COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Petroleum Search Subsidy Acts

PUBLICATION No. 66

Planet Warrinilla North No. 1 Well Queensland

OF

PLANET EXPLORATION COMPANY PTY LTD

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Minister for National Development
1965

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.

SECRETARY: R. W. BOSWELL

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: J. M. RAYNER

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FOREWORD

Under the Petroleum Search Subsidy Act 1959-1961, agreements relating to subsidized operations provide that the information obtained may be published by the Commonwealth Government six months after the completion of field work.

The Bureau of Mineral Resources, Geology and Geophysics is required, on behalf of the Department of National Development, to examine the applications, maintain surveillance of the operations, and in due course prepare the reports for publication. The growth of the exploration effort has greatly increased the number of subsidized projects and this increase has led to delays in publishing the results of operations.

The detailed results of subsidized operations may be examined at the offices of the Bureau of Mineral Resources in Canberra (after the agreed period) and copies of the reports may be purchased.

Planet Warrinilla North No. 1 was drilled under the Petroleum Search Subsidy Act 1959-1961, in Authority to Prospect 100P, Queensland. The well was located at latitude 24°52'49" S., longitude 148°31'50" E., about 32 miles south of Rolleston, and was drilled for Planet Exploration Company Pty Ltd by Delta Drilling Company of Brisbane, using a National 55 drilling rig.

This Publication deals with the results of this drilling operation, and contains information furnished by Planet Exploration Company Pty Ltd and edited in the Petroleum Exploration Branch of the Bureau of Mineral Resources. The final report was written by N.A. Meyers, of Cundill, Meyers and Associates, in November, 1963. The methods employed in the drilling operation and the results obtained are presented in detail.

J.M. RAYNER
DIRECTOR

CONTENTS

	Page
SUMMARY	1
INTRODUCTION	3
WELL HISTORY	4
General data	4
Drilling data	5
Logging and testing	7
GEOLOGY	
Summary of previous work	20
Summary of regional geology	21
Stratigraphy	23
Stratigraphic table	23 - 24
Quaternary	25
Triassic	25
Rewan Formation	25
Permian	27
Bandanna Formation	27
Mantuan Productus Bed	30
Catherine Sandstone	31
Ingelara Formation	33
Aldebaran Sandstone	36
Cattle Creek Formation	46
Pre-Cattle Creek beds	49
Structure	50
Occurrence of hydrocarbons	51
Porosity and permeability of section penetrated	55
Contributions to geological concepts resulting from drilling	58
REFERENCES	59

CONTENTS (Cont'd)

Page

APPENDICES

Appendix 1: Core descriptions 61

Appendix 2: Core analyses, by Core Laboratories, Inc. 79

Appendix 3: Reports on drillstem tests, by Halliburton Company 91

Appendix 4: Gas analyses, by Queensland Government Chemical Laboratory 104

Appendix 5: Water analyses, by Queensland Government Chemical Laboratory, and Core Laboratories, Inc. ... 108

Appendix 6: Well velocity survey, by H.A. Lukowitch 110

Appendix 7: Daily mud properties 115

Appendix 8: Palynological report, by P.R. Evans 117

Appendix 9: Additional data filed in the Bureau of Mineral Resources ... 125

ILLUSTRATIONS

FIGURES

Figure 1: Locality and geological map ... Frontispiece

Figure 2: Geological cross sections before and after drilling Warrinilla North No. 1 ... Opposite p. 50

Figure 3: Shooting plan, well velocity survey ... 111

Figure 4: Diagrammatic cross section, well velocity survey 113

Figure 5: Uphole velocity survey, Warrinilla North No. 1 ... ... Opposite p. 114

Figure 6: Time-Depth curves, well velocity survey... Opposite p. 114

PLATES

Plate 1: Composite Well Log (3 Sheets) ... At back of report

148°10′ 148°30′ 148°50′

SPRINGSURE BARALABA Rolleston Fig. 1

Springwood

Meteor C

A.O.E.N°3 (CONSUELO)

COMET R

Consuelo C

24°40′ 24°40′

A.O.E.N°1 (REIDS DOME)

A.O.E.N°2 (REIDS DOME)

WARRINILLA NORTH N°1

△ MT CARNARVON

Warrinilla

Carnarvon C

Wyseby

Ingelara

100 P

TAROOM

Area B

MORELLA N°1

Lake Nuga-Nuga

Moolayember C

25°00′ EDDYSTONE 25°00′

Bandanna

WARRINILLA N°1

Brown R

A.A.O.N°7 (ARCADIA)

25°20′ 148°10′ 148°30′ 25°20′ 148°50′

GEOLOGICAL MAP OF WARRINILLA AREA

Reference

QUATERNARY — Alluvium

TERTIARY — Volcanics

TRIASSIC–JURASSIC — Bundamba Group

TRIASSIC — Moolayember Formation; Clematis Sandstone; Rewan Formation

PERMIAN — Bandanna Formation; Catherine Sandstone; Ingelara Formation; Aldebaran Sandstone; Cattle Creek Formation

F—F Fault

Petroleum tenement boundary

Boundary of 1:250,000 sheet areas

Highway

Geological boundary

Anticline showing plunge

Syncline showing plunge

O Well location

5 0 5 10

MILES

After SHELL (Qld.) DEVELOPMENT PTY LTD

MK

SUMMARY

Planet Warrinilla North No. 1 Well was located approximately 32 miles south of Rolleston, and about 16-1/2 miles north of Planet Warrinilla No. 1 Well. The site was determined from an analysis of seismic data and was located on a culmination on the northern plunge of the Warrinilla Anticline in the Bowen Basin. Based on seismic control near the top of the Ingelara Formation, this structure is believed to have 120 feet of closure and an areal extent of six square miles.

Drilling operations at Warrinilla North No. 1 were carried out between 28th July and 8th October, 1963, after which production casing was set and further testing was undertaken between 10th-25th October. A full programme of logging, testing, and coring was carried out.

The well passed through the Triassic Rewan Formation, and Permian beds which included the Bandanna Formation, Mantuan Productus Bed, Catherine Sandstone, Ingelara Formation, Aldebaran Sandstone, and Cattle Creek Formation. The well bottomed in the pre-Cattle Creek fresh water beds at a depth of 6879 feet, and was abandoned on 25th October, 1963.

A number of gas shows were encountered in the well and although none of these proved commercial, much information was gathered both from the drilling of the well and from the evaluation testing that followed. A total of 23 drillstem tests was run. However, four of these were misruns. A maximum gas recovery of 162,000 cubic feet per day was obtained from the Aldebaran Sandstone.

The well was drilled by Delta Drilling Company using a National 55 rig. Technical control at the well site was provided by N.A. Meyers of Cundill, Meyers and Associates, mud logging by Core Laboratories, Inc., and electrical logging by Schlumberger Seaco Inc.

The test drilling operation at Planet Warrinilla North No. 1 was subsidized under the Petroleum Search Subsidy Act 1959-1961, from surface to total depth.

INTRODUCTION

Warrinilla North No. 1 was drilled in the Bowen Basin, approximately 32 miles south of the town of Rolleston in south-eastern Queensland. The well was drilled by Planet Exploration Company Pty Ltd on Authority to Prospect 100P, Queensland, and received Commonwealth Government subsidy under the terms of the Petroleum Search Subsidy Act 1959-1961.

The site was located by seismic methods and the objective was to test porous horizons on a culmination on the northern plunge of the Warrinilla Anticline.

This location was 16-1/2 miles north of, and down dip from, Warrinilla No. 1, where significant gas and oil shows were encountered, associated with poor to rarely fair porosity and poor permeability in the Permian. It was hoped that Warrinilla North No. 1 Well would encounter thicker sandstone sections and better porosity and permeability. The well was scheduled to bottom approximately 200 feet below the top of the pre-Cattle Creek fresh water beds, at a depth of about 5500 feet.

The well, which reached a total depth of 6879 feet, was drilled with a National 55 rig, operated by Delta Drilling Company. It spudded in at 4:00 am, 28th July, 1963, and passed through Rewan Formation of Triassic age to a depth of 1704 feet, and then through the Bandanna Formation, Mantuan Productus Bed, Catherine Sandstone, Ingelara Formation, Aldebaran Sandstone, and Cattle Creek Formation and bottomed in pre-Cattle Creek beds, all of Permian age. Drilling ceased on 8th October, 1963, after which a string of 5-1/2" casing was set and evaluation tests conducted. Gas detection equipment was used continuously throughout the drilling of the well.

A 12-1/4" surface hole was drilled to 547 feet; it was reamed out to 17-1/2" and 13-3/8" casing cemented at 543 feet. An 8-3/4" hole was drilled from there to total depth. First run Electric Log, Microlog-Caliper and Gamma-Sonic logs were run at 3376 feet. Second runs of Electric Log and Microlog-Caliper were run at 4579 feet. Third runs of Electric Log and Microlog-Caliper as well as a second run of Gamma-Sonic logs were run at total depth 6879 feet. A Velocity Survey and Dipmeter Survey were run at total depth.

A total of 35 cores was cut, twelve with a conventional 7-7/8" hard formation core head and 23 with a Truco 6-1/8" diamond core head. Of the twelve conventional cores, four were short, having been cut on going in to recover the previous core.

Twenty-three drillstem tests were run, four of which were misruns. Two were run in the coal unit of the Bandanna Formation, one in the Mantuan Productus Bed, two in sands of the Ingelara Formation, thirteen in the Aldebaran Sandstone, and one in the Cattle Creek Formation.

The well was plugged back to 5780 feet and 5-1/2" casing set at 5706.89 feet, and cemented to 2960 feet.

The following zones of the Aldebaran Sandstone were perforated and tested:

5616	-	5520 feet
4548	-	4526 feet
4100	-	4047 feet

All three zones were exhaustively tested using a clean-out acid treatment on each zone as well as hydraulic fracturing on one interval to see what effect artificial stimulation would have on the formation. Results of all three tests were disappointing, as no improvement of gas flow was obtained.

The well was abandoned by setting a cement plug at 850 - 1000 feet, and the rig was released on 30th October, 1963.

WELL HISTORY

General Data

Well name and number:	Planet Warrinilla North No. 1
Location:	Latitude 24°52'49" South, Longitude 148°31'50" East, in the county of Moolayember in the State of Queensland
Name and address of Tenement Holder:	Planet Exploration Company Pty Ltd
Details of Petroleum Tenement:	Authority to Prospect 100P, Queensland, held by Planet Exploration Company Pty Ltd, and expiring 1st January, 1969.
District:	Rolleston, Queensland
Total Depth:	6879 feet (Schlumberger), 6873 feet (Driller)
Date drilling commenced:	28th July, 1963
Date drilling completed:	8th October, 1963
Date well abandoned:	25th October, 1963
Date rig released:	30th October, 1963
Drilling time to total depth:	73 days
Elevation (ground):	1020 feet
Elevation (K.B.):	1036 feet (datum for all measurements)
Status:	Abandoned
Cost:	£138,524

Drilling Data

Name and address of drilling contractor:	Delta Drilling Company, Brisbane, Queensland	
Drilling Plant:		
Make:	National-Ideal	
Type:	55	
Rated capacity with 4-1/2" drill pipe:	9000 feet	
Motors:	Three Superior PTD6, 325 HP. diesels	
Mast:		
Make:	Lee C. Moore	
Type:	131 Heavy Duty	
Rated capacity:	550,000 lb.	
Pumps:		
Make:	National-Ideal C350	7 3/4" x 18" (one)
	Gardner-Denver FXQ	7 3/4" x 16" (one)
Motors:	Rig motors	
Blowout Preventer Equipment:		
Make:	Hydril	Cameron
Model:	GK	SS
Size:	12"	12"
Working pressure:	3000 psi.	3000 psi.
Hole size and depths:	12 1/4" to 547 feet reamed out to 17 1/2"; 8 3/4" to 6879 feet	
Casing details:		
Size (in.):	13 3/8	5 1/2
Weight (lb./ft):	48	17
Grade:	H.40	J.55
Range:	2	2
Depth (ft):	543	5707
Casing and Liner cementing details:		
	1st Str.	2nd Str.
Size (in.):	13 3/8	5 1/2
Setting depth (ft):	543	5707
Sacks cement used:	400	815
Rise of cement behind casing:	surface	2960 ft

Drilling Fluid:

Type: Water-base bentonite mud

Chemicals used in treatment: Bicarbonate of soda, C.M.C., Lovis, Caustic Soda, Lignosulfonate (LS_{22}), and barytes

Average weekly mud properties are given below :

Week	Depth (feet)	Weight (lb./gal.)	Viscosity (sec./1000 cc)	Water Loss (cc/30 mins)	pH	Filter Cake Thickness (1/32")	Sand Content (%)
1st	2264	9.8	46	6.6	8.8	2	1/2
2nd	3281	10.0	48	5.1	9.1	1	3/4
3rd	3885	10.5	66	5.3	8.5	2	1
4th	4343	10.7	68	5.3	8.4	2	1 1/4
5th	4644	11.0	65	5.0	8.6	2	1
6th	5071	10.5	63	5.4	8.3	2	1/2
7th	5435	10.7	59	5.8	8.2	2	3/4
8th	5825	10.8	66	5.8	8.0	2	3/4
9th	6331	10.8	72	5.6	8.3	2	3/4
10th	6819	11.0	57	6.5	8.5	2	5/8
11th	6873	11.0	65	6.0	8.4	2	1/2

For a daily record of mud properties see Appendix 7.

Water supply: Water was hauled by tank truck from Carnarvon Creek to the well, a distance of about six miles.

Perforation and shooting record:

5609 - 5616 feet
5590 - 5592 feet
5581 - 5585 feet
5548 - 5563 feet
5520.5 - 5528 feet
4538 - 4548 feet
4526 - 4532 feet
4087 - 4100 feet
4077 - 4081 feet
4066 - 4070 feet
4047 - 4062 feet

Note: All perforations were 4 x 1/2" shaped charge shots per foot.

Plugging back and squeeze cementation jobs:

	Interval (feet)	Length (feet)	Sacks of Cement
Plug back	5800-5900	100	60
Abandonment plug in 5-1/2" casing	850-1000	150	20

Baker bridge plugs were set in the 5-1/2" casing at 4188 feet and 4589 feet.

Baker cement retainers were set at 5575 feet and 5589 feet.

The following squeeze cementation jobs were conducted in the 5-1/2" casing:

Depth of perforations (feet)	Sacks cement squeezed	Pressure (psi.)
5590 - 5592 and 5609 - 5616	25	3500
5581 - 5585	40	2600

Fishing operation: Twisted off six drill collars at total depth; recovered same.

Side-tracked hole: Nil

Logging and Testing

Ditch Samples:

Interval: Samples were collected every 10 feet from surface to total depth. Each sample was described and checked for hydrocarbon shows. Drilling breaks were circulated up and bottom-hole circulation samples obtained before tripping. Cuts were distributed to the Bureau of Mineral Resources, the Queensland Mines Department, and Planet Exploration Company Pty Ltd.

Coring: A total of 35 cores was cut as follows :

Core No.	Interval (feet)	Feet Cut	Recovery (feet)	Recovery (%)	Type of Core Head
1	547- 560	13	13.0	100	Conventional HF
2	560- 562	2	1.8	90	Conventional HF
3	1068-1075.5	7.5	7.5	100	Conventional HF
4	1580-1590	10	9.5	95	Conventional HF
5	1590-1592	2	0.0	0	Conventional HF
6	2010-2020	10	1.3	13	Conventional HF
7	2020-2022	2	0.0	0	Conventional HF
8	2038-2048	10	9.8	98	Conventional HF
9	2410-2420	10	6.6	66	Conventional HF
10	2420-2422	2	1.5	75	Conventional HF
11	2718-2728	10	10.0	100	Conventional HF
12	2956-2991	35	34.6	99	Diamond
13	3281-3291	10	9.8	98	Conventional HF
14	3361-3371	10	10.0	100	Diamond
15	3600-3610	10	10.0	100	Diamond
16	3780-3800	20	20.0	100	Diamond
17	3813-3844	31	29.0	93.6	Diamond
18	3990-4016	26	26.0	100	Diamond
19	4030-4052	22	21.3	97	Diamond
20	4062-4101	39	39.0	100	Diamond
21	4333-4343	10	10.0	100	Diamond
22	4534-4542	8	7.5	93.8	Diamond
23	4543-4553	10	10.0	100	Diamond
24	4606-4616	10	10.0	100	Diamond
25	4696-4716	20	20.0	100	Diamond
26	4812-4822	10	10.0	100	Diamond
27	5064-5088	24	24.0	100	Diamond
28	5303-5313	10	8.8	88	Diamond
29	5367-5381	14	14.0	100	Diamond
30	5390-5414	24	24.0	100	Diamond
31	5528-5554	26	26.0	100	Diamond
32	5781-5806	25	25.0	100	Diamond
33	6237-6247	10	10.0	100	Diamond
34	6703-6713	10	9.0	90	Diamond
35	6839-6873	34	32.0	94.1	Diamond

Samples of the cores were distributed to the Bureau of Mineral Resources, and some plugs taken for core analysis and fracturing studies. The remainder were sent to the Queensland Mines Department.

Sidewall Sampling:

Sidewall cores were cut at the following depths :

Depth (feet)	Recovery (in.)
3024	1-3/4
3026	2
3363	1-1/2
3386	1-1/2
4202	1/2
5523	1/2
5526	1
5559	1/2
5562	0
5582	1-1/4
5584	1-1/4
5591	1-1/4
5612	1-1/4
5614	0
5619	1-1/2
5638	3/4
5763	3/4
5773	0
6741	3/4
6798	2

The last two cores were cut to determine whether high resistive streaks on the logs were coal seams. All the rest were cut for porosity determinations.

Electrical and other logs:

The hole was logged by Schlumberger Seaco Inc. as follows :

Electrical Log

Run 1, 543-3375 feet

Run 2, 3265-4578 feet

Run 3, 4440-6878 feet

Micrologg-Caliper Log

Run 1, 543-3375 feet

Run 2, 3265-4578 feet

Run 3, 4478-6878 feet

Sonic-Gamma Ray Log

Run 1, 543-3345 feet
Run 2, 543-6868 feet (Sonic)
100-6848 feet (Gamma Ray)

Dipmeter

Run 1, 3500-6875 feet

Velocity Survey:

Austral Geo Prospectors Pty Ltd, in conjunction with Schlumberger Seaco Inc., conducted a velocity survey with readings at the following levels (feet):

1310	2340	2945	3725	4010
4905	5647	6641		

Drilling Time and Gas Log:

A Geolograph, and a Core Laboratories Australia (Queensland) Ltd drilling rate recorder were used for the penetration rate. Core Laboratories gas detection and analysing equipment (Hotwire gas detector and programmed hydrocarbon detector) were used for the preparation of a gas log. The gas log appears on the composite log and is discussed later in this report, under "Occurrence of Hydrocarbons".

Formation Testing: (See Appendix 3)

Twenty-three drillstem tests were carried out. All tests were run using a Halliburton hydrospring single packer tester equipped with a dual closed-in pressure valve, equalizing retaining and by-pass valves, impact reverse circulating sub, Howco safety joint and jars. The bottom-hole choke was 5/8", surface choke 1", and the packer size was 7-1/2". Two pressure recording devices were used on all tests; these were Halliburton (BT) Bombs. There were four misruns including three packer seat failures and one test in which the tool could not get to bottom. A summary of drillstem tests is given below:

DST No. 1 2000 to 2072 feet

Initial closed-in period	25 minutes
Open flow period	30 minutes
Final closed-in period	25 minutes

Remarks : Weak initial blow lasting for three minutes. Recovered 5 feet of mud.

Pressure	Top Recorder
Initial hydrostatic	1035 psi.
Initial closed-in	85 psi.
Initial flow	20 psi.
Final flow	20 psi.
Final closed-in	29 psi.
Final hydrostatic	1035 psi.

DST No. 2 2228 to 2264 feet

Misrun. Tool did not get to bottom.

DST No. 3 2228 to 2264 feet

Initial closed-in period	30 minutes
Open flow period	60 minutes
Final closed-in period	30 minutes

Remarks : Weak air blow lasting for four minutes, decreasing to faint, dead in ten minutes.
Recovered 100 feet of mud.

Pressure	Top Recorder
Initial hydrostatic	1125 psi.
Initial closed-in	224 psi.
Initial flow	64 psi.
Final flow	73 psi.
Final closed-in	87 psi.
Final hydrostatic	1125 psi.

DST No. 4 2955 to 2991 feet

Initial closed-in period	30 minutes
Open flow period	90 minutes
Final closed-in period	30 minutes

Remarks : Good initial puff. Weak air blow remaining steady throughout test. No combustible gas to surface. Recovered 10 feet of mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	1566 psi.	1591 psi.
Initial closed-in	152 psi.	167 psi.
Initial flow	20 psi.	51 psi.
Final flow	20 psi.	40 psi.
Final closed-in	245 psi.	263 psi.
Final hydrostatic	1560 psi.	1585 psi.

DST No. 5 3721 to 3731 feet

Initial closed-in period	30 minutes
Open flow period	64 minutes
Final closed-in period	30 minutes

Remarks : Weak puff, faint blow lasting throughout test. No combustible gas or carbon dioxide to surface. Recovered 8 feet of mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2000 psi.	1994 psi.
Initial closed-in	256 psi.	259 psi.
Initial flow	32 psi.	26 psi.
Final flow	28 psi.	23 psi.
Final closed-in	218 psi.	213 psi.
Final hydrostatic	1994 psi.	1983 psi.

DST No. 6 3722 to 3813 feet

Initial closed-in period	33 minutes
Open flow period	60 minutes
Final closed-in period	30 minutes

Remarks : Good initial puff, fair air blow, increasing to strong and remaining steady. Gas to surface in 20 minutes at 65 Mcf/D, remaining steady. Chromatograph analysis of gas: 2450 units methane, 2300 units ethane, 150 units propane, and a trace of higher hydrocarbons. Pipe recovery of 330 feet of highly gas-cut mud and 90 feet of highly gas and mud-cut brackish water (2580 ppm. Cl).

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2036 psi.	2058 psi.
Initial closed-in	1530 psi.	1556 psi.
Initial flow	457 psi.	566 psi.
Final flow	204 psi.	190 psi.
Final closed-in	1321 psi.	1320 psi.
Final hydrostatic	2008 psi.	2023 psi.

DST No. 7 4005 to 4030 feet

Initial closed-in period	30 minutes
Open flow period	70 minutes
Final closed-in period	30 minutes

Remarks : Strong initial puff, followed by fair air blow. Gas to surface in 53 minutes, too small to measure, estimated at 5 Mcf/D. Blow remained steady throughout test. Chromatograph analysis of gas : 2650 units methane, 2400 units ethane, 300 units propane, and 100 units butane. Pipe recovery of 50 feet of slightly gas-cut mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2182 psi.	2205 psi.
Initial closed-in	561 psi.	569 psi.
Initial flow	25 psi.	47 psi.
Final flow	42 psi.	61 psi.
Final closed-in	1044 psi.	1058 psi.
Final hydrostatic	2174 psi.	2194 psi.

DST No. 8 4027 to 4062 feet

Initial closed-in period	30 minutes
Open flow period	120 minutes
Final closed-in period	30 minutes

Remarks: Strong initial puff. Gas to surface in two minutes at a rate of 70 Mcf/D increasing to 112 Mcf/D at the end of the test. Chromatograph analysis of gas: 2550 units methane, 2350 units ethane, 340 units propane, and 220 units butane. Pipe recovery of 130 feet of highly gas-cut mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2224 psi.	2240 psi.
Initial closed-in	1696 psi.	1700 psi.
Initial flow	59 psi.	70 psi.
Final flow	59 psi.	67 psi.
Final closed-in	1637 psi.	1643 psi.
Final hydrostatic	2205 psi.	2223 psi.

DST No. 9 4061 to 4120 feet

Initial closed-in period	30 minutes
Open flow period	90 minutes
Final closed-in period	30 minutes

Remarks: Good initial puff, strong steady blow of gas to surface in thirty minutes. Too small to measure. Estimated at 10 Mcf/D. Chromatograph analysis of gas: 2300 units methane, 2200 units ethane, 340 units propane, 40 units butane, 60 units higher hydrocarbons. Pipe recovery of 90 feet of slightly gas-cut mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2238 psi.	2280 psi.
Initial closed-in	311 psi.	341 psi.
Initial flow	44 psi.	87 psi.
Final flow	53 psi.	82 psi.
Final closed-in	1482 psi.	1510 psi.
Final hydrostatic	2230 psi.	2269 psi.

DST No. 10 4263 to 4360 feet

Misrun. Packer seat failed.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2364 psi.	2410 psi.
Final hydrostatic	2350 psi.	2404 psi.

:262-3

DST No. 11 4342 to 4410 feet

Initial closed-in period	30 minutes
Open flow period	30 minutes
Final closed-in period	15 minutes

Remarks: Very weak initial puff. Reset after ten minutes. Faint blow for five minutes, becoming very weak. Dead in ten minutes. Reset, a few bubbles; reset after twenty minutes of open flow period, a few bubbles. Recovered 75 feet of mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2437 psi.	2472 psi.
Initial closed-in	80 psi.	121 psi.
Initial flow	53 psi.	91 psi.
Final flow	54 psi.	103 psi.
Final closed-in	72 psi.	121 psi.
Final hydrostatic	2437 psi.	2472 psi.

DST No. 12 4460 to 4542 feet

Misrun. Packer seat failed.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2505 psi.	2554 psi.
Final hydrostatic	2505 psi.	2554 psi.

DST No. 13 4503 to 4542 feet

Misrun. Packer seat failed.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2531 psi.	2560 psi.
Final hydrostatic	2483 psi.	2530 psi.

DST No. 14 4535 to 4553 feet

Initial closed-in period	30 minutes
Open flow period	133 minutes
Final closed-in period	30 minutes

Remarks: Good initial puff. Strong air blow. Gas to surface in 26 minutes at a rate of 44 Mcf/D. Remained steady throughout test. Chromatograph gas analysis: 2300 units methane, 2150 units ethane, 250 units propane, 50 units butane. Pipe recovery of 125 feet moderately gas-cut mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2642 psi.	2601 psi.
Initial closed-in	1667 psi.	1677 psi.
Initial flow	25 psi.	50 psi.
Final flow	59 psi.	67 psi.
Final closed-in	1901 psi.	1905 psi.
Final hydrostatic	2642 psi.	2601 psi.

DST. No. 15 4510 to 4573 feet

Initial closed-in period	15 minutes
Open flow period	61 minutes
Final closed-in period	15 minutes

Remarks: Good initial puff. Fair air blow remaining steady. Gas to surface in 45 minutes, too small to measure, estimated at 5 Mcf/D, remaining steady. Chromatograph analysis of gas: 2550 units methane, 2350 units ethane, 275 units propane, 50 units butane. Pipe recovery of 120 feet moderately gas-cut mud.

Pressure	Top Recorder	Bottom Recroder
Initial hydrostatic	2556 psi.	2595 psi.
Initial closed-in	398 psi.	423 psi.
Initial flow	64 psi.	93 psi.
Final flow	68 psi.	99 psi.
Final closed-in	672 psi.	711 psi.
Final hydrostatic	2556 psi.	2595 psi.

DST No. 16 4686 to 4716 feet

Initial closed-in period	30 minutes
Open flow period	32 minutes
Final closed-in period	30 minutes

Remarks: Set base of anchor pipe on top of rat hole, skidded into rat hole. Reset tool, good initial puff, becoming weak, dead in 15 minutes. Recovered 210 feet of slightly gas-cut mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2577 psi.	2595 psi.
Initial closed-in	216 psi.	227 psi.
Initial flow	91 psi.	105 psi.
Final flow	102 psi.	117 psi.
Final closed-in	189 psi.	198 psi.
Final hydrostatic	2571 psi.	2590 psi.

DST No. 17 5123 to 5233 feet

Initial closed-in period	30 minutes
Open flow period	31 minutes
Final closed-in period	30 minutes

Remarks: Weak initial blow lasting for ten minutes. Reopened tool for main flow with no blow. Recovered 200 feet of mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2839 psi.	2905 psi.
Initial closed-in	400 psi.	464 psi.
Initial flow	83 psi.	155 psi.
Final flow	100 psi.	160 psi.
Final closed-in	248 psi.	312 psi.
Final hydrostatic	2833 psi.	2896 psi.

DST No. 18 5363 to 5381 feet

Initial closed-in period	30 minutes
Open flow period	67 minutes
Final closed-in period	0 minutes

Remarks: Very weak initial blow. Very faint blow, dead in ten minutes. Reset packer after 60 minutes, a few bubbles. Reset packer after another four minutes, a few bubbles. Recovered 15 feet of mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	3009 psi.	3023 psi.
Initial closed-in	2069 psi.	2073 psi.
Initial flow	38 psi.	53 psi.
Final flow	52 psi.	59 psi.
Final closed-in	-	-
Final hydrostatic	3003 psi.	3017 psi.

DST No. 19 5374 to 5414 feet

Initial closed-in period	30 minutes
Open flow period	60 minutes
Final closed-in period	30 minutes

Remarks: Weak initial blow, becoming faint throughout test. Recovered 350 feet of mud. (Note: this is twice the amount of mud below the packer in the rat hole).

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	2988 psi.	3017 psi.
Initial closed-in	1960 psi.	1977 psi.
Initial flow	87 psi.	119 psi.
Final flow	149 psi.	169 psi.
Final closed-in	1499 psi.	1512 psi.
Final hydrostatic	2983 psi.	3015 psi.

DST No. 20 5410 to 5467 feet

Initial closed-in period	30 minutes
Open flow period	60 minutes
Final closed-in period	30 minutes

Remarks: Fair air blow for five minutes, becoming weak. Dead in 30 minutes. Recovered 70 feet of slightly gassy mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	3038 psi.	3084 psi.
Initial closed-in	57 psi.	93 psi.
Initial flow	23 psi.	67 psi.
Final flow	23 psi.	82 psi.
Final closed-in	36 psi.	93 psi.
Final hydrostatic	3038 psi.	3084 psi.

