two similar teams were working on both sides of the base. However, on traverse C, the progress westward had been slowed down following several dozer break downs and the two shooter teams worked on the same side of the base.

The holes are loaded according to the orders given by the observer before the shot. As the distance between the recording truck (observer) and the shooter varies from 45,000 feet to 135,000 feet, the communication between them are made with VHF transmitter-receivers.

6.1. Transmission of the time break

They are also used for transmission of the time break. A special box (Time break box = TB Box) consisting mainly of an oscillator generating a 5,000 c.p.s. alternating voltage is connected on one hand to the transmitter-receiver, on the other hand to the blasting box. This alternating voltage is transmitted to the recorder through the transmitter-receiver.

At the exact moment of the shot, the starting of the blasting box stops the oscillator for a few seconds, and this signal received in the recorder appears as the time break.

6.2. Explosives and its problems

Two sorts of explosives were used during the survey:
- Gelignite on sticks of 10 Lb, 5 Lb and 1/3 Lb, for reflection and refraction.
- Nitrate activated by distillate, for refraction only.

The gelignite can be used under any conditions, in holes full of water as well as in dry holes. The nitrate has to be used exclusively in dry holes. This fact excluded the use of the latter during the first part of the survey (reflection work) since the charges had to be loaded below the water table.

When working in refraction, the depth of the holes, were smaller and nitrate could be used. But in some location, the water table was shallow enough to prevent the use of such explosive. Since nitrate costs less than gelignite it was decided that the totality of explosives supplied after the leave would be nitrate. To save the few gelignite left, the holes were drilled at Kelly depth (15 feet) wherever the water table was shallower than 45 or 30 feet.

The Nitrate supplied in 80 Lb plastic bags has to be activated by distillate. The recommendation relative to the preparation of the activated nitrate indicate to pour the distillate in the bags a few hours before use. We did not find it different, as far as the efficiency of the explosive is concerned, to make the preparation immediately before loading the hole with the explosive mixture. The routine way of preparation consisted then of pouring in the bags the distillate every morning, prior to the departure from camp to the working site. During the last month, each shooter truck used to carry a drum of distillate and pouring was done just before loading the hole. The nitrate needs a primer to explose properly. Small 1/3 Lb sticks of gelignite were used and an average of 4 sticks was put in one 80 Lb sack, to relay the first exploding wave and ensure the explosion of the totality of the nitrate.

The Nitrate was delivered at Christmas Creek Homestead where it had to be picked up by the Party's vehicles and personnel. This involved many trips, which usually had to be made during the week-end. Besides this extra work, the several handlings, loading and unloading of these sacks resulted in a lost amount of explosive that can be estimated at approximately 10% of the total quantity delivered. The plastic bags are rather fragile and it frequently happened to some of them to be torn open. As results further handling is very difficult and the nitrate so exposed to atmospheric agents can become wet (rain, humidity) which makes it completely inadequate to be used as an explosive. We must add that the volume occupied by these sacks is large enough to make any storage very difficult if not impossible.

It was attempted to "Bull" the holes, but the results were not very good, mainly because of the softness of the ground. These tests were made in refraction since the holes were systematically preloaded in reflection work.
The tamping was made either with water (reflection) or with sand (refraction).

The general difficulties encountered were due to bad travelling conditions and fire danger in dry and hot spinifex area. This point led to a regrettable and almost dramatic accident when one shooter truck set fire to a wisp of spinifex which had come in contact with hot exhaust. The fire extended quickly and nothing could be done against it and to prevent the explosion of the shooting truck.

All information regarding the quantities of explosives and detonators used for each hole are recorded on the shooter's daily report (see appendix 8).

7. RECORDING OPERATIONS

The field technique applied in reflection is the classical technique, as well for routine exploitation as for various experiments. The pre loading technique used simplified the shooting operations and reduced the part of the observer, as far as charges were concerned.

7.1. Refraction field operations.

Recording is generally made on only 23 equally spaced traces and the 24th (that is the last one in the direction of the recorder progression) is used as tie trace. This tie geophone is hence always located at the double spacing from the 23rd trace, that is on the first trace of the last spread recorded.

After all shots have been recorded on one spread, one base (12 traces) is picked up and moved to its new location. At the same time the tie geophone is placed on its new location. Meanwhile, the observer has closely studied the records and has given the shooters the necessary instructions regarding the holes to be charged and the amount of the charge. The latter is function of the shooting distance, of the noise conditions and furthermore is continuously adjusted in function of these parameters and according to the results obtained, since the quality of the records can vary a great deal with the ground conditions, all other parameters being constant.

The preparation of the shot point is therefore made during the moving of the base. When the laying out of the new spread is completed, the observer performs the center shots and/or weathering shots at this new location. This operation does not require the presence of a shooter or shooting truck since the charges involved are generally small (centre shot : from 1 to 4 pounds) and since a transmitter-receiver was set up on one line Land Rover. The center shot allows a check of all connections of the geophones and cables.

When both recording team and shooting teams are ready, the shots can be fired, provided that the noise (wind mainly, sometimes cows walking along traverse) is low enough. As a matter of fact, the observer has sometimes to wait quite a long time till the noise level decreases to reasonable values, since reducing gain would require a corresponding increase of the amount of explosives. This is generally incompatible with an economically sound exploitation.

7.2. Shot point set-up-reflection

On traverse A for the routine shots, two holes were drilled at 30 feet and 90 feet on a perpendicular to the traverse. When the two holes were shot separately, the first one shot was the closer to the traverse. The holes were generally located on the east of the traverse. However it was sometimes very difficult or not possible to place the holes in these locations, because access or drilling was not convenient.

The holes were then located on the west of the traverse but the distance generally remained 30 to 90 feet. Anyhow it should be noted that whatever the exact locations of the holes is, this is shown on the labels.

For the experiments, various experimental shot-point patterns were tested. All parameters regarding the patterns are given:

- on plate 8A : 36 holes diamond pattern and 7 holes in line.
- on plate 8B : 81 holes diamond pattern and 9 holes diamond pattern
- on plate 10 : deep holes. Traverse C

The distance between the center of the pattern and the line varied according to the possibility to locate these patterns in convenient areas, the actual distance is shown on the label in any case.

7.3. Shot-point set-ups - refraction

While working on refraction, the same type of pattern of holes was used. They were drilled perpendicularly to the traverse, the distance between holes being 10 feet. When a great number of holes was needed, two parallel lines were made to avoid the extreme holes to be too far away from the traverse. When surface shots were made, the location of the bags or group of bags of explosives were similar to the pattern of the holes, described above.

7.4. Geophones set-up - reflection

Basic string of geophones. It consisted of 12 geophones distant of 15 feet; two groups of 6 geophones in parallel were connected in series.

Normal geophone group. Two of the above strings were connected in series, the total number of geophones per trace was 24. The two strings were laid out on the traverse with the same direction. The total length of one trace is 23 x 15 = 345 feet (see plate 10).

Experimental geophones group. The 48 geophones patterns consisted in two lines of 24 geophones. The first unit of 24 geophones was identical to the one used for normal geophones group electrically as well as geometrically speaking.

The second line of 24 geophones was laid out parallel to the first one and at 20 feet distance : these two lines were connected in series.

The 96 geophones pattern consisted in four lines of 24 geophones. Each line was identical to the one used for the normal geophone group. The first line was laid out on the traverse and the other ones 20 feet apart, all of them being parallel to traverse. The two units were connected in series, and the two groups thereby obtained were connected in parallel.

Normal spread : It consisted of 12 traces, 150 ft apart. The distance between the traces 12 and 13 was also 150 feet and therefore the distance between traces 12 or 13 and centre of the spread was 75 feet (see plate 10).

For the 96 geophones per trace experiments, the spread consisted of 6 traces, 300 feet apart. The distance between the closest trace and the center of the spread was either 75 feet (trace 13) or 225 feet (trace 14); the actual value is shown on the labels.

7.5. Geophone set-up refraction

A single geophone was used which was located at the theoretical location of the trace, on the traverse.

Each base consisted of 12 traces 900 feet apart. Two consecutive bases were laid out and shot together. In order to secure a tie between two consecutive bases, either geophone 1 of base N was put on the location of geophone 12 of base N-1 or geophone 12 of base N + 1 was put on location 1 of base N + 2 according to the way of the recorder progression along the traverse. The distance between geophone 1 of base N and geophone 12 of base N + 1 (i.e. either between 12 of N - 1 and 12 of N + 1 or 1 of N and 1 of N + 2) was therefore: 24 x 900 = 21,600 feet.

In both reflection and refraction works the geophones were buried. They were buried of their height in reflection. In refraction work, a test was made to find out the way of getting the smallest possible amount of noise (mainly wind noise). The results showed that the clearing of the area around the geophone does not lead to any improvement and that the depth of burial does not change the level of noise. The refraction geophones were therefore buried in a one foot hole dug with a hand auger. Their depth represents approximately the height of the geophone.

