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A REPORT

ON

THE SEISMIC REFLECTION SURVEY BNT 81

conducted in

OP. 186

NORTHERN TERRITORY

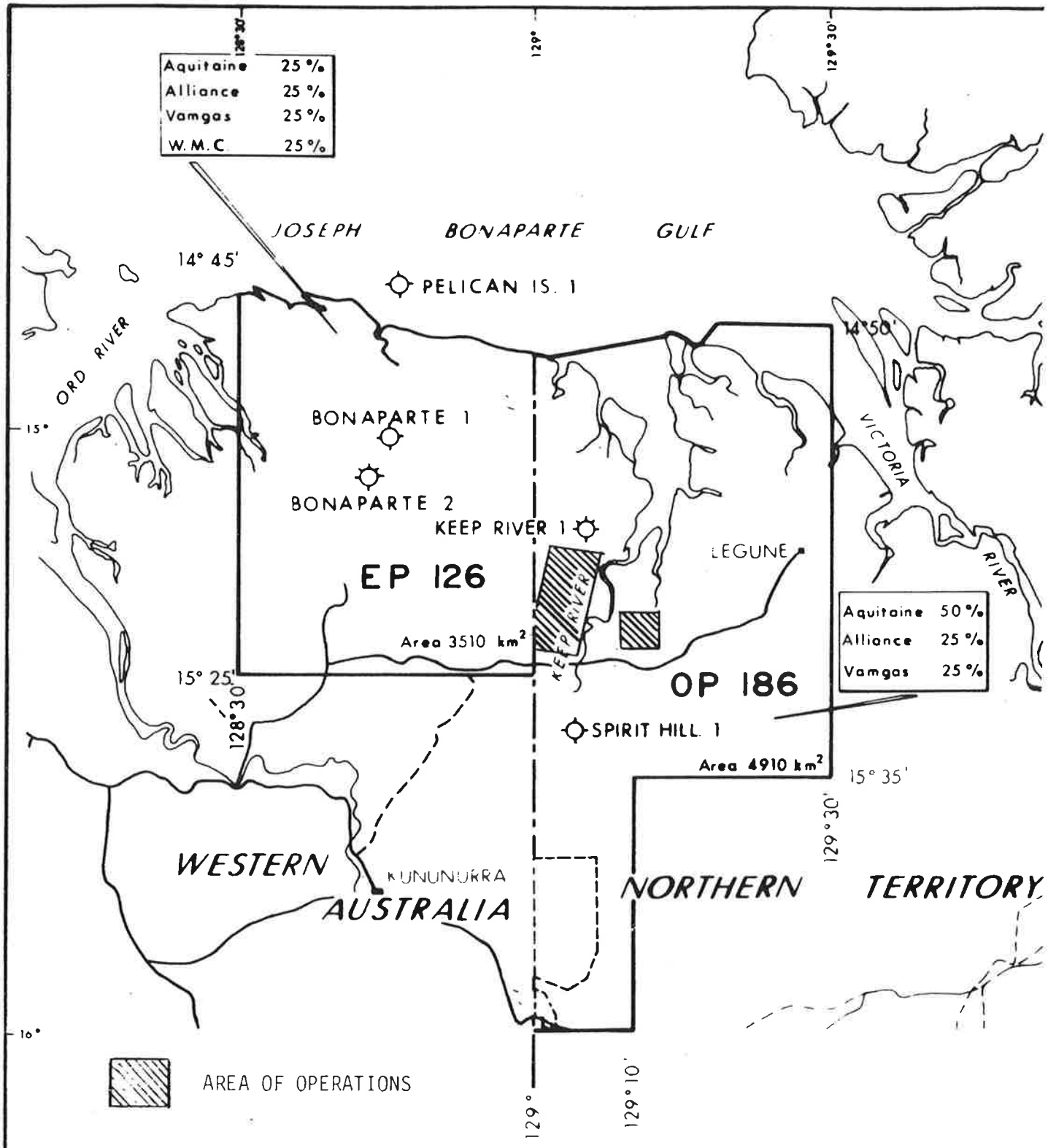
by

HORIZON EXPLORATION (INTERNATIONAL) LIMITED

for

AUSTRALIAN AQUITAINE PETROLEUM PTY. LIMITED

AREA OF OPERATIONS



Australian Aquitaine Petroleum Pty Ltd.