DST No. 21 5510 to 5575 feet

Initial closed-in period	30 minutes
Open flow period	96 minutes
Final closed-in period	30 minutes

Remarks: Strong initial air blow. Gas to surface in five minutes at 44 Mcf/D, increasing to 62 Mcf/D after 15 minutes with slight surge, increasing to 88 Mcf/D after 45 minutes and to 102 Mcf/D after 90 minutes. Pipe recovery was 300 feet of heavy gas-cut mud. Chromatograph analysis of gas was 2900 units methane, 2650 units ethane, 400 units propane, 150 units butane.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	3098 psi.	3150 psi.
Initial closed-in	975 psi.	1009 psi.
Initial flow	85 psi.	122 psi.
Final flow	95 psi.	134 psi.
Final closed-in	1987 psi.	2020 psi.
Final hydrostatic	3098 psi.	3150 psi.

DST No. 22 5574 to 5644 feet

Initial closed-in period	30 minutes
Open flow period	64 minutes
Final closed-in period	30 minutes

Remarks: Strong initial air blow. Gas to surface in one minute at 250 Mcf/D decreasing to 162 Mcf/D and surging, mud to surface in 52 minutes, brackish water spray in 61 minutes. Pipe recovery of 675 feet of heavy gas-cut brackish water, (3400 ppm.Cl). Chromatograph analysis of gas: 2950 units methane, 2750 units ethane, 300 units propane, and 50 units butane.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	3159 psi.	3205 psi.
Initial closed-in	2344 psi.	2376 psi.
Initial flow	318 psi.	315 psi.
Final flow	462 psi.	493 psi.
Final closed-in	2109 psi.	2142 psi.
Final hydrostatic	3150 psi.	3193 psi.

DST No. 23 6350 to 6438 feet

Initial closed-in period	30 minutes
Open flow period	38 minutes
Final closed-in period	30 minutes

Remarks: Weak initial blow, becoming faint after 15 minutes. Dead in 30 minutes. Recovered 10 feet of drilling mud.

Pressure	Top Recorder	Bottom Recorder
Initial hydrostatic	3622 psi.	3689 psi.
Initial closed-in	57 psi.	120 psi.
1st Initial flow	25 psi.	87 psi.
2nd Initial flow	30 psi.	87 psi.
1st Final flow	23 psi.	85 psi.
2nd Final flow	23 psi.	85 psi.
Final closed-in	34 psi.	99 psi.
Final hydrostatic	3622 psi.	3689 psi.

Deviation Surveys :

The following deviation surveys were run:

Depth (feet)	Deviation from Vertical (degrees)
100	1/4
250	1/2
547	1
785	1
1068	2
1400	1-1/4
1580	2
2000	2-1/4
2400	2-3/4
2710	2-1/4
2930	2-1/4
3090	2
3370	1-1/2
3600	1-1/4
3710	2
3932	2
4170	1-3/4
4400	1-1/2
4561	1
4700	1
4890	1-1/2
5500	1
5780	3/4
6174	1-1/4
6435	2
6839	3-1/4

Temperature Surveys:

Bottom hole temperatures were taken in the course of logging operations as follows :

Depth (feet)	Temperature (°F)
3376	115
4579	130
6879	164

GEOLOGY

Summary of Previous Work

Early workers in the Bowen Basin included Etheridge (1884), Jack (1895), and Dun (1909). Subsequent workers included Richards (1918), Jensen (1920-1926), Reid (1930-1936), and Booker (1932).

In 1934, Reeves and Condit conducted geological surveys for Oil Search Limited between Roma and Springsure. This company drilled the Hutton Creek well (O.S.L. No. 2) between 1935 and 1938 to a depth of 4688 feet, and the Arcadia well (O.S.L. No. 3) between 1936 and 1939 to a depth of 6036 feet on structures located in the area. Gas was encountered in the Permian section in the Arcadia well at 1187, 2670, and below 2887 feet.

Shell (Queensland) Development Pty Ltd was granted an Authority to Prospect of 136,000 square miles in the area and began exploratory work in 1940. Geological reconnaissance surveys, air photograph work, and gravity surveys were carried out.

The work of Denmead (1943), Crockford (1942), Crespin (1945), Fletcher (1945), and Hill (1951), contributed to the knowledge of the Bowen Basin during this period.

Between 1950 and 1951, Shell drilled S.Q.D. No. 1 (Morella) to a depth of 4634 feet. Seismic traverses were undertaken by the company which released its tenement in 1951. The Shell report of 1952 on work in their former tenement, added significantly to the knowledge of the area.

During 1954, Australasian Oil Exploration Ltd drilled two wells on Reid's Dome and one on the Consuelo Anticline. The first Reid's Dome well encountered a shallow gas zone at 448 to 467 feet.

In the period following, Whitehouse (1955), Webb (1956), and Veevers et al., (1961) published papers relating to the area. In 1957, Associated Australian Oilfields N.L. drilled a well at Arcadia (A.A.O. No. 7) to a depth of 3280 feet but no gas shows of commercial importance were encountered.

The review of the Bowen Basin in the Geology of Queensland (Hill and Denmead, 1960) provided a broad picture of the knowledge of the Basin to that date. A report was compiled by J.E. Mack, Jr, of Union Oil Development Corporation in 1960-1961, on the geology of the Bowen-Surat Basin.

In recent years, the Bureau of Mineral Resources in conjunction with the Geological Survey of Queensland has conducted geological surveys in and around the Bowen Basin, particularly in regard to the mapping of the Mt Coolon, Clermont, Emerald, Mackay, and Bowen map sheets. Further mapping was being carried out while Warrinilla No. 1 and Warrinilla North No. 1 wells were being drilled.

Associated Australian Oilfields N.L. drilled A.A.O. Glentulloch No. 1 in 1961 to a depth of 4083 feet and in 1962, the company drilled A.A.O. Westgrove Nos 1, 2 and 3 to depths of 6442, 5550, and 12,663 feet respectively. In 1963, A.A.O. Kildare No. 1 between Glentulloch No. 1 and Westgrove No. 2 was drilled to 5723 feet and Kildare No. 2 was drilled to 7666 feet. A.F.O. Bandanna No. 1, on the south end of the Serocold Anticline, was drilled to a depth of 4043 feet concurrently with the drilling of Warrinilla No. 1. A.F.O. Inderi No. 1 and A.F.O. Purbrook No. 1, which reached depths of 5433 and 4949 feet respectively, were drilled concurrently with the drilling of Warrinilla North No. 1. Significant gas shows were obtained in most of these wells. Glentulloch No. 1 and Westgrove Nos 2 and 3 wells were completed as capped gas wells.

In 1962, the Institute Francais du Petrole issued a report on the Permo-Triassic of the Bowen-Surat Basin, and Dickins, Malone, and Jensen of the Bureau of Mineral Resources prepared the report "Subdivision and Correlation of the Middle Bowen Beds". Palynological work on the basin is currently being carried out by P.R. Evans of the Bureau of Mineral Resources.

A number of seismic surveys have been carried out in and adjacent to the Bowen Basin. In Planet Exploration Company's Permits 710 and 712 (now A to P 100P), seven months of reflection seismic survey was carried out by Austral Geo Prospectors Pty Ltd prior to the drilling of Warrinilla No. 1 and Warrinilla North No. 1 wells.

Summary of Regional Geology

Warrinilla North No. 1 is located in the Bowen Basin, a basin of Permian sedimentation, which extends between the Charters Towers granite complex in the north, the Anakie High in the west, and the Auburn granitic complex to the east. To the south, the basin is overlapped by sediments of the Great Artesian Basin. The Auburn granitic complex separates it from the Yarrol Basin to the east.

The Permian sediments of the Bowen Basin are generally divided into Lower, Middle and Upper Bowen. The Lower Bowen beds may also be partly Upper Carboniferous in age. In as far as the Warrinilla area is concerned, the Lower Bowen beds are taken to consist of the pre-Cattle Creek fresh water sediments and volcanic rocks, the Middle Bowen to include the partly marine Catherine, Ingelara, Aldebaran and Cattle Creek formations, and the Upper Bowen to consist of the predominantly non-marine Bandanna Formation.

Sedimentation in the Bowen Basin began in late Carboniferous to early Permian times. The Lower Bowen deposits were largely terrestrial, and by early Artinskian times the floor of the Bowen Basin was covered by an assortment of volcanic, fresh-water, and minor glacial and marine rocks. Swamp and fresh-water lake conditions probably prevailed between islands of volcanic rocks, with marine incursions restricted largely to the north-east.

Attempts to correlate units in these Lower Bowen beds have met with considerable difficulty. Variations in thickness and facies are common; patterns of vulcanism, tectonism, and sedimentary history are fairly local; and the main regional factor is the overall instability of source and basin areas which produced these variations.

The Lower Bowen rocks include such diverse lithologic types as the Mount Devlin Volcanics, the Mount Devlin Coal Measures, and the Mount Toussaint Volcanics, all of the Collinsville area; the Joe Joe Creek conglomerates, glacials, and continental clastics to the west; the Orion, Stanleigh and pre-Cattle Creek shales and coal measures to the south-west (Warrinilla area); the andesites at Morella; the clastics, coal seams, and andesites at Arcadia and Hutton Creek; interbedded volcanics and marine sediments to the north-east; the andesitic flows, dacite, tuffs and agglomerates of the Cracow Formation to the east; and possibly the bottom hole andesites and dacites of the Cabawin and Moonie areas respectively.

The remarkably sustained and widespread burst of Lower Bowen volcanic activity was probably accompanied by widespread faulting and tectonic activity. Structurally low areas were filled with swamp and shallow lake deposits, which contained the first Glossopteris flora in the basin. Fresh water deposition continued for a considerable time, subsidence, if any, not

being sufficient to allow flooding of the area by the ocean, except into the north-east where marine Lower Bowen sediments have been reported. These Lower Bowen sediments acted as a floor for the Middle Bowen deposition.

The first significant downwarp occurred in late Sakmarian or earliest Artinskian times, and the earliest Middle Bowen sea entered the lower lying portions of the basin. Its presence is indicated by a marine fauna probably early Artinskian in age. This has been identified in the Dilly Beds at Springsure, at the base of the Cattle Creek Formation in the Carnarvon area, at the base of the Back Creek Formation in the Cracow-Theodore area, and in the north-east of the Bowen Basin.

This earliest Middle Bowen sea spread over the basin from the north-east, where the Lower Bowen sea had been largely restricted. This was part of an epicontinental sea that may have entered the Bowen Basin from the Yarrol Basin, which was a basin of deposition in Carboniferous times. The entry from the Yarrol Basin may have been achieved via the Broad Sound area and between volcanic islands in the Styx River area, Apis Creek area, and south of Biloela. As the basin subsided the sea flooded the low lying swamps, lakes, and the lesser volcanic hills of the lower Bowen, but the higher areas remained above sea level. It was naturally deeper in its north-eastern area of origin where extreme thicknesses of Middle Bowen marine sediments have been identified. Faunal subdivisions of the Middle Bowen beds have been made in this area by Dickins, Malone, and Jensen. These subdivisions can be carried southwards to the Arcadia area. The Back Creek Formation of the south-eastern part of the basin was also deposited in this Middle Bowen sea. This sea did not reach west of the Anakie High, nor did it transgress the Devonian-Lower Carboniferous volcanics of the Clermont area. The general downwarping coincident with its transgression, however, resulted in the deposition of the fresh-water Colinlea Sandstone; deposition of this formation possibly continued until the final transgression of the Middle Bowen sea. The Collinsville Coal Measures in the far north of the basin were also laid down during this time.

The earliest marine units laid down in the first transgression of the Middle Bowen sea are present in the Springsure-Reid's Dome-Warrinilla area, as the Dilly Beds, Sirius Formation, Cattle Creek Formation, and Aldebaran Sandstone. The earliest unit (Cattle Creek) in the Morella area, thins markedly over Lower Bowen andesites, and representatives of this transgression are only doubtfully present at Arcadia. This sea appeared to be absent from the Hutton Creek and Roma areas. The Middle Bowen sea then became more widespread. This further transgression brought the sea over areas not inundated earlier. This is the sea in which the Ingelara Formation and the Catherine Sandstone were deposited.

In the Clermont area, on the western side of the basin, between 1000 and 2000 feet of sediments were deposited in this sea. In the Reid's Dome area, 1200-1500 feet of sediments were deposited; at Morella 1300 feet; at Warrinilla about 800 feet; at Arcadia about 800 feet; at Hutton Creek 500 feet. In the north-east of the basin from 4500 to 8000 feet of marine sediments were deposited in the Middle Bowen sea during this period. At Cabawin, some 1300 feet of sediments were deposited.

Before the Middle Bowen sea disappeared from the Bowen Basin, it became, in a geological sense, fleetingly very widespread. This final phase resulted in the Mantuan Productus Bed being laid down beyond the limits of the Bowen Basin from Birkhead in the west, to Pickanjinnie in the south. The Colinlea fresh water sediments west of the Anakie High were also transgressed by this Mantuan sea.

After the final phase the Middle Bowen sea began to recede, at the same time depositing the basal marine part of the Bandanna Formation. Finally non-marine conditions prevailed and the Upper Bowen sediments and coal seams were laid down. Throughout a fairly large part of the basin, conditions and thicknesses of sediments appear to be of the same order, in contrast to the earlier Permian units. The coal at Blair Athol was laid down at this time. Volcanic activity is evident in the Upper Bowen; interbeds of volcanic ash and tuff occur.

There is evidence for an unconformity in the basin at the top of the Permian sections. Non-marine Triassic sediments were deposited over the Permian at least in the southern part of the basin. These sediments are an extension of those deposited in the Great Artesian Basin. At the end of Lower Triassic time, uplift terminated deposition as the sea left the Bowen Basin area. The uplift was partly contemporaneous with the folding of the sedimentary squence of the basin. Although the main folding occurred in post-Moolayember (Lower Triassic) time, some movement also involved later Mesozoic sediments.

The main compressive forces producing the folding appear to have come from the east and north-east from the direction of the Hunter-Bowen Thrust, and were also coincident with the emplacement of plutonic rocks east of the Dawson and McKenzie rivers. The nature of the folding varied across the basin. A number of tectonic elements in the basin (Springsure Shelf, Denison Trough, Comet Platform, Intermediate Zone, Dawson Tectonic Zone) exhibit characteristic variations of fold direction and intensity. The Warrinilla Anticline on which Warrinilla No. 1 and subsequently Warrinilla North No. 1 were drilled, was formed at this time.

In the more easterly tectonic units, the direction of the folding tends to be north-west and in the more westerly areas, tends to be more nearly north. On the Comet Platform, the folding is more gentle, as if the compressive forces were being transmitted largely through the basin basement. The structural elements also probably exhibited varying degrees of stability during Permian deposition. This variation probably contributed to the extent and depth of the various marine transgressions.

Stratigraphy

The stratigraphic sequence encountered in Warrinilla North No. 1 is shown in the Table below:

Age	Formation	Informal Rock Unit	Depth Intervals (feet)	Thickness (feet)
Quaternary		Clay and shale	16 - 55	39
Triassic	Rewan Formation	Shale	55 - 1315	1260
		Shale and sandstone	1315 - 1704	389
Permian	Bandanna Formation	Shale, sandstone, siltstone	1704 - 2070	366
		Coal	2070 - 2349	279
		Shale and siltstone	2349 - 2656	307
		Tuff and shale	2656 - 2945	289

Age	Formation	Informal Rock Unit	Depth Intervals (feet)	Thickness (feet)
Permian	Mantuan *Productus* Bed	Sandstone and shale	2945 - 3068	123
	Catherine Sandstone	Siltstone and shale	3068 - 3326	258
		Sandstone	3326 - 3450	124
	Ingelara Formation	Shale and siltstone	3450 - 3725	275
		* Sandstone	3725 - 3850	125
		Shale	3850 - 3920	70
		Shale and siltstone	3920 - 4010	90
	Aldebaran Sandstone	* "A Unit" Sandstone	4010 - 4104	94
		Shale	4104 - 4112	8
		"B Unit" Sandstone	4112 - 4375	263
		Shale	4375 - 4403	28
		*"C Unit" Sandstone	4403 - 4560	157
		Shale	4560 - 4627	67
		"D Unit" Conglomerate and sandstone	4627 - 4900	273
		Shale	4900 - 4932	32
		"E Unit" Sandstone and shale	4932 - 5185	253
		Shale	5185 - 5250	65
		"F Unit" Sandstone	5250 - 5316	66
		Shale	5316 - 5342	26
		"G Unit" Sandstone	5342 - 5450	108
		Shale	5450 - 5520	70
		"H Unit" Sandstone	5520 - 5645	125
	Cattle Creek Formation	Siltstone, sandstone, shale	5645 - 5970	325
		Limestone, siltstone, shale	5970 - 6180	210
		Siltstone, shale, sandstone	6180 - 6643	463
	pre-Cattle Creek beds	Conglomerate, sandstone, shale	6643 - 6879(T.D.)	236

* Gas obtained in drillstem tests from portions of these sandstones.

Some confusion exists in the Warrinilla area with regards to nomenclature and the correlation with the type section in outcrop. In outcrop the following sequence is found:

Bandanna Formation
Mantuan *Productus* Bed
Catherine Sandstone
Ingelara Formation
Aldebaran Sandstone
Cattle Creek Formation

On the northern half of Reid's Dome the shaly sequence below the Mantuan Productus Bed, has been called the "Dry Creek Shale" and the sandstone beneath this has been called the "Early Storms Sandstone". The latter is the equivalent of the sandstone member of the Catherine Sandstone. This is discussed more fully later in this report.

In Warrinilla North No. 1, three sandstone beds are developed between the Bandanna and the Aldebaran formations. The first is found associated with the Mantuan Productus Bed. The second occurs between the siltstone-shale sequence below the Mantuan Productus Bed and the Ingelara Formation as picked in Warrinilla No. 1. The third sandstone, which is well developed, occurs within the unit correlated with the Ingelara Formation as picked in Warrinilla No. 1. It is not known which of the two lower sandstone beds, if either, is correlative with the sandstone member of the Catherine Sandstone in outcrop.

In order to maintain uniformity between the two wells, the top of the Ingelara Formation has been placed so as to correlate with the pick made at Warrinilla No. 1. The sandstone that occurs above this pick is considered to be the sandstone member of the Catherine Sandstone (or "Early Storms Sandstone"), while the lower is considered to be a sandstone member of the Ingelara Formation.

Quaternary: 16 to 55 feet (39 feet)

Clay and shale.

Lithology:

The clay is generally white, rarely yellow, orange, and mottled with red. It is slightly silty and soft, and is interbedded with siltstone, light grey and grey-brown, argillaceous, clayey, and soft. There is a fair amount of shale, red, blocky, in part slightly silty and soft. The shale may be present in the form of interbeds or boulders. There are also minor amounts of coal, black, hard, brittle and shiny.

Rewan Formation (Triassic): 55 to 1704 feet (1649 feet)

The Rewan Formation can be divided into two informal rock units:

Shale unit	55 to 1315 feet (1260 feet)
Shale and sandstone unit	1315 to 1704 feet (389 feet)

Detailed description, Rewan Formation

Shale unit, 55 to 1315 feet (1260 feet)

Lithology :

This unit consists predominantly of shale, red, reddish-brown, and dark reddish-brown, with a trace of mottled green, blocky, rarely fissile, in part slightly to very silty and arenaceous, micaceous, occasional carbonaceous specks, and a rare trace of calcite and andesitic inclusions. Between 340 and 680 feet, the red and brown shales are mottled and interbedded with shale, green, grey-green, and grey, blocky to slightly fissile, slightly to very silty, moderately carbonaceous to very carbonaceous, with carbonized plant fragments. The

shales of the Rewan Formation disintegrate readily on exposure to air. There are a few thin interbeds of siltstone and sandstone throughout. Better developed sandstone beds were noted between 220 and 240 feet, 270 and 310 feet, 340 and 680 feet. The siltstones are red-brown, green, and green-grey, generally very argillaceous and slightly clayey, micaceous and carbonaceous. In places they are coarse-grained and grade to very fine-grained sandstone. The sandstones are light to dark green, greenish-grey and red-brown in colour. The grains vary from very fine to medium-grained and coarse-grained, poor to well-sorted, angular to subangular, quartz and feldspar with red, green, yellow, and black lithic rock fragments and minerals. The matrix consists mainly of clay with white kaolinitic specks, and varies from slightly to very argillaceous. Disseminated throughout the sand are large flakes of mica (biotite) which are aligned parallel to bedding, and carbonaceous specks and carbonized plant fragments. The sandstones are generally tight. The bedding is poorly developed and varies from flat to 20^{o} dip.

Cores No. 1 (547 to 560 feet); No. 2 (560 to 562 feet); and No. 3 (1068 to 1075.5 feet) were cut in this unit.

Shale and sandstone unit, 1315 to 1704 feet (389 feet)

Lithology:

This unit of the Rewan Formation consists of interbedded shale and sandstone. The shale is predominantly grey-green, green, and greenish-grey, blocky, slightly to very silty, micaceous with few fine carbonaceous specks. There are minor amounts of red-brown shale as above. The sandstone is light to medium green, very fine to fine-grained, with angular to well-sorted quartz, feldspar, green and red lithic rock fragments and minerals. The matrix is generally very clayey. There are traces of mica and carbonaceous specks. The basal 40 feet of the unit is more carbonaceous. The sandstone is generally tight, but there is a trace of poor porosity.

Cores No. 4 (1580 to 1590 feet); and No. 5 (1590 to 1592 feet) were cut in this unit.

Electrical Characteristics, Rewan Formation:

No resistivity logs or Sonic logs were run over the interval from 16 to 547 feet because of the surface casing. The Gamma Ray log reads an average of 55 API units for the shale and as low as 42 API units for the sandstone beds. Below the surface casing there is a shift of about 35 API units, and the shales read about 95 API units, the sandstones about 80 API units, except for the sandstone beds below 1315 feet where Gamma Ray readings are as low as 68 API units.

The self potential is generally featureless over the predominantly shale section, and varies from -22 to -10 millivolts in the sandstones below 1315 feet. However, these readings do not appear to be related to effective porosity or permeability since the Microlog shows only traces of poor porosity and only a few thin streaks have mud cake build-up. The resistivity in these sandstones is about 21 ohms, while the sandstone beds above 1315 feet have a resistivity of about 7 ohms. The shales have a resistivity of about 5 to 6 ohms.

The Sonic log indicates an average travel time of about 105 microseconds per foot in the shales and 80 to 90 microseconds per foot in the sandstones indicating a porosity of between 10% and 14% after making compaction corrections.

The Caliper log, run with the Microlog, shows the average hole size to be about 10" with washouts up to 13". A later Caliper log run with the Sonic-Gamma Ray log, found little change in the size of the hole.

Bandanna Formation (Permian): 1704 to 2945 feet (1241 feet)

The Bandanna Formation has been divided into four informal rock units. The top is based on correlation with Warrinilla No. 1. As in the case at that well, it is possible that the top of the Bandanna Formation should be placed at the first discrete coal seam which would be at 2070 feet. The constituent units are :

Shale, sandstone and siltstone unit	1704 to 2070 feet (366 feet)
Coal unit	2070 to 2349 feet (279 feet)
Shale and siltstone unit	2349 to 2656 feet (307 feet)
Shale and tuff unit	2656 to 2945 feet (289 feet)

Detailed description, Bandanna Formation

Shale, sandstone, and siltstone unit, 1704 to 2070 feet (366 feet)

Lithology:

This unit closely resembles, and is gradational into, the overlying Rewan Formation. It consists predominantly of shale interbedded with sandstone, siltstone, and a trace of limestone.

The shale is generally green and grey-green near the top of the interval grading into green-grey and medium to dark grey near the base. There is a trace of red-brown shale in the cuttings but this is probably cavings. The first appearance of grey shale is at 1750 feet and the first appearance of medium to dark grey shale is at about 2030 feet. The shale is generally blocky, slightly to very silty, micaceous, slightly to moderately carbonaceous, becoming in part very carbonaceous towards the base with laminations of coaly and carbonaceous material including carbonized plant fragments.

The sandstone is generally light green to white, becoming green-grey, and brown-grey below 1900 feet. It is very fine to fine-grained, less commonly medium-grained, poorly sorted, with angular to subangular quartz, weathered feldspar, green, yellow and black lithic rock fragments and minerals, becoming tuffaceous below 1900 feet. The matrix generally consists of white, slightly calcareous clay, with white specks of kaolinite. The sandstone is micaceous and is commonly carbonaceous with carbonaceous and coaly laminae and specks. It is usually friable to slightly hard and tight, with a trace of poor porosity.

The siltstone is grey-brown, grey and grey-green, sandy, micaceous and carbonaceous.

A trace of limestone was found between 1960 and 1980 feet. It was green-grey, and brown-grey, crypto-crystalline, very argillaceous and had algal like structures. It resembled a fresh-water limestone, perhaps a lacustrine deposit or caliche.

Cores No. 6 (2010 to 2020 feet); No. 7 (2020 to 2022 feet); and No. 8 (2038 to 2048 feet); were cut near the base of this unit. The cores showed cyclic graded bedding from shale through siltstone to sandstone. The beds dipped between 3^{o} and 5^{o}.

Coal unit, 2070 to 2349 feet (279 feet)

Lithology:

This unit comprises siltstone, interbedded with coal, sandstone, and shale.

The siltstone is light tan and white to medium grey, sandy, slightly argillaceous, micaceous, with thin carbonaceous laminae and inclusions.

The coal is black, soft to brittle, shiny with a conchoidal fracture and is occasionally shaly. The following seams were noted:

2070 - 2077 feet	2260 - 2270 feet
2130 - 2135 feet	2288 - 2292 feet
2220 - 2238 feet	2333 - 2343 feet

The sandstone in this unit is light tan and white, fine to medium-grained, poorly sorted, with subangular to angular grains of quartz, and feldspar, tuffaceous fragments, and finely disseminated carbonaceous fragments. The matrix is a white clay, probably kaolinite. The sandstone is firm to friable and tight.

The shale is light to medium grey and grey-green, blocky, silty and sandy, micaceous, and slightly carbonaceous.

No cores were cut in this unit.

Shale and siltstone unit, 2349 to 2656 feet (307 feet)

Lithology:

The shale and siltstone unit of the Bandanna Formation comprises mainly siltstone, thinly interbedded with lesser amounts of sandstone and shale in the top 190 feet, and siltstone thinly interbedded with shale in the bottom 100 feet. The percentage of shale increases towards the base of the unit.

The siltstone in the upper part of the unit is light to medium grey and light grey-brown, firm, sandy, with carbonaceous laminations and inclusions. The siltstone in the lower part of the unit is medium to dark grey, and slightly micaceous.

The sandstone in this unit is similar to that in the coal unit, except that it is finer grained and silty and grades into the siltstone-shale unit. The sandstone is poorly sorted, with subangular to angular grains of quartz and feldspar, tuffaceous fragments and finely disseminated carbonaceous material. The matrix is clayey, probably kaolinitic, and the sandstone is tight.

The shale is light to medium grey, blocky, silty and sandy, micaceous and moderately carbonaceous. In the upper part it is similar to that in the coal unit and becomes medium to dark grey in the basal part. The shale is also partly fissile and in places very carbonaceous. A trace of calcite was noted and is probably present in the form of veins.

Cores No. 9 (2410 to 2420 feet), and No. 10 (2420 to 2422 feet) were cut in the top of this unit. The bedding in the cores appeared to be essentially flat.

Shale and tuff unit, 2656 to 2945 feet (289 feet)

Lithology:

This unit consists of dark grey, fissile to blocky shale which is micromicaceous, carbonaceous, and in part slightly silty. It is thinly interbedded with tuff and tuffaceous shale, which are white, light green, grey, and brown-green and light brown. Some of the thin flakes appear translucent when wet. They are distinctively splintery to fissile, with a soapy feel and texture. The tuff contains fragments and shards of volcanic glass and crystals of biotite.

There are many siliceous and cherty, grey and brown laminations. The tuffaceous shales are sometimes calcareous; these disintegrate readily on exposure to air and water. There is a higher percentage of tuff and tuffaceous shale in the bottom 120 feet.

There are minor amounts of siltstone, light to dark grey-brown, in the top 100 feet of the unit. It is lithologically the same as the siltstone in the shale-siltstone unit. There are also traces of brown siderite, calcite, pyrite, and coal.

Core No. 11 (2718 to 2728 feet) was cut near the top of this unit. Dip in the core is generally horizontal.

Electrical Characteristics, Bandanna Formation:

The self potential in the coal unit shows some fluctuation varying from -10 to -4 millivolts over sands, the shale base line being the same as for the Rewan Formation. The resistivity curves in this unit show a great amount of variation with shales increasing in resistivity up to 10 ohms indicating that they are quite silty and sandy. The sandstones reach a maximum of 28 ohms. This is probably because they are very tight which is corroborated by the Microlog which also shows very high resistivities and no indication of porosity.

The Sonic log shows porosities of only 7% with a travel time of about 65 microseconds per foot. The shales have an average travel time of 90 microseconds per foot indicating greater compaction than the shales of the Rewan Formation. The shales have an average Gamma Ray reading of 96 API units and increase to 112 API units near the base. The sands read about 64 API units.

The most pronounced features on the logs are the coal seams which show up as high resistivities with a maximum of 47 ohms and high travel times on the Sonic log of 138 microseconds per foot. However, the Gamma Ray log reads a low of 16 API units.

The Caliper log on the first run shows the hole to be in gauge below 2100 feet, except for the coal seams which in one case washed out to 16 inches. A Caliper log run at the completion of drilling shows the shale section to be over gauge by only one inch.

The shale-siltstone unit is rather monotonous. The self potential is featureless and the resistivities are very low with shales varying from 3 to 5 ohms and siltstones from 5 to 10 ohms.

The average Gamma Ray reading is 96 API units with the exception of a 35-foot siltstone-sandstone sequence at 2395 feet, which shows an average of 64 API units. The average travel time for this unit is 90 microseconds per foot. The Caliper log shows the hole to be in gauge.

In the tuff and shale unit, the self potential is featureless except for a gradual increase of +5 millivolts. The resistivity is also characterless and fluctuates between 2 and 7 ohms. The Gamma Ray and Sonic curves show rapid fluctuations of between 80 to 144 API units and 115 to 75 microseconds per foot respectively. The Caliper log shows minor washouts up to one inch in the tuff beds.

Mantuan Productus Bed (Permian): 2945 to 3068 feet (123 feet)

Lithology:

This unit was encountered at 2945 feet and a core, No. 12, was cut from 2956 to 2991 feet. This unit consists predominantly of sandstone interbedded with minor sandy shale.