7.6. Instruments settings

7.6.1. Reflection

The setting used for recording in reflection have been varied. The figures given below are not comprehensive and the reader is invited to refer to the C.P.O. plates where the settings corresponding to the records are indicated.

- Filters : 2/20 - out
- A.G.C. : O, Slow or Medium
- Expander (initial gain - 15 to - 36 dB)
  (Slope 80 to 200 dB/octave
  (Delay 120 to 960 milliseconds
- Suppressor (initial gain - 18 to - 42 dB.
  (delay 80 to 200 milliseconds
  (final gain - 21 to max. dB

7.6.2. Refraction

The main parameter used for recording in refraction are the filter and the gain.

The A.G.C. was systematically "out" with the exception of the center shots for which a "fast" A.G.C. was used on both groups of 6 traces close to the shot point (trace 12 to 7 and 13 to 18).

The filters used all along the refraction survey were: Out - 2/28

The input gain is a parameter which, for the same charges and same shot distances, varies with the noise conditions, that is to say the wind conditions. The reader is invited to refer to the "Operations Diagrams" (Plates 22A and 22B) where the values of gain are shown.

8. FIELD PLAY BACK OPERATIONS

For both reflection and refraction, the recording was made on both magnetic tapes and photographic paper (monitor). The latter actually is more handy for exploitations purposes and has been systematically used while working in refraction.

But in reflection when a wide set of frequencies is recorded on the monitor, the use of a smaller range of frequencies is necessary for exploitation purposes.

However, in both cases, a field play back on teledelto (electro sensitive support) is made by processing the raw tapes immediately after their recording. The purpose of such an operation is to check that the magnetic tape actually contains all informations. In addition, this gives a working document for reflection (as previously said) and can be used in refraction to give more readable record, when the monitor appear undershot or overshot, by using different gains for the play back.

As well in reflection as in refraction, the instruments settings can widely differ and a comprehensive list cannot be given here. All informations regarding these settings appear on the corresponding labels.

9. MISCELLANEOUS OPERATIONS

9.1. Bull dozer operations

As said previously, the progress of the various teams was slowed down by the very difficult travelling conditions encountered between the camp and the working sit e or along the traverse. The use of a dozer was felt necessary, to clear the tracks and traverses and allow a faster and safer progression.

As a matter of fact, the areas crossed by reflection and refraction traverses were almost entirely spinifex covered areas, and the contact of hot exhaust could easily set fire to a wisp of spinifex, mainly when the plant is very dry and very hot (both conditions encountered during the course of the survey). This represents a great cause of danger while travelling or while drilling holes, since the density of spinifex did not allow us to locate them naturally in cleared areas. On the other hand, the laying out of the spread and geophones is easier when carried out on a cleared location.

The dozer was working behind the surveyor's team. Therefore the way was clearly marked since the traverse had been pegged. At each shot point, the dozer would clear a space where the holes were to be drilled (this could be done only on traverse C). Actually, it would have been preferable that the dozer be ahead of all teams, including the surveyor's team. The progress of the dozer is generally slow enough (1.5 to 2 miles/hour in spinifex area, less in sand dunes) to allow the driver to keep a good straight back alignment. The pegging of the traverses would therefore be easier and furthermore there would be no risk for the dozer to pull out some pegs as this may happen when the dozer clears the traverse after the pegging has been done. With the dozer capable of keeping alignment, this way of working implies that it is somewhat ahead of the other crews. This has a further advantage that if the dozer happens to have a break down, the teams will not be stopped immediately.

It was hoped that the dozer could manage a track (from Christmas Creek Homestead to camp) that would be suitable for all sorts of trucks and would allow them to deliver the supplies directly at camp site. The main obstacle was the crossing of the Christmas Creek, and we could not find any place narrow enough for a crossing to be conveniently arranged.

9.2. Permanent markers

Permanent markers were placed every 5 shot points (10 miles) and at the crossing of traverses.
These markers consisted in ten feet long shot hole casing on which the following welding-cut marks appear :

S.S. 1962	standing for	Seismic Survey 1962
A (or C)	"	Traverse A (or C)
91/6	"	Base 91. Geophone 6

Three feet of casing were buried in a hole, a detonator coated with gelignite was exploded at the bottom of the hole. As result the casing was cut and a kind of clutch was made which tied the casing to the earth.

The inscriptions, which were written at approximately two feet below the top of the markers, appear therefore at five feet above the level of the earth. So they are reasonably reachable to anybody and also are safe from destruction by animals. A list of the permanent markers is given. Furthermore, their location appears on the location map.

9.3. Supply systems

An average of two trips a week to Fitzroy Crossing were necessary to pick up food and dispatch and pick up the mail. Those trips were made either with the supply and store truck or with Land Rover, according to the amount of goods to carry and the availability of the vehicles.

Almost all spare parts needed, either for vehicles or for electrical or any other purposes had to come from Perth.

As a matter of fact, it was very difficult to find the convenient part either in Derby or in Darwin. Since the shiproad communication between Perth and Fitzroy Crossing was very slow, a great number of orders had to be airfreighted, with the exception of too heavy or not urgent material.

Trips to Christmas Creek Homestead were also necessary in order to pick up and bring back to camp the supplies such as fuels and explosives. The only trucks capable of making such transportations were the supply and store truck or the two shooting trucks. The problem was particularly accute during the second part of the survey where the explosive used was almost exclusively nitrate. The average possible loading of our trucks was from 8,000 Lb to 9,000 Lb which means that several trips a week were to be made in order to supply the necessary quantity of explosives. Since we could not afford to divert a shooting truck from its own work during the week, a great number of these explosive supply trips had to be made during the weekends, on Saturdays and Sundays.

Fuel trips up to Christmas Creek Homestead or Fitzroy Crossing were made when necessary and were planned according to the average consumption of lubricants and fuels. These also were made with the supply and store truck.

9.4. Camp shifting. Flying camp operations.

The shifting of the camp took place on the 13th, 14th and 15th of September. Since the production was not stopped during this operation the latter had to be done with few people and also few vehicles. Furthermore, the weather was hot and prevented us from travelling with the trailers by day time. The sandy parts of the tracks were very soft, and we had to shift the equipment by night time. Several trips between both new and old camps were needed to carry the whole of the material up to the new camp site.

During the course of this survey a few fly camps had to be settled for a time as short as possible, because of all problems involved by such organisation. The various supplies were the main problems : food, water and fuel for all, explosives for the shooting crews. All these were supplied from the main camp, and were generally delivered at fly camp site at the same time as the necessary camp equipment.

Further trips were made as required for the supplies. The surveyor team, however, managed his own settlement by itself, since this team was the smallest and could afford to carry with it all goods and supplies of fuel necessary to stay in the field 3 or 4 days, without coming back to the main camp

ELEVATIONS TRAVERSE "A"

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 82		323	Base 94	1	343 9
SP 83		317		2	342 3
SP 84		323		3	342 1
SP 85		315		4	341 9
SP 86		318		5	342 2
SP 87		315	SP 94	6	342 5
SP 88		315		7	343 5
SP 89		322		8	344
SP 90		342 7		9	345 7
SP 91		356 9		10	346 4
Base 92	1	358 5		11	347
	2	360 2		12	346 2
	3	360 2	Base 95	1	341 8
	4	360 4		2	342 7
	5	360		3	344 7
SP 92	6	360 1		4	346 2
	7	359 9		5	344 5
	8	360 1	SP 95	6	346 9
	9	358 1		7	347
	10	358 6		8	348 6
	11	355 8		9	351 5
	12	355 8		10	351
Base 93	1	355 2		11	351 5
	2	353 2		12	349 5
	3	352 4	Base 96	1	351
	4	351		2	353 6
	5	351		3	357 3
SP 93	6	349 9		4	359 4
	7	348 8		5	360 7
	8	348 3	SP 96	6	360 6
	9	347 7		7	360 2
	10	347 2		8	357 8
	11	345 8		9	354 9
	12	345 2		10	356 4

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 96	11	354	Base 100	1	387 6
	12	355 3		2	388
Base 97	1	355 6		3	388 7
	2	357 4		4	388
	3	360 3		5	385 7
	4	363 1	SP 100	6	385
	5	365 3		7	384 8
SP 97	6	366 5		8	385
	7	368		9	383
	8	369 2		10	383
	9	369 7		11	382 5
	10	370 5		12	382 5
	11	372 3	Base 101	1	382 4
	12	373 2		2	383
Base 98	1	373 8		3	383 4
	2	374 6		4	383 5
	3	375 1		5	383 6
	4	376 2	SP 101	6	388
	5	376 9		7	389 9
SP 98	6	376 6		8	393
	7	378 8		9	398 9
	8	379		10	407
	9	380 6		11	412 3
	10	380		12	419
	11	379 5	Base 102	1	425 5
	12	379 6		2	430
Base 99	1	379 8		3	433 8
	2	380 8		4	437
	3	380 1		5	441 7
	4	379 5	SP 102	6	448
	5	380 9		7	450 5
SP 99	6	381 7		8	450
	7	383 4		9	452 3
	8	384 5		10	453
	9	384 8		11	455 2
	10	386 3		12	445
	11	388 6	Base 103	1	427 4
	12	380 4		2	414