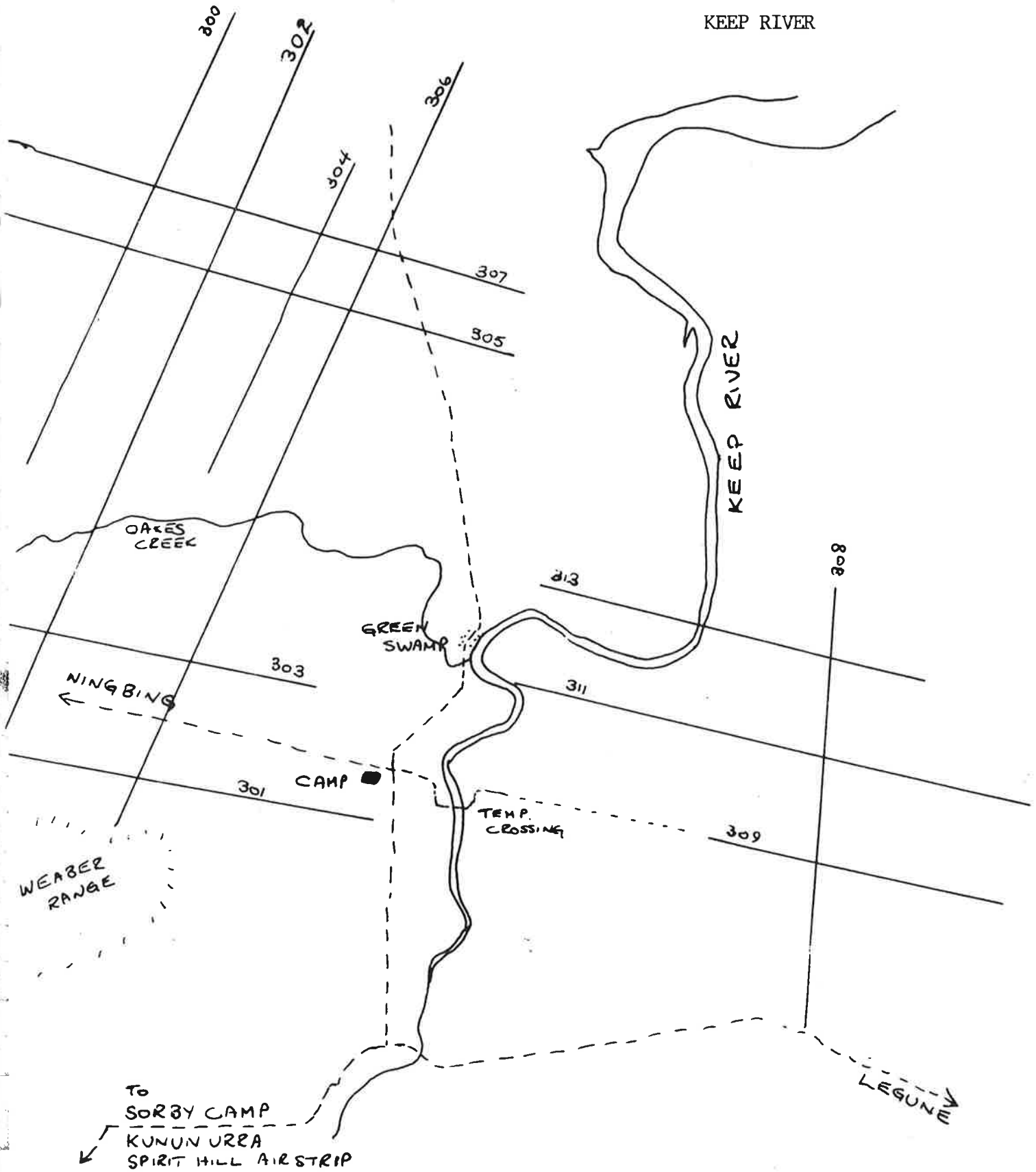
PERMIT AREAS
BONAPARTE GULF BASIN

SCALE 1 : 1 000 000

---- NATIONAL PARK BOUNDARY

SKETCH MAP

KEEP RIVER



CONTENTS

Sketch Maps - Areas of Operations OP. 186 ✓
- Keep River ✓

APPENDICES

ENCLOSURES

(1) SYNOPSIS

This report covers a seismic reflection survey in Licence Area OP. 186, Northern Territory on behalf of Australian Aquitaine Petroleum Pty. Limited during the period 16th August 1981 to 1st October 1981. The survey was recorded 48 trace, 24 fold, split spread, using vibrators as the energy source.