The sandstone is light grey, very fine to fine-grained, and occasionally medium and coarse-grained, fair sorting, with angular to subangular quartz, chert, and feldspar. There are also fragments of lithic tuff and some traces of green and orange lithic rock fragments and minerals. The matrix is white, slightly to moderately calcareous, kaolin. There are a few traces of glauconite, large flakes of biotite, and pebbles of tuffaceous shale. There are a few thin carbonaceous laminae and abundant carbonaceous specks and plant fragments scattered throughout. The sandstone is generally tight with a trace of poor porosity. A drillstem test was run in the upper 45 feet and recovered only mud. An additional three feet of porosity is indicated by the Microlog below the tested interval. However, sidewall cores indicate that this porosity is poor.

The shale is dark to medium grey, blocky, micaceous, silty and sandy, in part very sandy, slightly calcareous. It often grades into argillaceous sandstone. The shale is richly fossiliferous and contains brachiopods, pelecypods, and bryozoa. These are discussed later.

There are some tuffs and tuffaceous shales in the cuttings between 3010 and 3070 feet. However, most of these are believed to be cavings.

The bedding is Core No. 12 was irregular and exhibited some cross-bedding. The core was richly fossiliferous, mainly with brachiopods. However, it included some pelecypods and bryozoa. These fossils were identified in the field by J.M. Dickins as follows:

Brachiopods:

Terrakea solida
(Etheridge & Dun) 1909

Strophalosia cf. clarkei
(Etheridge Sr) 1872

Neospirifer sp. A

Ingelarella sp.

Large dielasmatid

Pelecypods: Parallelodon sp. (one specimen)

Volsellina ? mytiliformis
(Etheridge Jr) 1892

The bryozoa included fenestellid types and Stenopora. Based on the above identification, this core was cut in the Mantuan Productus Bed or a somewhat younger formation.

Electrical Characteristics, Mantuan Productus Bed:

The self potential has a maximum fluctuation of -20 millivolts in the sandstones of the Mantuan Productus Bed with a high resistivity of 27 ohms. The Microlog shows the sandstone to be tight with the exception of traces of very poor porosity and one 4-foot porous zone at 3025 feet with slightly better porosity. The Sonic log shows porosities ranging between 11% and 17% throughout the sandstone. Core analysis indicated porosities of about 16% with no permeability. The sand at 3025 feet shows a mud cake build-up indicating some permeability, which is probably in the low range.

The Gamma Ray log reads 55 API units in the clean sands and 100 API units in the shaly breaks.

Catherine Sandstone (Permian): 3068 to 3450 feet (382 feet)

The Catherine Sandstone consists of an upper siltstone-shale unit and a lower sandstone unit. Shell (Qld) Development Pty Ltd (1952) named this sequence the "Catherine Series". Mines Administration Pty Ltd refers to the upper siltstone-shale unit as the "Dry Creek Shale" and the lower sandstone as the "Early Storms Sandstone", on the northern half of Reid's Dome. However on the southern end of Reid's Dome, Mines Administration Pty Ltd refers to the lower part of the Bandanna Formation as the "Dry Creek Shale" and a sandy facies of the Mantuan Productus Bed as the "Early Storms Sandstone". In this report, as in the final report on Warrinilla No. 1, Shell's terms are used in their original sense.

The two units of the Catherine Sandstone encountered in this well are :

Siltstone-shale unit (in part "Dry Creek Shale")	3068 to 3326 feet (258 feet)
Sandstone unit (in part "Early Storms Sandstone")	3326 to 3450 feet (124 feet)

Detailed description, Catherine Sandstone

Siltstone-shale unit, 3068 to 3326 feet (258 feet)

This unit is a monotonous sequence, consisting mainly of siltstone, thinly interbedded with lesser amounts of shale and minor amounts of sandstone.

Lithology:

The siltstone is light to medium grey-brown becoming, for the most part, dark grey-brown below 3210 feet. It is sandy and argillaceous, in part very argillaceous and shaly,

firm, with a few slightly calcareous and finely disseminated carbonaceous specks and carbonaceous laminations. There is a trace of mica and tuff.

The shale is medium to dark grey, firm, blocky and fissile, slightly to very silty and sandy, micaceous with mica flakes often well developed along bedding planes. In part, the shales are very carbonaceous with specks and laminations, and traces of carbonized plant stems and other plant fragments.

The shale is often gradational into the siltstone. There are minor amounts of sandstone throughout the unit and a greater percentage at the top. This, however, is probably cavings from the Mantuan Productus Bed. Some of the sandstone is probably from pebbles scattered throughout the shale and siltstone. The sandstone is medium to light grey and tan, very fine-grained and silty, with moderately sorted quartz in a slightly calcareous kaolinitic, siliceous matrix. It is usually quite feldspathic and tuffaceous, firm and tight.

Core No. 13 (3281 to 3291 feet) was cut near the base of the unit. The bedding was very irregular and the dips varied from 0^{o} to 5^{o}.

Sandstone unit, 3326 to 3450 feet (124 feet)

The correlation of this unit with the equivalent unit found in outcrop is uncertain.

Lithology:

Lithologically, this unit can be divided into two types of sandstone. The upper from 3326 to 3420 feet is predominantly light grey to white, mostly fine to medium-grained but coarse-grained and silty in places, moderately to well sorted. It is composed of angular to subangular grains of quartz and grey chert with some feldspar and fragments of grey-brown and grey-green tuff. There are occasional white specks of kaolin. The matrix is slightly calcareous and kaolinitic. It is micaceous and has black carbonaceous specks and a few carbonaceous laminae and plant fragments. The sandstone is generally tight with rare, thin, poorly porous streaks; there are a few thin beds and laminae of shale, dark grey, fissile, very micaceous and carbonaceous, moderately arenaceous. Core No. 14 (3361 to 3371 feet) was cut in this part of the Catherine Sandstone. From 3420 to 3450 feet the sandstone is brown to grey-brown, medium to fine-grained, with fair sorting, angular quartz and weathered feldspar, and specks of white kaolin in a brown limy matrix. It is hard and tight. This sandstone is interbedded with tuff and tuffaceous shale near the base.

Core No. 14 had poorly developed and irregular bedding, and dips varied from 0^{o} to 5^{o}.

Electrical Characteristics, Catherine Sandstone:

Siltstone-shale unit

This unit is a monotonous sequence on the logs. The self potential is featureless and the resistivity curve varies from 10 to 14 ohms. The Microlog shows negative separation

and the Caliper log on both first and final runs indicates the hole is nearly in gauge. The Gamma Ray log is about 112 API units and the travel time on the Sonic log is about 80 microseconds per foot.

Sandstone unit

The self potential decreased approximately 10 millivolts from the shale base line and the resistivity averages about 15 to 20 ohms over most of the sandstone, except at 3430 feet where it peaks at about 50 ohms. This is caused by a more calcareous streak in the sandstone. The Microlog shows that most of the sandstone is tight except for two thin porous streaks that have a calculated porosity of 25%. The Caliper log shows a slight filter cake build-up in the over-gauge hole, opposite the porous streaks, indicating some poor permeability. The Gamma Ray curve averages 66 API units in the top part of the unit and decreases to a maximum of 46 API units near the base. The travel time of the Sonic log averages 77 microseconds per foot which gives about 17% porosity.

Ingelara Formation (Permian): 3450 to 4010 feet (560 feet)

The Ingelara Formation has been divided into four informal rock units:

Shale and siltstone unit	3450 to 3725 feet (275 feet)
Sandstone unit	3725 to 3850 feet (125 feet)
Shale unit	3850 to 3920 feet (70 feet)
Shale and siltstone unit	3920 to 4010 feet (90 feet)

Detailed description, Ingelara Formation

Shale and siltstone unit, 3450 to 3725 feet (275 feet)

Lithology :

This unit is mainly a very silty shale which is medium to dark grey-brown, blocky, in part fissile, slightly calcareous, with laminations and finely disseminated carbonaceous material. It is moderately micaceous and there is, in places, a trace of calcite. The shale is hard and breaks with a subconchoidal fracture, and the more fissile parts disintegrate readily on exposure to air and water. The shales grade into, and are interbedded with, siltstone, particularly in the upper 100 feet. The siltstone is medium to dark grey-brown and light grey, very argillaceous and carbonaceous, in part arenaceous and slightly calcareous.

There are a few interbeds of dolomite, medium grey-brown, micro to cryptocrystalline, moderately argillaceous, dense and hard, and limestone, brown crypto-crystalline, fossiliferous with fragments of bryozoa, brachiopods and brachiopod spines. The shales are also fossiliferous with brachiopods, bryozoa, and corals. There was also observed what appeared to be calcified stems of sea plants.

There are a few laminations of tuff and tuffaceous shale which is green and grey-green, has a soapy texture, and fragments of volcanic glass and mica flakes. These tuffs disintegrate very readily on exposure to air.

Core No. 15 (3600 to 3610 feet) was cut in this unit. The bedding was poorly developed and no dip could be seen. Core No. 15 also exhibited some slickensiding.

Sandstone unit, 3725 to 3850 feet (125 feet)

At first, this unit was thought to be the Aldebaran Sandstone. However, it differs lithologically from the Aldebaran in that it is finer grained, less angular, better sorted, slightly tuffaceous and generally cleaner. It closely resembles outcrop samples of the sandstone unit of the Catherine Sandstone and may well be the subsurface equivalent of that unit. However, since it partly correlates with the middle shale unit of the Ingelara Formation, as defined in Warrinilla No. 1, it is considered in this well to be a sandstone member of the Ingelara Formation.

Lithology:

The sandstone is light grey to white, generally fine-grained to medium-grained with well-sorted, subangular quartz, weathered feldspar, and fragments of tuff and a trace of green and black minerals in a white slightly calcareous, kaolinitic matrix. It is mostly micaceous with white and brown flakes of mica, and sometimes carbonaceous. There are a few argillaceous inclusions and irregular laminations and swirls of shale, which is dark grey to black, fissile, very carbonaceous, arenaceous and micaceous, with large flakes of white and brown mica. The shales contain a few fossils which appear to be pelecypods. There is also a six-foot band of sandstone between 3824 feet and 3830 feet which is brown, fine to medium-grained, with moderately sorted, angular to subangular quartz, weathered feldspar, and specks of white kaolin with a trace of tuff fragments in a brown, very calcareous to limy matrix. This band is hard and tight. The remainder of the sandstone is generally tight with some fair porosity.

Two cores were cut in this unit, Core No. 16 (3780 to 3800 feet) and Core No. 17 (3813 to 3844 feet). The bedding is gradational and poorly developed with no visible dips.

Shale unit, 3850 to 3920 feet (70 feet)

Lithology:

This unit consists predominantly of medium to dark grey shale which is firm, blocky, slightly silty, micaceous, slightly calcareous. There is a trace of glauconite and calcite. The shale is interbedded with minor tuff which is light green and white, has a soapy texture and fragments of volcanic glass. This tuff may be cavings.

No cores were cut in this unit.

Shale and siltstone unit, 3920 to 4010 feet (90 feet)

Lithology:

This unit is made up of shale interbedded with siltstone and minor limestone.

The shale is similar to that in the overlying unit except that it is more glauconitic, more fossiliferous with bryozoa, brachiopods, corals, and abundant well preserved crinoid stems. One crinoid stem in Core No. 18, extended the width of the core and was 3/4" in diameter. A few blebs and stringers of pyrite occur. The amount of pyrite increases towards the base. The basal ten feet of this unit is also very conglomeratic, with abundant very coarse sand grains, granules and pebbles, scattered throughout the shale. The pebbles consist of sandstone, siltstone, shale, and quartzite.

Interbedded with the shale is siltstone, medium to dark grey-brown, very argillaceous, in part slightly sandy, very slightly calcareous, micaceous, with a trace of glauconite and carbonaceous material.

Near the top of the unit, there are minor limestone interbeds, which are brown, micro to crypto-crystalline, hard, very argillaceous, and fossiliferous with fragments of crinoid stems, bryozoa, and corals.

Core No. 18 (3990 to 4016 feet) was cut at the base of this unit and straddles the contact with the underlying Aldebaran Sandstone. The bedding in the core was poorly developed but appeared to be generally flat.

Electrical Characteristics, Ingelara Formation:

The self potential is featureless in the shale-siltstone unit. However, the resistivity shows some character. The top 30 feet varies from 4 to 10 ohms. Below this, between 3480 and 3585 feet, the resistivity reaches a plateau of 12 ohms, with little variation. This feature may prove to be a good Electrical log marker, since it shows up in Warrinilla No. 1 and the Morella wells. The remainder of the unit fluctuates from 5 to 15 ohms. The Microlog shows negative separation for the most part. The Caliper log shows the hole to be fairly well in gauge, except for the last 25 feet, which are washed out to a size of 10-1/2 inches.

The Gamma Ray and Sonic logs show similar characteristics to those of the resistivity curve. The top 30 feet show a Gamma Ray reading of about 90 API units and a Sonic fluctuation between 70 and 110 microseconds per foot. Below this, to 3585 feet, the Gamma Ray curve averages about 102 API units and the Sonic log reads an almost constant 80 microseconds per foot. For the remaining part of the unit, the Gamma Ray log fluctuates between 115 and 60 API units and the Sonic log between 105 and 70 microseconds per foot.

The sandstone unit shows a great amount of character both on the self potential and on the resistivity curves. The unit can be divided into three separate sandstone beds, divided by shaly streaks. The upper sandstone has a self potential deflection of -20 millivolts and a resistivity of 20 to 25 ohms. The self potential deflection is an indication of porosity which on the Microlog calculates to be about 19%. However, there is little or no corresponding mud cake build-up indicating poor permeability. The Sonic log indicates a porosity of about 14%. Gamma Ray log readings average about 63 API units, which is slightly greater than the underlying sandstone, which means it is slightly more shaly. The middle sandstone has a self potential-deflection of -24 millivolts and a corresponding resistivity of 25 to 30 ohms. The Microlog shows a porosity of 11% and the Sonic log a porosity of 13% except for a streak at the top which reads 15%. A

value of 11% to 15% is probably correct. There is a slight mud cake build-up indicating some permeability. The Gamma Ray log reads an average of 60 API units.

The lower sandstone bed is divided by a dense streak six feet thick, which is very limy. This has a high resistivity of about 70 to 80 ohms. The remainder of the sand is about 25 ohms. The self potential deflection is -20 millivolts and the Microlog porosity is 14% with no mud cake build-up. The Sonic log porosity averages about 14% also. The Gamma Ray log reads about 63 API units except for the limy streak, which peaks at 48 API units. The sandstones are only 3/4" over gauge on the Caliper. However, the shaly streak washed out to a maximum of 12 inches.

A drillstem test of the upper sand recovered only mud. However, a second drillstem test of all three sands recovered 65 Mcf/D of gas and 330 feet of gas-cut mud and 90 feet of gas-cut brackish water (2580 ppm.Cl). This water recovery is probably not indicative, since it most likely contains some filtrate. Nevertheless, using this water resistivity, the logs give a water saturation of about 55% to 60%.

The shale unit is rather featureless both on the self potential and resistivity curves. The latter is about 5 ohms. The Microlog shows negative separation and the hole is washed out up to two inches on the Caliper. The Gamma Ray log averages 96 API units and the Sonic log reads about 88 microseconds per foot.

The shale and siltstone unit is also featureless on the self potential and shows a fluctuation between 7 and 20 ohms on the resistivity curves. The Microlog has negative separation with some tight streaks and the Caliper shows the hole washed out to 11 inches. The Gamma Ray curve fluctuates between 107 and 64 API units and the Sonic log between 75 and 90 microseconds per foot.

Aldebaran Sandstone (Permian): 4010 to 5645 feet (1635 feet)

The Aldebaran Sandstone in this well is very thick and for ease in discussion, has been broken down into eight units which have been designated as "A, B, C, etc, through to H"; "A" being the uppermost. Separating the various units are shales or very shaly intervals. The units are as follows :

"A Unit" Sandstone	4010 to 4104 feet (94 feet)
Shale unit	4104 to 4112 feet (8 feet)
"B Unit" Sandstone	4112 to 4375 feet (263 feet)
Shale unit	4375 to 4403 feet (28 feet)
"C Unit" Sandstone	4403 to 4560 feet (157 feet)
Shale unit	4560 to 4627 feet (67 feet)
"D Unit" Conglomerate and sandstone	4627 to 4900 feet (273 feet)
Shale unit	4900 to 4932 feet (32 feet)
"E Unit" Sandstone and shale	4932 to 5185 feet (253 feet)
Shale unit	5185 to 5250 feet (65 feet)

"F Unit" Sandstone	5250 to 5316 feet (66 feet)
Shale unit	5316 to 5342 feet (26 feet)
"G Unit" Sandstone	5342 to 5450 feet (108 feet)
Shale unit	5450 to 5520 feet (70 feet)
"H Unit" Sandstone	5520 to 5645 feet (125 feet)

Detailed description, Aldebaran Sandstone

"A Unit" Sandstone, 4010 to 4104 feet (94 feet)

This unit is almost entirely made up of sandstone with occasional thin beds of conglomerate, shale, and siltstone. Most of the unit was cored with Cores Nos 18, 19 and 20.

Lithology:

The sandstone is predominantly light grey, generally medium to fine-grained, and occasionally coarse to very coarse-grained, poorly sorted, with angular quartz, some weathered feldspar, and a trace of green and black minerals and lithic rock fragments in a white kaolinitic type clay matrix. It is mostly medium grey, silty, and the matrix is moderately to very argillaceous and has irregular shaly inclusions and laminae. In places, these two types are gradational with one another. There are slight traces of mica, pyrite, and carbonaceous material. The sandstone beds may be conglomeratic or interbedded with thin beds of conglomerate particularly in the top 14 feet.

The conglomerates are grey and comprise granules, pebbles and cobbles of vitreous quartz, quartzite, sandstone, siltstone, and shale in a very fine to very coarse sandstone matrix which consists of angular, poorly sorted grains of quartz in a kaolinitic matrix. There are a few thin beds of shale, medium to dark grey and grey-brown, blocky, silty, in part sandy, very micaceous and carbonaceous. They are usually very pyritic with the pyrite taking the form of lenses and blebs and a trace of pyritized wood. There are many laminae of siltstone associated with the shale which are medium to light grey-brown, argillaceous, arenaceous, feldspathic, micaceous, and slightly carbonaceous.

There is some poor and less commonly, fair porosity, associated with the sandstone.

Cores Nos 18 (3990 to 4016 feet), 19 (4030 to 4052 feet), and 20 (4062 to 4101 feet) were cut in this unit. Core No. 18 includes the top and Core No. 20 the base of the unit. The bedding is for the most part, poorly developed and gradational. There is some cross bedding exhibited in the cores, and dips generally vary from 0^{o} to 4^{o}.

Shale unit, 4104 to 4112 feet (8 feet)

Lithology :

This unit consists predominantly of shale, medium to dark grey-brown, blocky, silty and slightly sandy, pyritic, with the pyrite taking the form of stringers and blebs with

some finely disseminated pyrite, micaceous, and a trace of carbonaceous material. It is thinly interlaminated with siltstone, light grey, argillaceous, sandy and micaceous.

Core No. 20 (4062 to 4101 feet), penetrated the top of this unit.

"B Unit" Sandstone, 4112 to 4375 feet (263 feet)

This unit consists predominantly of sandstone with numerous shaly interbeds and some siltstone and conglomerate beds.

Lithology:

The sandstone in this unit is generally light to medium grey and grey-brown, very fine to coarse-grained, poorly sorted with angular quartz and weathered feldspar, green and black mafic minerals, and lithic rock fragments. The matrix is generally very kaolinitic and clayey and often shaly. There is a trace of pyrite and carbonaceous material. The sandstone is usually coarser grained in the top 163 feet, mainly very fine and fine-grained in the basal 100 feet. The sandstone is occasionally conglomeratic and interbedded with conglomerate, particularly between 4168 and 4178 feet, and again between 4230 and 4240 feet. The pebbles consist mainly of vitreous quartz, quartzite, sandstone, siltstone, and shale. The sandstone is interbedded, in part, with shale and siltstone.

The shale is medium to dark grey, blocky, in part slightly fissile, silty and sandy, very sandy in parts, micaceous, pyritic, and carbonaceous, with occasional lenses of coal.

The siltstone is medium to light grey-brown, sandy, slightly to very argillaceous, micaceous, and carbonaceous. It is best developed between 4200 and 4300 feet. A relatively high percentage of tuff and tuffaceous shale was encountered in the cuttings between 4160 and 4330 feet. This material was originally thought to be cavings; however, it is now believed that it is part of the unit. It is light grey, light brown, and light green, soft, splintery, with a soapy texture, micaceous, and with fragments of volcanic glass disseminated throughout.

Core No. 21 (4333 to 4343 feet) was cut in this unit. The top three feet of the core consisted of thinly interbedded sandstone, shale, and siltstone as described above. The sandstone was very fine to fine-grained, and silty, conglomeratic, with poorly sorted quartz in a very shaly and clayey matrix. The next five feet consisted of cleaner sandstone interbedded with dirty sandstone, shale, and siltstone as described above. The basal two feet consisted of a cleaner, better sorted, angular, quartz sandstone, with a kaolinitic matrix. The bedding in this core was generally flat.

The sandstone in this unit is similar to that of "A Unit" except that it is more clayey and shaly. As a result, the sandstone is not as porous or permeable. It is generally tight with only a trace of poor porosity.

Shale unit, 4375 to 4403 feet (28 feet)

This unit consists of shale, medium to dark grey-brown, blocky, silty, firm, in part slightly carbonaceous and micaceous, interbedded with siltstone, light brown, firm, blocky, sandy, argillaceous, very carbonaceous, with a trace of mica. No cores were cut in this unit.

"C Unit" Sandstone, 4403 to 4560 feet (157 feet)

This unit is comprised mainly of sandstone interbedded with minor shale, siltstone, and conglomerate, and minor thin beds of limestone.

Lithology:

The sandstone is generally fine to medium-grained, occasionally coarse to very coarse-grained, fair to well sorted, angular quartz and feldspar, with occasional green and black minerals and lithic rock fragments. The feldspars are weathered in places. The matrix consists of a white kaolinite. The quartz is usually vitreous, although there is some milky and smokey quartz. Between 4486 and 4498 feet the matrix is slightly calcareous, and between 4498 and 4504 feet, it becomes quite dolomitic and limy. Below 4460 feet, the sandstone becomes quite coarse-grained and conglomeratic and probably interbedded with minor conglomerate. The pebbles are usually made up of quartz and quartzite, with some sandstone, siltstone, and shale and minor grey chert. There is some light to medium grey, argillaceous sandstone. However between 4520 and 4560 feet, the sandstone is noticeably cleaner and less clayey.

There are interbeds of shale, medium to dark grey, blocky, silty and sandy, slightly carbonaceous and micaceous, and some siltstone, medium grey, firm, sandy, slightly argillaceous, carbonaceous, and micaceous. There are also a few thin interbeds of limestone, mottled brown-white, microcrystalline, and sandy.

This unit is similar to "A" and "B" units, except that it is coarser grained and cleaner, especially below 4520 feet. The porosity is generally poor throughout the unit but becomes fair and rarely good below 4520 feet. Cores Nos 22 (4534 to 4542 feet) and 23 (4543 to 4553 feet) were cut in the base of "C Unit". The bedding in Core No. 22 was flat.

Shale unit, 4560 to 4627 feet (67 feet)

This unit consists mainly of shale, medium to dark grey, firm, blocky, in part fissile, sandy and silty, slightly carbonaceous, with traces of carbonized plant fragments, micaceous. It is thinly interlaminated with siltstone, light grey, micaceous, sandy and slightly argillaceous, firm.

From logs it would appear that this shale is interbedded with sandstone, between 4566 and 4601 feet. This sandstone is light grey and medium grey-brown, with fine-grained, angular, well-sorted quartz, weathered feldspar, and lithic rock fragments in a kaolinitic and shaly matrix.

In the cuttings, a high percentage of sandstone was logged through this interval. Most of this sandstone is probably cavings.

Core No. 24 (4606 to 4616 feet) was cut at the base of this unit. Dips are low.

"D Unit" Conglomerate and sandstone, 4627 to 4900 feet (273 feet)

This is a very distinctive unit and is made up mostly of conglomerate interbedded with sandstone and minor shale and siltstone. There is also a trace of limestone.

Lithology:

Generally the conglomerate is comprised of pebbles, cobbles, and granules. Although there are some boulders present, in general they are poorly sorted, and are usually subrounded to subangular and very rarely rounded or angular. The general shape tends to be flat. The overall colour of the conglomerate is usually light to medium grey. However, the individual granules, cobbles, and pebbles are dark to light green, olive-green, grey-green, and light to dark grey and white. They consist of phyllites, quartzites, quartz, slate, chert, tuffs, sandstones, tuffaceous sandstones, siltstones and shales. They may be pyritized and chloritic. The matrix consists of sandstone, light grey and white, generally coarse-grained, some fine to medium-grained, with angular, poorly sorted quartz, some chert, feldspar and green lithic rock fragments in a siliceous, kaolinitic, and sometimes calcareous matrix. There are traces of pyrite. The quartz is usually vitreous throughout, sometimes milky and smoky. There are a few dark grey shale partings and laminae. The conglomerates are fossiliferous. Brachiopods, bryozoa, and corals have been noticed, particularly between 4644 and 4660 feet, 4760 and 4790 feet, and traces in Core No. 26 at 4819 feet.

The conglomerate is interbedded with sandstone which is light grey and light to medium grey-brown, very fine to very coarse-grained, with poorly sorted, angular quartz, chert, some feldspar, and green and black lithic rock fragments in a siliceous or calcareous, kaolinitic matrix. It is slightly micaceous, pyritic, and carbonaceous. The sandstones are clayey and argillaceous, firm to friable, generally tight, with a trace of poor porosity.

There are a few interbeds of shale and siltstone, particularly between 5735 and 5785 feet. The shale is medium to dark grey, firm, blocky, silty to sandy, carbonaceous, and very slightly calcareous. The siltstone is light to medium grey and brown-grey, very argillaceous and sandy, slightly carbonaceous and micaceous, in part slightly calcareous. There are a few thin beds of limestone, brown, crypto to micro-crystalline, argillaceous and arenaceous, tight, fossiliferous, with brachiopods, bryozoa, and corals; in part they have an oolitic appearance. These beds occur between 4644 and 4660 feet and again between 4760 and 4790 feet.

The bottom foot of Core No. 24 (4606 to 4616 feet) was taken near the top of this unit and Cores Nos 25 (4696 to 4716 feet) and 26 (4812 to 4822 feet) were cut within the unit. Core No. 25 had dips of about 14^{o}, while in Core No. 26, the bedding was not distinct but appeared to be flat.

Shale unit, 4900 to 4932 feet (32 feet)

This unit comprises thinly interbedded shale, siltstone, and sandstone.

Lithology:

The shale is medium to dark grey-brown, firm, blocky, silty, very slightly calcareous with a trace of mica and carbonaceous material.

The siltstone is medium grey, firm, blocky, sandy, with thin carbonaceous laminae.

The sandstone is light grey and light tan, fine to medium-grained, with angular, poorly sorted quartz, feldspar, in kaolinitic matrix. It also has shaly inclusions and a trace of finely disseminated carbonaceous material.

No cores were cut in this unit.

"E Unit" Sandstone and shale, 4932 to 5185 feet (253 feet)

This unit consists of sandstone interbedded with shale and siltstone.

Lithology:

The sandstone is usually light to medium grey-brown and occasionally light grey to white and dark grey, and varies from very fine to very coarse-grained, though mainly fine to medium-grained; it is composed of poorly sorted angular grains of quartz, feldspar, and some green lithic rock fragments. The matrix is usually moderately argillaceous, siliceous and kaolinitic, and in parts calcareous. The sandstone is slightly to very carbonaceous. There are usually irregular inclusions and laminations of shale, some resembling worm bores. Traces of pyrite and fossil fragments which appear to be brachiopods are present. These were noticed in Core No. 27 at 5070 feet and in the cuttings between 5135 and 5150 feet. The sandstone appears to be conglomeratic below 5140 feet. The sands are usually tight with a trace of poor porosity.

The siltstone is medium to dark grey-brown, firm, blocky, moderately to very argillaceous and carbonaceous, in part sandy, pyritic, micaceous, and feldspathic. The greatest percentage of siltstone is between 5000 and 5064 feet. The actual percentage of shale in this unit is quite small. The shale is usually medium to dark grey, firm, blocky, usually very silty and sandy, slightly micaceous, and pyritic, and occurs as laminations. It varies from slightly to very carbonaceous, and there is a trace of coal in the cuttings from 5160 to 5180 feet, but this may be cavings.

Core No. 27 (5064 to 5088 feet), was cut in this interval; there was no apparent bedding in the core.

Shale and shaly-sandstone unit, 5185 to 5250 feet (65 feet)

This unit consists of shale interbedded with a very shaly sandstone and some siltstone.

The shale is medium to dark grey and black, firm, blocky, carbonaceous, in part silty and sandy, with a trace of pyrite.

The sandstone is distinctive in that it is medium to dark grey-brown, very fine to fine-grained and silty, and consists of poorly sorted quartz, feldspar, and a trace of green lithic rock fragments in a very shaly matrix. There is a trace of carbonaceous specks and mica.

The siltstone is medium to dark grey-brown and light grey, firm, blocky, slightly to moderately argillaceous, in part sandy, with carbonaceous laminae and a trace of pyrite.

No cores were cut in this unit.

"F Unit" Sandstone, 5250 to 5316 feet (66 feet)

This unit is similar to the overlying unit and consists mainly of sandstone, interbedded with minor shale and siltstone. It differs from the "E Unit" in that it is cleaner and finer grained.

Lithology:

The sandstone is light grey and tan, very fine to fine-grained, fair sorted, angular quartz and feldspar with a trace of chert and green lithic rock fragments in a siliceous, slightly kaolinitic matrix. The top twenty feet are very clayey. It is hard and tight and slightly carbonaceous, with a trace of pyrite. The sandstone becomes conglomeratic towards the base. The shale is medium to dark grey and black, blocky, micaceous, and in part very carbonaceous. The siltstone is medium to dark grey, argillaceous, in part sandy, micaceous, with carbonaceous laminae.