Base or SP	Geophone No.	Elevation in feet
Base 103	3	406 9
	4	407 5
	5	410
SP 103	6	413
	7	416 1
	8	415
	9	425 5
	10	429
	11	432 9
	12	438
Base 104	1	437 2
	2	441 7
	3	444 1
	4	439 6
	5	441 1
SP 104	6	444
	7	447 2
	8	452
	9	452 3
	10	446
	11	447 2
	12	450
Base 105	1	456 3
	2	456 6
	3	453 7
	4	446 9
	5	449 2
SP 105	6	451 3
	7	452
	8	456 7
	9	458 3
	10	467 2
	11	469
	12	471 2
Base 106	1	475 3
	2	469 1
	3	467 8
	4	471 3
	5	476 8

Base or SP	Geophone No.	Elevation in feet
SP 106	6	486 3
	7	489 9
	8	487 1
	9	478 7
	10	474 1
	11	472 7
	12	471 5
Base 107	1	470 5
	2	472 5
	3	477 1
	4	483 7
	5	478 3
SP 107	6	475 7
	7	469 5
	8	465 9
	9	464
	10	459 5
	11	459 7
	12	461 3
Base 108	1	457 6
	2	460
	3	459 4
	4	458 8
	5	454 4
SP 108	6	455 3
	7	449 2
	8	448 5
	9	448 9
	10	449 2
	11	448 9
	12	447 2
Base 109	1	449 7
	2	448 9
	3	450 1
	4	457 3
	5	457 9
SP 109	6	459 2
	7	460 8
	8	461 6

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 109	9	462	Base 113	1	573
	10	462 5		2	573
	11	457 1		3	574
	12	463		4	575
Base 110	1	463		5	577
	2	464 7	SP 113		574
	3	467 7		6	575
	4	471 8		7	575
	5	473 7		8	575
SP 110	6	476 1		9	576
	7	480 2		10	576
	8	480 9		11	577
	9	482 5		12	577
	10	482 3	Base 114	1	581
	11	487 2		2	582
	12	488 4		3	578
Base 111	1	490 5		4	579
	2	492 9		5	579
	3	496 8	SP 114		581
	4	499 7		6	580
	5	502 8		7	583
SP 111	6	510 3		8	586
	7	514 9		9	586
	8	519		10	583
	9	522 7		11	585
	10	526 4		12	586
	11	528	Base 115	1	587
	12	532 9		2	590
Base 112	1	535 8		3	593
	2	546 8		4	595
	3	551 7		5	597
	4	553 4	SP 115		599
	5	555 1		6	599
SP 112	6	558 6		7	601
	7	561 5		8	601
	8	564 9		9	602
	9	569 6		10	604
	10	573 2		11	607
	11	573 1		12	609
	12	573	Base 116	1	611

Base or SP	Geophone No.	Elevation in feet
Base 116	2	615
	3	622
	4	631
SP 116		631
	5	632
	6	640
	7	652
	8	642
	9	656
	10	649
	11	651
	12	654
Base 117	1	659
	2	662
	3	668
	4	673
SP 117		675
	5	680
	6	687
	7	693
	8	697
	9	702
	10	707
	11	712
	12	718
Base 118	1	721
	2	726
	3	732
SP 118		736
	4	736
	5	742
	6	749
	7	756
	8	762
	9	770
	10	781
	11	794
	12	807

Base or SP	Geophone No.	Elevation in feet
Base 119	1	804
	2	800
	3	799
SP 119		797
	4	797
	5	794
	6	792
	7	789
	8	788
	9	789
	10	785
	11	796
	12	776
Base 120	1	772
	2	770
	3	762
	4	759
	5	758
Surface Sp 120		758
SP 120	6	756
(Drilled)	7	757
	8	747
	9	747
	10	747
	11	747
SP 121	12	747
Base 121	1	752
	2	746
	3	746
	4	747
	5	747
	6	763
	7	747
	8	744
	9	741
	10	741
	11	742

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 122		743	SP 125		746
	12	744		11	746
Base 122	1	784		12	753
	2	753	SP 126		752
	3	746	SP 127		743
	4	746	SP 128		727
	5	748	SP 129		719
	6	751	SP 130		715
	7	753	SP 131		711
	8	758	SP 132		721
	9	754			
	10	747			
Drilled SP 123	11	747			
	12	749			
Surface SP 123		755			
Base 123	1	762			
	2	750			
	3	750			
	4	753			
	5	753			
	6	753			
	7	756			
	8	766			
	9	753			
	10	753			
	11	750			
SP 124		750			
	12	750			
Base 124	1	749			
	2	749			
	3	748			
	4	748			
	5	747			
	6	746			
	7	746			
	8	748			
	9	747			
	10	746			

ELEVATIONS TRAVERSE "C"

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 43		608	SP 53	6	671
SP 44		579		7	669
SP 45		578		8	664
SP 46		568		9	658
SP 47		569		10	652
SP 48		571		11	650
SP 49		569		12	647
SP 50		588	Base 54	1	645
Base 51	1	627		2	639
	2	639		3	635
	3	648		4	629
	4	651		5	627
	5	655	SP 54	6	626
SP 51	6	659		7	622
	7	660		8	617
	8	661		9	614
	9	656		10	611
	10	652		11	610
	11	650		12	609
	12	649	Base 55	1	610
Base 52	1	646		2	612
	2	646		3	619
	3	647		4	618
	4	648		5	614
	5	649	SP 55	6	620
SP 52	6	652		7	623
	7	654		8	628
	8	655		9	633
	9	657		10	641
	10	659		11	648
	11	663		12	654
	12	660	Base 56	1	656
Base 53	1	663		2	661
	2	663		3	664
	3	663		4	671
	4	664		5	675
	5	665	SP 56	6	688

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 56	7	699	SP 59	9	712
	8	702		10	715
	9	711		11	722
	10	707		12	725
	11	720	Base 60	1	729
	12	717		2	724
Base 57	1	733		3	723
	2	748		4	725
	3	763		5	725
	4	767	SP 60	6	726
	5	766		7	726
SP 57	6	762		8	727
	7	756		9	737
	8	750		10	721
	9	747		11	718
	10	743		12	716
	11	737	Base 61	1	717
	12	736		2	718
Base 58	1	731		3	717
	2	726		4	713
	3	723		5	712
	4	719		6	716
	5	717	SP 61	7	721
SP 58	6	715		8	720
	7	712		9	719
	8	710		10	718
	9	709		11	720
	10	707		12	721
	11	705	Base 62	1	720
	12	704		2	720
Base 59	1	704		3	720
	2	703		4	720
	3	701		5	719
	4	701	SP 62	6	719
	5	701		7	720
SP 59	6	702		8	722
	7	704		9	722
	8	706		10	720

Base or SP	Geophone No.	Elevation in feet	Base or SP	Geophone No.	Elevation in feet
SP 62	11	717	Base 66	1	791
	12	715		2	797
Base 63	1	714		3	795
	2	714		4	792
	3	715		5	783
	4	716	SP 66	6	772
	5	716		7	767
SP 63	6	717		8	765
	7	716		9	762
	8	716		10	762
	9	716		11	761
	10	716		12	765
	11	717	Base 67	1	769
	12	719		2	776
Base 64	1	722		3	782
	2	724		4	800
	3	727		5	809
	4	731	SP 67	6	796
	5	729		7	789
SP 64	6	733		8	783
	7	738		9	778
	8	745		10	773
	9	750		11	772
	10	754		12	772
	11	753	Base 68	1	769
	12	756		2	763
Base 65	1	760		3	755
	2	766		4	749
	3	769		5	740
SP 65	4	775	SP 68	6	730
	5	777		7	723
	6	789		8	718
	7	795		9	710
	8	795		10	701
	9	776		11	693
	10	775		12	681
	11	776	Base 69	1	673
	12	777		2	668

Base or SP	Geophone No.	Elevation in feet
Base 69	3	666
	4	666
	5	666
SP 69	6	666
	7	673
	8	668
	9	668
	10	670
	11	681
	12	681
SP 70		649
SP 71		614
SP 72		596
SP 73		571
SP 74		582

UNDERLINED VALUES CORRESPOND WITH THE PERMANENT MARKERS' LOCATIONS.