An advance survey and line clearance party was established in the area on 14th July 1981.

The programme consisted of 12 lines amounting to 128.75 kilometres. Lines BNT 308, 309, 311 and 313 to the east of the Keep River were in black soil country. Lines BNT 300 to 307 were in more heavily wooded country in very fine alluvial clay. Lines BNT 301 and 303 extended by 5.5 kilometres and 6 kilometres respectively into Licence Area EP. 126 Western Australia, becoming BWA 81-301 and 303.

Camp was located near the intersection of lines BNT 80-205 and BNT 80-204. Drinking water was obtained from the Aquitaine Camp at Sorby Hills and a bore on camp provided water for showers and washing. Supplies were brought by road from Kununurra.

The station owner at Spirit Hill gave permission for the use of the airstrip. This proved useful at the time of mobilization and for flying in urgently needed spares. Other airstrips in the area have been declared out of bounds by the government.

Velocity control for static corrections was computed from data acquired by means of a concurrent uphole drilling and refraction (LVL) programme.

(2) LINE CLEARANCE

Lines were cleared using two bulldozers; a Fiat Allis 14C and a Caterpillar D8. The Fiat Allis was for a time replaced by a Caterpillar D6.
The bulldozers were set off and kept on course by the surveyors who carried out daily sunshots for this purpose.
During cutting the operator maintained course by sighting on survey pegs aligned for him by his assistant.
Each bulldozer was backed up by the assistant driving a four-wheel drive vehicle.
A grader was used to finish off the cut lines and maintain access tracks.
It was found that while most trees could be removed by machines the size of the D6, it was advisable to keep the D8 for the occasions where heavy timber impeded progress.
The plant and operators were supplied by sub-contractors as follows:-

Bulldozer	-	Fiat AD12	Morningside Trust
Bulldozer	-	Caterpillar D6	Kununurra Earthmoving Co.
Bulldozer	-	Caterpillar D8	Mining & Exploration Service
Grader	-	Caterpillar 12E	R. Shattock
Grader	-	Caterpillar 12E	Kununurra Earthmoving Co.,

(3) SURVEYING

An advance survey crew commenced work directing line clearance in the area on the 14th July, 1981. The full survey crew started on the 16th August, 1981.

Sunshots, bearings and elevations were obtained using a Wild T1A Theodolite. Horizontal measurements, e.g. station intervals were made with a Topofil survey measure, the cotton being broken every 500 metres to eliminate any chance of errors caused by stretch. This method was checked every three days against a base line laid by survey chain.

Stations were identified with painted wooden pegs which were left in situ.

Permanent markers consisting of steel 'star pickets' with affixed aluminium survey tags stamped with line and vibrator point numbers were established at the ends of each line, at 5km intervals and/or at line intersections. These locations are listed in Appendix 4.

Topographic maps used for this area were the 1:100,000 scale National Mapping Sheets "Legune" and "Carlton."

All adjusted elevations were sent to the Processing Centre. Copies of the field survey notes were sent to Westralian Computer Consultants Pty. Ltd., to provide:-

(i) 1:100,000 Vibrator Point Location Map (See Enclosure 1).

(ii) 1:50,000 Vibrator Point Location Map.

(iii) 1:100,000 Horizontal Loop Closure Map (See Enclosure 2).

(iv) 1:100,000 Vertical Loop Closure Map

SURVEYING Cont/...

For the purposes of horizontal control several known points in the area were incorporated into the 1981 survey. At the southern end of line BNT 81-308, VP 100 was tied to BM number 3 which is approximately 10 metres from VP 100 star picket on the Legune track. This point was also tied to a government station (No. 4) 5kms to the east along the Legune track.

At the eastern end of line BNT 81-307 station 337 was tied to Australian Aquitaine Petroleum bench Mark No.1. At the intersection of line BNT 80-204 and BNT 81-302, the permanent marker was tied to government station M60N.