No cores were cut in this unit.

Shale, sandstone, and siltstone unit, 5316 to 5342 feet (26 feet)

This is a very shaly unit. It comprises interbedded shale, siltstone, and sandstone. Core No. 28 (5303 to 5313 feet) was cut near the top of the unit.

Lithology:

The shale is dark grey, blocky to fissile, micaceous, silty and sandy, with very carbonaceous laminae, and is thinly interbedded and interlaminated with siltstone and sandstone.

The siltstone is light grey, coarse-grained and sandy, in places grading to sandstone. It is feldspathic, slightly micaceous, in part slightly to moderately argillaceous, with carbonaceous laminae, and carbonized plant fragments.

The sandstone is usually medium to dark grey-brown, very fine-grained and silty, with poorly sorted, angular quartz and feldspar in a clayey and shaly matrix. It is slightly micaceous and very carbonaceous with specks and larger fragments of carbonized plants. It is rarely light brown, fine-grained, well-sorted and slightly calcareous. The sandstones, siltstones, and shales may be gradational into one another.

Core No. 28 shows some cross-bedding, and dips from 0° to 20°.

"G Unit" Sandstone, 5342 to 5450 feet (108 feet)

This unit consists predominantly of sandstone with some shaly interbeds.

Lithology:

The upper 14 feet of this unit consist of sandstone, light grey, fine to very coarse-grained, with poorly sorted, angular quartz, a trace of feldspar, grey chert, green and dark grey lithic rock fragments in a siliceous kaolinitic cement. In part it is slightly conglomeratic, which is generally tight with a trace of poor porosity. The next 18 feet are made up of similar sandstone, except that it is more argillaceous and shaly. Below this are 15 feet of sandstone which is light grey to white, generally very fine to fine-grained, with some medium and coarse-grained beds, with fair to well-sorted angular quartz and feldspar, white kaolinitic specks, and a trace of dark grey lithic rock fragments and mafic minerals in a slightly calcareous kaolinitic and rarely siliceous matrix. This interval is poorly porous with a trace of fair to good porosity. For the next 16 feet, the sandstone is light to medium grey, very fine to fine-grained, and poorly sorted. The matrix is slightly to moderately argillaceous. The sandstone is thinly interlaminated with shale, dark grey to black, fissile, silty and sandy, very carbonaceous, with carbonized plant fragments, and very micaceous. The sandstone is generally tight. The next 11 feet of sandstone are light to medium grey, very fine to fine-grained, with subangular to angular quartz and weathered feldspar, kaolinitic specks and green, black, and grey lithic rock fragments in a slightly calcareous kaolinitic matrix. It is generally tight with a trace of poor porosity. This is followed by eight feet of shale and shaly sandstone. The basal 26 feet are comprised of sandstone, light grey to light brown, fine to coarse-grained with poorly sorted, angular to subangular quartz, feldspar, and lithic rock fragments in a siliceous kaolinitic matrix. It is generally tight and in part slightly conglomeratic.

Two cores were cut in the unit, Cores Nos 29 (5367 to 5381 feet) and 30 (5390 to 5414 feet). Bedding dips varied from 0^{o} to 15^{o} in the cores.

Shale, and sandstone unit, 5450 to 5520 feet (70 feet)

Lithology:

The shale beds are medium to dark grey, firm, blocky, in part silty, micaceous, with a few thin carbonaceous laminae, and traces of pyrite. The shale is interbedded with sandstone that is similar to the overlying unit but differs in that it is very conglomeratic, hard and tight.

No cores were cut in this unit.

"H Unit" Sandstone, 5520 to 5645 feet (125 feet)

This unit consists of sandstone with a few shaly streaks.

Lithology:

The sandstone is light grey, fine to medium-grained, and rarely coarse-grained, well sorted, with angular to subangular quartz and feldspar, in part weathered to kaolinite, some grey, green, and black lithic rock fragments and minerals. The matrix is in part moderately calcareous but mainly kaolinitic and slightly siliceous. It is generally friable and poorly porous with some fair and good porosity in the basal 37 feet. There are occasional shale laminations which are dark grey, fissile, sandy, very carbonaceous and micaceous. These shaly streaks are located between 5541 and 5549 feet, 5564 and 5581 feet, and again between 5594 and 5608 feet.

Core No. 31 (5528 to 5554 feet) showed generally flat dips.

Electrical Characteristics, Aldebaran Sandstone:

In general the Aldebaran Sandstone is quite distinctive on the logs. The self potential shows a great deal of character because of the interbedded nature of the sandstones, shales, and siltstones. However, rarely does the self potential show a deflection greater than -15 millivolts. This is because the sandstones are generally quite shaly and clayey. The resistivity fluctuates a fair amount too, and has some fairly high readings. This is because of two reasons. In the more porous and permeable sandstones the high readings are caused by the hydrocarbon content. In other cases, the high readings are caused by dense conglomerate beds. Large fluctuations in the Gamma Ray curve are again caused by the interbedded nature of the sandstones and shales. The Caliper log shows much washing out of the sandstones. This is a result of the clayey matrix, and the sandstone disintegrates readily shortly after being opened up. Thus it is difficult to tell if there is a filter cake build-up.

The self potential in the "A Unit" shows a maximum deflection of -15 millivolts and a resistivity on the 64" normal of 60 ohms near the centre of the unit, and 70 ohms near the base. Microlog porosities vary between 15% and 17% and the Sonic log indicates porosities in a similar range, that vary between 17% and 11%. The average travel time for this unit is 75 microseconds per foot. The Gamma Ray averages 60 API units for the sandstones with peaks down to 48 API units. The shaly intervals read about 108 API units.

The shale unit between "A Unit" and "B Unit" is distinctive in that it reads a low of 7 ohms on the resistivity curve, which is much lower than the shaly streaks in either "A" or "B" units and the Gamma Ray reads a high of 140 API units.

"B Unit" sandstone beds are more shaly than "A Unit". This is depicted by the self potential which has a maximum deflection of only -10 millivolts and the resistivities, with one exception, read only 20 ohms on the 16" normal and 30 ohms on the 64" normal. The exception referred to reaches 35 ohms. Porosities are not calculable from the Microlog, but on the Sonic log they range between 8% and 14%. The average travel time from 4112 to 4265 feet is 73 microseconds per foot and below this to 4375 feet, it is 67 microseconds per foot. The Gamma Ray varies from 108 to 125 API units for the shaly sections and from 42 to 74 API units for the sandstones.

The shale unit between "B Unit" and "C Unit" returns to the shale base line on self potential and the resistivity reaches a low of 6.5 ohms. The Gamma Ray log goes above 240 API units. Sandstones in the "C Unit" appear to be somewhat cleaner and the self potential deflection is -12 millivolts in the top of the unit and a maximum of -19 millivolts near the base. The upper sandstones have poor porosity as indicated by the Microlog. However, between 4526 and 4560 feet, the porosities range from 11% to 19% and the Sonic log porosities are about 10% to 13% with an average travel time of 70 microseconds per foot. The 64" normal shows a resistivity of between 65 and 70 ohms. This gives a water saturation of 55%. The Caliper log shows some mud cake build-up indicating the zone has some permeability.

The shale unit between "C Unit" and "D Unit" is not as pronounced as the shale breaks between the previous units. The self potential only reaches the shale base line and the resistivity reaches a low of 17 ohms and the Gamma Ray log reads 120 API units.

"D Unit" shows a great deal of character on the logs, particularly the Electrical log where, in the first 55 feet, a high resistivity of 60 ohms on the 16" normal and 100 ohms

on the 64" normal, is recorded. However, there is only a slight deflection of -5 millivolts on the self potential. This is caused by the dense conglomerate. Over the next 50 feet, which appears to be sandier, the self potential gradually reaches a deflection of -19 millivolts and the resistivity fluctuates between 25 and 40 ohms on the 16" normal and between 45 and 60 ohms on the 64" normal. In the next 60 feet, the resistivity is similar; however, the self potential drops back to the shale base line. This is probably because the zone is more shaly. Over the remaining 108 feet, the resistivity fluctuates between 17 and 40 ohms, and the maximum self potential deflection is -12 millivolts. The average travel time in "D Unit" is about 63 microseconds per foot and the Gamma Ray curve fluctuates between 96 and 48 API units. The Sonic log and Microlog indicate very poor porosities in the order of 7%.

The shale break marking the base of "D Unit", and the top of "E Unit" shows up well on the Gamma Ray log where it increases to 140 API units and the self potential returns to the shale base line. The corresponding resistivities are about 17 ohms.

The sandstones in "E Unit" are quite shaly, which can be seen on the self potential where there is a maximum deflection of only -9 millivolts and the resistivity reaches a maximum of only 28 ohms and generally it fluctuates between 15 and 20 ohms. The Gamma Ray curve averages about 72 API units and shows up two pronounced shaly streaks, the first between 5010 and 5038 feet, and the second between 5130 and 5150 feet. The latter peaks at 130 API units. The Microlog shows only a few poorly porous streaks, averaging around 10% to 12% on the Sonic log.

The shale and shaly sandstone unit, between 5185 and 5250 feet, does not show up well on the logs. The self potential barely reaches the shale base line and the Gamma Ray log varies from 65 to 100 API units. The self potential in "F Unit" has a deflection of only -9 millivolts. However, this is not because of shaliness, since the Gamma Ray log indicates the sandstone is fairly clean with a maximum reading of 32 API units. Therefore, the sandstone is probably very tight and this is the reason for the high resistivity reading of 37 ohms on the 16" normal and 60 ohms on the 64". The Microlog and Sonic log also show that the sandstone is very tight with a porosity of about 6 percent.

The break between "F Unit" and "G Unit" shows up well on the logs. The self potential returns to the shale base line and the Gamma Ray readings peak at 125 API units. The resistivity in this interval is about 14 ohms.

Generally the sandstones in "G Unit" have only a -7 to -9-millivolt deviation from the shale base line, except for the bed between 5376 and 5388 feet, where it is -15 millivolts. The resistivity shows very little character and ranges from 10 to 19 ohms. The resistivity opposite the low self potential reading is only 10 ohms. The Microlog and Sonic log show that for the most part the sandstones are poorly porous, in the range of 12%. One two-foot zone opposite the low self potential reading has a porosity of 15%. The average travel time is 70 microseconds per foot. The Gamma Ray curve fluctuates between 110 and 42 API units. The Caliper log has a mud cake build-up in the over-gauge hole opposite the two-foot porous streak indicating some permeability.

The break separating "G Unit" and "H Unit" does not show up well on the Electrical log, but does on the Gamma Ray log where the shale beds reach 140 API units. The sandstone interbeds have a Gamma Ray reading of 48 API units. On the Sonic log, the shales peak at 85 microseconds per foot and the sandstones average around 77 microseconds per foot. The self potential fluctuates between the shale base line and -5 millivolts. The resistivity curve fluctuates between 8 and 24 ohms.

62-5

"H Unit" sandstone is very distinctive on the logs. It can be divided into two parts, the upper one from 5520 to 5608 feet, has a maximum self potential deflection of -22 millivolts and a maximum resistivity of 20 ohms. The Microlog and the Sonic log show porosities ranging from 11% to 23%. However, the Microlog shows that for the most part the sandstones are tight. The Gamma Ray log shows the sands to be generally clean with average readings of about 48 API units with minimum readings as low as 32 API units and maximum readings up to 72 units. The average travel time on the Sonic log is 74 microseconds per foot. The Caliper log shows some build-up opposite porous streaks between 5580 and 5592 feet, indicating permeability. The lower unit, from 5608 to 5642 feet, shows self potential deflections from the shale base line of -32 millivolts. The resistivities are very low ranging from 13 to 19 ohms. The Gamma Ray curve averages 42 API units with peaks as low as 33 units indicating the sandstones are very clean. The Microlog and Sonic log show good porous development with porosities ranging from 13% to 20%. The good build-ups on the Caliper log are indicative of permeability. The water saturation is calculated to be 55%.

Cattle Creek Formation (Permian): 5645 to 6643 feet (998 feet)

The Cattle Creek Formation is generally a monotonous unit though quite distinctive from the overlying Aldebaran Sandstone. It consists predominantly of siltstone. However, it can be broken up into a number of informal rock units as listed below:

Siltstone, shale, and sandstone unit	5645 to 5970 feet (325 feet)
Limestone, siltstone, and shale unit	5970 to 6180 feet (210 feet)
Siltstone, shale, and sandstone unit	6180 to 6643 feet (463 feet)

Detailed description, Cattle Creek Formation

Siltstone, shale, and sandstone unit, 5645 to 5970 feet (325 feet)

This unit consists predominantly of siltstone interbedded with shale and minor sandstone.

Lithology:

The siltstone is medium to dark grey-brown, in part light grey, blocky, firm, moderately to very argillaceous, in part sandy, moderately to very carbonaceous with streaks and laminations and occasionally specks of carbonaceous and coaly material, slightly micaceous, and a trace of pyrite. There are scattered brachiopod shell fragments which become more numerous in the basal 30 feet. Traces of scattered pebbles of quartz and chert occur throughout. The siltstone may be gradational and interbedded with shale, particularly from 5865 to 5950 feet, and with sandstone between 5763 and 5865 feet.

The shale in general is dark grey, blocky, to slightly fissile, generally silty and occasionally sandy, carbonaceous and micaceous, with a trace of pyrite.

The sandstone is light to medium grey, and light brown, very fine to coarse-grained, poorly sorted, with angular quartz, feldspar, and grey lithic rock fragments in a siliceous, slightly to very argillaceous matrix. It is generally tight, slightly carbonaceous and micaceous. In the interval mentioned above, the sandstone becomes more argillaceous and

silty towards the base of the interval. There are traces of coal, in the form of laminations. A high percentage of sandstone was logged in the cuttings in the first 40 feet. Most of this was caving from the Aldebaran Sandstone.

In Core No. 32 (5781 to 5806 feet), bedding was poorly developed, but appeared to be generally flat with some dips up to 15°.

Limestone, siltstone, and shale unit, 5970 to 6180 feet (210 feet)

This unit can be split into three parts, an upper limestone unit from 5970 to 6045 feet, a middle shale and siltstone unit from 6045 to 6100 feet, and a lower limestone unit from 6100 to 6180 feet.

Lithology:

The limestone is moderately hard, medium to dark brown, cryptocrystalline, sandy, coquinoidal, with abundant brachiopod shells and spines, generally very argillaceous and silty, and thinly interbedded and interlaminated with siltstone and shale.

The siltstone is typically medium to dark grey-brown, moderately hard, blocky, very argillaceous and sandy, in part grading to silty shale and silty sandstone. It is feldspathic, moderately carbonaceous with specks and laminations, slightly micaceous, and slightly fossiliferous.

The shale is dark grey, blocky, firm, silty, carbonaceous and micaceous. The lower limestone unit appears to be more interbedded with shale and siltstone.

No cores were cut in this unit.

Siltstone, shale, and sandstone unit, 6180 to 6643 feet (463 feet)

This unit comprises siltstone interbedded with shale, minor amounts of sandstone, and rare beds of limestone.

Lithology:

The siltstone is typically medium to dark grey-brown, in part light grey, blocky, firm to hard, moderately to very argillaceous, and slightly to moderately carbonaceous, in part slightly to very sandy, slightly micaceous, pyritic, and fossiliferous. The siltstone in this unit has become slightly calcareous. The fossil content is variable but generally the upper part of the unit is more fossiliferous. The fossils are mainly brachiopods, with some bryozoa and a few pelecypods. This unit is noticeably more consistently pyritic than either of the above units. The siltstone is interbedded with shale, the latter becoming more pronounced towards the base of the unit.

The shale is dark grey and dark grey-brown, in part slightly to moderately silty, slightly calcareous, moderately carbonaceous with finely disseminated specks and plant fragments. It is usually pyritic and fossiliferous. There is some black and brown shale below 6250 feet that may be bituminous. The siltstone and shale are interbedded and gradational with sandstone between 6290 and 6370 feet.

The sandstone is light to medium grey, very fine to fine-grained, with well-sorted angular quartz and feldspar and a rare trace of lithic rock fragments in a kaolinitic and siliceous matrix which becomes moderately calcareous towards the base. It is also slightly carbonaceous.

Between 6440 and 6470 feet, the character of the logs indicates the siltstone and shales are interbedded with minor amounts of limestone. This was not detected in the cuttings. It is probably due to a more fossiliferous development or thin limestone bands similar to those in the above unit. There is a trace of coal in the cuttings and this is probably from thin laminations.

Core No. 33 (6237 to 6247 feet) showed poorly developed bedding that appeared to be essentially flat.

Electrical Characteristics, Cattle Creek Formation:

The upper siltstone, shale, and sandstone unit is a rather monotonous sequence on the logs. The self potential is featureless except for a -5-millivolt deflection from the shale base line between 5763 and 5777 feet. The resistivity fluctuates between 12 and 17 ohms between 5645 and 5763 feet. The sandstone interbeds between 5763 and 5875 feet, cause higher resistivity readings with peaks up to 26 ohms on the 16" normal. The bottom part of this unit shows only very minor fluctuations between 12 and 16 ohms. The Microlog shows no porosity and in fact, the sandstones appear to be quite dense. The Caliper log shows the average hole size to be about 12-1/2" in the upper part of the unit, 11-1/2" in the interbedded sandstone interval, and 12" in the lower more shaly interval. The top 35 feet of the siltstone, shale, and sandstone unit does not appear to be as dirty on the Gamma Ray curve and it averages 84 API units. The readings then increase to an average of 114 API units. The interbeds of sandstone between 5763 and 5875 feet result in fluctuations in the Gamma Ray curve from 40 to 125 API units. The remainder of this unit averages about 84 API units. This unit averages 73 microseconds per foot on the Sonic log. The porosity of the sandstone appears to be above 7% on the Sonic log.

The limestone, siltstone, and shale unit shows up well on the logs. The apparent self potential reversal of +6 millivolts opposite the limestone beds probably represents a return to the true shale base line rather than a reversal as a result of fresh formation water. In the upper limestone beds the resistivity increases to a maximum of 55 ohms on the 16" normal, while the 18'8" lateral curve reads 200 ohms. In the lower limestone beds, resistivities are 35 ohms, 60 ohms, and 75 ohms respectively on the 16" normal, 64" normal, and 18'8" lateral curves. The intermediate siltstone and shale beds have a resistivity of 15 ohms. The Microlog shows no porosity in this unit. The upper limestone beds have an average Gamma Ray reading of 50 API units and a travel time of 63 microseconds per foot. The intermediate siltstone and shale unit averages 70 API units on the Gamma Ray curve, and 70 microseconds per foot on the Sonic log. The lower limestone beds show up on the Gamma Ray log as being shalier and have an average reading of 70 API units and an average travel time of 70 microseconds per foot. The Caliper log shows that the limestone beds have a greater tendency to wash out than do the siltstones and shales. The former has washouts to 12-1/2" and the latter to 11-1/4".

The siltstone, shale, and sandstone unit from 6180 to 6643 feet, is a monotonous sequence on the logs. The self potential is featureless except for a few deflections from the shale base line of about -3 millivolts opposite sandstone interbeds and one reversal of the self potential because of a thin limestone bed at about 6455 feet. The 16" normal ranges between 15 and 20 ohms except for sandstone beds where it reaches a high of 28 ohms and the

limestone beds are a little higher reaching 37 ohms. The Microlog shows no porosity and the Caliper log shows the hole washed out to a maximum of 11-1/2". The Gamma Ray averages around 90 API units except for the sandstone and limestone beds where it drops to about 60 API units. The average travel time for this unit is about 67 microseconds per foot.

Pre-Cattle Creek beds: 6643 to 6879 feet (236 feet)

A sharp lithologic change was encountered at 6643 feet. The unit consists of conglomerate interbedded with sandstone, shale, siltstone and coal.

Detailed description, pre-Cattle Creek beds

Lithology:

The conglomerate is markedly different from those in the overlying formations in that it contains mainly volcanic rock fragments. The pebbles are of a variety of colours and include green, orange, brown, grey, cream, and yellow, with some red and black pebbles. They are mainly lithic tuffs but there are some breccias and crystalline types as well as chert, quartz, and metamorphics. They appear to be associated mainly with the acid type of volcanic. Associated with the conglomerate and often forming the matrix is a sandstone which is usually light to medium brown and light grey, fine to very coarse-grained and finely conglomeratic, with poorly sorted, angular to subangular grains of mainly lithic rock fragments similar to the conglomerate pebbles, with some quartz and feldspar. The matrix is usually siliceous, slightly to moderately calcareous, tuffaceous and argillaceous. It is carbonaceous with coaly fragments of plant fossils, and it is generally tight.

The shale is medium to dark grey-brown and black, blocky, slightly fissile, silty, occasionally sandy, very carbonaceous with abundant plant fossils including leaves and stems, and contains thin laminations and streaks of coal.

The siltstone is medium to dark grey-brown, firm, blocky, very argillaceous and sandy with fragments of tuff. It is moderately to very carbonaceous and coaly with abundant plant fragments and fossils.

The coal is usually black, shiny and brittle, though in parts dull and shaly. There are many blebs and stringers of pyrite associated with the coal as well as the shale and siltstone. The percentage of coal increases downwards.

A few brachiopod fragments were noted in the samples. However, there were no marine fossils in the cores. It is felt that the brachiopod fragments are cavings and that these beds are continental in origin and part of the pre-Cattle Creek beds.

Core No. 34 was cut near the top of this interval from 6703 to 6713 feet. It consisted predominantly of silty shale with thin beds of sandstone and conglomerate as above. There was 0.1 foot of coal at the top of the core. There was a trace of slickensides and the dip varied from flat to 22^{o}.

Bottom hole Core No. 35 (6839 to 6873 feet) was also cut in this unit. It consisted mainly of conglomerate as described above, interbedded with sandstone, siltstone, and shale as described above, and thin laminations of coal, black, shiny, and brittle. Dips varied from 0^{o} to 15^{o}.

Electrical Characteristics, pre-Cattle Creek beds:

The pre-Cattle Creek beds do not stand out well on the Electrical log. The self potential is generally featureless with only minor 2 to 3-millivolt fluctuations. The resistivity curves show more character, especially in the conglomerate beds where high resistivities up to 46 ohms are recorded on the 16" and 64" normal. Two high resistivity peaks are noted on the lateral curve. The one at 6740 feet is 65 ohms and the one at 6796 feet is 50 ohms. These appear to be caused by very carbonaceous shale or coal. The remainder of the section fluctuates between 5 and 20 ohms. On the Gamma Ray-Sonic log, the pre-Cattle Creek beds show more character. The conglomerates have a low Gamma Ray reading of about 48 API units and a low travel time of 60 to 65 microseconds per foot. The remainder of the section averages about 84 API units and a travel time of 80 to 90 microseconds per foot except for the one high resistivity peak at 6796 feet which reads 105 microseconds per foot. The Microlog shows no porous developments and the Caliper log indicates the hole is fairly well in gauge.

Structure

Warrinilla North No. 1 Well was located on a culmination that occurs on the northern plunge of the Warrinilla Anticline. Based on seismic control near the top of the Ingelara Formation, this structure is believed to have 120 feet of closure over an area of six square miles.

The well drilled through a normal section down to 6879 feet which was 236 feet into the pre-Cattle Creek beds. No apparent faulting was encountered in the section. Slickensiding occurred in Cores Nos 1, 8, 11, 15, 24 and 34, and was restricted to shale beds. Dips measured in the cores varied from 0^{o} to 20^{o}. For the most part they were flat or in the 4^{o} to 5^{o} range. The steeper dips were probably due to current bedding.

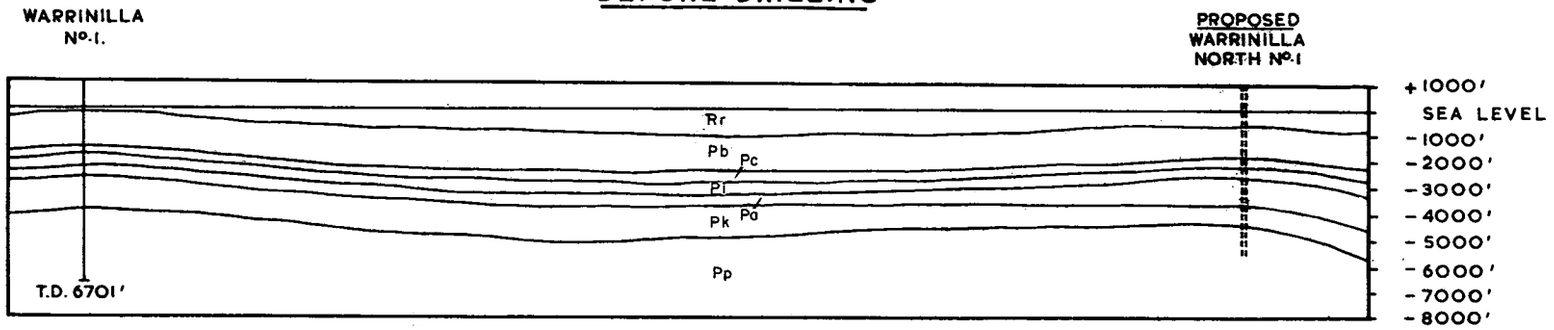
A continuous dipmeter survey was run on the well from 3500 feet to total depth. The results of the survey were plotted on circular graphs (rosettes) for each of the formations.

Formation	Interval (feet)	Number of readings recorded on Dipmeter	Number of readings used to obtain average dip and direction	Average dip and Magnetic Bearing
Ingelara Formation	3513-4010	12	9	3^{o} at 124^{o}
Aldebaran Sandstone	4010-5645	23	19	4^{o} at 252^{o}
Cattle Creek Formation	5645-6499	16	16	3^{o} at 224^{o}
	6499-6643	4	4	9^{o} at 243^{o}
pre-Cattle Creek beds	6643-6867	10	6	9^{o} at 209^{o}

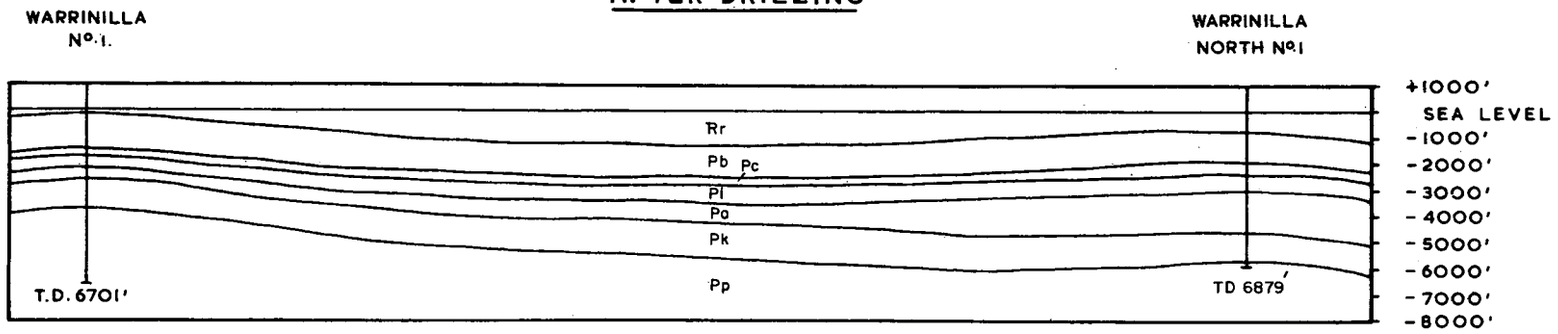
Fig. 2

SOUTH NORTH

BEFORE DRILLING



AFTER DRILLING



LEGEND

Rr	REWAN FORMATION
Pb	BANDANNA FORMATION
Pc	CATHERINE SANDSTONE
Pi	INGELARA FORMATION
Pa	ALDEBARAN SANDSTONE
Pk	CATTLE CREEK FORMATION
Pp	PRE-CATTLE CREEK BEDS

PLANET EXPLORATION COMPANY PTY. LTD.

WARRINILLA AREA CROSS SECTIONS BEFORE & AFTER DRILLING

SCALE	AUTHOR	DATE	NUMBER
	M.G.McK.	JAN. 1964	D·194

An angular discordance is suggested between the Ingelara and the Aldebaran formations, but no significant changes occur below 5645 feet.

Occurrence of Hydrocarbons

Rewan Formation: (55 to 1704 feet)

No oil or gas shows were recorded by means of fluorescence or the gas detector in the Rewan Formation.

Bandanna Formation: (1704 to 2945 feet)

No oil or gas shows were noted in the top of the Bandanna Formation down to a depth of 2252 feet. A drillstem test was run between 2000 and 2072 feet (DST No. 1) and recovered only five feet of mud.

Between 2252 and 2350 feet, the Johnson and Williams continuous hotwire filament gas detector and the programmed hydrocarbon detector or chromatograph, showed gas readings up to 60 units on the former and 85 units methane with 5 units of higher hydrocarbons on the latter. Associated with these shows, was a trace of poor porosity. DST No. 3 was run from 2228 to 2264 feet and recovered 100 feet of mud. The remainder of the shows below 2264 feet appear to be associated with coal seams. The siltstone and shale unit of the Bandanna Formation had no shows and the shale and tuff unit showed only a very slight rise in the level of the gas readings.

Mantuan Productus Bed: (2945 to 3068 feet)

A good show was recorded in the sandstones of the Mantuan Productus Bed in the core and cuttings as well as on the gas detectors. A 35-foot core was cut in the top of this zone (Core No. 12). The bottom 15 feet of this core comprised sandstone that had fair gas bleeding and a speckled gold fluorescence. However, there was no cut with carbon tetrachloride.

The hydrocarbon detectors showed only two units on the hot-wire filament and 10 units methane with no higher hydrocarbon on the chromatograph while coring. However, trip gas from this interval recorded 26 units on the hotwire filament and 61 units methane on the chromatograph. A drillstem test of the interval from 2955 to 2991 feet (DST No. 4) recovered 10 feet of mud with no combustible gas to the surface even though there was a weak steady blow throughout the whole of the 90-minute open-flow period.

Anomalous readings were recorded throughout the remainder of the Mantuan Productus Bed with a maximum of 26 units on the hotwire filament and 50 units methane on the chromatograph between 3020 and 3040 feet and 18 units on the hotwire filament with 32 units methane on the chromatograph, between 3090 and 3100 feet.