APPENDIX 7

REDUCTION AND PRESENTATION OF DATA

1. REFLECTION FIELD CORRECTIONS (Plate 12)

The first experiment showed that better results were obtained when charges were above the water level. This level was accepted as the limit of the weathered zone. Furthermore a few shallow refraction shots taken during the first days of the survey led to consider a 6,000 feet/sec layer below the water level. This value was adopted as velocity correction.

The computation of the shot points corrections, which are the field data reduction and the first step to the computation of play-back corrections, involved the knowledge of the vertical travel time between the charge and the surface. This was obtained with a shot-hole geophone located close enough to the hole so that the seismic path might be considered as vertical. The actual travel path taken by the wave which comes back at the geophone located near the shot-point is a travel as (BRG). The objective of the static corrections is to make all data comparable. Hence this actual travel will be replaced by a fictitious path such as (A' ABRG G') which would be obtained if both geophone and shot were located on the Datum plane. The difference between both actual and fictitious travel times is the correction which is to be applied to the data.

This correction can be broken into two components.

a/Travel A' $\longrightarrow$ B going down

b/Travel T $\longrightarrow$ G' going up

<u>Travel A' $\longrightarrow$ B</u> = $(Ec)_{SP} + (Wc)_{SP}$.

One must add to its algebrical value the travel time between the datum plane and the bottom of the charge, which is relative to a wave of velocity Ve.

$A'B = Do - (E_{SP} - d\ max)$

and $(Ec)_{SP} + (Wc) = \dfrac{Do - (E\ sp - d\ max)}{Ve}$

Travel $T \longrightarrow G' = (Ec)_g + (Wc)_g$

The actual path TG, which is to be replaced by the fictitious path travel TG' is the path followed by the wave which is recorded by the shot hole geophone. The actual travel time TG is therefore equal to the vertical time ts.

$TG' = Do - (Eg - d\ min)$

and $(Ec)\ g + (Wc)\ g = \dfrac{Do - (Eg - d\ min) - ts}{Ve}$

The total correction to be applied to the values recorded at each shot point is:

$$C = \frac{Do - (E\ sp - d\ max)}{Ve} + \frac{Do - (Eg - d\ min)}{Ve} - ts$$

Very frequently shot point and geophone locations are close enough together, and the area is flat enough for assuming

$Esp = Eg$

The total correction can therefore be written:

$$C = \frac{2\ Do - [2\ E\ sp - (d\ max + d\ min)]}{Ve} - ts$$

This method allows the simultaneous computation of the elevation correction : E sp or E g and the weathering correction : W sp or W g. It is very quickly calculated since the only information picked on the record is the value of the vertical time ts. This method also implies that the charge is really placed below the base of the weathered zone. As a matter of fact, should the charge be placed within the weathered layer, both parts of the path between the charge and the base of the weathered zone would be kept with their own velocity and the times would therefore be too long. However, when the base of this weathered layer is well defined and known with certainty, the method leads to very good results. An important element is the value of the vertical time which is read on the record. If for any reason the reading of that vertical time is somewhat difficult, a good check is possible with the first arrivals on both traces nearest to the shot-point (trace 12 and 13). They are generally close enough to the shot-point to allow a computation of the vertical time with the hypothesis of linear path and can give an accurate result. When several shots are fired in a same hole the various values (Ec) g + (Wc) g should be the same. The experience shows that it may exist a slight difference between the first shot and the following ones, mainly due to the different conditions of the ground after the first shot. When this occurs, it is always the value of the first shot which is chosen for computation of the corrections.

2. REFRACTION FIELD CORRECTIONS (plate 21)

As for reflection correction the purpose of the refraction corrections is to make all data comparable and to eliminate the influence of the weathered zone. An exploitation of the first arrivals of the reflection records showed that the average velocity of the weathering zone was Vo = 3,500 feet/sec, whereas the average velocity of the sub-weathering layer was V = 8,000 feet/sec.

Symmetrical weathering shots were recorded at each base with a 680 feet special line where the take outs were symmetrically placed in relation with the center of the spread, so that shots could be performed at each end of the cable. Although the exploitation of these weathering shots showed some small variations in the values of the velocities Vo and V, the computations were systematically made with the values given above, since an error of these values does not involve a great error on the value of the corrections.

2.1. Principle of the corrections:

Let us consider a path from A (earth level) to C (contact point with the marker M). The base of the weathering zone is met at B and the path is supposed to be linear between B and C. The seismic ray travels along the marker M as CC'. In the absence of weathering zone and with A in the Datum Plane the theoretical travel path would be A'C' where A' is the projection of A on the datum plane. The difference between these two travel times (ABC C') and (A'B'C') represents the correction which is to be applied to the recorded times.

The actual travel time between A and C' is:

$$T_1 = \frac{\overline{AB}}{Vo} + \frac{\overline{BC}}{V} + \frac{\overline{CC'}}{Vm}$$

The fictitious travel time between A' and C' is

$$T_2 = \frac{\overline{A'C'}}{V}$$

The difference T 2 - T 1 is the correction C:

$$C = \frac{\overline{A'C'}}{V} - \left(\frac{\overline{AB}}{Vo} + \frac{\overline{BC}}{V} + \frac{\overline{CC'}}{Vm} \right) \qquad (1)$$

We can write:

$$\overline{A'C'} = \overline{A'B'} + \overline{B'C'} \quad (2)$$

$$\overline{CC'} = \overline{BB'} = \overline{A_1B'} - \overline{A_1B} \quad (3)$$

$$\overline{BC} = \overline{B'C'} \quad (4)$$

A'C', CC' and BC given by (2), (3) and (4) are substituted in (1) and:

$$C = \frac{\overline{A'B'}}{V} + \frac{\overline{B'C'}}{V} - \left(\frac{\overline{AB}}{Vo} + \frac{\overline{B'C'}}{V} + \frac{\overline{A_1B'} - \overline{A_1B}}{Vm}\right)$$

$$C = \left(\frac{A'B'}{V} - \frac{A_1B'}{Vm}\right) - \left(\frac{AB}{Vo} - \frac{A_1B}{Vm}\right) \quad (5)$$

We see that C appears as a difference between two delay times and can be written :

$$C = \frac{\overline{A'A_1} \cos \theta}{V} - \frac{\overline{AA_1} \cos \theta_o}{Vo}$$

where $\frac{\sin \theta o}{V0} = \frac{\sin \theta}{V} = \frac{1}{Vm}$

Since $\overline{A'A_1} = \overline{A'A} + \overline{AA_1}$ (7)

C can be written: $C = \frac{\overline{AA'} \cos \theta}{V} - \overline{AA_1}\left(\frac{\cos \theta o}{Vo} - \frac{\cos \theta}{V}\right)$ (8)

Let : E dp = Do: elevation of the datum plane

Eg = Elevation of the geophone

Dg = Depth of the weathering zone below geophone G (located in A)

Therefore : $\overline{AA'}$ = E dp - Eg, and AA_1 = Dg

and : $Cg = (E\,dp - Eg)\frac{\cos \theta}{V} - Dg\left(\frac{\cos \theta o}{Vo} - \frac{\cos \theta}{V}\right)$

C appears as a difference between two terms:

The first one, which is related only to the elevations of both datum plane and geophone is the : elevation correction.
The second one, which is related only to the depth of the weathering zone below the geophone is the : Weathering zone correction.

The correction at the shot point involves the maximum depth of the buried charge 'd'. This will enter in both elevation and weathering times, but is to be added to the elevation correction whereas it is to be subtracted from the Weathering correction. The correction at the shot point: C sp will therefore be written :

$$C\ sp = (E\ dp - E\ sp + d)\frac{\cos\theta}{V} - (D\ sp - d)\left(\frac{\cos\theta}{Vo} - \frac{\cos\theta}{V}\right)$$

Besides the elevation data, the corrections involve some weathering zone data (thickness and velocity) and also the knowledge of the marker since its velocity Vm is needed in order to compute cos θ and cos θo.

2.2. Effect of a variation of Vm

Actually two different markers can be recorded on a single record. Let us see the influence of a variation in the marker's velocity on the value of the correction.
Let d Vm the variation of the velocity of the marker and dC the corresponding variation of C and all other times being kept unchanged.
One can easily see that:

$$dC = \left[(E\ Dp - Eg)\ tg\ \theta - Dg\ (tg\ \theta o - tg\ \theta)\right]\frac{d\ Vm}{V_m^2}$$

....

With the values : V_o = 3,500 feet/sec

V = 8,000 feet/sec

V_m = 18,000 feet/sec

dV_m = 2,000 feet/sec

we arrive to:

$dC < 4.10^{-3}$ (E dp - Eg) - Dg in milliseconds

We see that dC will reach one millisecond when :

(E dp - Eg) - Dg will have the value of 250 feet. This occurred on the very last bases of traverse A (southern part) and on traverse C (western part).