A traverse run from M60N to AAP1 along the 1981 survey produced a misclosure of minus 35 metres in northing and minus 42 metres in easting over a total distance of 18, 778 metres giving a relative error of 1 to 340. This traverse, and loop closures, within the 1981 survey were to a reasonable standard of accuracy. However, many of the 1981 survey lines were not closed by loops other than by using 1980 or earlier surveys. As there is a discrepancy between 1981 survey and previous surveys it was not possible to do loop closures to any degree of accuracy with these lines.

Traverses and loop closures were run using an EDM provided by the Client.

Co-ordinates common to the 1981 survey and previous surveys are presented in Appendix 4, as an indication of the degree of mistie between the two surveys. This list is for information only. These values have not been incorporated into the 1981 survey.

SURVEYING Cont/...

Co-ordinates of trigs:-

M60N	499,909.95E	8,304,774.58N
AAP3	515,691 E	8,313,678 N (Decca-provisional)
AAP1	511,636.2 E	8,313,713.8N

(4) RECORDING

Recording commenced in the area on the 16th August, 1981 with a noise analysis and array comparisons on line BNT 81-302 near the intersection with line OC8 and, array comparisons near the intersection of BNT 81-302 and 305. These two sites were chosen for their difference in data quality apparent from previous surveys.

Record quality was generally fair.
Field monitor paper records were made about every fifth vibrator point to check on data quality.
Daily tests were made on the recording instruments and vibrator electronics. More extensive tests were made on a monthly basis, the recorded tapes of which were sent to the Processing Centre of Horizon Exploration Limited and the crew informed of the results.
The field tapes, monitor records and static corrections were sent to Digicon Processing Centre in Singapore.

During the period 16th - 30th August the recording crew encountered an abnormal amount of equipment failures, delaying the completion of the experimental programme. These failures were largely attributed to the rough passage suffered by the recording truck during mobilisation.

(5) DRILLING

Drilling on the uphole and LVL survey commenced on the 24th August, 1981. The drill used for a Mayhew 1000 mounted on a Magirus Deutz 6 x 6 truck accompanied by a truck mounted compressor with a capacity of 450 cfm and a Toyota 4 x 4 back-up vehicle.

Drilling was mostly in sandstone throughout the area. The sandstone varied in consistency, the hardest causing some impedance to drilling progress. Clay was evident in small amounts throughout the area but in the north it was more predominant. The water level varied from 25 to 50 feet, the deeper levels being found in the areas of thicker clay beds.

In the area east of the Keep River the very hard sandstone gave many problems and of the five upholes attempted only one was successfully drilled.

(6) LVL AND UPHOLES

The LVL spread cable was laid between two shot holes and shot into from both directions. The holes were drilled to kelly depth (6m) and loaded with 2kg of Anzite Blue. The distance between shot holes was changed during the survey as follows:-

450m length
Lines BNT 81-300,302,303,304,306 and part 301
300m length
Lines BNT 81-301 (part) 305,307,308,309, 311 and 313.

The initial target depth for upholes was 60 metres but this was reduced to 55 metres. Charges were detonated at 5 metre intervals up the hole to the 15 metre level and thence at 12,9,6 and 3 metre levels. The charges used were ICI Anzomex "D" boosters.

Depth/time plots were made and used by the computer for velocity calculations. All original records and plots were submitted to the Client.

(7) COMPUTING

Static corrections were computed for each station using adjusted elevations obtained from the surveyors and velocities obtained from the uphole and LVL operations.
The existence was noted of an intermediate velocity, thus giving rise to the application of a three layer case. For this reason the standard formula was expanded from:-

$$\text{Total Static (ms)} = \frac{E - dw}{Ve} + \frac{dw}{Vw}$$

to

$$\text{Total Static (ms)} = \frac{E - dw2}{Ve} + \frac{dw2 - dwl}{Vw2} + \frac{dwl - dw}{Vwl} + \frac{dw}{vw}$$

Where E = elevation (m)
dw = weathering depth (m)
dwl = weathering depth (m) of 1st intermediate layer
dw2 = weathering depth (m) of 2nd intermediate layer
Ve = elevation velocity (m/sec)
Vw = weathering velocity (m/sec)
Vwl = weathering velocity (m/secs) 1st intermediate layer
Vw2 = weathering velocity (m/secs) 2nd intermediate layer

Datum chosen was Mean Sea Level (AHD).