The sandstones, in combination with their shows, were generally tight with a trace of poor porosity. They had a dull yellow fluorescence and no cut in carbon tetrachloride. In view of the results of DST No. 4 no further tests were run.

Catherine Sandstone: (3068 to 3450 feet)

There were no hydrocarbon shows in the siltstone and shale unit comprising the upper part of this formation.

Sandstone unit:

There were no shows on the continuous hotwire filament or chromatograph throughout this unit. There was however, a speckled gold fluorescence in the cuttings and in Core No. 14 (3361 to 3371 feet). There was also some gas bleeding in this core. Because of the poor porosity, no drillstem tests were run.

Ingelara Formation: (3450 to 4010 feet)

No shows were observed on the gas detectors or cuttings in the shale and siltstone of the Ingelara Formation.

The sandstone unit from 3725 to 3850 feet on the other hand, had a maximum reading of 8 units on the hotwire filament and a corresponding reading of 9 units methane, with no higher hydrocarbons, on the chromatograph. Two cores were cut in this interval. Core No. 16 (3780 to 3800 feet) had spotty gold fluorescence and gas bleeding combined with some poor to fair porosity. Core No. 17 (3813 to 3844 feet) also had slight gas bleeding and occasional dull gold fluorescence combined with poor porosity. However, this core was also bleeding salt water.

A drillstem test run at the top of the unit (DST No. 5, 3721 to 3731 feet) recovered only 8 feet of mud. Another drillstem test (DST No. 6, 3722 to 3813 feet) was run, and recovered gas to surface in 20 minutes at 65 Mcf/D and remained steady throughout the test. The pipe recovery of this test was 330 feet of highly gas-cut mud and 90 feet of gas and mud-cut brackish water.

No further shows were recorded in the remainder of the Ingelara Formation.

Aldebaran Sandstone: (4010 to 5645 feet)

The Aldebaran Sandstone is characterized by a multiplicity of shows in the cuttings, cores, and drillstem tests. However, the gas detectors gave little or no warning of the presence of gas in the sandstones of the formation. An attempt was made to explain the reason for this lack of detection. The detectors themselves were checked and appeared to be in proper working order. They would pick up the trip gas after drillstem tests were run, but would not detect the gas on drilling into the zone. The mud properties were varied. This included raising and lowering the weight and viscosity with no avail. Since the gas detection equipment was good on the Warrinilla No. 1 Well, and the same drilling rig and mud logging unit were present on both wells, all the factors that might control gas detection were simulated. However, the detection did not improve and the reasons for this remained unexplained after the well was completed.

Most of the sandstones of "A Unit" were cored. The cores covering this unit are Core No. 18 (3990 to 4016 feet), Core No. 19 (4030 to 4052 feet), and Core No. 20 (4062 to 4101 feet). The sandstone in all the cores showed fair gas bleeding, a petroliferous odour on fresh fracture, and a bright yellow fluorescence with a cut in carbon tetrachloride. Associated with these shows was some poor to fair porosity and some permeability.

Three drillstem tests were run in this unit. DST No. 7 (4005 to 4030 feet) recovered gas to surface in 53 minutes at an estimated rate of 5 Mcf/D. DST No. 8 (4027 to 4062 feet) recovered gas to surface in two minutes at a rate of 70 Mcf/D which increased to 112 Mcf/D after 120 minutes. DST No. 9 (4061 to 4120 feet) recovered gas to surface at an estimated rate of 10 Mcf/D. With the exception of DST No. 8, formation pressures were fairly low and the initial shut-in pressure was less than the final shut-in pressure, indicating there was some formation damage because of the mud.

The gas detector in this unit, recorded a maximum of 4 units on the hotwire filament and 18 units methane with no higher hydrocarbons on the chromatograph.

The sandstones in "B Unit" were generally very poorly porous and impermeable. The hotwire filament usually recorded one unit of gas and occasionally up to 4 units. Corresponding highest readings on the chromatograph were 5 units methane with no higher hydrocarbons. There were no shows in the cuttings and only a trace of dull gold fluorescence with slight gas bleeding in Core No. 21 (4333 to 4343 feet).

A drillstem test from 4263 to 4360 feet (DST No. 10) was unsuccessful and DST No. 11 (4342 to 4410 feet) recovered only 75 feet of mud with very low formation pressures.

The upper part of "C Unit" from 4403 to 4526 feet was generally very poorly porous and had only a trace of yellow fluorescence in the cuttings. There were no shows on the gas detectors in this part of "C Unit". In the lower part of the unit, 4 units of gas were recorded on the hotwire filament and 13 units methane with no higher hydrocarbons on the chromatograph. Cores Nos 22 (4534 to 4542 feet) and 23 (4543 to 4553 feet) were cut in this part of "C Unit". Both these cores had a good bright yellow-white fluorescence and cut in carbon tetrachloride. There was also gas bleeding and petroliferous odour on fresh fracture in the cores. Two attempts at testing this zone failed, but a third drillstem test (DST No. 14, 4535 to 4553 feet) recovered gas to surface in 26 minutes at 44 Mcf/D which remained steady throughout the test. Another drillstem test (DST No. 15, 4510 to 4573 feet) was run so as to cover all the porosity. It recovered only an estimated 5 Mcf/D. On both tests, the initial shut-in pressure was less than the final, again indicating formation damage.

"D Unit" of the Aldebaran Sandstone had no shows in the cuttings or in Cores Nos 24 (4606 to 4616 feet) and 26 (4812 to 4822 feet). Part of Core No. 25 (4696 to 4716 feet) had slight gas bleeding and spotty gold fluorescence. However, DST No. 16 (4686 to 4716 feet), which was run over this interval recovered only 210 feet of slightly gassy mud. The formation pressures on this test indicate very poor permeability. No shows were recorded on the gas detector in this unit.

While drilling and coring "E Unit", the maximum gas detector recording was 2 units on the hotwire filament and 8 units methane on the chromatograph. There were no shows in the cuttings and only slight gas bleeding with a spotty gold fluorescence in the cores. DST No. 17 (5123 to 5233 feet) which was run at the base of this unit recovered 200 feet of mud and had very low formation pressures.

Unit "F" was similar to unit "E". An anomalous reading on the gas detectors at 5223 feet was due to trip gas. Part of unit "F" was covered by DST No. 17. Core No. 28 (5303 to 5313 feet) was cut in the base of the unit and had no shows.

"G" sandstone unit from 5342 to 5450 feet had an abundance of shows. The cuttings from 5360 to 5367 feet had a good yellow fluorescence and cut with carbon tetrachloride. Two cores were cut in this unit - Cores Nos 29 (5367 to 5381 feet) and 30 (5390 to 5414 feet). Both cores had slight to fair gas bleeding, a petroliferous odour on fresh fracture, and a bright yellow to white fluorescence with a good cut in carbon tetrachloride. In the cores, there was observed what was thought to be a light brown oil stain. The presence of this oil saturation is corroborated to some degree by core analysis of Core No. 29, where a 25% oil saturation was found in the more shaly sandstones. However, the porous and permeable sandstones were almost devoid of oil saturation.

Three drillstem tests were run in this unit. DST No. 18 (5363 to 5381 feet), recovered only 15 feet of mud and DST No. 19 (5374 to 5414 feet) recovered 350 feet of mud. It is interesting to note that the latter recovery was twice the amount of mud in the rat hole below the packer. Since there was no drop of the mud level in the annulus, it can only be assumed that the mud came from the formation. Although the initial pressure was fairly high, the final pressure was much lower, indicating low permeability. DST No. 20 (5410 to 5467 feet) at the base of the unit, recovered 70 feet of mud and the formation pressures were very low. Thus the zone tested was impermeable.

The gas detectors gave a maximum reading of 2 units on the hotwire filament and 14 units methane with no higher hydrocarbons.

Unit "H" gave slightly better results on the gas detectors. The hotwire filament recorded 5 units gas and the chromatograph had a corresponding reading of 22 units methane with no higher hydrocarbons. A dull to medium yellow fluorescence was noted in the cuttings down to 5620 feet, with a trace of a cut in carbon tetrachloride. From there to the base of the unit only a dull yellow fluorescence was noted. Core No. 31 (5528 to 5554 feet) had a bright yellow to dull gold fluorescence with a good cut in carbon tetrachloride. It also exhibited fair gas bleeding.

The drillstem tests gave good results. DST No. 21 (5510 to 5575 feet) recovered gas to surface in 5 minutes at a rate of 44 Mcf/D increasing to 102 Mcf/D after 90 minutes and a pipe recovery of 300 feet of heavily gas-cut mud. DST No. 22 (5574 to 5644 feet) recovered gas to surface immediately at 250 Mcf/D, decreasing to 162 Mcf/D and a brackish water spray to surface in 61 minutes. The pipe recovery was 675 feet of brackish water.

Cattle Creek Formation: (5645 to 6643 feet)

The only shows in the siltstone, shale, and sandstone unit of the Cattle Creek Formation were between 5770 and 5780 feet where the cuttings indicated a sandstone bed which had a bright yellow fluorescence with a fair cut in carbon tetrachloride. Over this interval, the hotwire filament read 9 units and the chromatograph read 25 units methane. No drillstem tests were run since there was no porosity evident in the cuttings or in Core No. 32, (5781 to 5806 feet) which also had no shows.

The limestone, shale, and siltstone unit had only one show at 6000 feet and this was on the gas detector which showed 5 units on the hotwire filament and 18 units methane on the chromatograph. No shows were seen in the cuttings.

The bottom siltstone, shale, and sandstone unit of the Cattle Creek Formation had anomalous readings on the gas detector almost throughout the unit. The highest reading

was at 6400 feet, where the hotwire filament recorded 35 units and the chromatograph had 70 units methane with 12 units ethane and 2 units higher hydrocarbons. Most of these shows were associated with siltstone and shale with no evidence of porosity or fluorescence in the cuttings. However, the large anomalous readings at 6400 feet were associated with sandstone and a drillstem test was run. This was DST No. 23 (6350 to 6438 feet) and it recovered 10 feet of mud. The formation pressures on this test were very low.

Pre-Cattle Creek beds: (6643 to 6879 feet)

Small gas shows were observed in the pre-Cattle Creek beds. Core No. 34 (6703 to 6713 feet) had slight gas bleeding from the shales and the conglomerates, and Core No. 35 (6839 to 6873 feet) had a gold fluorescence that would not cut with carbon tetrachloride. This is believed to be a mineral fluorescence.

The maximum readings on the gas detectors were 7 units on the hotwire filament and 10 units methane on the chromatograph. No tests were run because of the poor porosity.

Porosity and Permeability of Section Penetrated

Rewan Formation

The sandstones of the Rewan Formation appear tight and impermeable on the Microlog. The Sonic log indicates the porosities are in the 10% to 14% range after making allowances for compaction. Core analysis by the Bureau of Mineral Resources shows the porosities of the sandstones to be between 19% and 28% with nil permeability. The high porosities and low permeability are a function of the kaolinitic matrix.

Bandanna Formation

The sandstones in the Bandanna Formation are less porous than those of the Rewan. The Microlog shows them to be tight and impermeable. The Sonic log gives a calculated porosity of only 7%. Two drillstem tests in the Bandanna Formation confirmed that the sandstones are tight.

Mantuan Productus Bed

The porosity of the sandstones in the Mantuan Productus Bed varies between 10% and 18% as determined from the Microlog, Sonic log, and core analysis. However, the core analysis of the sandstones between 2976 and 2990 feet indicates no permeability. This appears to be true for the whole sandstone except for four feet of porosity at 3025 feet which on the Microlog and Caliper log appear to be porous and permeable. One test run at the top of this unit confirms that the sandstones are impermeable.

Catherine Sandstone

Sandstone unit:

The Microlog indicates that most of this sandstone is tight or very poorly porous and impermeable, except for two thin porous streaks between 3362 and 3366 feet, and between 3380 and 3392 feet, which have a total of seven feet of porous and permeable sandstone. The porosity in these streaks is calculated to be 25%. The Sonic log indicates the porosities of

the sandstone unit to be generally about 17%. Core analysis of Core No. 14 (3361 to 3371 feet) shows the porosities to be between 9.3% and 16.8% with permeabilities ranging from 0.1 to 12.8 millidarcys.

Ingelara Formation

The only porosity in the Ingelara Formation is confined to the sandstone unit from 3725 to 3850 feet. This unit can be divided into three separate sandstone beds. The upper one (3725 to 3745 feet) has a total of 17 feet of porous and permeable sandstone with a porosity of 19% as calculated on the Microlog. The Sonic log indicates the porosity to be about 15%. A drillstem test in this interval recovered no formation fluid or gas.

The middle sandstone bed from 3753 to 3790 feet, with a total of 31 feet of porosity at an average of 11% is also permeable as indicated by the Microlog. This porosity is confirmed by the Sonic log. Core No. 16 (3780 to 3800 feet) straddles the middle and lower sandstone beds. Core analysis shows the porosity to be about 14% and the permeability between one and 15 millidarcys. The lower sandstone bed from 3799 to 3850 feet has a total of 38 feet of porous and permeable sandstones. The Microlog indicates the porosity is about 14%. The Sonic log shows it to range from 12% to 16%. Core analysis of Core No. 16 (3780 to 3800 feet) and Core No. 17 (3813 to 3844 feet) shows the porosity to range from 10.7% to 13.6% and the permeabilities to vary from less than 0.1 to 0.7 millidarcys.

Aldebaran Sandstone

The Aldebaran Sandstone has porous and permeable sandstones throughout. For ease of discussion, the formation has been broken up into a number of units designated "A" through to "H", and each will be discussed separately.

"A Unit":

This sandstone unit consists of several porous and permeable sandstone streaks separated by less porous and impermeable streaks. The Microlog indicates a total of 40 feet of porous and permeable sandstone with porosities ranging from 15% to 17%. The Sonic log shows similar porosities of 11% to 17%.

Three cores were cut in this unit and plugs from two of these were analysed - Cores Nos 19 (4030 to 4052 feet) and 20 (4062 to 4101 feet). Core analysis porosities range from 11.2% to 16.5% and the permeabilities from 0.3 to 6.7 millidarcys for Core No. 19, and from 9.7% to 12.9% porosity with 0.1 to 53 millidarcys permeability for Core No. 20.

"B Unit":

The sandstone in this unit is quite shaly and clayey and is not calculable on the Microlog. It shows up as being impermeable and very poorly porous, probably in the 7% to 10% range. The Sonic log shows the porosities to range from 8% to 14%. One plug was analysed from Core No. 21 (4333 to 4343 feet). It had a porosity of 11.5% and a permeability of less than 0.1 millidarcy.

"C Unit":

The upper 126 feet of this unit has sandstone that is similar to unit "B". The interval from 4526 to 4560 feet shows up on the Microlog as being porous and permeable.

There is a total of 20 feet of porous and permeable sandstone from 4526 to 4560 feet. The porosities on the Microlog range from 11% to 19% and on the Sonic log they range from 10% to 13%.

Two cores were cut in this unit - Cores Nos 22 (4534 to 4542 feet) and 23 (4543 to 4553 feet). In Core No. 22 porosities range from 10% to 11% and the permeabilities from 0.1 to 336.8 millidarcys.

"D Unit":

Two cores were cut in this unit - Cores Nos 25 (4696 to 4716 feet) and 26 (4812 to 4822 feet). They appeared to be tight. Both the Sonic log and Microlog, as well as DST No. 16 (4686 to 4716 feet) confirm this. Log porosities are about 7%.

"E Unit":

The sandstone in "E Unit" is quite shaly although the Sonic log shows porosities to be between 10% and 12%. The Microlog shows the sandstone to be generally tight with only a few poorly porous streaks and the Caliper log indicates that it is impermeable. Core No. 27 (5064 to 5088 feet) and DST No. 17 (5123 to 5233 feet) confirm that the sandstone is generally tight and impermeable.

"F Unit":

The Microlog and Sonic log both indicate that the sandstone of this unit is very poorly porous and impermeable. The porosity is calculated to be about 6%. An analysis of Core No. 28 (5303 to 5313 feet) agrees with the logs.

"G Unit":

The Sonic log shows that most of the porosity is in the range of 12% except for one two-foot zone at 5383 feet which has a porosity of 15%. The Microlog indicates that this unit is tight and impermeable except for the two-foot zone referred to above which has a porosity of 23% and appears to be permeable.

Two cores were cut in this unit - Cores Nos 29 (5367 to 5381 feet) and 30 (5390 to 5414 feet). Core No. 29, which includes the two-foot porous zone, was analysed. The analysis shows that generally the porosities range from 7.8% to 15.3%. The two-foot porous zone had a porosity of 18.3% and permeabilities between 25.4 and 96 millidarcys, while the permeability in the remainder of the core was from less than 0.1 to 1.3 millidarcys. Three tests were run, but recovered only mud. These were DST's 18, 19 and 20. DST No. 19 (5374 to 5414 feet) had a faint blow throughout the test and recovered twice the amount of mud in the rat hole below the packer. Since this extra mud probably came from the formation, the recovery may not be indicative of the formation's potential.

"H Unit":

This unit has a total of 42 feet of porous and permeable sandstones on the Microlog with porosities ranging from 18% to 23%. The Sonic log shows the porosities in this zone to range from 14% to 19%. Core No. 31 was cut from 5528 to 5554 feet, and catches the top part of the porosity. The core was described as being poorly porous with occasional poor to fair porosity. Two drillstem tests were run in this unit. DST No. 21 (5510 to 5575

feet), recovered gas at a rate of 102 Mcf/D, and DST No. 22 (5574 to 5644 feet) recoverd gas at 250 Mcf/D, and had a recovery of 675 feet of brackish water.

Cattle Creek Formation

The Cattle Creek Formation consists mainly of impermeable siltstone and shale with some limestone and sandstone. The limestone is dense, while the sandstone is generally tight or very poorly porous with a maximum of 7% porosity on the Sonic log.

Pre-Cattle Creek beds

The pre-Cattle Creek beds consist of dense conglomerates, poorly porous to tight sandstones, and impermeable siltstones and shales.

Contributions to Geological Concepts resulting from Drilling

Generally Warrinilla North No. 1 Well has added greatly to the stratigraphic, lithologic, and structural knowledge of the area. In particular, the following contributions have been made:

(i) It will help to solve some of the stratigraphic problems involving the Mantuan Productus Bed, Catherine Sandstone, or "Early Storms Sandstone", and "Dry Creek Shale", and the Ingelara Formation.

(ii) It has shown extensive thickening of the Aldebaran Sandstone and shown that it is at least, in part marine, as well as providing additional knowledge about the lithology of the formation.

(iii) It has provided additional knowledge of the lithology of the Cattle Creek Formation and pre-Cattle Creek beds.

(iv) It has provided useful information on the structural relationships of some of the formations penetrated as well as helping to solve the structure in the area.

(v) It has proved the presence of petroliferous gas in sandstone of the Ingelara Formation as well as gas shows in the Catherine, Mantuan Productus Bed and Aldebaran formations, and a possible oil show in the Aldebaran Sandstone.

(vi) The well has recovered water from the Ingelara and Aldebaran formations which is useful in log interpretation.

(vii) It has added further to the knowledge of the porosities and permeabilities of prospective reservoirs.

(viii) Additional valuable palaeontological and palynological information has been obtained for the area.

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APPENDIX 1

WARRINILLA NORTH NO. 1

CORE DESCRIPTIONS

Core No. 1	547 to 560 feet (13 feet)	Recovered 13 feet (100%)
	(Note: Core No. 1 was recovered on going in to cut Core No. 2)	
Top 6.0 feet	Shale, mainly reddish-brown with irregular spots, brownish-grey, and rare interbeds of mottled red, reddish-brown, and green-grey, generally blocky with a slight fissility, micaceous, slightly silty, with a rare trace of floating sand grains and a rare trace of carbonaceous specks. Mottled interbeds are slickensided. Bedding poorly defined.	
Next 2.7 feet	Shale, green-grey, rarely mottled with reddish green-grey, blocky, micaceous, slightly to occasionally very silty, trace of carbonaceous flakes, very slightly slickensided. There is some thinly laminated siltstone, green-grey, very argillaceous, arenaceous and micaceous, with grains of quartz and red and green lithic rock fragments and minerals. Bedding poorly defined.	
Next 4.3 feet	Sandstone, light green-grey, very fine-grained, poorly sorted subangular to angular quartz, weathered feldspars, and green, yellow, and black lithic rock fragments and minerals, large flakes of mica (biotite), very argillaceous matrix with white kaolinitic specks, silty, carbonaceous specks and carbonized plant fragments and stems, hard to slightly friable, tight, no shows. Thinly interbedded and interlaminated with shale, grey and greenish-grey, blocky to moderately fissile, micaceous, and rare trace of carbonaceous specks. Bedding is well developed with dips at about 10°.	
Core No. 2	560 to 562 feet (2 feet)	Recovered 1.8 feet (90%)
1.8 feet	Sandstone, light grey-green, fine to very fine-grained, fair sorting, angular quartz, weathered feldspar, green, yellow, and black lithic rock fragments and minerals, large flakes of mica (biotite), kaolinitic and clayey matrix with white specks of kaolinite, carbonaceous specks with occasional very thin coaly laminations and carbonized plant fragments, slightly friable to firm, tight. A rare trace of shale pebbles. No bedding. No shows.	
Core No. 3	1068 to 1075.5 feet (7.5 feet)	Recovered 7.5 feet (100%)
	(Note: Core barrel jammed)	
Top 4.3 feet	Sandstone, green, fine-grained, well-sorted, angular to subangular quartz, feldspar, and green, red, yellow, orange, and black lithic rock fragments and minerals, medium-sized mica flakes (biotite), white kaolinite specks, clayey and in part slightly calcareous cement, slightly friable to hard, tight. No shows. Bedding poorly developed but appears to dip at 20°.	

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Next 0.2 foot — Thinly interbedded, shale, red-brown, blocky, silty, micaceous, and sandstone, light grey-green, very fine-grained, angular quartz, and feldspar with some yellow and green lithic rock fragments and minerals, micaceous, very argillaceous matrix, silty, friable, tight. No shows. Dip on the bedding varies from essentially flat to 20°.

Next 3.0 feet — Shale, red-brown, blocky, micaceous, hard, thinly interlaminated with shale which is slightly silty. Slightly slickensided. No apparent bedding.

Core No. 4 — 1580 to 1590 feet (10 feet) Recovered 9.5 feet (95%)
(Note: Core No. 4 recovered after pulling Core No. 5)

Top 8.9 feet — Shale, medium to dark greenish-grey, and rare traces of reddish-brown mottling, blocky, silty, micaceous, with carbonaceous specks, becoming very silty and arenaceous towards base. The basal 6 inches are thinly laminated with siltstone, light green-grey, very argillaceous, micaceous, with specks of white kaolinite, very arenaceous, grading into the basal sandstone unit described below.

Bottom 0.6 foot — Sandstone, green-grey, fine to very fine-grained, poorly sorted, angular quartz, feldspar, and green and black lithic rock fragments and minerals, speckled with white kaolin, micaceous, argillaceous matrix, hard to slightly friable, tight, no shows.

Core No. 5 — 1590 to 1592 feet (2 feet) Recovered nil (0%)

Core No. 6 — 2010 to 2020 feet (10 feet) Recovered 1.3 feet (13%)

Top 1.3 feet — Shale, medium to dark grey, blocky, slightly micaceous, silty, with occasional thin laminae, very silty.

Core No. 7 — 2020 to 2022 feet (2 feet) Recovered nil (0%)

Core No. 8 — 2038 to 2048 feet (10 feet) Recovered 9.8 feet (98%)

Top 2.2 feet — Shale, medium to dark grey, blocky to slightly fissile, slightly micaceous, with carbonaceous specks, in part slightly silty becoming very silty towards base of interval. The basal 6 inches are lensed and interlaminated with a very silty shale that is almost an argillaceous siltstone. Dip about 3°.

Next 1.9 feet — Shale, medium grey, blocky, moderately to very silty, slightly micaceous, with abundant carbonaceous specks. This shale is thinly interbedded and interlaminated with siltstone, light to medium grey, argillaceous, and in part arenaceous, feldspathic and tuffaceous, becoming very arenaceous towards base of interval. There are abundant carbonaceous specks. The dip in this interval varies from 3° to 5°.

Next 0.8 foot — Sandstone, light grey, very fine-grained, well-sorted, angular to subangular quartz and weathered feldspar, with green and orange minerals, tuffaceous, with a calcareous, slightly siliceous, kaolinitic matrix, hard, tight, no shows, with a trace of carbonaceous specks, interlaminated with shale, grey, blocky to fissile, silty, with carbonaceous specks and small carbonized plant fragments. Dip at 5°.

Next 1.4 feet — Shale, medium to dark grey, interlaminated, with light to medium brown-grey shale, blocky, in part slightly to very silty, numerous carbonaceous specks. Dip approximately 4°.

Next 1.2 feet — Shale, medium to dark grey, blocky, micromicaceous in part, slightly to very silty, with carbonaceous specks, thinly interbedded and interlaminated with siltstone, light grey, very argillaceous and in part very arenaceous, carbonaceous and coaly specks with carbonized plant fragments, slightly calcareous. Dips between 3° and 5°.

Next 1.8 feet — Shale, medium to dark grey, blocky, in part silty, becoming very silty and arenaceous towards base, micaceous, with a trace of carbonaceous specks. Slightly slickensided.

Basal 0.5 foot — Sandstone, light grey, fine to medium-grained, well-sorted angular to subangular quartz and weathered feldspar, with green and black lithic rock fragments and minerals, tuffaceous, slightly calcareous and siliceous kaolinitic matrix, hard, tight, no shows, numerous carbonaceous specks, interlaminated with shale, grey, silty and arenaceous, carbonaceous, micaceous. Cores exhibited cyclic graded bedding, with dips ranging from 3° to 5°.

Core No. 9 — 2410 to 2420 feet (10 feet) Recovered 6.6 feet (66%)
(Note: Core No. 9 was recovered on going in to cut Core No. 10; the top three feet are badly broken up because of re-coring.)

Bottom 6.6 feet — Sandstone, light grey to white, very fine-grained and silty, poorly sorted, angular to subangular quartz, feldspar, with abundant yellow tuffaceous rock fragments and a trace of green lithic rock fragments and minerals. There are carbonaceous specks and laminations with some carbonized plant fragments. The matrix is moderately calcareous and kaolinitic, tight, firm, no shows. The sandstone is thinly interbedded and interlaminated with siltstone, particularly in the top three feet. The siltstone is medium-grey, light grey and light brown, occasionally coarse-grained and sandy, in part very argillaceous and carbonaceous with laminations and carbonized plant fragments. The bedding appears to be essentially flat.

Core No. 10 — 2420 to 2422 feet (2 feet) Recovered 1.5 feet (75%)

1.5 feet — Sandstone, light grey to white, very fine-grained and silty, poorly sorted, angular to subangular quartz, feldspar, with abundant yellow tuffaceous rock fragments and a trace of green lithic rock fragments and minerals with some carbonaceous specks and laminations and fossil plant fragments. The rock has a slightly to moderately calcareous kaolinitic matrix and is generally tight, with no shows. The bedding is poorly developed but is essentially flat.

Core No. 11 — 2718 to 2728 feet (10 feet) Recovered 10 feet (100%)

Top 8.1 feet — Shale, dark grey, blocky to splintery and slightly fissile, micromicaceous, with occasional mica flakes embedded so that the long axis is perpendicular

to the bedding plane. There is a trace of finely disseminated carbonaceous specks. One oblique fracture occurs near the top of the core; it dips at an angle of about 55° and has a slickensided surface. Bedding appears to be essentially flat and the core breaks readily along bedding plane surfaces. However, it occasionally has a subconchoidal fracture.

Bottom 1.9 feet — Shale, dark grey, as above, with thin interbeds of shale, light greyish-green and light brown and light brownish-green, flaky, soft, with a soapy lustre and feel. It is tuffaceous with finely disseminated fragments of volcanic glass and mica. The thin flakes of tuff appear white and somewhat translucent. It disintegrates readily on exposure to air and water. A thin lamination at the contact with the overlying unit consists of flakes and fragments of dark grey shale embedded in a matrix of brownish-green, tuffaceous shale. Bedding is essentially flat.

Core No. 12 — 2956 to 2991 feet (35 feet) — Recovered 34.6 feet (99%)

Top 3.7 feet — Shale, dark grey to medium grey, blocky, micaceous, silty and arenaceous, in part slightly calcareous, often grading to argillaceous sandstone. Very fossiliferous with fossils comprised of brachiopods (Strophalosia sp., Terrakea sp., and Neospirifer sp.) and bryozoans (Stenopora sp.).

Next 5.9 feet — Sandstone, light grey, fine-grained, occasionally medium-grained, well-sorted angular to subangular quartz, weathered feldspar, with a trace of tuff and volcanic ash fragments and rare traces of green and orange minerals. Rare pebbles of tuffaceous shale, trace of mica and carbonaceous specks. The matrix consists of slightly to moderately calcareous kaolinite, tight, hard, no shows. Occasional thin carbonaceous laminae scattered throughout, and a rare trace of fossils (productids).

Next 7.7 feet — Shale, medium to dark grey, blocky, micaceous, slightly to very arenaceous, silty, often grading to argillaceous sandstone, richly fossiliferous, in part almost a coquina. Fossils are brachiopods mainly, including Strophalosia sp., Terrakea sp., Neospirifer sp., bryozoans (Fenestella) and pelecypods.

Next 2.3 feet — Sandstone, light grey, very fine-grained and occasionally fine-grained, angular well-sorted quartz, weathered feldspar, rare green grains of glauconite, very micaceous with large flakes of brown and clear mica abundant, carbonaceous specks and plant fragments in a white kaolinitic matrix, tight, thinly interbedded with shale, dark grey, blocky, silty, finely micaceous, carbonaceous. Bedding irregular and exhibits some cross-bedding. Contact with underlying unit consists of two inches of shale fragments and irregular inclusions in sandstone as above.

Bottom 15 feet — Sandstone, light grey, fine-grained, occasionally medium-grained and rarely coarse-grained, fair-sorted angular to subangular quartz and grey to dark grey chert, trace of weathered feldspar, fragments of tuff and volcanic ash, rare green grains of glauconite and flakes of brown mica. The matrix consists of slightly to moderately calcareous kaolinite, generally tight with a trace of poor porosity. Speckled gold fluorescence. The core bubbled

gas after removal from core barrel and had a faint petroliferous odour on fresh fracture. The basal two feet have thin shale laminations, which are dark grey, blocky, silty, micaceous and carbonaceous.