It is therefore not necessary to compute the value of C with different values of Vm and the routine computations were calculated with the average value Vm = 18,000 feet/sec. The weathering data were recorded at each station of the recording truck i.e. between each trace 1 and 12 of two consecutive bases. In between two points of measurement, the base of the weathered zone was extrapolated which did not present great difficulties since the survey showed the thickness of the weathering zone to remain practically constant. The value of the depth between extreme shot point, was also extrapolated. Even if the actual depth is somewhat different of the chosen depth this does not lead to erroneous final results since the difference in time due to the difference of correction will be entered into the tie-constant when all intercepts are tied together in order to give the continuous relative intercept curve.

3. PLAY BACK CENTRE CORRECTIONS IN REFLECTION WORK

The tapes processed at the CPO will give a final corrected cross section. Two types of corrections are applied to these tapes.

"static corrections" which are elevation and weathering corrections generally different for each trace of each spread.

"Dynamic" or "move out corrections" which are made in order to compensate the obliquity of the path. They are different for each trace but are the same for all spreads, provided the velocity function be the same and the distance between shot points and traces remains constant.

3.1. Choice of velocity function

For both corrections the knowledge of the vertical velocity function is required. In the Poole Range area, we had but very few elements to compute such a velocity function. The results on the records were generally too poor to make a $T/\Delta T$ analysis possible. Anyhow, the average vertical velocity is quite large and the results of such analysis, if possible, would not have been very accurate.

On the other hand, every data regarding the vertical velocities recorded in bores are quite far from the actual location of our survey (Grant Range No. 1 is approximately 120 miles away). However, the lack of any other information led us to use the Grant Range seismic velocity survey in order to compute a velocity function that appeared to be suitable for the surveyed area. The Miller method of computation was used and led us to the following function:

$$V = 12,000 + 0,5 D$$

where V is the velocity in feet per second and D is the depth in feet.

3.2. Static corrections

The method used for the computation of the correction corresponding to each geophone group is similar to the "Plus-Minus Method" indicated by J.G. HAGEDOORN "The plus-minus method of interpreting seismic refraction section" Geophysical Prospecting Vol. VII No. 2.

3.3. Move out corrections.

The purpose of such corrections is to compensate for the curvature of the alignments due to the obliquity of the seismic paths.

The corrections correspond to a velocity function made of three parts:

a / a velocity Vo constant between 0 and 500 milliseconds (recorded):

b/ a velocity Vt varying according to the function :

$\frac{1}{Vt} = \frac{1}{Vo} - KT$ between 500 milliseconds and a given time To

c/ a velocity V_f constant beyond the time To.

A set of diagrams gives the values of the necessary constant (Vo, Vf, K, To) when T and Δ T are known.

The corrections given to the CPO are the $\frac{X}{Vf}$ for each trace, where X is the distance between the geometrical centre of the shot-point and the geometrical centre of the trace and Vf the final velocity defined as above. The knowledge of these values at the same time with the values of the constants Vo, To and K allows the CPO to realize the move-out corrections.

Further details regarding the elaboration of the CPO "correction sheet" are included in Appendix 8: "Explanatory note regarding the corrections sheets used by CGG party and CPO".

4. PLAY BACK CORRECTIONS IN REFRACTION WORK

The CPO processing of refraction data involves the knowledge of both "static" and "Dynamic" corrections.

Static corrections. These are the geophone and shot point weathering and elevation corrections as defined below "Refraction field corrections".

Dynamic corrections. These are used when the resulting CPO cross section is to be presented as intercept times. The values of the corrections : $\frac{X}{V}$ where X is the distance between shot point and geophone and V the velocity of the marker, is to be subtracted from the time plotted at the corresponding geophone.

Since the length of recording is generally long in refraction and can exceed the time of one revolution of the tape, a fictitious zero, or "Index" is used as time origin on the magnetic tape. This index, which corresponds with the start of recording on the tape, is recorded at the same time on both magnetic tape and galvanometric record. The actual time break is recorded also on the galvanometric record; therefore the origin of the time on the magnetic tape is easily transformed into the time origin of times by addition of the value of the "Index" = distance between actual time break and index, read on the galvanometric record.

5. VALUES USED FOR ROUTINE WORK

The Datum Plane elevation was 450 feet A. M. S. L. which was the average elevation of the ground for the first part of the survey.

The constants for CPO dynamic corrections were:

V_o = 13,000 feet/sec

T = 1,250 milliseconds

V_f = 16,000 feet/sec

The velocities used for static refraction corrections were:

V_o = 3,500 feet/sec

V = 8,000 feet/sec

The velocities used for $\frac{X}{V}$ computation were:

V_m : 20,000 feet/sec for the deeper marker

V_m : 17,500 feet/sec for the other markers.

6. PRESENTATION OF FIELD DATA

We intend to give here an explanatory description of the interpretation documents in order to provide for a full understanding of the data presented with the report.

6.1. The reflection plates are self explanatory and furthermore comments are given in the parts of text which refer to these plates.

6.2. Refraction plates. All plates exist for both traverses A and C and are identical as far as the general features are concerned.

6.2.1. Diagram operations (plates 22A and B)

On the line separating the sheet into two parts are represented the bases at the scale of 1 cm to 4,500 feet.

This line is therefore a conventional representation of the traverse. The orientation appears at both ends.
In order to visualize both direct and reverse spreads, slant lines are drawn, on which are reported the bases actually shot. A scale placed at the extremities allows a direct determination of the shooting distance.
On each slanted base, the following information appears:

Kind of explosive =	G for gelignite explosive, no information for nitrate explosive
Characteristics of the shot:	Charge (in Lb) and gain (in decibel) S standing for surface shot No information for buried shot.
Quality of the records:	U standing for undershot O " overshot No information for normal shot.

Furthermore, a dashed line shows the chosen limit used for the CPO intercept computation with 17,500 feet/sec (short shots) or 20,000 feet/sec (long shots).

6.2.3. Diagram exploitation (plates 23A and B)

The conventional representation of traverse and bases is the same as previously described.
The information appearing on these diagrams are:
- The limit of appearance of the markers,
- The interfered areas and the interfered records,
- The faults,
- The slower or faster events seen on the records,
- The actual velocity of the various markers.

All conventional symbols are indicated in a reference placed on each plate.

6.2.4. Exploitation plates (plates 24A and B, 25A and B)

The traverse is represented by the line of the bases at the scale of 1 cm to 1,800 feet. Below the line representing the traverse are the elevation corrections and elevation plus weathering correction curves. For both of them, the vertical scale is 1 cm to 100 milliseconds. The information concerning the extreme shot points: distance between them, elevation and elevation plus weathering corrections are tabulated on both sides of the plate.

Both direct and reverse relative intercept curves show above the traverse. The vertical scale is 1 cm to 100 milliseconds and the values of the times can be read in relation to the corresponding scales located on right hand side for reverse and left hand side for direct. Only the selected intercepts are plotted on these plates and for each segment the shot point concerned is indicated above the arrow limiting the corresponding segment.

The same direct and reverse curves, shifted toward their respective shot point origin by a distance equal to the offset give the relative intercept curve in marker position. The scale is still 1 cm to 100 milliseconds and the value of the offset appears with an arrow showing the direction of the shift.

The average curve resulting from the averaging of the two above curves in marker position are represented in between these two curves. It is transformed into an absolute delay curve by plotting calculated delays on it. The values of the actual velocity of the marker appear above each segment of the delay curve which are limited by the absolute delay time scales (1 cm to 100 millisec.)

The curve at the top, or deviation curve, represents the difference in time between both direct and reverse relative intercept in marker position, i.e. the double convergence of the curves. Each point is plotted and the average line drawn as best fit is used for the computation of the actual marker velocity.

On all intercept and delay curves the faults are located as hachured areas,

- Local and shallow anomalies appear on both direct and reverse relative curve in geophone position as the same geophone locations. These are corrected and the corresponding zone appears darkened.

6.2.5. Delay curves (plates 26A and B)

All exploited markers of one traverse are plotted on the same delay curves plate. The traverse appears with an horizontal scale of 1 cm to 4,500 feet, at the level of the Datum Plane wherever possible, and in any case at the bottom. The values of the velocities appear below each segment of curve. The faults are plotted and represented by hachured zones. Besides, the values of the offsets are plotted for each marker.

The intersection of traverses, and surface main features are indicated at the top of the plate.

6.2.6. Depth curves (plates 27A and B)

The general presentation is the same as the delay curves. Besides the horizontal velocity of each segment of marker, the value of the vertical velocities used for computation of the depth appear in the intervals between markers. An explanatory note regarding these computations is added on the left hand side of the plate.

The Bouguer anomaly curves appear at the bottom of each plate. The vertical scale is 1 cm to 10 milligals.