The elevation velocity (Ve) was regarded as a constant 3000 m/sec.
The weathering velocity (Vw) ranged from 500-1000 m/sec
The intermediate velocities (Vwl-Vw2) ranged from 1000-2800 m/sec.

COMPUTING Cont/...

Weathering depths (dw) computed were between 2-15 metres but generally were 4-6 metres. Secondary depths (dw_1) and (dw_2) varied from 10-71m but generally dw_1 was approximately 20 metres and dw_2 was 40 metres.

The sub-surface coverage and static correction sheets (stacking diagrams) were completed on the crew and submitted to the Processing Centre.

The following formulae were used to calculate weathering depths:

1. For a shot in the first layer

If $Vo < V1 < V2$

$$ZO = \frac{Vo \quad I1}{2\cos\theta 01} + \frac{P}{2} \quad (Vo \backsimeq \frac{P}{\text{Vertical time}})$$

$$Z1 = \frac{V1}{2\cos\theta 12} I_2 - \frac{I1 \cos\theta 02}{\cos\theta 01}$$

where
- I1 = intercept time of velocity V1
- Vo = velocity of the first layer
- I2 = intercept time of velocity V2
- V1 = velocity of the 2nd layer
- V2 = velocity of the 3rd layer
- P = hole depth
- $\sin\theta 01$ = Vo / V1
- $\sin\theta 02$ = Vo / V2
- $\sin\theta 12$ = V1 / V2

2. For a shot in the second layer

If $Vo < V1 < V2$

$$ZO = \frac{Vo \quad I1}{\cos\theta 01} \quad (\text{If } P \backsimeq Zo \quad Vo = \frac{P}{\text{Vertical time}})$$

$$Z1 = 1/2 \left[\frac{V1}{\cos\theta 12} \left(I_2 - \frac{Zo \cos\theta 02}{Vo} \right) - Zo + P \right]$$

(notation as for shot in 1st layer)

COMPUTING (Cont)

Depths were computed separately for each end-on shot and then interpolated across spreads and between spreads.

Weathering depths were plotted to produce layer profiles and complete static contour maps were produced in order to interpolate for areas of missing values or for results of dubious reliability.

Expected discrepancies occurred between the vertical uphole velocities and LVL velocities but total statics tied well. Line intersections all tied to within 5ms.

The sub-surface coverage and static correction sheets (stacking diagrams) were completed on the crew and submitted to the Processing Centre.

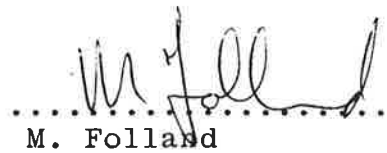
(8) CONCLUSIONS AND RECOMMENDATIONS

With the parameters used recording production can be maintained at a rate of 4.5 kilometres per day. As this is higher than the line clearance average a sufficient lead time is needed for the line clearance crews.

The existence of heavy timber in the area requires the presence of earthmoving equipment the size of the Caterpillar D-8.

The apparent need of almost total LVL coverage in addition to an uphole programme should be met by a crew of greater strength, in both personnel and vehicles, than that originally perceived.

This report is respectfully submitted by



.....
Richard R. Pearce
(Manager - Australia)

.....
M. Folland
(Operations Supervisor)

for & on behalf of HORIZON EXPLORATION (INTERNATIONAL) LTD.,

APPENDIX 1

(1) Personnel

Party Chief	K. Darbyshire
Computer	B. Adair,
	P. Langley
Observers	D. Underwood,
	P. Farrington
Assistant Observers	T.J. Lim,
	R. Chinniah
LVL Observer Computer	M. Seman, K. Cunniffe
Surveyors	R. Barter,
	A. Radich, B. Cooper
Vibrator Technicians/ Mechanics	J. Andre, F. Newland, P. Caudwe
Vibrator Operators	6
Helpers	20
Drillers	G. Filby, C. Leitch

(11) Equipment

(a) Recording

Geosource MDS-10 recording instruments 48 channels at 2ms sampling.
Geosource SMM-1 summer with 48 channels.
Maximum record length at 2ms is 21 seconds.
Geosource DC2400 correlator.
Geosource RCV 310A Vibrator electronics.
Geosource SDW 400B electrostatic camera.
Motorola Micor 50 watt 4 channel radios.
Input/Output roll along switch.
Geosource line tester.
40 De Regt land cables with 3 take-outs at 75m per cable, 110 conductor for 48 trace operation.
500 Strings of Sensor SM-4, 10Hz digital grade geophones each string consisting of 6 geophones at 10m interval.