Core No. 13 — 3281 to 3291 feet (10 feet) — Recovered 9.8 feet (98%)

9.8 feet — Thinly interbedded and interlaminated shale and siltstone. Shale, medium to dark grey, firm, blocky, slightly silty, moderately to very micaceous with mica flakes occasionally well developed along bedding planes. Trace of carbonized plant stems (length of core) and other plant fragments. Siltstone, light grey, firm, blocky, slightly arenaceous, finely disseminated carbonaceous material and mica. The bedding is very irregular and dips vary from 0^{o} to 5^{o}. The percentage of shale is approximately 50%.

Core No. 14 — 3361 to 3371 feet (10 feet) — Recovered 10 feet (100%)

Top 2 feet — Sandstone, light grey, fine-grained with occasional medium to coarse grains, fair-sorted angular to subangular quartz and grey chert, with black carbonaceous specks and grey-brown and grey-green tuffaceous fragments, occasional white kaolinitic specks in a slightly calcareous, kaolinitic matrix, hard, tight, with a speckled gold fluorescence, thinly interbedded and interlaminated with shale, dark grey, fissile, very micaceous and carbonaceous, moderately arenaceous.

Bottom 8 feet — Sandstone, light grey, fine to medium-grained, well-sorted angular quartz, grey chert, and mafic minerals with fragments of grey-brown and grey-green tuff, slightly to very micaceous with mica flakes aligned to bedding planes, slightly carbonaceous in the form of specks and laminations, occasional carbonized plant fragments. The matrix is slightly calcareous and kaolinitic. The rock is generally hard and tight, and has a speckled gold fluorescence. There was some gas bleeding from the core when removed from the core barrel. The bedding is poorly developed and irregular; dips vary from 1^{o} to 5^{o}.

Core No. 15 — 3600 to 3610 feet (10 feet) — Recovered 10 feet (100%)

Top 0.6 foot — Dolomite, medium grey-brown, slightly mottled with dark grey-brown, micro to cryptocrystalline, moderately argillaceous, dense, hard, with subconchoidal fracture. No shows.

Bottom 9.4 feet — Shale, medium to dark grey, blocky, in part slightly fissile, occasionally slightly silty, moderately micaceous with scattered brown mica flakes. Trace of finely disseminated carbonaceous material, occasional thin beds very fossiliferous with crinoid stems, branching corals, bryozoans (Stenopora) and a few brachiopods. Trace of calcite veins and crystals, and clusters of fine, lengthy calcite stems, possibly a calcified sea plant. The shale is generally hard, and breaks with a subconchoidal fracture, more fissile portions break up readily on exposure to air and water. The contact with the overlying dolomite is somewhat distorted and slickensided with calcite developed on the face of the slickensides. There are rare

laminations of tuffaceous shale, grey-green, soapy feel and lustre, micaceous, and some volcanic glass fragments.

Core No. 16	3780 to 3800 feet (20 feet)	Recovered 20 feet (100%)
Top 12 feet	Sandstone, light grey to white, generally fine-grained, occasionally medium-grained, fair-sorted angular quartz, trace of weathered feldspar and green lithic rock fragments in a very slightly calcareous kaolinitic matrix, flakes of white and brown mica, carbonaceous and shaly inclusions, generally tight with some poor porosity, trace of dull gold fluorescence. Irregular swirly laminations of shale, dark grey to black, fissile, very carbonaceous, arenaceous, and micaceous with occasional large flakes of white and brown mica. Trace of fossils (pelecypods).	
Bottom 8 feet	Sandstone, light grey, fine-grained, fair-sorted quartz, with a rare trace of green, yellow, and red minerals and tuffaceous rock fragments and scattered specks of carbonaceous material, and some rare shale inclusions in a white very slightly calcareous matrix, generally tight, with some poor porosity, gas bleeding, and spotty gold fluorescence appears wet on fresh fracture. Bedding poor.	
Core No. 17	3813 to 3844 feet (31 feet)	Recovered 29 feet (93.6%)
Top 6 feet	Sandstone, light grey, fine to medium-grained, fair-sorted angular quartz, with a rare trace of green and black minerals, micaceous, in a very slightly calcareous, kaolinitic matrix, generally tight, with occasional poor porosity, slight gas bleeding and occasional dull gold fluorescence, appears wet on fresh fracture, and bled salty water. This unit grades into next unit.	
Next 6 feet	Sandstone, brown, fine to medium-grained, poorly sorted angular quartz, weathered feldspar, and specks of white kaolin with a trace of tuff fragments, micaceous. The matrix is brown and very calcareous. Tight, no shows.	
Bottom 17 feet	Sandstone, light grey, fine to medium-grained, poorly sorted subangular to angular quartz, with a rare trace of green and black minerals, occasional finely disseminated carbonaceous material, slightly micaceous, slightly calcareous, white clay matrix with a possible trace of poor porosity, trace of spotty dull yellow fluorescence. Bedding is gradational, and poorly developed, no visible dip.	
Core No. 18	3990 to 4016 feet (26 feet)	Recovered 26 feet (100%)
Top 9.0 feet	Shale, dark grey, fissile to blocky, micaceous, abundant fine to very coarse floating sand grains, becoming very sandy and conglomeratic towards base, silty, occasional coaly inclusions, numerous blebs of pyrite with some large inclusions of pyritic sandstone. Numerous large well preserved crinoid stems. Bedding not distinct. This unit grades into the next unit.	
Next 3.3 feet	Shale, medium to dark grey, very sandy and finely conglomeratic in part, grading to argillaceous, conglomeratic sandstone, blocky, large flakes of brown mica, numerous blebs and irregular inclusions of pyrite. Trace of carbonaceous material. Sand grains are angular and vary from fine to very coarse-grained and granule. Pebbles consist mainly of sandstone and siltstone. This unit grades into the one described below.	

Next 6.7 feet — Sandstone, medium grey, very fine to very coarse-grained, poorly sorted angular to subangular quartz, feldspar, and mafic minerals in a very argillaceous kaolinitic matrix. It is moderately to very conglomeratic with some thin beds of conglomerate. The pebbles consist of sandstone, siltstone, shale, quartzite, and vitreous quartz and measure up to 2 inches in diameter. The rock is generally tight with a slight trace of poor porosity, and has spotty, bright yellow fluorescence with fair gas bleeding.

Next 5.7 feet — Sandstone, light grey, fine to medium-grained, poor to fair-sorted angular quartz, weathered feldspar, green and black lithic rock fragments and minerals in a white kaolinitic matrix, numerous wavy and irregular argillaceous streaks and inclusions. Some scattered large pebbles and cobbles of quartzite and sandstone. Generally tight, with a trace of poor porosity, with spotty, bright yellow fluorescence and moderate gas bleeding. The basal 7 inches are very argillaceous.

Next 0.2 foot — Shale, dark grey, blocky, silty, micaceous, carbonaceous flecks, trace of pyrite, and small pebbles of sandstone.

Next 0.9 foot — Conglomerate, grey, with pebbles and cobbles of vitreous quartz, quartzite, sandstone, siltstone, and shale, in a very fine to very coarse-grained, angular, poorly sorted quartz and kaolinitic sandstone, generally tight, with a trace of yellow fluorescence, fair gas bleeding. The top 5 inches are very argillaceous.

Next 0.2 foot — Sandstone, light grey, fine to medium-grained, fair-sorted angular quartz, and weathered feldspar with a trace of mafic minerals, slightly calcareous, kaolinitic matrix. Generally tight with a trace of spotty yellow fluorescence, fair gas bleeding. Bedding is poorly developed but appears to be flat.

Core No. 19 — 4030 to 4052 feet (22 feet) Recovered 21.3 feet (97%)

Top 8.0 feet — Sandstone, light to medium grey, fine to medium-grained, and occasionally coarse-grained, poorly sorted angular quartz and weathered feldspars in a white kaolinitic matrix in part very argillaceous, with shaly laminations and irregular inclusions, slightly micaceous, and trace of carbonaceous specks, generally tight, with a trace of poor porosity, and spotty bright yellow fluorescence, with fair gas bleeding. The base becomes very shaly and has a 2-inch conglomerate bed, consisting of pebbles of quartz, quartzite, sandstone, siltstone, and shale. The diameter of the pebbles is up to 2 inches. Bedding dips at about 4°.

Next 2.2 feet — Shale, dark grey, fissile to blocky, silty, very pyritic in the form of blebs, stringers and finely disseminated pyrite, slightly arenaceous, micaceous, and interbedded with siltstone, medium grey-brown, argillaceous and arenaceous, with fine grains of quartz and feldspars, micaceous, traces of carbonaceous material and pyrite.

Next 4.1 feet — Sandstone, light grey, occasionally medium grey, fine to medium-grained and coarse-grained, poorly sorted angular quartz with minor weathered

feldspars and green lithic rock fragments in a white kaolinitic matrix, tight to poorly porous, with bright yellow fluorescence, and fair gas bleeding. Numerous shaly stringers and inclusions. Two inches of conglomerate near base of interval consisting of pebbles and cobbles of quartz, quartzite, sandstone, and shale up to two inches in diameter.

Bottom 7.0 feet — Sandstone, light grey, medium to coarse-grained and very coarse-grained, poorly sorted angular quartz, with a trace of weathered feldspar and green lithic rock fragments in a white kaolinitic matrix. Generally tight to poor porosity with occasional fair porosity and a trace of good permeability, with the mud penetrating to centre of core. Spotty bright yellow fluorescence and fair gas bleeding. Four inches of conglomerate at base similar to conglomerate as above, with pebbles up to three inches in diameter.

Core No. 20 — 4062 to 4101 feet (39 feet) — Recovered 39 feet (100%)

Top 2.0 feet — Sandstone, light grey to white, fine to medium-grained and rarely coarse-grained, poorly sorted angular quartz, with a trace of mafic minerals and weathered feldspar in a kaolinitic matrix, micaceous, generally tight with a trace of poor porosity, and bright yellow and gold fluorescence, fair gas bleeding. Numerous horizontal fractures near top of interval. Occasional shaly and carbonaceous inclusions.

Next 2.5 feet — Shale, medium to dark grey, blocky, silty and arenaceous, micaceous, blebs and stringers of pyrite and trace of pyritized wood, firm, thinly interbedded and laminated with siltstone, medium to light grey-brown, moderately to very argillaceous, very micaceous, occasionally sandy and sandstone, light grey, fine-grained, occasionally medium and very fine-grained, poorly sorted angular quartz, and weathered feldspar with a trace of mafic minerals and lithic rock fragments in a kaolinitic matrix. Generally tight, with a trace of yellow fluorescence and slight gas bleeding. Bedding dips between 0^{o} and 5^{o}.

Next 4.5 feet — Sandstone, light to medium grey as above, micaceous, and argillaceous, in part very argillaceous, and laminated with shale, dark grey, blocky, silty, arenaceous and micaceous, trace of pyrite. Sandstone and shale are occasionally conglomeratic with pebbles and irregular inclusions of sandstone becoming very conglomeratic towards base with pebbles and granules of quartz and shale. Generally very tight, with a rare trace of poor porosity, occasional spotty yellow fluorescence. Slight gas bleeding. Bedding is generally flat with minor cross-bedding.

Next 4.5 feet — Sandstone, light grey, fine-grained, rarely medium and very fine-grained with a trace of coarse grains, poor to fair sorted quartz, and mafic minerals. Rare trace weathered feldspar, slightly micaceous in a kaolinitic matrix, occasional shaly stringers and inclusions. Becomes medium grey and very argillaceous at base. Generally tight with a trace of poor porosity. Spotty, yellow fluorescence, fair gas bleeding.

Next 5.2 feet — Shale, medium to dark grey and grey-brown, blocky, silty, in part sandy, very pyritic in the form of lenses and blebs, very micaceous, slightly carbonaceous, thinly interbedded and laminated with siltstone, light to medium grey-brown, argillaceous and arenaceous, feldspathic and micaceous and slightly carbonaceous; sandstone, light grey, very fine-grained, silty, poorly sorted angular quartz, slightly micaceous in a kaolinitic matrix, in part very argillaceous. Tight, slight spotty, gold fluorescence. Minor conglomerate with pebbles, up to 3/4 inch in diameter, of sandstone, siltstone, and quartzite.

Next 14.8 feet — Sandstone, light grey to medium grey and white, mainly medium-grained and rarely fine and coarse-grained. Well-sorted angular quartz with scattered mafic minerals and chert grains. Occasional weathered feldspar, rare fragments of carbonaceous material in a kaolinitic matrix, rarely slightly argillaceous. Mostly tight with some poor porosity and rare fair porosity. Good bright yellow and gold fluorescence with fair gas bleeding. Occasional thin conglomerate interbeds with pebbles of siltstone, sandstone, quartz, and quartzite.

Bottom 5.5 feet — Shale, medium to dark grey-brown, blocky, silty and sandy, pyritic, in the form of stringers, blebs and some finely disseminated pyrite, micaceous, trace carbonaceous material. Thinly interbedded and interlaminated with siltstone, light grey, argillaceous, sandy, and micaceous. No shows.

Core No. 21 — 4333 to 4343 feet (10 feet) — Recovered 10 feet (100%)

Top 3.2 feet — Thinly interbedded and interlaminated sandstone, shale and siltstone. The sandstone is dark to light grey, fine to very fine-grained and silty. Occasionally slightly conglomeratic, becoming very conglomeratic towards base. Angular to subrounded, poorly sorted quartz, and mafic minerals with specks of white kaolin, micaceous and slightly carbonaceous in a very shaly matrix grading to clayey. Tight, no shows. Shale, dark grey, blocky, silty and arenaceous, micaceous, slightly carbonaceous with rare coaly laminations; siltstone, medium to light grey, arenaceous, very argillaceous, micaceous, with traces of carbonaceous material. The basal 0.9 foot is very conglomeratic with pebbles up to 3/4 inch in diameter of siltstone, sandstone, shale, and quartzite. Bedding is flat.

Next 3.7 feet — Sandstone, light grey, very fine-grained and silty, grading to siltstone, angular, poorly sorted quartz, feldspathic with a kaolinitic matrix, micaceous, interlaminated with sandstone, medium grey, very argillaceous, micaceous and carbonaceous. Tight, no shows. Also thinly interbedded with siltstone, medium to light grey, arenaceous, very argillaceous and micaceous with traces of carbonaceous material. Occasional thin interbeds of shale, dark grey, blocky, carbonaceous, silty and sandy. The bedding is flat.

Next 1.3 feet — Sandstone, medium grey, very fine to fine-grained and silty, occasionally very coarse-grained, angular quartz and mafic minerals with large flakes

of mica and specks of white kaolin in a shaly matrix with irregular inclusions and streaks being very argillaceous. Generally tight; no shows.

Bottom 1.8 feet — Sandstone, light to occasionally medium grey, fine-grained, fair-sorted angular quartz with mafic minerals and dark lithic rock fragments, in a white kaolinitic matrix. Generally tight, with a trace of poor porosity. Very slight gas bleeding and a trace of gold fluorescence. Poor contact with overlying unit.

Core No. 22 — 4534 to 4542 feet (8 feet) — Recovered 7.5 feet (93.8%)

Top 3.8 feet — Sandstone, light grey, very coarse-grained, occasionally fine to medium-grained and conglomeratic with granules and pebbles up to one inch in diameter, of vitreous quartz, quartzite, shale, sandstone, and siltstone. Sand grains are mainly angular, fair to poorly sorted vitreous quartz with some milky and sandy quartz with a trace of weathered feldspar and lithic rock fragments in a white, kaolinitic matrix generally firm to friable, poorly porous, with occasional fair porosity and permeability, bright yellow-white fluorescence and cut with carbon tetrachloride, and slight gas bleeding.

Next 1.7 feet — Sandstone, light grey, medium to coarse-grained, fair to well-sorted angular quartz, grey chert, and trace of weathered feldspar, with some lithic rock fragments in a kaolinitic matrix, firm to friable, generally tight with some poor porosity, bright yellow fluorescence, and slight gas bleeding; horizontal fractures probably along bedding plane, which is flat.

Next 1.2 feet — Sandstone, light grey, very coarse-grained and occasional granules, angular, poorly to fair-sorted vitreous quartz, and some sandy quartz, weathered feldspar, and lithic rock fragments in a kaolinitic matrix, friable to firm, poor to rarely fair porosity, bright yellow fluorescence, with slight gas bleeding, occasional very thin carbonaceous shale, trace pyrite.

Bottom 0.8 foot — Sandstone, light grey, medium-grained, well-sorted angular vitreous quartz with occasional smoky quartz, weathered feldspar and mafic minerals in a kaolinitic matrix, friable to firm, generally tight with a trace of poor porosity. Some laminations and one thin bed of shale at top of interval which is dark grey, silty, sandy, micaceous and carbonaceous.

Core No. 23 — 4543 to 4553 feet (10 feet) — Recovered 10 feet (100%)

Top 2.8 feet — Sandstone, light grey, very fine to fine-grained, angular, poorly sorted vitreous quartz, feldspar and lithic rock fragments in a kaolinitic matrix, very micaceous, hard, tight, no shows, becoming very argillaceous in basal three inches and interbedded with shale, dark grey, fissile, silty, sandy, very micaceous and carbonaceous.

Next 3.0 feet — Sandstone, light grey, generally very coarse-grained, with very fine to coarse grains and rarely conglomeratic, angular, poorly sorted vitreous quartz with a trace of weathered feldspar and lithic rock fragments in a

kaolinitic matrix, poorly porous, trace of yellow fluorescence and slight gas bleeding. Pebbles are up to two inches in diameter and consist of shale, quartz, siltstone, and sandstone.

Next 2.2 feet — Sandstone, light to medium grey, medium to coarse-grained, fair to poorly sorted angular quartz and feldspar, with abundant chert, mafic minerals and lithic rock fragments in a kaolinitic matrix; generally tight, with a trace of poor porosity, trace of yellow fluorescence and slight gas bleeding, occasional thin laminations and irregular inclusions of shale, dark grey, carbonaceous, very micaceous and sandy.

Bottom 2.0 feet — Shale, dark grey, blocky to fissile, very silty and micaceous, carbonaceous with traces of carbonized plant fragments. Thinly interlaminated with siltstone, light grey, micaceous, sandy and slightly argillaceous, firm; and one thin bed of sandstone, light grey, fine-grained, angular well-sorted quartz, weathered feldspar and lithic rock fragments in a kaolinitic matrix, slightly micaceous and carbonaceous, tight, no shows.

Core No. 24 — 4606 to 4616 feet (10 feet) — Recovered 10 feet (100%)

Top 9.0 feet — Thinly interbedded and interlaminated shale, siltstone, and sandstone. The shale is dark grey, blocky to slightly fissile, silty and sandy, very micaceous, trace of carbonaceous specks and carbonized plant fragments; occasionally slickensided. Siltstone, light grey to medium grey-brown, firm, slightly argillaceous, moderately to very sandy, in part almost a sandstone, micaceous, slightly carbonaceous, and slightly feldspathic. Sandstone, light to medium grey-brown, very fine-grained and silty, angular poorly sorted quartz and feldspar with some lithic rock fragments in a kaolinitic matrix; tight, no shows. Bedding is very irregular and exhibits cross-bedding as well as other depositional features; however, it generally appears flat.

Bottom 1.0 foot — Conglomerate, medium grey, consisting of subangular to subrounded granules and pebbles of shale, phyllite, quartz, quartzite sandstone and siltstone up to one inch in diameter, in a matrix of sandstone which is light grey, fine to very coarse-grained, poorly sorted, angular to subangular quartz and weathered feldspar, with lithic rock fragments in a kaolinitic, slightly siliceous matrix. Trace of pyrite; tight, no shows. Some fossils mainly brachiopods (productids) including Strophalosia sp.

Core No. 25 — 4696 to 4716 feet (20 feet) — Recovered 20 feet (100%)

Top 7.0 feet — Sandstone, light grey, generally medium-grained, occasionally coarse to very coarse-grained near the top of the interval, fair-sorted angular vitreous quartz, occasionally grey and milky quartz, some feldspar grains, in part weathered, with a trace of green, grey, and red lithic rock fragments and mafic minerals in a kaolinitic slightly siliceous matrix, firm to friable, tight, with rare pinpoint porosity, slight gas bleeding, and spotty, gold fluorescence.

Bottom 13 feet — Conglomerate and conglomeratic sandstone, light to medium grey, consisting of angular to subrounded, very small to large pebbles and cobbles, with one boulder near base in a sandstone matrix. Pebbles and cobbles consist of the following rock types - phyllites, quartzites, quartz, tuff, orthoquartzitic sandstone, tuffaceous sandstones, slates, shales, and siltstones. The boulder is a green orthoquartzite or quartz-phyllite with spots of secondary carbonate and pyrite well dispersed throughout rock; it is jointed and measures over 10 inches in length. The matrix consists of sandstone, light grey, coarse-grained, angular vitreous quartz, with some milky and grey quartz, some feldspar and a trace of green, red, and grey lithic rock fragments and pyrite in a siliceous, kaolinitic matrix. It is generally tight with a rare trace of poor porosity; no shows. There is one thin shale bed three inches thick, 5.7 feet from the top of the interval. The shale is dark grey, blocky, very sandy, silty and micaceous, firm. Contact with conglomerate dips at about 14^{o}.

Core No. 26 — 4812 to 4822 feet (10 feet) — Recovered 10 feet (100%)

Top 0.8 foot — Sandstone, light to medium grey-brown, very fine to very coarse-grained, very poorly sorted angular quartz, feldspar, green, dark grey and black lithic rock fragments; slightly micaceous and carbonaceous, in part argillaceous, in a clayey slightly siliceous cement, firm to slightly friable, tight, no shows.

Next 1.3 feet — Conglomerate, light grey, consisting of angular to subrounded cobbles, pebbles and granules of quartz, phyllite, quartzite, quartz, chert, slate, tuff, andesite?, diorite?, sandstone, siltstone, and shale. Cobbles measured up to 2-1/2 inches in diameter. The matrix is sandstone, white, generally coarse-grained, angular, poorly sorted quartz, feldspar, and lithic rock fragments in a kaolinitic, siliceous matrix. Tight. No shows. Occasional dark grey shale laminations and partings.

Next 4.9 feet — Sandstone, light grey, fine to medium-grained, well-sorted angular quartz, feldspar, and green, grey, black, and red lithic rock fragments, in a siliceous slightly calcareous matrix, friable, generally tight, with a rare trace of poor porosity, numerous shaly partings and laminations, which are dark grey, carbonaceous, micaceous, and sandy. One large fossil fragment near the base of the interval (productid?), rare scattered pebbles.

Next 2.3 feet — Conglomerate, medium grey-green, subangular to subrounded pebbles, cobbles and granules of quartz, phyllite, green volcanics, tuff, diorite?, quartzite, quartz, slate, sandstone, siltstone and shale, in a sandstone matrix, which is light grey, fine to medium-grained, poorly sorted angular quartz, feldspar and green lithic rock fragments in a clay matrix; tight, no shows.

Bottom 0.7 foot — Sandstone, light grey, very fine to fine-grained, angular fair-sorted quartz, feldspar, and a trace of green and dark grey lithic rock fragments in a siliceous kaolinitic matrix; tight, no shows.

Core No. 27 — 5064 to 5088 feet (24 feet) — Recovered 24 feet (100%)

Top 12.0 feet — Sandstone, medium to dark grey, generally fine to medium-grained, occasionally very fine and very coarse-grained, with scattered rare pebbles of quartz. Poorly sorted, angular quartz grains with some feldspar and lithic rock fragments in a very argillaceous clayey matrix. The rock is generally tight with very rare pinpoint pores. There is a trace of poorly preserved fossil fragments (brachiopods?). There are numerous irregular, dark grey, carbonaceous shaly inclusions and partings, and some have the appearance of worm bores. Slight gas bleeding, and a gold speckled fluorescence with poor cut in carbon tetrachloride was noted.

Bottom 12.0 feet — Sandstone, light to medium grey, generally medium-grained, and occasionally fine and coarse-grained, angular quartz and feldspar with a trace of green and grey lithic rock fragments. The matrix is clayey and slightly siliceous and in part slightly and moderately argillaceous. It is generally tight with a trace of poor porosity. There are occasional irregular inclusions and laminations of shale, dark grey as above, and some worm bores as above. There was a slight gas bleeding and spotty gold fluorescence. There is no apparent bedding.

Core No. 28 — 5303 to 5313 feet (10 feet) — Recovered 8.8 feet (88%)

Top 2.8 feet — Shale, dark grey, blocky to fissile, micaceous, silty and sandy, carbonaceous laminae. Thinly interbedded and interlaminated with siltstone, light grey, coarse-grained, sandy and grading to sandstone, feldspathic in part, slightly to moderately argillaceous, with carbonaceous laminae, carbonized plant fragments and slight trace of mica. Bedding is somewhat irregular with dips up to 4^{o} but generally flat.

Next 3.2 feet — Sandstone, medium to dark grey-brown, very fine-grained and silty, grading to siltstone, angular, poorly sorted quartz and feldspar in a slightly siliceous, clayey and argillaceous matrix, slightly micaceous and very carbonaceous with specks and larger fragments of carbonized plants, hard, tight, no shows. Becomes very argillaceous towards base, in part shale, dark grey, silty and sandy, micaceous and carbonaceous, with irregular large inclusions of sandstone, light grey, very fine-grained, well-sorted angular quartz and feldspar in a clayey matrix with carbonaceous laminae and slightly micaceous; tight, no shows. Bedding is very irregular and shows depositional flow structure.

Next 1.9 feet — Sandstone, light brown, very fine-grained, well-sorted angular quartz and feldspar in a slightly calcareous, clayey matrix, slightly micaceous, with a trace of carbonaceous specks and shaly inclusions. Hard, tight, no shows. Bedding appears essentially flat.

Next 0.5 foot — Conglomerate, light grey-brown, with pebbles up to two inches in diameter of mainly white quartz, and some quartzite, phyllite, chert, tuff, sandstone, siltstone, and shale pebbles and granules in a sandstone matrix as in the overlying unit.

Bottom 0.4 foot — Sandstone, light grey-brown, very fine-grained and silty, poorly sorted angular quartz and feldspar in a siliceous kaolinitic matrix. Carbonaceous laminae and specks; tight, no shows. Thinly interbedded and interlaminated with shale, dark grey, blocky, silty, micaceous, very carbonaceous. Cross-bedding and dips to 20°.

Core No. 29 — 5367 to 5381 feet (14 feet) Recovered 14 feet (100%)

Top 8.6 feet — Sandstone, light grey-brown, generally fine-grained, with some medium and coarse grains and rarely coarse-grained, fair to well-sorted, angular to subangular quartz and feldspar with white kaolinitic specks, trace of dark grey lithic rock fragments and mafic minerals, in a slightly calcareous, kaolinitic matrix, rarely siliceous, slightly micaceous, friable. Generally poorly porous with occasional fair to good porosity, very slight gas bleeding and light brown oil stain. Good bright yellow and dull gold fluorescence, good cut with carbon tetrachloride, petroliferous odour on fresh fracture. Trace plant fossils, rare thin laminations and irregular inclusions of shale, dark grey, blocky, micaceous, silty and sandy, very carbonaceous.

Next 5.0 feet — Sandstone, light to medium grey, very fine to fine-grained, angular, poorly sorted quartz and feldspar with white kaolinitic specks in a clayey, in part slightly to moderately argillaceous, matrix, slightly micaceous, in part slightly to very carbonaceous, thinly interlaminated with shale, dark grey to black, fissile, silty and sandy, very carbonaceous with carbonized plant fragments, very micaceous. The sandstone is generally tight, with trace of very poor porosity, trace of fluorescence as above.

Bottom 0.4 foot — Sandstone, light grey-brown, very fine to medium-grained and occasionally coarse-grained, poorly sorted angular quartz, feldspar and white kaolinitic specks with a trace of grey, green, and black lithic rock fragments in a slightly calcareous, kaolinitic matrix, slightly micaceous and carbonaceous, friable, generally tight, with some poor porosity, good yellow fluorescence and cut with carbon tetrachloride. Dip varies from 0° to 10° but is generally flat.

Core No. 30 — 5390 to 5414 feet (24 feet) Recovered 24 feet (100%)

Top 10.1 feet — Sandstone, light grey and light grey-brown, fine-grained to rarely medium and coarse-grained, generally fair-sorted, occasionally poorly sorted, angular and subangular grains of quartz, feldspar, in part weathered feldspar and specks of white kaolin with some dark grey, green, and black lithic rock fragments and possible fragments of tuff, in a slightly to rarely moderately calcareous, clayey matrix; slightly micaceous and carbonaceous with laminae and specks, very friable. Generally poor porosity with rare fair porosity; occasionally good yellow-white and dull yellow fluorescence, fair gas bleeding, petroliferous odour on fresh fracture and light brown oil stain which deteriorates after exposure to air. Occasional thin shale partings and laminations, dark grey to black, fissile, slightly to very micaceous, very carbonaceous, in part silty and sandy. Some irregular shaly inclusions that appear to be worm bores; bedding dips from 0° to 15°.

Next 1.8 feet — Sandstone, light to medium grey, very fine to fine-grained, angular, poorly sorted quartz, feldspar, with grey and green lithic rock fragments in a very slightly calcareous kaolinitic matrix. Generally tight with a trace of poor porosity, trace of dull gold fluorescence. Irregular argillaceous and shaly inclusions, no apparent bedding.

Next 8.1 feet — Sandstone, light grey, fine-grained, angular to subangular quartz, weathered feldspar, white kaolinitic specks, green, black, grey, and dark grey lithic rock fragments and mafic minerals in a slightly calcareous kaolinitic matrix, slightly micaceous, friable. Generally tight with occasional poor to rarely fair porosity. Fair gas bleeding and light brown oil stain. Good yellow and gold fluorescence with good cut in carbon tetrachloride. Very rare irregular argillaceous inclusions. Bedding dips between 0^{o} and 15^{o}.

Next 2.2 feet — Sandstone, medium to dark grey, very fine to fine-grained, poorly sorted angular quartz, feldspar and grey lithic rock fragments in a moderately to very shaly matrix, micaceous and carbonaceous, firm to friable, tight, with a trace of dull gold fluorescence and slight gas bleeding. Grades to dark grey sandy shale near base. Bedding poorly developed.