7. PRESENTATION OF REFLECTION PLAY BACK DATA

7.1. Headings of the sections.

The headings of reflection CPO Cross Sections contain all informations regarding the recorder settings, the geophone and shot point characteristics. In addition, the headings of the Cross-sections for the traverse A show the following curves:

- The elevation curve, at the scale of 1 cm to 25 feet,
- The total correction (E cg + W cg + ts) curves at the scale of 1 cm to 5 milliseconds,
- On the vertical of each shot point, down from the elevation curve, a line is representing the hole, with indications of the value of the charge (thicker line) and a simplified log of the hole. The following symbols were adopted for representing the lithology:

Sd : Sand

Sh : Shale

St : Sandstone

WL : water level

L : limestone

Gr : gravel

Sh + Sd : Shaly sand

7.2. Records of the sections (Plate 33)

The records of the reflection CPO cross sections contain a certain number of pips and remarkable points. The following notes give explanation to insure a correct checking and a full understanding of the cross section symbols.

7.2.1. Mechanical time break of the machine and auxiliary sub DP

The mechanical time break (1) or zero of the machine is superimposed on the time scale.
Variable density : The timebreak appears as a black rectangle.
Variable area : It appears as an interruption in a continuous line.
In both presentations, the upper edge indicates the zero point of the mechanical timebreak. The space between the zero and the DP is the correction A to the sub-DP.
For a sub-DP of + 50, the zero point will appear at 50 milliseconds above the mechanical timebreak of the machine.

7.2.2. Normal Moveout Correction Curve (2)

The normal moveout correction curve appears as a continuous, regularly indented line.

For each trace, this curve represents the fall of the normal moveout correction head (reading head) in the slot of the time correction drum. This slot has been designed for the proper positioning and tension (stretch) of the magnetic tape.

Since the fall of the head occurs during the adjustment of the X/V corresponding to the trace, the normal moveout correction curve offers only a qualitative indication. In other words, its presence shows that the normal moveout corrections were actually carried out when the cross section was made.

The scattering of the values with the respect to the hyperbola is unimportant.

7.2.3. Static time Correction Curve (3)

When the signal passes through the time correction drum (i.e., when it is corrected) there is, for each processed trace, a sharp pulse called "static pip" showing the position of the static correction head (recording head).

The values of the corrections for each trace can thus be checked. The sequence of static pipe outlines the correction curve. It is continuous when the DP remains unchanged. If there is a change from one DP to another, the discontinuity corresponds to the difference of the sub-DP corrections.

To compare the static time correction curve with the elevation (altimetric) curve, it must be taken into account that the former is repeated twice - i.e., a point A of the elevation curve is expressed by points a' and a'' on the traces (figure 2). The curve corresponding to traces 13-24 of shotpoint "n" must be identical to the curve corresponding to the traces 1-12 of shotpoint "n+ 1."

7.2.4. Time breaks

The TB trace of each section is partially reproduced on trace 1. This overprinting is shown by a darker grey colour on a Variable Density section. The static pip, occurring when the TB trace is played back, is aligned with the zero point of the corrections. The pip appears as point 4.

7.2.5. Verifications

The alignment of all the pips serves as a reference line from which the static time corrections (carried out during actual processing) may be measured by the time scale of the section.

The corrections are positive when the pips of each trace are above the alignment of pips 4 and negative when they are below.

7.2.6. Auxiliary or sub-DP

The timebreak alignment drum makes it possible to check the alignment of the field tapes and that of their timebreaks (5) with the mechanical timebreak (1) of the machine. The tapes are aligned with respect to the auxiliary or sub-DP.

7.2.7. Actual DP

The DP proper (6) is not marked by the machine. The DP is added (straight line) to the cross section during the labelling of the latter.

8. PRESENTATION OF REFRACTION PLAY BACK DATA

The diagram "Operations" (6.2.1.) shows the line separating both velocities 17,500 and 20,000 feet/sec used for the computation of the intercept times.

The CPO cross section are presented as follows: all tapes relative to a given shot point and a given direction (either direct or reverse) are assembled together.
A blank interval separates the traces corrected with 17,500 feet/sec. and 20,000 feet/sec velocity. The limits of both 17,500 and 20,000 are marked by figures (1), (2), (3) and (4) which also appear on the headings at the same time with the corresponding shot distances.
Two kind of presentation : variable area and galvanometric (wriggly lines) are provided.

APPENDIX 8

MISCELLANEOUS FORMS

Several forms were used by the Party, for various purposes. All these forms were made out after discussion with the B.M.R. Representative, as far as the presentation, terms and symbols are concerned.

These forms are mainly of three types:

- Daily reports, where all informations regarding the work of each day are recorded.
- Labels, where are recorded all informations required to define without ambiguity the document to which the label is attached.
- Computational forms, which are the "working tools" of the office.

We will now consider all these forms with explanation when necessary.

1. DAILY REPORTS

1.1. Drillers daily reports (plate 29A)

Besides the informations regarding the drilling crew and its working time, all characteristics of the shot point (number and depth of holes, simplified log) are recorded. Every noticeable incident appears in the space "Remark". When the holes were pre-loaded (in reflection work) the amount of explosives and the number of the detonators used appear in the corresponding spaces.

1.2. Observer daily reports (plates 29B and 29C)

Two models were used according to the type of work (reflection or refraction) since the recording characteristics are different in both cases. In the reflection work, the characteristics of the field play-back records were written just below those of the monitor record on the daily report.

1.3. Shooter daily reports (plate 29D)

This is a record of all characteristics of the holes (maximum and minimum depth of charges), and all characteristics of the components of the charge (nature and quantity of explosives used, number of detonators).

In addition, the number of holes left on the shot point after each refraction shot is noted. This information is very useful in refraction work where extra shots have sometimes to be made. The knowledge of the number of holes left allow us to determine whether such extra shots can be performed without extra drilling and what value of charge can be used.

2. LABELS

2.1. Reflection record label (plate 30A)

The same label is used for both monitor and play-back records. It contains all informations required to define:

- The location and surveying characteristics of the spread.
- The recording and play-back spread set-up.
- The shot point.
- The value of the correction at the centre of the spread and at both extreme traces (1 and 24).
- The geophones arrangement.
- The instruments characteristics and settings.

2.2. Refraction record label (plate 30B)

Besides the same informations as those of the reflection label (2.1.), this form contains boxes that allow the whole computation of the corrections for each trace :

- Shot point correction, at the right hand side.
- Geophone correction, and CPO correction at the left hand side. The latter are obtained by subtracting the value X/V from the value of the total correction, and by subtracting also the value of the Index (see appendix 7 for details).

2.3. Tape label

The following informations appear on the tape label which has been placed on the tape by the manufacturer:

- Number of the tape (printed by the manufacturer)
- Name of the client
- Name of the prospect
- Number of the party (mission)
- Designation of the traverse (profil)
- Designation of the shot point (point de tir)
- Number of the shot (No de tir)
- Date and hour (heure) of the shot
- Lacking traces (traces manquantes)
- Dead traces (traces raides)
- Reversed traces (traces inversees)
- Bases number (in refraction work)
- Shot point number (in reflection work)

2.4. Field labelling of the records

As soon as the shot was recorded and the monitor record was processed, the following informations were indicated on the back of the record in order to avoid any later mid-identification of the documents :

- Date of the shot
- Shot point number
- Shot number in the day (figure)
- Shot number in the hole (letter)
- Tape number
- Charge and depth

Furthermore, the number of the bases was added when shooting refraction spreads.

The informations were written on a convenient place, so that they could not be cut off when trimming the record and would not obliterate the first events when printing the record.

The same procedure was applied to field play-back records. Informations relative to the play-back set-ups were added : filtering, AGC, Gain...

3. COMPUTATIONAL FORMS

3.1. Intercept sheets (Pl. 31B)

The intercept sheets used are either red (direct shot) or black (reverse shot).

A few general informations, name of the prospect, number of the party and the designation of traverse and spread (bases and shot points) appear in the top part of the sheet.

In the column below "X" are recorded the calculated distances between the shot point and each geophone of both recorded bases.

Three identical series of boxes allow the computation for various markers and for various marker's velocities V_M.

The components of each of these boxes are :

- t = corrected time as shown on the record's label.

- Corr Cycle : Cycle correction, the value of which was either 60 millisec. or 70 millisec. according to the concerned marker.

- T = t - c : Difference between the corrected time and the cycle correction : it represents therefore the corrected time of the very first break (onset of the wave)

-X/V : Ratio between the distance shot point - geophone and the marker's velocity chosen for computation

- $T - \frac{X}{V}$ = Intercept time.

The two following columns are used to compute the difference between the intercept times of two identical spreads shot from different shot points, this is used to compute the tie constant which allows to build the relative intercept curve.

- Relat. In this last column appears the value of the relative intercept, which is the difference between the raw intercept and the constant relative to the shot point considered.