(b) Vibrating

4 Failing Y1100 vibrators mounted on Industrial Vehicle International Birdwagon Mk111 centre pivot buggies.
4 Geosource SHV310A vibrator electronics.
4 Motorola Micor 50 watt, 4 channel radios.

(c) Uphole/Refraction

OYO 24 trace recorder.
3 De Regt 12 trace refraction cables.
30 Sensor single geophones.

(d) Surveying

2 Complete sets of survey equipment including Wild T1A Theodolites.
Additional Equipment = EDM

(e) Drilling

1 Magirus 6 x 6 truck.
1 Airdrill 450 cfm compressor.

(lll) Vehicles

Office	1 Station Wagon.
Survey	2 Utilities.
Recording	1 truck with air-conditioned recording cab.
	3 Geophone utilities.
	1 Cable Truck.
	1 LVL/UH Utility.
Vibrating	4 Birdwagon Mklll centre-pivot buggies.
	1 Line workshop truck.
	1 Utility.
Workshop	1 Camp workshop truck
	1 Utility.
Supply/Water	3 13 ton trucks
Drilling	1 Utility

(All vehicles are 4 x 4)

APPENDIX 2

Statistics

Commencing Dates:

Surveying	14th July, 1981
	17th August, 1981
Line Clearance	14th July, 1981
	17th August, 1981
Drilling	14th August, 1981
Recording	16th August, 1981

Completion Dates:

Line Clearance	5th August, 1981
	27th August, 1981
Surveying	5th August, 1981
	27th August, 1981
Recording	1st October, 1981
Drilling	3rd October, 1981

From 6th-17th August Survey and Line Clearance crews operated in EP. 126.

Recording

Recording Hours	307.28
	includes 15 hours experimental
Total Travel Time (hours)	37
Total Down Time (hours)	156.5
Total Number of VP's	2575
Total Surface Coverage (kms)	128.75
Average Surface Coverage per 10 hour day	3.9

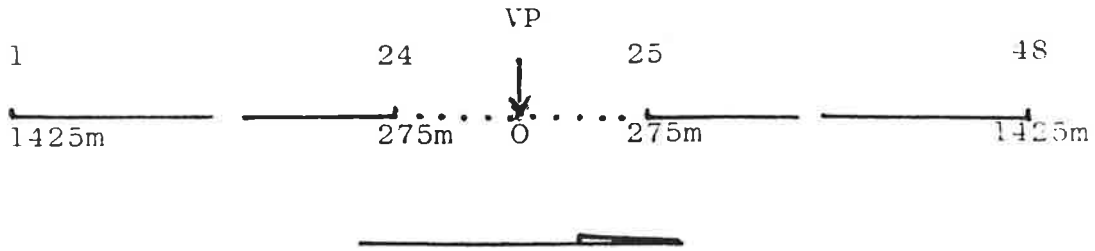
APPENDIX 2 Cont/...

Drilling

Kelly Depth Holes	-	total	272
	-	footage	660
	-	hours	138
Upholes	-	total	15
	-	footage	2688
	-	hours	107
Total Travel Time	-	hours	33
Camp Work	-	hours	35½

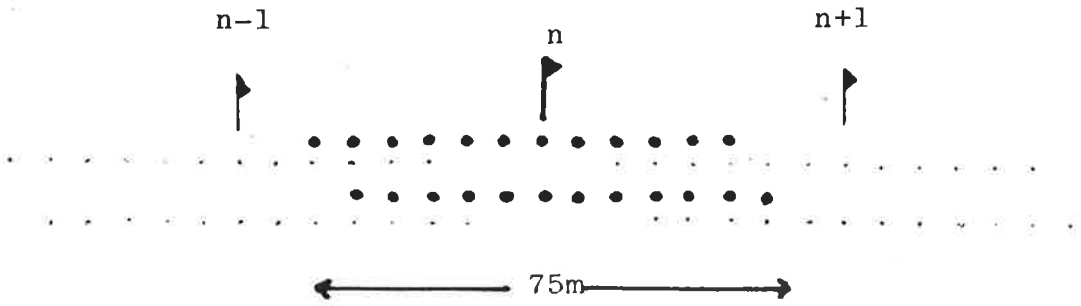
APPENDIX 3 (i)

SPREAD DIAGRAM — 50m Station Interval. Vibrator Point Midway Between Geophone Stations.