Next 1.3 feet — Sandstone, light to medium grey, fine to occasionally very fine-grained, angular quartz, feldspar, white kaolinitic specks and black, grey, green, and yellow lithic rock fragments and mafic minerals in a kaolinitic and slightly siliceous matrix, firm to friable, generally tight, with a trace of poor porosity, bright yellow fluorescence and cut with carbon tetrachloride, fair gas bleeding and light brown oil stain. Bedding poorly developed.

Bottom 0.5 foot — Shale, dark grey, black, blocky, micaceous, carbonaceous, and in part slightly sandy. Bedding dips at 5^{o}.

Core No. 31 — 5528 to 5554 feet (26 feet) Recovered 26 feet (100%)

26 feet — Sandstone, light grey, fine to medium-grained, rarely coarse-grained, well-sorted angular to subangular quartz and feldspar, in part weathered to kaolinite, with some grey, green, and black lithic rock fragments and minerals. The matrix is slightly to moderately calcareous but mainly kaolinitic. The rock is generally friable but very poorly porous with occasional poor and fair porosity. It showed bright yellow and dull gold fluorescence with fair gas bleeding and petroliferous odour on fresh fracture. There are occasional thin shale laminations which are dark grey, fissile, sandy, very carbonaceous and micaceous. The bedding is irregular and poorly developed, but appears essentially flat.

Core No. 32 — 5781 to 5806 feet (25 feet) Recovered 25 feet (100%)

25 feet — Siltstone, medium to very dark grey, moderately hard, very micaceous, variably, but generally very calcareous, moderately carbonaceous, with laminations and specks. One thin layer of coal, black and shiny at 5792.5 feet. Rare well-rounded conglomerate pebbles occur scattered throughout; these consist of lighter coloured, sandy siltstone, quartz, and calcite.

The siltstone is often sandy and grades to sandstone. Two bands of very coarse sandstone occur at 5792 and 5793 feet. The percentage of shaly material increases downward and the bottom two feet are a silty shale with laminations of argillaceous siltstone. There are occasional (?) brachiopod shell fragments present. There is no apparent porosity or hydrocarbon shows. The dip is poorly developed and varies from generally flat to 15°.

Core No. 33 — 6237 to 6247 feet (10 feet) Recovered 10 feet (100%)

10 feet — Shale, dark grey to dark grey-brown, blocky, slightly to in part moderately silty, and occasionally arenaceous, in part slightly calcareous, moderately carbonaceous, with finely disseminated specks and small plant fragments; numerous small blebs and streaks of pyrite, occasional scattered small pebbles of white quartz and grey quartzite. There are a number of fossils scattered throughout the core as follows:

Bryozoa	-	Stenopora sp.
		Fenestella sp.
Brachiopoda	-	Neospirifer sp.
		Ingelarella sp.(?)
Pelecypoda	-	?

The bedding is poorly developed but appears essentially flat.

Core No. 34 — 6703 to 6713 feet (10 feet) Recovered 9 feet (90%)

Top 0.1 foot — Coal, black, shiny, brittle, in part shaly, numerous thin stringers and blebs of pyrite.

Next 2.6 feet — Shale, dark grey to black, blocky, silty, very carbonaceous with numerous carbonized plant fossils and fragments, finely micaceous, and trace pyrite, thinly interbedded with sandstone, orange to green-grey, generally coarse-grained to finely conglomeratic, occasionally very fine to medium-grained, poorly sorted, angular, predominantly green, orange, light brown, and red lithic rock fragments of altered volcanics with some quartz and feldspar in a siliceous matrix, generally tight, and dull gold fluorescence, no cut with carbon tetrachloride. Slight gas bleeding from shales. The dip varies from generally flat to 10°.

Bottom 6.3 feet — Shale, dark grey to black, blocky, silty, very carbonaceous, with numerous carbonized and coaly plant fragments, finely micaceous, blebs and stringers of pyrite, rare thin beds of conglomerate, with small pebbles of green, orange, light brown, and red lithic rocks, probably altered volcanics and quartz in a tan sandstone matrix consisting of poorly sorted, angular grains of mainly lithic rock fragments as above, with quartz and feldspar in a siliceous matrix, hard and tight. Dull gold fluorescence, no cut in carbon tetrachloride. Slight gas bleeding from shales. Trace of slickensides. The dip varies from flat to 22°.

Core No. 35 6839 to 6873 feet (34 feet) Recovered 32 feet (94.1%)

Top 2.3 feet — Shale, dark grey, silty, very carbonaceous, with numerous carbonized and coaly plant fossils and fragments, thinly interbedded and interlaminated with siltstone, light grey-brown, medium to dark grey-brown, sandy, in part argillaceous, carbonaceous, with some carbonized and coaly plant fossils and fragments. Two inches sandstone near base of interval, grey-brown, medium to very coarse-grained, angular to subangular poorly sorted grains of green, grey, and brown lithic rock fragments, mostly volcanic and chert, with some quartz and feldspar in a slightly calcareous and siliceous matrix; tight; gold mineral fluorescence, no cut in carbon tetrachloride. There is a wedge of conglomerate nine inches from base of interval. It consists of pebbles and cobbles up to 1-1/2 inches in diameter of green, brown, cream, and grey lithic rock fragments; mostly volcanic such as tuffs and breccias, with some chert and quartz in a brown sandstone matrix which consists of medium to very coarse grains of quartz and lithic rock fragments as above, in a slightly calcareous, siliceous matrix, in part argillaceous; tight, with a gold mineral fluorescence, no cut with carbon tetrachloride.

Next 0.8 foot — Conglomerate, as above, with subrounded to angular granules and pebbles up to 1 inch in diameter, and some cobbles up to 2 inches in diameter near top of interval in sandstone matrix. One coaly lamination at base of interval.

Next 0.8 foot — Sandstone, brown, medium to very coarse-grained, finely conglomeratic, consisting of angular to subangular grains of poorly sorted quartz and lithic rock fragments, yellow, green, grey, brown, and orange colour, in a siliceous matrix; tight, thinly interbedded and interlaminated, with siltstone, medium to dark grey-brown, very argillaceous and carbonaceous with carbonized plant fragments.

Next 4.7 feet — Conglomerate, as above, comprised mainly of pebbles between 1/2 and 3/4 inch in diameter, with some cobbles up to 2-1/2 inches in diameter of varicoloured volcanic rock types which include breccias and tuffs mainly; there is some quartzite, quartz and chert in a sandstone matrix as above; tight, no shows.

Next 0.5 foot — Siltstone, brown to dark brown, very argillaceous and slightly sandy, with abundant coaly and carbonized plant fragments and plant fossils, tuffaceous in appearance.

Next 0.9 foot — Conglomerate, as above.

Next 0.4 foot — Siltstone, grading to sandstone, medium brown, very argillaceous with abundant fine grains of lithic rock fragments and quartz and trace of carbonaceous specks; tight, no shows.

Next 4.7 feet — Conglomerate, as above, in a brown sandstone matrix as above, except more argillaceous and silty.

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Bottom 16.9 feet Siltstone, as above, thinly interbedded and interlaminated with sandstone, as above, and shale, dark grey to black, fissile to blocky, in part silty, very carbonaceous, with specks and plant fragments, abundant fossil plant leaves and stems, poorly preserved, probably Glossopteris, and thin laminations of coal, black, shiny, brittle. Bedding is irregular and varies from 0^{o} to 15^{o}, but is generally flat.

APPENDIX 2

WARRINILLA NORTH NO. 1

CORE ANALYSES

by

Core Laboratories, Inc.

Core No. 12

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per cent)	Residual Saturation			Probable Production	Remarks
		Horizontal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
1	2976	0.0	-	13.1	0.17	5.4	80.0	(3)	Sand, fn-cse gnd, calc, coal lenses, sl/od.
2	2977	0.0	-	17.2	0.0	0.0	84.4	(3)	Sand, fn-md gnd, calc, coal lenses, gd/od.
3	2978	0.0	-	18.2	0.0	0.0	85.2	(3)	Sand, fn-md gnd, kaolinitic gd/od.
4	2979	0.0	-	17.3	0.23	1.3	72.2	(3)	Sand, fn-gnd, kaol, gd/od.
5	2980	0.0	-	7.5	0.0	0.0	81.3	(3)	Sand, fn-md gnd, v/calc, gd/od.
6	2981	0.0	-	11.4	0.0	0.0	86.8	(3)	Sand, fn-md gnd, v/calc, sl/od.
7	2982	0.0	-	16.9	0.0	0.0	68.0	(3)	Sand, fn-cse gnd, mica, kaol, sl/od.
8	2983	0.0	-	13.8	0.0	0.0	76.9	(3)	Sand, fn-md gnd, calc, kaol, sl/od.

(3) Insufficient permeability

Core No. 12 (Cont'd)

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per cent)	Residual Saturation			Probable Production	Remarks
		Horizontal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
9	2984	0.0	-	14.7	0.0	0.0	75.5	(3)	Sand, md gnd, calc, kaol, sl/od.
10	2985	0.0	-	17.9	0.0	0.0	71.0	(3)	Sand, fn-md gnd, sl/calc, kaol, sl/od.
11	2986	0.8	-	16.8	0.24	1.4	72.2	(3)	Sand, md, gnd, calc, kaol, mica, sl/od.
12	2987	0.0	-	18.4	0.0	0.0	70.1	(3)	Sand, fn-md gnd, calc, kaol, sl/od.
13	2988	0.0	-	14.0	0.0	0.0	74.3	(3)	Sand, md gnd, calc, kaol.
14	2989	0.0	-	16.2	0.25	1.5	68.6	(3)	Sand, md gnd, sl/calc, kaol, sl/od.
15	2990	0.0	-	16.7	0.60	3.6	79.6	(3)	Sand, fn-md gnd, mica, kaol, sl/od, mica bands.

(3) Insufficient permeability

Core No. 14

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (percent)	Residual Saturation			Probable Production	Remarks
		Horizontal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
16	3362	12.8	-	10.8	0.0	0.0	69.5	Water	Sand, med grn, kaol, & feldspathic.
17	3363	0.1	-	10.2	0.0	0.0	79.5	(3)	Sand, med grn, kaol, feldspathic w/sh partings & plant frags.
18	3364	0.3	-	13.6	0.2	1.5	72.6	(3)	Sand, med grn, kaol, & feldspathic w/sh & mica.
19	3365	0.3	-	9.8	0.0	0.0	80.5	(3)	Sand, med grn, kaol, & feldspathic w/sh, mica & coal.
20	3366	0.7	-	14.3	0.0	0.0	72.7	(3)	Sand, fn grn, arkosic, w/kaol & mica.
21	3367	0.3	-	15.6	0.5	2.94	86.0	(3)	Sand, fn-med grn, w/numerous coal frags, mica & feldspathic.
22	3368	0.7	-	9.8	0.0	0.0	86.5	(3)	Sand, fn grn, calc, & kaol, w/trc mica.
23	3369	0.4	-	9.3	0.0	0.0	89.5	(3)	Sand, fn grn, calc, & kaol, w/trc mica.
24	3371	0.1	-	16.8	0.0	0.0	79.8	(3)	Sand, fn grn, sl/calc, & v/micaceous.

(3) Insufficient permeability

Core No. 19

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per-cent)	Residual Saturation			Probable Pro-duction	Remarks
		Horizon-tal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
25	4033	0.3	-	11.2	0.0	0.0	76.9	(3)	Sand, v/carb, fn-cse grn, micac.
26	4036	0.3	-	12.5	0.0	0.0	55.9	(3)	Sand, v/carb, fn-cse grn, micac.
27	4040	2.6	-	11.6	0.0	0.0	40.6	Gas	Congl. sand, fn-cse grn, silice-ous & carb.
28	4041	6.5	-	11.4	0.0	0.0	36.5	Gas	Congl. sand, fn-cse grn, mica, siliceous & carb.
29	4042	4.2	-	16.5	0.0	0.0	51.2	Gas	Congl. sand, fn-cse grn.
30	4043	1.3	-	12.1	0.0	0.0	40.3	Gas	Sand, fn-med grn, clean.
31	4044	1.8	-	12.1	0.0	0.0	44.4	Gas	Sand, fn-med grn, mica, clean.
32	4045	1.9	-	14.7	0.0	0.0	41.9	Gas	Sand, fn-med grn, kaol.
33	4046	3.3	-	15.8	0.2	1.3	39.4	Gas	Sand, fn-med grn, occas. cse grns.
34	4047	1.2	-	14.6	0.2	1.4	44.0	Gas	Sand, fn-med grn & clean.
35	4048	1.0	-	15.1	0.0	0.0	38.2	Gas	Sand, fn-medgrn & clean w/occas. cse grns.

(3) Insufficient permeability

Core No. 19 (Cont'd)

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per-cent)	Residual Saturation			Probable Pro-duction	Remarks
		Horizon-tal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
36	4049	6.7	-	15.7	0.0	0.0	37.4	Gas	Sand, fn-med grn & clean.
37	4050	2.7	-	13.8	0.0	0.0	36.5	Gas	Sand, fn-med grn w/kaol. & mica.
38	4051	1.4	-	14.8	0.2	1.4	33.8	Gas	Sand, fn-med grn w/micac. bands & kaol.
39	4052	0.3	-	13.2	0.2	1.5	54.9	(3)	Sand, fn-med grn w/mica.

(3) Insufficient permeability

Core No. 16

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per-cent)	Residual Saturation			Probable Pro-duction	Remarks
		Horizon-tal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
40	3781	15.0	-	14.0	0.0	0.0	55.0	Gas	Sand, fn-med grn, ang, & sl/ calc.
41	3783	2.2	-	14.8	0.0	0.0	53.4	Gas	Sand, fn-med grn, ang, & sl/ calc.
42	3785	1.0	-	9.4	0.0	0.0	74.5	Water	Sand, fn-med grn, w/silt bands, argil, w/coal & mica.
43	3787	0.9	-	11.5	0.0	0.0	56.5	(3)	Sand, fn-med grn, w/coal, mica & kaol.
44	3789	0.1	-	10.2	0.0	0.0	61.7	(3)	Sand, fn-cse grn & banded, w/fo-ssil frags & coal.
45	3793	0.3	-	13.6	0.0	0.0	55.9	(3)	Sand, fn-med grn, mica & kaol.
46	3795	0.3	-	12.7	0.0	0.0	59.9	(3)	Sand, fn-med grn, w/mica, kaol, and coal.
47	3797	0.1	-	5.0	0.0	0.0	68.0	(3)	Sand, fn-med grn; mica & well cemented w/calcite.

(3) Insufficient permeability

Core No. 17

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per-cent)	Residual Saturation			Probable Pro-duction	Remarks
		Horizon-tal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
48	3815	0.4	-	12.6	0.0	0.0	57.1	(3)	Sand, fn-med grn, sl/calc.
49	3817	0.1	-	11.2	0.0	0.0	61.6	(3)	Sand, fn-med grn, w/carb. grns.
50	3819	<0.1	-	3.3	0.0	0.0	60.6	(3)	Sand, fn-cse grn, w/calc cement & mica.
51	3821	0.1	-	1.9	0.0	0.0	68.5	(3)	Sand, fn-cse grn, w/calc cement, mica & kaol.
52	3823	<0.1	-	2.0	0.0	0.0	65.0	(3)	Sand, fn-cse grn, w/calc cement, mica & kaol.
53	3825	<0.1	-	5.9	0.0	0.0	78.0	(3)	Sand, fn-cse grn, w/calc cement, mica & kaol.
54	3827	0.1	-	11.7	0.0	0.0	56.5	(3)	Sand, fn-med grn, w/mica, coal frags & kaol.
55	3829	<0.1	-	12.7	0.0	0.0	53.5	(3)	Sand, fn-med grn & sl/calc, w/mica & coal frags.
56	3831	<0.1	-	12.8	0.0	0.0	57.0	(3)	Sand, fn-med grn, w/coal frags.
57	3833	0.7	-	13.1	0.0	0.0	60.2	(3)	Sand, fn-med grn, & sl/calc, w/kaol.

(3) Insufficient permeability

Core No. 17 (Cont'd)

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (percent)	Residual Saturation			Probable Production	Remarks
		Horizontal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
58	3835	0.1	-	13.2	0.0	0.0	63.6	(3)	Sand, fn-med grn, & sl/calc, w/kaol.
59	3837	0.7	-	11.5	0.0	0.0	56.5	(3)	Sand, fn-cse grn, w/large coal inclusion & mica.
60	3839	<0.1	-	10.7	0.0	0.0	54.1	(3)	Sand, fn-med grn, & sl/calc, w/ mica, small coal frags.
61	3841	<0.1	-	8.7	0.0	0.0	60.9	(3)	Sand, fn-cse grn, & sl/calc, w/ mica & small coal frags.

(3) Insufficient permeability

Core No. 20

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (percent)	Residual Saturation			Probable Production	Remarks
		Horizontal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
62	4062	0.7	-	9.7	0.0	0.0	37.1	Gas	Sand, fn-cse grn, sl/calc, & sl/kaol.
63	4063	53.0	-	11.3	0.0	0.0	34.5	Gas	Sand, fn-cse grn, sl/calc, w/horizontal frac.
64	4064	1.3	-	12.9	0.0	0.0	48.1	Gas	Sand, fn-cse grn, sl/calc, w/coal frags.
65	4079	15.0	-	12.6	0.0	0.0	27.8	Gas	Sand, fn-cse grn, sl/calc, & kaol.
66	4080	0.7	-	11.2	0.0	0.0	35.8	Gas	Sand, fn-cse grn, sl/kaol.
67	4081	1.6	-	11.4	0.0	0.0	40.3	Gas	Sand, fn-cse grn.
68	4082	3.7	-	12.0	0.0	0.0	32.5	Gas	Sand, fn-med grn, kaol.
69	4086	0.1	-	10.6	0.0	0.0	52.9	(3)	Sand, fn-med grn, calc, & sl/kaol, w/carb. frags.
Core No. 21									
70	4343	<0.1	-	11.5	0.0	0.0	63.5	(3)	Sand, fn-cse grn, argil.

(3) Insufficient permeability.

Core No. 22

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per-cent)	Residual Saturation			Probable Pro-duction	Remarks
		Horizon-tal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
71	4534	3.0	-	10.1	0.0	0.0	45.4	Gas	Congl. sand, fn-v/cse grn, sl/calc.
72	4536	36.8	-	10.0	0.0	0.0	33.0	Gas	Congl. fn grn, sd-5mm pebbles, argil.
73	4538	21.7	-	11.5	0.0	0.0	47.9	Gas	Sand, fn-med grn, qtzitic.
74	4540	0.1	-	10.7	0.0	0.0	54.2	(3)	Sand, fn-med grn, sl/argil.

(3) Insufficient permeability

Core No. 29

Core Analysis Results

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (per-cent)	Residual Saturation			Probable Pro-duction	Remarks
		Horizon-tal	Vertical		Oil		Total Water		
					% Volume	% Pore	% Pore		
75	5367	1.3	-	13.4	0.0	0.0	54.6	Gas	Sand, med grn, clean.
76	5368	0.5	-	12.4	0.2	1.6	63.7	(3)	Sand, med grn, clean.
77	5369	96.0	-	14.8	0.0	0.0	41.9	Gas	Sand, cse grn, clean.
78	5370	25.4	-	18.3	0.0	0.0	54.0	Gas	Sand, med grn, clean.
79	5371	0.7	-	15.3	0.0	0.0	62.8	(3)	Sand, med grn, feldspathic.
80	5372	0.7	-	14.1	0.2	1.4	56.7	(3)	Sand, med grn, clean.
81	5373	0.9	-	13.5	0.0	0.0	57.7	(3)	Sand, med grn, clean, micaceous.
82	5374	0.3	-	13.3	0.0	0.0	61.6	(3)	Sand, med grn, sl/kaol.
83	5375	0.5	-	7.8	2.0	25.6	51.3	(3)	Sand, med grn, sl/feldspathic & kaol.
84	5376	0.1	-	9.0	2.0	22.2	47.9	(3)	Sand, med grn, sl/feldspathic & kaol.
85	5377	0.1	-	9.2	2.0	21.8	45.6	(3)	Sand, med grn, kaol, feldspathic, micaceous.
86	5378	< 0.1	-	7.9	2.0	25.3	63.4	(3)	Sand, v/coaly, med grn, mica, kaol, feldspathic.

(3) Insufficient permeability

Core No. 29 (Cont'd)

Sample Number	Depth (feet)	Permeability (millidarcys)		Porosity (percent)	Residual Saturation			Probable Production	Remarks
		Horizontal	Vertical		Oil % Volume	Oil % Pore	Total Water % Pore		
87	5379	0.5	-	9.3	0.2	2.2	52.8	(3)	Sand, med grn, feldspathic, kaol.
88	5380	0.5	-	10.6	0.2	1.9	50.0	(3)	Sand, med grn, sl/siliceous, feldspathic, kaol.

(3) Insufficient permeability

APPENDIX 3

WARRINILLA NORTH NO. 1

REPORTS ON DRILLSTEM TESTS

by

Halliburton Company

Twenty-three drillstem tests were carried out in Warrinilla North No. 1 Well. All tests were run using a Halliburton hydrospring single packer tester equipped with a dual closed-in pressure valve, equalizing retaining and by-pass valves, impact reverse circulating sub, Howco safety joint and jars. The bottom hole choke was 5/8 inch, surface choke 1 inch, and the packer size was 7-1/2 inches. Two pressure recording devices were used on all tests; these were Halliburton Type "BT" Recorders.

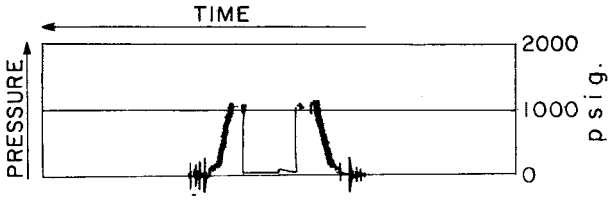
There were four misruns as follows :

DST No. 2,	2228 to 2264 feet.	Tool did not reach bottom
DST No. 10,	4263 to 4360 feet.	Packer seat failed
DST No. 12,	4460 to 4542 feet.	Packer seat failed
DST No. 13,	4503 to 4542 feet.	Packer seat failed

Details of the successful 8-3/4" open hole drillstem tests are recorded on the following pages.

DST No. 1

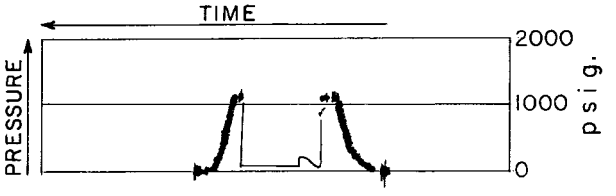
Date:	4th August, 1963
Interval tested:	2000 to 2072 feet
Formation tested:	Bandanna Formation
Reovery in pipe:	Five feet mud
Remarks:	Tool opened for a 3-min. first flow with a weak blow. Rotated tool for a 25-min. initial c.i.p. Tool reopened for a 30-min. second flow period. Took a 25-min. final c.i.p.
Top Chart:	Recorder depth 1983 feet



D.S.T. Nº 1 – TOP CHART

DST No. 3

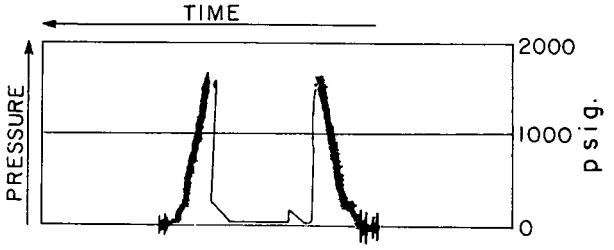
Date:	5th August, 1963
Interval tested:	2228 to 2264 feet
Formation tested:	Bandanna Formation
Recovery in pipe:	100 feet mud
Remarks:	Opened tool for 4 min. first flow with weak blow. Closed tool for 30-min. initial c.i.p. Reopened tool for 60-min. second flow with fair blow; dead in 10 min. Closed tool for 30-min. final c.i.p.
Top Chart:	Recorder depth 2211 feet



D.S.T. Nº 3 – TOP CHART

DST No. 4

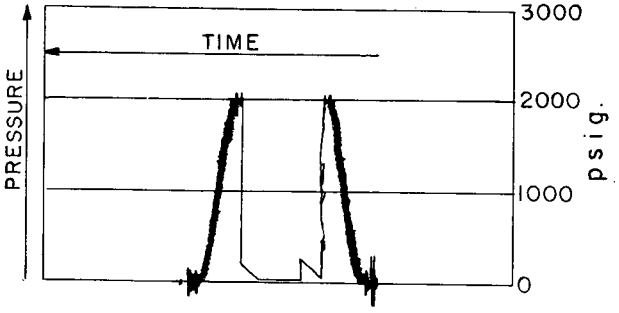
Date:	10th August, 1963
Interval tested:	2955 to 2991 feet
Formation tested:	Mantuan Productus Bed
Recovery in pipe:	Ten feet mud
Remarks:	Opened tool for 3-min. first flow with good blow. Closed tool for 30-min. initial c.i.p. Reopened tool for 90-min. second flow with steady blow throughout test. Closed tool for 30-min. final c.i.p.
Bottom Chart:	Recorder depth 2991 feet



D.S.T. Nº 4 — BOTTOM CHART

DST No. 5

Date:	16th August, 1963
Interval tested:	3721 to 3731 feet
Formation tested:	Ingelara Formation
Recovery in pipe:	Eight feet mud
Remarks:	Tool opened with a weak blow for a 3-min. first flow. Rotated tool for a 30-min. initial c.i.p. Reopened tool with a weak blow for 64-min. second flow. Took a 30-min. final c.i.p. No gas or fluid to the surface.
Top Chart:	Recorder depth 3708 feet

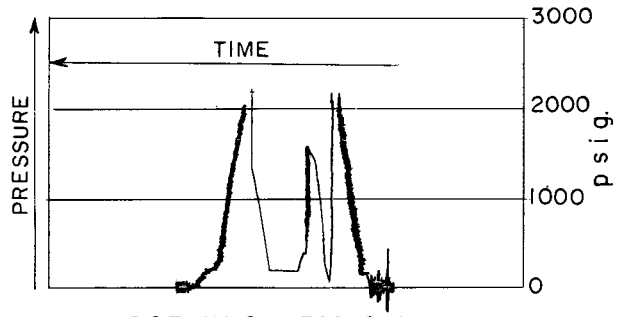


D.S.T. Nº 5 — TOP CHART

.262-8

DST No. 6

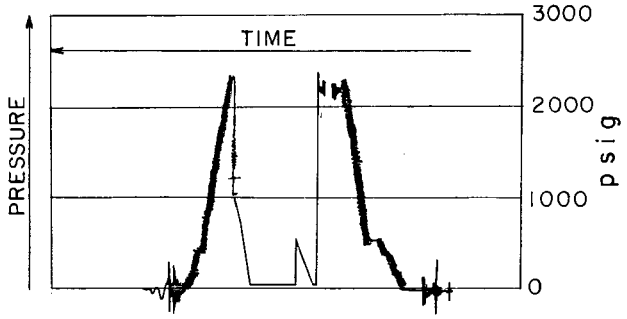
Date:	17th August, 1963
Interval tested:	3722 to 3813 feet
Formation tested:	Ingelara Formation
Recovery in pipe:	330 feet highly gas-cut mud; 90 feet salt water.
Remarks:	Opened tool with a good blow. Closed for 33 min. Reopened tool with a good blow increasing to a strong blow in 2 min., and continued through test. Gas to surface in 20 min., at rate of 65 Mcf/D. No fluid to surface. Closed for 30 min.
Top Chart:	Recorder depth 3705 feet



D.S.T. Nº 6 - TOP CHART

DST No. 7

Date:	21st August, 1963
Interval tested:	4005 to 4030 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	50 feet slightly gas-cut mud
Remarks:	Opened tool for 5-min. first flow with fair blow. Closed tool for 30-min. initial c.i.p. Reopened tool for 70-min. second flow with weak blow throughout test. Gas to surface in 53 min. (too small to measure). Closed tool for 30-min. final c.i.p.
Top Chart:	Recorder depth 3992 feet



D.S.T Nº 7 - TOP CHART

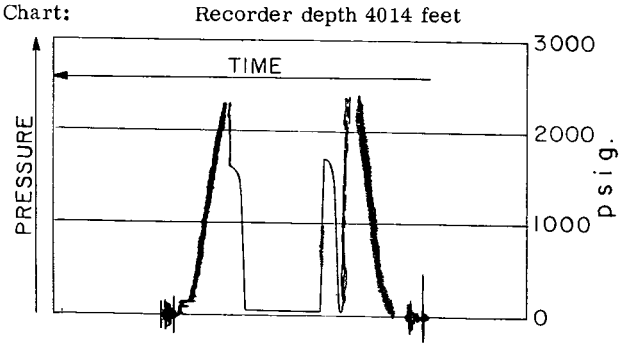
DST No. 8

Date:	22nd August, 1963
Interval tested:	4027 to 4062 feet
Formation tested:	Aldebaran Sandstone
Mud weight:	10.5 lb./U.S. gal.
Mud viscosity:	60 sec. (Marsh)
Bottom hole temperature:	135°F
Cushion:	None
Recovery in pipe:	130 feet highly gas-cut mud
Remarks:	Tool opened with a strong blow for a 4 min. first flow. Rotated tool for a 30-min. initial c.i.p. Reopened tool with strong blow, gas to surface in 2 min. at rate of 70 Mcf/D, increasing to 112 Mcf/D at end of 2 hours. No fluid to surface.