3.2. C.P.O. Correction sheets

The C.P.O. correction sheets contain all informations for the processing of the tapes. Since these sheets are established with conventional CGG symbols in French, a comprehensive explanation is given in the following paragraph, "Explanatory note regarding the correction sheets used by C.G.G. party and Central Office".

4. EXPLANATORY NOTE REGARDING THE CORRECTION SHEETS USED BY C.G.G. PARTY AND CENTRAL PROCESSING OFFICE

These sheets (Pl. 31A) contain all informations needed by the Central to process the magnetic tapes without any ambiguity.

BOX 1

- Name of the client
- Identification of the party
- Profil = Traverse = Identification of the traverse

Etude = Prospect : Name of the prospect.

- Feuille de correction No : ordinal number of the correction sheet
- Boite No = Box No. This is reserved for the Central for his own filing system.

BOX 2

- DP reel a $\pm$ ... m : there is shown the algebraical value of the actual Datum Plane.

Should the values of the static corrections be beyond the possibilities of the equipment, an auxiliary Datum Plane is used. The value of the auxiliary DP is shown as :

DP aux. = $\pm$ ... ms.

BOX 3

X = length of the spread, the distance between two shot points

e = distance between two geophones group centres,

d = distance between centre of shot point (or hole) and centre of nearest geophone group.

BOX 4

- Loi de vitesse = Velocity function which permits to calculate the increase of the velocity as a function of the depth.
- Vitesse C^{te} approchee = approximate constant velocity, for the case where the chosen velocity is constant between the Datum Plane and the bottom of the recorded section.

- Vo, Vf, To, A : constants which define the velocity function computed for the "dynamic" correction.

BOX 5

- Ier Document ou 2 eme Document = Two types of documents can be made at the same time, as for example sections in variable density and variable area. Different filters and AGC can be used for these two documents. The characteristics wanted are entered in the corresponding boxes,

COMPOS. compositing is indicated:

- the proportion of the composition
- the kind of the composition either optical (o) or electronic (E)

FILTERS. Low cut and high cut chosen for the tapes processing

A.V.C. = A.G.C. Att = Attack
Rel = Release

Pas. = Spacing of the traces. It corresponds to the width of the variable area or variable density traces.

FEN. (window) = aperture of the shutter, used for the production of the variable density sections.

VITESSE. Rotation speed of the drums ; two speeds are possible

(1/1 : 38 mm = 100 milliseconds
(1/2 : 19 mm = 100 milliseconds

REP. Reproduction. The sort of printing is defined there (either VA or VD)

GAIN. Box used by the central for his own benefit.

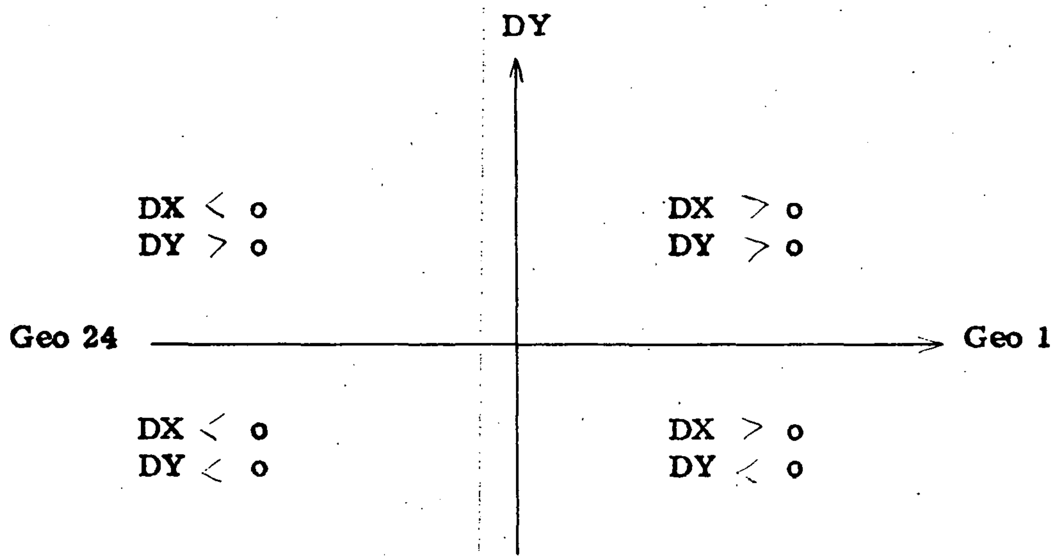
BOX 6. P min/P max = minimum and maximum depth of the charge

Charges = size of the charges

Deports = Offset of the shot-point location in relation with the theoretical shot-point centre on the traverse.

DX = component of the offset parallel to the traverse

DY = Component of the offset perpendicular to the traverse.



V. CORR - Velocity chosen for the computation of the shot point correction.

S N
O E = Orientation of the traverse

TRANS : Transcription used only by the Central

OBS : observations : remarks

GROUPEMENTS : used only by the Central.

BOX 7 Pts de tir - Shot point Number and number of the shot in the hole.

No du tir : Number of the shot in the day

PAS 1.12) (see before "PAS")

PAS 13.24) (spacing of the traces

STAT = In these columns are written the values of the static corrections. Should a correction be negative, it is replaced by its complement to 1,000.

Example - 10 is written as : 990

DYN = in these columns are written the values of the dynamic corrections.

APPENDIX 9

LIST OF MAGNETIC TAPES

1.1. Reflection Magnetic Tapes

Number of the Tapes	SHOT POINT	Shot No.	Number of the Tapes	SHOT POINT	Shot No.
74449	100 X	2 A	74407	100 X	10 A
74450	100 X	3 A	74406	100 X	11 A
74441	100 X	4 A	74405	100 X	12 A
74442	100 X	1 A	74404	100 X	13 A
74443	100 X	2 A	74403	100 X	14 A
74444	100 X	3 A	74402	100 X	15 A
74445	100 X	4 A	74401	100 X	16 A
74436	100 X	5 A	74651	100 X	17 A
74437	100 X	6 A	2	100 X	18 A
74438	100 X	7 A	3	100 X	19 A
74439	100 X	8 A	4	100 X	20 A
74440	100 X	9 A	5	100 X	21 A
74431	100 X	10 A	6	100 X	22 A
74432	100 X	11 A	7	100 X	1 A
74433	100 X	12 A	8	100 X	2 A
74434	100 X	13 A	9	100 X	3 A
74426	100 X	2 A	74660	100 X	4 A
74427	100 X	3 A	1	100 X	5 A
74428	100 X	4 A	2	100 X	6 A
74429	100 X	5 A	3	100 X	1 A
74430	100 X	6 A	4	100 X	2 A
74421	100 X	7 A	5	100 X	3 B
74435	100 X	7 B	6	100 X	4 A
74422	100 X	8 A	7	100 X	5 A
74416	100 X	1 A	8	100 X	6 B
74411	100 X	2 A	9	100 X	7 A
74412	100 X	3 A	74670	100 X	8 B
74413	100 X	4 A	1	100 X	9 C
74414	100 X	5 A	2	100 X	10 A
74415	100 X	6 B	3	100 X	11 B
74410	100 X	7 A	4	100 X	12 A
74409	100 X	8 A	5	100 X	13 A
74408	100 X	9 A	6	100 X	14 B

Number of the Tapes	SHOT POINT	Shot No.	Number of the Tapes	SHOT POINT	Shot No.
74677	1	1 A	74866	115	3 A
8	1	2 A	7	114	4 A
9	1	3 A	8	113	5 A
74680	1	4 A	9	112	6 A
1	1	5 A	74870	112	7 A
2	1	6 A	1	111	1 A
3	1	7 A	2	111	2 A
4	1	1 A	3	110	3 A
5	1	2 B	4	110	4 A
6	1	3 A	5	109	1 A
7	1	4 A	6	109	2 A
8	1	5 B	7	109	3 A
9	1	6 A	8	109	4 A
74690	1	7 A	9	108	1 A
1	130	1 A	74880	108	2 A
2	130	1 A	1	107	3 A
3	129	1 A	2	107	4 A
4	128	2 A	3	106	1 A
5	127	3 A	4	106	2 A
6	126	4 A	5	106	3 A
7	125	1 A	6	105	4 A
8	124	2 A	7	105	5 A
9	124	3 A	8	104	6 A
74700	123	4 A	9	104	7 A
74851	122	1 A	74890	106	1 A
2	122	2 A	1	106	2 A
3	121	1 A	2	107	1 A
4	121	2 A	3	107	2 A
5	120	3 A	4	103	3 A
6	120	4 A	5	103	4 A
7	119	5 A	6	102	5 A
8	118	1 A	7	102	6 A
9	118	2 A	8	101	7 A
74860	118	3 A	9	101	8 A
1	118	4 A	74801	105	9 A
2	117	1 A	2	106	10 A
3	116	2 A	3	106	1 A
4	115	1 A	4	106	2 A
5	115	2 A	5	106	1 A