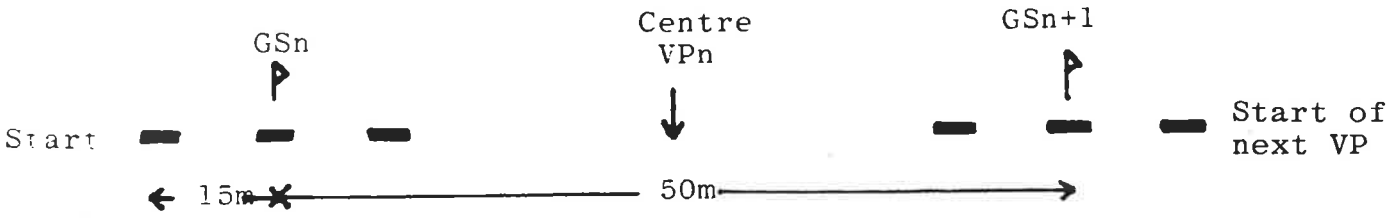


direction of progress

GEOPHONE ARRAY — 24 geophones, in-line ~~6.25~~ 3.125m interval



VIBRATOR ARRAY — Centre of array midway between geophone station
Vibrator point number (VPn) is same as preceding
Geophone Station (GSn)



Direction of Progress

AQUISITION PARAMETERS - BNT 81

LINES BNT 81-	SOURCE PARAMETERS						SPREAD PARAMETERS			
	Sweep * Length(s)	Sweep (Hz) f1	Sweep (Hz) f2	Sweeps per VP	Move up (m)	Vib. interval (m)	Station interval (m)	Central gap (m)	Geophones weighted array	Geophone interval (m)
302 VP 429-391	12	10	60	12	4.16	15	50	2 x 275	1,2,2,2,2,2,2,2,2,2,2,2,1	6.25
302 (VP 390-106) 300, 304, 306	12	12	60	12	4.16	15	50	2 x 275	"	6.25
307 (VP 100-205)	15	12	60	10	5	15	50	2 x 275	"	6.25
307 (VP 206-244)	15	14	60	10	5	15	50	2 x 275	"	6.25
307 (VP 245-336) 301,303, 305,308, 309,311, 313	15	13	60	10	5	15	50	2 x 275	"	6.25

* Does not include 4 seconds listening time

Parameters common to all lines :

Sample Rate 4ms Gain Mode IFP
Tape Format SEG B, 800 BPI, NRZI

Filters - Lo cut - 9 Hz 18db /Octave
- Hi cut -62.5 Hz Anti - Alias

Appendix 3 (ii)

APPENDIX 4

PERMANENT MARKERS

Line BNT 81/300

	Height (m)	Co-ordinates	
VP 100	31.29	500540E	8308946N
VP 121 + 3M (int. 80/201)	32.87	500972E	8309906N
VP 178 +13m (int. 80/202)	34.69	502147E	8312514N
VP 205 +47m (int. 81/305)	40.70	502715E	8313776N
VP 232 +28m (int. 81/307)	33.08	503262E	8314989N
VP 310 (end of line)	29.20	504852E	8318520N

Line BNT 81/302

VP 106 (start of line)	68.44	499659E	8303179N
VP 124 +10m (int. 81/301)	57.48	600039E	8304026N
VP 150 (int. 80/204)	41.80	500616E	8305155N
VP 174 +41m (int. 81/303)	38.83	501094E	8306311N
VP 220	28.57	502066E	8308349N
VP 302 + 7m (int. 80/202)	31.82	503749E	8312106N
VP 328 + 2m (int. 81/305)	33.98	504290E	8313285N
VP 354 +46m (int. 81/307)	28.99	504850E	8314508N
VP 430 (end of line)	21.51	506416E	8317925N

Line BNT 81/304

VP 100	25.17	504086E	8308914N
VP 144 +14m (int. 80/203)	26.31	504998E	8310933N
VP 185 +23m (int. 81/305)	30.03	505846E	8312810N
VP 212 +20m (int. 81/307)	26.32	506400E	8314038N
VP 246 (end of line)	20.50	507092E	8315570N