Number of the Tapes	SHOT POINT	Shot No.
74806	107	1 A
7	107	2 A
8	103	1 A
9	103	2 A
74810	107	3 A
1	107	4 A
2	106	1 A
3	115	1 A
4	115	2 A
113376	201	1 A
7	201	3 A
8	202	4 A
9	202	5 A
113380	203	6 A
1	203	7 A
2	203	8 A
113383	203	9 A

1.2. Refraction Magnetiques Tapes

Number of the Tapes	SHOT POINT	BASES	Number of the Tapes	SHOT POINT	BASES
74816	106	104-105	74852	105	94-95
7	106	104-105	3	106	94-95
8	106	104-105	4	103	94-95
74815	106	104-105	5	108	94-95
74819	103	104-105	6	102	94-95
74820	103	104-105	7	104	93-94
1	108	104-105	8	103	92-93
2	110	104-105	9	105	92-93
3	99	104-105	74560	102	92-93
4	112	104-105	1	109	101-102
5	97	104-105	2	113	102-103
6	95	104-105	3	111	103-104
7	93	104-105	4	114	103-104
8	99	102-103	5	115	103-104
9	106	102-103	6	96	103-104
74831	97	102-103	7	113	104-105
74830	108	102-103	8	91	104-105
74832	110	102-103	9	100	105-106
74833	95	102-103	74570	114	105-106
4	112	102-103	1	96	105-106
5	93	102-103	2	115	105-106
6	112	100-101	3	94	105-106
7	110	100-101	4	117	105-106
8	97	100-101	5	95	106-107
9	95	100-101	6	116	106-107
74840	108	100-101	7	97	106-107
1	106	100-101	8	98	106-107
2	107	99-100	9	99	106-107
3	109	99-100	74580	112	106-107
4	106	98-99	1	112	106-107
5	108	98-99	2	113	106-107
6	107	97-98	3	114	107-108
7	108	96-97	4	96	107-108
8	106	96-97	5	114	107-108
9	105	96-97	6	115	107-108
74850	104	95-96	7	100	107-108
74851	107	95-96	74588	117	107-108

Number of the Tapes	SHOT POINT	BASES	Number of the Tapes	SHOT POINT	BASES
74589	99	108-109	113479	89	96-97
74590	98	108-109	113480	87	96-97
1	97	108-109	1	96/97	96-97
2	101	108-109	2	89	96-97
3	102	109-110	3	86	95-96
4	100	109-110	4	88	95-96
5	101	110-111	5	86	95-96
6	103	110-111	6	90	95-96
7	104	111-112	7	95/96	95-96
8	102	111-112	8	85	95-96
9	97	106-107	9	84	95-96
74600	98	106-107	113490	87	94-95
113451	92	101-102	1	87	94-95
2	90	101-102	2	83	94-95
3	90	101-102	3	94/95	94-95
4	94	101-102	4	89	94-95
5	101/102	101-102	5	89	94-95
6	101/102	101-102	6	82	93-94
7	91	102-103	7	86	93-94
8	91	100-101	8	88	93-94
9	93	100-101	9	99	93-94
113460	99/100	99-100	113500	99	93-94
1	92	99-100	74451	101	93-94
2	99/100	99-100	2	93/94	93-94
3	92	99-100	3	85	93-94
4	90	99-100	4	84	93-94
5	94	99-100	5	87	92-93
6	93	98-99	6	100	92-93
7	91	98-99	7	92/93	92-93
8	93	98-99	8	118	107-108
9	93	98-99	9	118	107-108
113470	98/99	98-99	74460	107/108	107-108
1	89	98-99	1	119	107-108
2	92	97-98	2	116	108-109
3	88	97-98	3	120	108-109
4	86	97-98	4	108/109	108-109
5	97/98	97-98	5	117	109-110
6	97/98	97-98	6	118	109-110
7	90	97-98	7	109/110	109-110
113478	91	96-97	74768	119	109-110

Number of the Tapes	SHOT POINT	BASES	Number of the Tapes	SHOT POINT	BASES
74469	121	109-110	74609	111	115-116
74470	120	110-111	74610	123	115-116
1	110/111	110-111	1	125	115-116
2	122	110-111	2	127	115-116
3	118	111-112	3	124	116-117
4	119	111-112	4	126	116-117
5	121	111-112	5	113	116-117
6	111/112	111-112	6	116/117	116-117
7	123	111-112	7	128	116-117
8	117	111-112	8	129	117-118
9	120	112-113	9	110	117-118
74480	103	112-113	74620	127	117-118
1	122	112-113	1	117/118	117-118
2	105	112-113	2	125	117-118
3	105	112-113	3	112	117-118
4	124	112-113	4	111	117-118
5	112/113	112-113	5	130	118-119
6	108	112-113	6	113	118-119
7	121	113-114	7	118/119	118-119
8	109	113-114	8	109	118-119
9	109	113-114	9	128	118-119
74490	107	113-114	74630	131	119-120
1	106	113-114	1	110	119-120
2	104	113-114	2	110	119-120
3	113/114	113-114	3	129	119-120
4	123	113-114	4	119/120	119-120
5	125	113-114	5	111	119-120
6	105	114-115	6	127	119-120
7	108	114-115	7	132	120-121
8	108	114-115	8	112	119-120
9	114/115	114-115	9	113	120-121
74500	114/115	114-115	74640	130	120-121
74601	126	114-115	1	120/121	120-121
2	124	114-115	2	128	120-121
3	122	114-115	3	116	121-122
4	104	115-116	4	128	120-121
5	107	115-116	5	129	121-122
6	115/116	115-116	7	116	121-122
7	109	115-116	8	114	121-122
74608	110	115-116	74649	112	121-122

Number of the Tapes	SHOT POINT	BASES	Number of the Tapes	SHOT POINT	BASES
74650	131	121-122	113440	50	56-57
113401	110	121-122	1	63	56-57
113402	121/122	121-122	2	56/57	56-57
3	111	121-122	3	48	56-57
4	115	122-123	4	65	56-57
5	122/123	122-123	113445	48	56-57
6	112	123-124	6	46	56-57
7	113	122-123	7	51	57-58
8	123/124	123-124	8	47	57-58
9	114	123-124	9	49	57-58
113410	116	123-124	113450	49	57-58
1	60	51-52	74701	48	58-59
2	58	51-52	2	58/59	58-59
3	51/52	51-52	3	52	58-59
4	62	51-52	4	50	58-59
5	61	52-53	5	51	59-60
6	63	52-53	6	53	59-60
7	52/53	52-53	7	59/60	59-60
8	59	52-53	8	55	59-60
9	64	53-54	9	52	60-61
113420	53/54	53-54	74710	54	60-61
1	62	53-54	1	60/61	60-61
2	60	53-54	2	56	60-61
3	47	53-54	3	53	61-62
4	45	53-54	4	57	61-62
5	43	53-54	5	61/62	61-62
6	44	54-55	6	55	61-62
7	65	54-55	7	58	62-63
8	63	54-55	8	58	62-63
9	54/55	54-55	9	62/63	62-63
113430	46	54-55	74720	56	62-63
1	61	54-55	1	55	63-64
2	48	54-55	2	59	63-64
3	62	55-56	3	63/64	63-64
4	49	55-56	4	57	63-64
5	64	55-56	5	60	64-65
6	49	55-56	6	56	64-65
7	47	55-56	7	64/65	64-65
8	55/56	55-56	8	58	64-65
9	45	55-56	74729	61	65-66

Number of the Tapes	SHOT POINT	BASES
74730	57	65-66
1	65/66	65-66
2	59	65-66
3	62	66-67
4	66/67	66-67
5	58	66-67
6	60	66-67
7	63	67-68
8	67/68	67-68
9	59	67-68
74740	61	67-68
1	60	68-69
2	60	68-69
3	68/69	68-69
4	60	55-56
5	61	56-57
6	64	57-58
7	53	57-58
8	62	57-58
9	54	58-59
74750	63	58-59
113351	65	58-59
2	67	58-59
3	66	59-60
4	64	59-60
5	68	59-60
6	65	60-61
7	67	60-61
8	69	60-61
9	66	61-62

Number of the Tapes	SHOT POINT	BASES
113360	66	61-62
1	68	61-62
2	66	61-62
3	66	62-63
4	69	62-63
5	71	62-63
6	72	63-64
7	68	63-64
8	70	63-64
9	69	64-65
113370	71	64-65
1	73	64-65
2	74	65-66
3	72	65-66
4	70	65-66
113375	66	57-58

The C.P.O. refraction cross sections are not listed here since they are not completely processed. The detailed list and the sections will be provided when arriving in Australia.