LINT BNT 81/306

		Height (m)	Co-ordinates	
	VP 100	64.05	502465E	8302657N
	VP 115 (int. 81/301)	55.51	502777E	8303341N
	VP 140 (int. 81/204)	42.57	503285E	8304484N
	VP 165 +27m (int. 81/303)	36.01	503828E	8305646N
	VP 207 +25m (int. 81/203)	26.47	504700E	8307560N
	VP 292 +19m (int. 81/202)	27.03	506465E	8311432N
	VP 315 (int. 81/305)	36.48	506938E	8312472N
	VP 341 +42m (int. 81/307)	31.05	507494E	8313686N
	VP 424 (end of line)	17.10	509202E	8317435N

Line 81/301

*	VP 100	49.10	494165E	8305436N
	VP 231 + 7m (int. 80/201)	57.86	500537E	8303864N
	VP 308 (int. 80/203)	46.06	504272E	8302942N
	VP 384 +22m (int. 80/205)	21.86	507986E	8302025N
	VP 402 (end of line)	19.57	508839E	8301815N

Line BNT 81/303

*	VP 100	49.79	493859E	8308054N
*	VP 131 +16m (int. BWA 81/205)	49.25	495379E	8307688N
	VP 166 + 5m (int. BWA 80/107)	40.31	497066E	8307281N
	VP 241 +34m (int. 80/201)	35.50	500733E	8306398N
	VP 319 +12m (int. 80/203)	34.35	504496E	8305491N
	VP 360 (end of line)	22.94	506474E	8305015N

* These points located in BWA 81 programme area.

LINE BNT 81/305

		Height (m)	Co-ordinates	
VP 100		53.00	499442E	8314768N
VP 138 +19m	(int. 80/201)	44.09	501279E	8314204N
VP 219 +33m	(int. 80/203)	37.13	505171E	8313009N
VP 304	(int. 80/205)	24.57	509209E	8311770N
VP 320	(end of line)	19.52	509975E	8311535N

LINE BNT 81/307

VP 100		36.44	499093E	8316264N
VP 148	(int. 80/201)	48.14	501390E	8315563N
VP 299 +15m	(int. 80/203)	30.35	505281E	8314377N
VP 287 + 3m	(int. road)	33.40	508046E	8313534N
VP 315 +33m	(int. 80/205)	28.71	509414E	8313116N
VP 335	(end of line)	22.40	510340E	8312834N

LINE BNT 81/308

VP 100		16.20	515692E	8298078N
VP 174 +39m	(int. 81/309)	15.75	515983E	8301806N
VP 214 +36m	(int. 81/311)	15.27	516138E	8303796N
VP 255 +18m	(int. 81/313)	14.96	516296E	8305822N
VP 289	(end of line)	14.04	516427E	8307499N

LINE BNT 81/309

VP 100	(int. 80/207)	17.33	513982E	8302244N
VP 225	(end of line)	15.49	520086E	8300901N

LINE BNT 81/311

	Height (m)	Co-ordinates	
VP 100	14.54	509541E	830524
VP 150	15.75	511983E	830470
VP 193 +28m (int. 80/207)	15.42	513176E	830424
VP 328 (end of line)	13.71	520679E	830281

LINE BNT 81/313

VP 100	18.80	510431E	830713
VP 178 +26m	14.45	514265E	830629
VP 255	13.33	518000E	830547

Notes:

Star picket at VP 150 on line BWT 81/302 is also the same picket as the one at the intersection of old lines BNT 80/204 and BNT 80/201.

Star picket at VP 100 on line BNT 81/309 is the same marker used at the intersections of old lines BNT 80/207 and BNT 80/204.

APPENDIX 4 (ii)

CO-ORDINATE COMPARISONS OF 1981 AND PREVIOUS SURVEYS

STATION	1981	PREVIOUS	(M)
81-302 VP 150	N8305155	N8305083	+72
	E 500616	E 500605	+11
81-302 VP 240	N8306407	N8306433	-26
	E 500630	E 500616	+14
81-224 VP 135	N8309905	N8309939	-34
	E 493884	E 493702	+182
81-304 VP 165	N8311877	N8311711	+166
	E 505419	E 505354	+65
81-309 VP 100	N8302244	N8302042	+202
	E 513982	E 513870	+112

APPENDIX 5
UPHOLE LOCATIONS