Pressure Readings (Office Corrected Values):

		Top Gauge (4014 ft)	Bottom Gauge (4059 ft)
Initial Hydrostatic Mud Pressure		2224 psig.	2240 psig.
First Flow Period (4 min.)	I.F.P.	70 "	99 "
	F.F.P.	66 "	76 "
First Closed-in Period (30 min.)	C.I.P.	1696 "	1700 "
Second Flow Period (120 min.)	I.F.P.	59 "	70 "
	F.F.P.	59 "	67 "
Second Closed-in Period (30 min.)	F.C.I.P.	1637 "	1643 "
Final Hydrostatic Mud Pressure		2205 "	2223 "

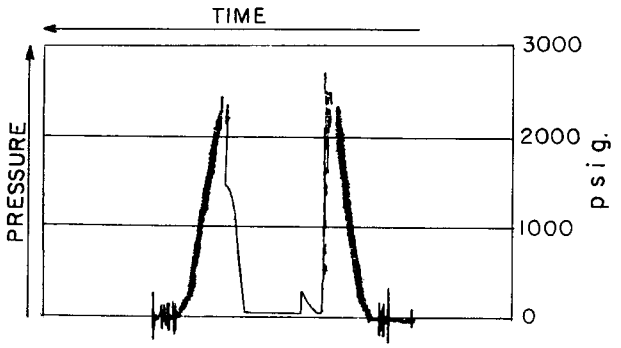
Top Chart: Recorder depth 4014 feet



D.S.T. No 8 — TOP CHART

DST No. 9

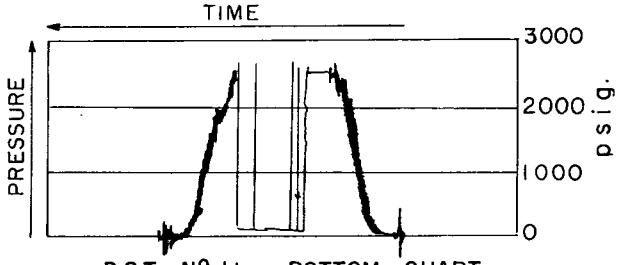
Date:	23rd August, 1963
Interval tested:	4061 to 4120 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	90 feet slightly gas-cut mud
Remarks:	Tool opened for a 5-min. first flow with a good blow. Closed tool for a 30-min. initial c.i.p. Reopened tool for a 90-min. second flow with a strong blow. Gas to surface in 30 min. at rate of 10 Mcf/D. No fluid to surface. Closed tool for a 30-min. final c.i.p.
Top Chart:	Recorder depth 4047 feet



D.S.T. No 9 – TOP CHART

DST No. 11

Date:	27th August, 1963
Interval tested:	4342 to 4410 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	75 feet mud
Remarks:	Opened tool with a few bubbles and died. Bypassed after 10 min. with a weak blow, dead in 10 min. Bypassed and opened with a few bubbles. Bypassed after 20 min. with a few bubbles. No gas or fluid to surface.
Bottom Chart:	Recorder depth 4406 feet



D.S.T. No 11 – BOTTOM CHART

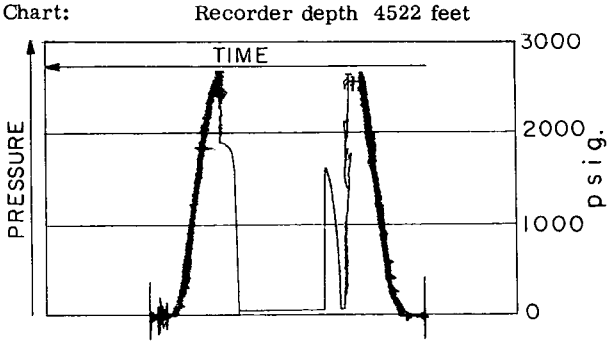
DST No. 14

Date:	30th August, 1963
Interval tested:	4535 to 4553 feet
Formation tested:	Aldebaran Sandstone
Mud weight:	10.5 lb./U.S. gal.
Mud viscosity:	90 sec. (Marsh)
Bottom hole temperature:	120°F
Cushion:	None
Recovery in pipe:	125 feet mod. gas-cut mud
Remarks:	Tool opened for a 5-min. first flow with a fair blow. Rotated tool for a 30 min. initial c.i.p. Tool reopened with a strong blow. Gas to surface in 26 min. at rate of 44 Mcf/D. No fluid to surface. Took a 30-min. final c.i.p.

Pressure Readings (Office Corrected Values):

		Top Gauge (4522 ft)	Bottom Gauge (4550 ft)
Initial Hydrostatic Mud Pressure		2642 psig.	2601 psig.
First Flow Period (5 min.)	I.F.P.	61 "	67 "
	F.F.P.	49 "	67 "
First Closed-in Period (30 min.)	C.I.P.	1667 "	1677 "
Second Flow Period (133 min.)	I.F.P.	25 "	50 "
	F.F.P.	59 "	67 "
Second Closed-in Period (30 min.)	F.C.I.P.	1901 "	1905 "
Final Hydrostatic Mud Pressure		2642 "	2601 "

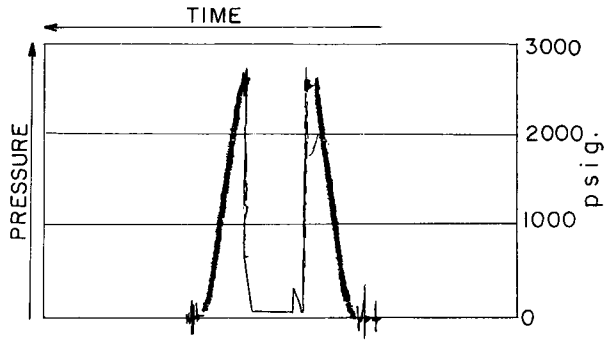
Top Chart: Recorder depth 4522 feet



D.S.T. No 14 - TOP CHART

DST No. 15

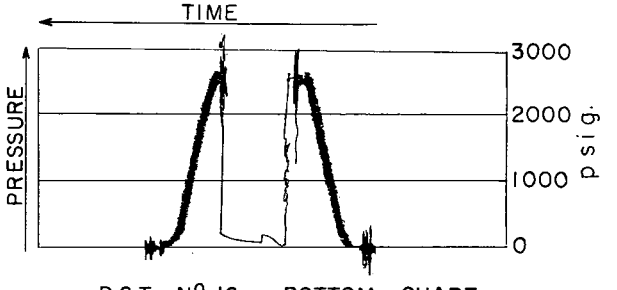
Date:	31st August, 1963
Interval tested:	4510 to 4573 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	120 feet moderate gas-cut mud
Remarks:	Opened tool for 3-min. first flow with good blow. Closed tool for 15-min. initial c.i.p. Reopened tool for 61 min. second flow with strong blow throughout test; gas to surface in 45 min. at est. 5 Mcf/D. Closed tool for 15 min. final c.i.p.
Top Chart:	Recorder depth 4497 feet



D.S.T. No 15 - TOP CHART

DST No. 16

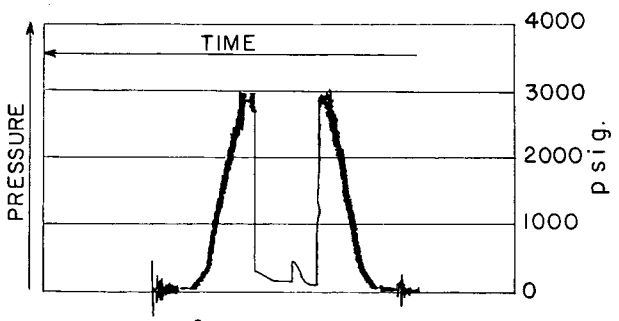
Date:	3rd September, 1963
Interval tested:	4686 to 4716 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	210 feet slightly gas-cut mud
Remarks:	Tool opened for a 7-min. first flow, went to T.D., and opened tool with a weak blow. Opened tool for second flow, weak blow, dying in 15 min. No gas or fluid to surface.
Bottom Chart:	Recorder depth 4712 feet



D.S.T. N° 16 - BOTTOM CHART

DST No. 17

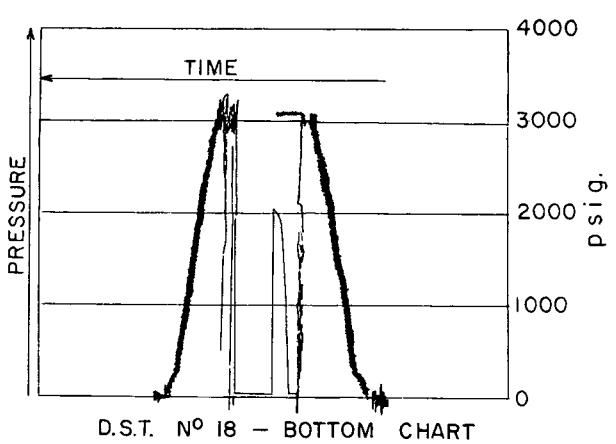
Date:	11th September, 1963
Interval tested:	5123 to 5233 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	200 feet mud
Remarks:	Opened tool with a weak blow for 10 min. Closed for 30 min. Reopened tool with no blow. No gas or fluid to surface. Closed for 30 min.
Bottom Chart:	Recorder depth 5230 feet



D.S.T. N° 17 — BOTTOM CHART

DST No. 18

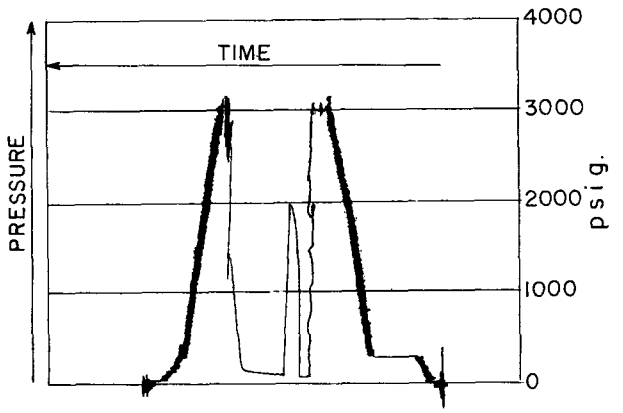
Date:	14th September, 1963
Interval tested:	5363 to 5381 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	15 feet mud
Remarks:	Tool opened with very weak blow for a 10 min. first flow. Rotated tool for a 30-min. initial c.i.p. Reopened tool with a very weak blow to dead. Reset tool; allowed flow for 7 min.
Bottom Chart:	Recorder depth 5378 feet



D.S.T. N° 18 — BOTTOM CHART

DST No. 19

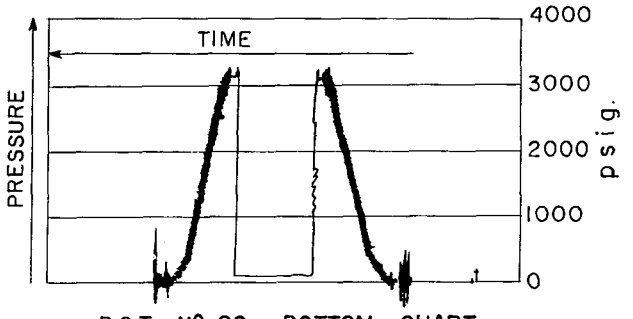
Date:	15th September, 1963
Interval tested:	5374 to 5414 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	350 feet mud
Remarks:	Opened tool for 10-min. first flow with faint blow. Closed tool for 30-min. initial c.i.p. Reopened tool for 60 min. second flow with faint steady blow. Closed tool for 30-min. final c.i.p.
Bottom Chart:	Recorder depth 5411 feet



D.S.T Nº 19 – BOTTOM CHART

DST No. 20

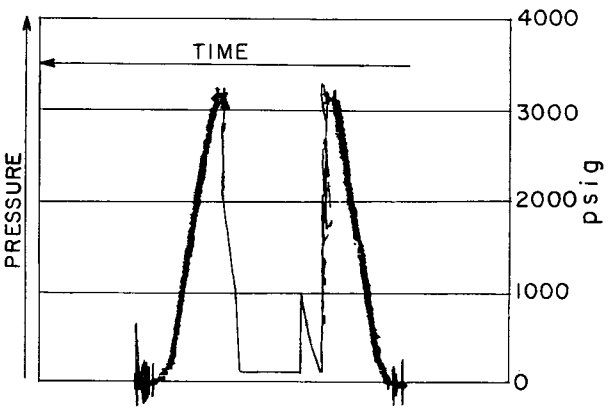
Date:	16th September, 1963
Interval tested:	5410 to 5467 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	70 feet slightly gassy mud
Remarks:	Opened tool for 5 min. Closed for 30 min. Reopened tool with a weak to dead blow. Closed for 30 min.
Bottom Chart:	Recorder depth 5464 feet



D.S.T. Nº 20 – BOTTOM CHART

DST No. 21

Date:	18th September, 1963
Interval tested:	5510 to 5575 feet
Formation tested:	Aldebaran Sandstone
Recovery in pipe:	300 feet highly gas-cut mud
Remarks:	Opened tool for 5 min. with a strong blow. Closed for 30 min. Reopened tool with a strong blow; gas to surface in 5 min; increased in flow from 44 Mcf/D to 102 Mcf/D. Closed for 30 min.
Top Chart:	Recorder depth 5493 feet



D.S.T. No 21 – TOP CHART

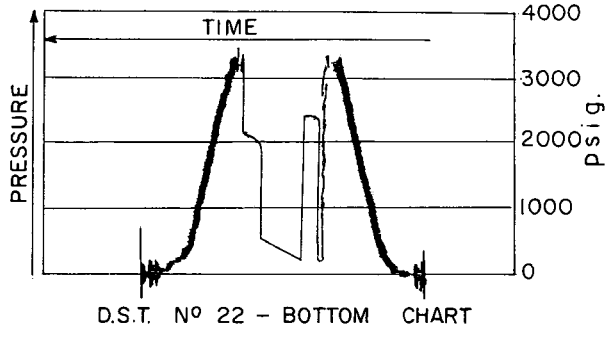
DST No, 22

Date:	19th September, 1963
Interval tested:	5574 to 5644 feet
Formation tested:	Aldebaran Sandstone
Mud weight:	10.7 lb./U.S. gal.
Mud viscosity:	58 sec. (Marsh)
Bottom hole temperature:	130°F
Cushion:	None
Recovery in pipe:	675 feet gas-cut brackish water
Remarks:	Tool opened for a 5-min. first flow with a strong blow. Gas to surface. Closed tool for a 30-min. initial c.i.p. Reopened tool for a 64 min. second flow; rate 250 Mcf/D to 162 Mcf/D. Mud to surface in 52 min; salt water in 61 min. Closed tool for a 30-min. final c.i.p.

Pressure Readings (Office Corrected Values):

		Top Gauge (5557 ft)	Bottom Gauge (5641 ft)
Initial Hydrostatic Mud Pressure		3159 psig.	3205 psig.
First Flow Period (5 min.)	I.F.P.	208 "	277 "
	F.F.P.	201 "	245 "
First Closed-in Period (30 min.)	C.I.P.	2344 "	2376 "
Second Flow Period (64 min.)	I.F.P.	318(?)"	315 "
	F.F.P.	462 "	493 "
Second Closed-in Period (30 min.)	F.C.I.P.	2109 "	2142 "
Final Hydrostatic Mud Pressure		3150 "	3193 "

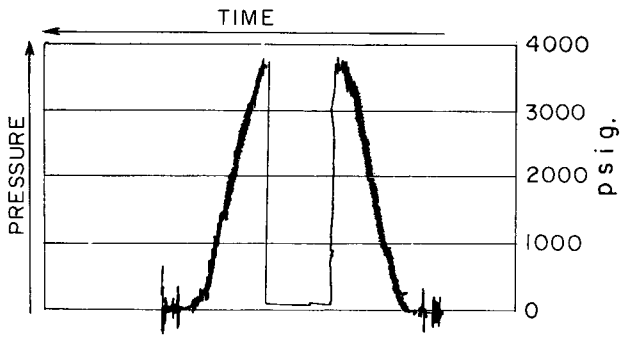
Bottom Chart: Recorder depth 5641 feet



D.S.T. Nº 22 – BOTTOM CHART

DST No. 23

Date:	1st October, 1963
Interval tested:	6350 to 6438 feet
Formation tested:	Cattle Creek Formation
Recovery in pipe:	Ten feet mud
Remarks:	Tool opened for a 5-min. first flow with a weak blow. Closed tool for a 30-min. initial c.i.p. Reopened tool for a 38-min. second flow with weak to dead blow. Closed tool for a 30-min. final c.i.p.
Bottom Chart:	Recorder depth 6435 feet



D.S.T. Nº 23 - BOTTOM CHART

APPENDIX 4

WARRINILLA NORTH NO. 1

GAS ANALYSES

by

Queensland Government Chemical Laboratory

General

Sample No. 810/63/GS
DST No. 6: Interval 3722 to 3813 feet

Analysis

MOLES PERCENT		
Methane		61.90
Ethane		2.70
Propane		1.21
Butane -	iso	0.27
	normal	0.37
Pentane -	iso	0.18
	normal	0.13
Hexanes plus		0.20
Nitrogen)		32.60
Oxygen)		
Carbon dioxide		0.40
Calorific Value (gross)		749 btu/cu.ft
	(net)	677 btu/cu.ft

General

Sample No. 811/63/GS
DST No. 7: Interval 4005 to 4030 feet

Analysis

MOLES PERCENT		
Methane		80.00
Ethane		4.60
Propane		3.00
Butane -	iso	0.66
	normal	1.11
Pentane -	iso	0.42
	normal	0.49
Hexanes plus		0.82
Nitrogen)		8.80
Oxygen)		
Carbon dioxide		0.09
Calorific Value (gross)		1103 btu/cu.ft
	(net)	999 btu/cu.ft

General

Sample No. 812/63/GS
DST No. 8: Interval 4027 to 4062 feet

Analysis

MOLES PERCENT

Methane			80.20
Ethane			4.60
Propane			2.90
Butane	-	iso	0.61
		normal	0.06
Pentane	-	iso	0.40
		normal	0.49
Hexanes plus			0.80
Nitrogen)			8.60
Oxygen)			
Carbon dioxide			0.31

Calorific Value	(gross)	1098 btu/cu.ft
	(net)	994 btu/cu.ft

General

Sample No. 1027/63/GS
DST No. 14: Interval 4535 to 4553 feet

Analysis

MOLES PERCENT

Methane			82.10
Ethane			3.80
Propane			2.10
Butane	-	iso	0.53
		normal	0.80
Pentane	-	iso	0.38
		normal	0.37
Hexanes plus			0.78
Nitrogen)			8.40
Oxygen)			
Carbon dioxide			0.70

Calorific Value	(gross)	1064 btu/cu.ft
	(net)	963 btu/cu.ft

General

Sample No. 1028/63/GS
DST No. 15: Interval 4510 to 4573 feet

Analysis

MOLES PERCENT

Methane			82.30
Ethane			3.80
Propane			2.20
Butane	-	iso	0.54
		normal	0.82
Pentane	-	iso	0.39
		normal	0.38
Hexanes plus			0.62
Nitrogen)			8.60
Oxygen)			
Carbon dioxide			0.31
Calorific Value		(gross)	1063 btu/cu.ft
		(net)	962 btu/cu.ft

General

Sample No. 1029/63/GS
DST No. 21: Interval 5510 to 5575 feet

Analysis

MOLES PERCENT

Methane			63.90
Ethane			4.40
Propane			2.50
Butane	-	iso	0.52
		normal	0.91
Pentane	-	iso	0.36
		normal	0.47
Hexanes plus			1.01
Nitrogen)			10.10
Oxygen)			
Carbon dioxide			15.80
Calorific Value		(gross)	918 btu/cu.ft
		(net)	832 btu/cu.ft

General

Sample No. 1109/63/GS
DST No. 22: Interval 5574 to 5644 feet

Analysis

MOLES PERCENT

Methane		64.10
Ethane		4.70
Propane		2.50
Butane -	iso	0.52
	normal	0.87
Pentane -	iso	0.36
	normal	0.44
Hexanes plus		0.89
Nitrogen)		6.00
Oxygen)		
Carbon dioxide		19.60

Calorific Value	(gross)	917 btu/cu.ft
	(net)	831 btu. cu.ft

APPENDIX 5

WARRINILLA NORTH NO. 1

WATER ANALYSIS

by

Queensland Government Chemical Laboratory

General

Sample No. 1108/63/GS
DST No. 22: Interval 5574 to 5644 feet

Analysis

Parts per million:

Total Solids	19340
Sodium Na^+	6589
Calcium Ca^{++}	12
Magnesium Mg^{++}	5
Sulphate $SO_4^=$	Trace
Chloride Cl^-	3035
Carbonate $CO_3^=$	780
Bicarbonate HCO_3^-	10736
Alkalinity as $CaCO_3$	10100
Hardness as $CaCO_3$	50
Resistivity ohms/cm at 25^oC	47
pH	8.6
Organic Matter	present

WATER ANALYSIS

by

Core Laboratories, Inc.

General

Sample No. 1
DST No. 6: Interval 3722 to 3813 feet

Analysis

Constituents	meq/l	mg/l	Constituents	meq l	mg/l
Sodium	63.9	1471.0	Chloride	66.2	2343.0
Calcium	6.0	120.0	Bicarbonate	6.4	390.4
Magnesium	5.9	72.9	Sulphate	3.4	164.0
Iron	0.2	6.7	Carbonate	0.0	0.0
Barium	-	-	Hydroxide	0.0	0.0

pH = 7.5

APPENDIX 6

WARRINILLA NORTH NO. 1

WELL VELOCITY SURVEY

by

H.A. Lukowitch*

INTRODUCTION

A survey was conducted on 9th October, 1963 in Planet Warrinilla North No. 1 Well for the purpose of obtaining subsurface velocities, and also for a subsequent calibration of a Schlumberger Sonic Log that was conducted in the same well.

Warrinilla North No. 1 was drilled to 6879 feet (Schlumberger) and except for surface pipe set at 543 feet no other casing had been set in the well at the time of the survey.

FIELD PROCEDURE

The standard procedure of conducting a velocity survey was used. On each side, two shotholes were drilled a distance of 500 feet and diametrically opposite from the well (see Shooting Plan, Fig. 3). All shotholes were drilled to a depth of 220 feet to be below the base of the weathered zone. Another hole a short distance from the well was drilled to a depth of 300 feet and was used for conducting an uphole velocity survey.

A pressure sensitive S.S.C. Model GCE-101 well geophone was used for the survey and a Schlumberger cable was used to lower and raise the well geophone in the well. The well geophone was checked to ensure that it was working properly before being lowered in the hole.

The times to eight predetermined depths were measured and all well depths were measured with a Schlumberger cable with reference to the rotary table. No difficulties were encountered in lowering or raising the well geophone in the hole.

The trace arrangements on the velocity records were as follows:

Trace No. 1:	Well Geophone	-	Low Gain
Trace No. 2:	Well Geophone	-	Medium Gain
Trace No. 3:	Well Geophone	-	High Gain
Trace No. 4:	Time Break		
Trace No. 5:	Uphole Geophone		

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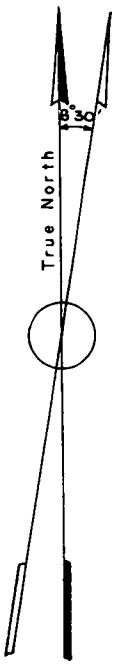
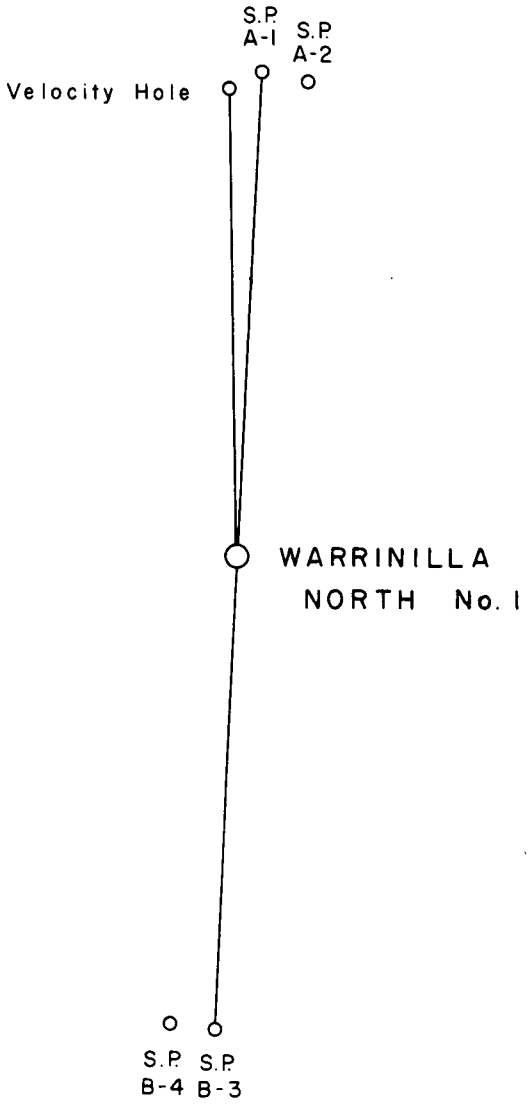
* Austral Geo Prospectors Pty Ltd.

Fig. 3

SHOOTING PLAN
WELL VELOCITY SURVEY
WARRINILLA NORTH No. 1





Scale 1 inch = 200 feet

LEGEND

○ Shotpoint

◯ Well

62-10

INTERPRETATION AND RESULTS

Sixteen velocity records were obtained and are available for inspection at the Bureau of Mineral Resources, Canberra. The quality of the "first breaks" was generally good and all data are considered to be reliable. The travel time was taken from the High Gain trace because it has the sharpest and therefore most accurate break.

Velocity Determinations

The observed travel times(T) were corrected to an elevation datum of 900 feet above sea level, using a sub-weathering velocity of 9000 feet per second. The times were trigonometrically corrected to a vertical travel path to facilitate plotting of a time-depth curve and velocity curves.

Time lags due to the shattering effect of repeated charges in the shotholes were investigated and were found not to affect seriously the velocity determinations.

The uphole velocity survey was conducted to a depth of 300 feet and showed a subsurface velocity of 9000 feet per second. The depth of weathering appears to be about 60 feet and the velocity in the weathering was approximately 3800 feet per second.

Identification of Reflections

The measured energy from which the velocity is calculated is a "first arrival" of energy to the well geophone. The times normally picked in reflection work are trough times which are later than the "first arrival" times. The amount of such lag is variable, being primarily a function of the instruments, the form of the energy envelope, the recorded frequency, and the velocity itself.

The computed vertical times have been used for the determination of the reflection times. The troughs of the reflections associated with the desired formation are usually 0.035 to 0.050 second behind the calculated "first arrival" time of that particular horizon. There may also be a lag from the magnetic tape to the playback record on which the identifications are made.

VELOCITY DATA COMPUTATIONS

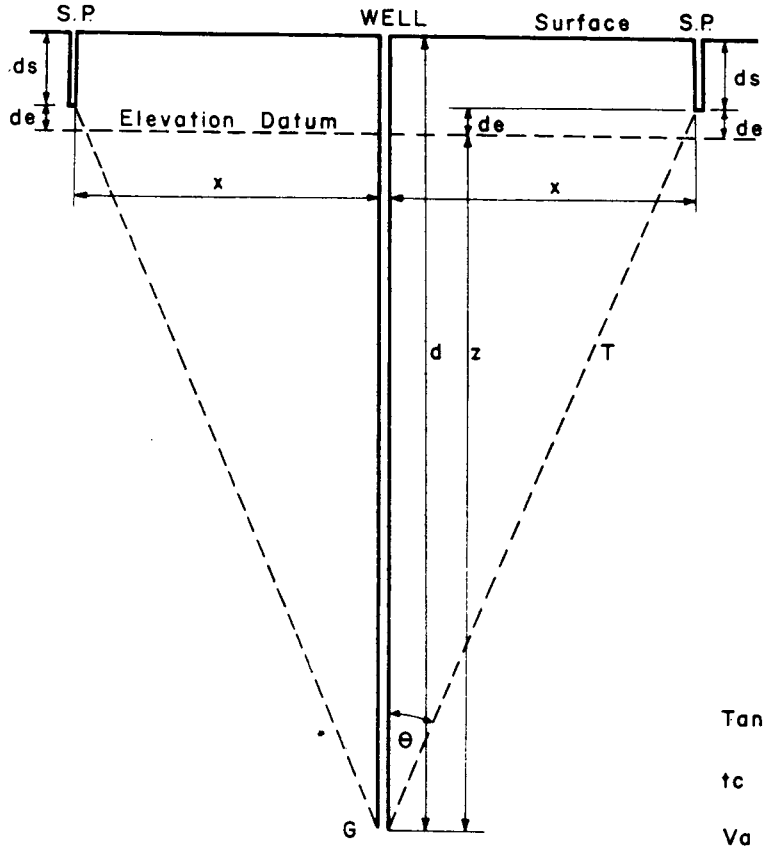
WARRINILLA NORTH NO. 1

S.P.	Geoph. Depth	Charge	ts	ds	S.P. Elev.	de	Geoph z	tan θ	cos θ	T	Tcos θ	te	tc	tc Av	Va	Vi
A-1	1310'	10	.036	198'	1020'	+ 78	1174'	.4562	.9098	.127	.116	+.009	.125	.1245	9,429	
B-3		5	.035	199'	1023'	+ 76	1174'	.4554	.9100	.128	.116	+.008	.124			10,510
A-1	2340'	2-1/2	.029	150'	1020'	+ 30	2204'	.2300	.9745	.224	.218	+.003	.221	.2225	9,905	
B-3		2-1/2	.027	150'	1023'	+ 27	2204'	.2297	.9746	.227	.221	+.003	.224			10,341
A-1	2945'	2-1/2	.029	150'	1020'	+ 30	2809'	.1799	.9842	.280	.276	+.003	.279	.281	9,996	
B-3		2-1/2	.028	150'	1023'	+ 27	2809'	.1797	.9842	.285	.280	+.003	.283			12,380
A-1	3725'	2-1/2	.029	150'	1020'	+ 30	3589'	.1405	.9902	.341	.338	+.003	.341	.344	10,433	
B-3		2-1/2	.027	150'	1023'	+ 27	3589'	.1404	.9902	.347	.344	+.003	.347			13,255
A-1	4010'	5	.028	150'	1020'	+ 30	3874'	.1301	.9916	.363	.360	+.003	.363	.3655	10,599	
B-3		5	.026	150'	1023'	+ 27	3874'	.1300	.9916	.368	.365	+.003	.368			14,320
A-1	4905'	5	.028	150'	1020'	+ 30	4769'	.1055	.9944	.424	.422	+.003	.425	.428	11,142	
B-3		5	.026	150'	1023'	+ 27	4769'	.1054	.9944	.430	.428	+.003	.431			15,142
A-1	5647'	10	.027	137'	1020'	+ 17	5511'	.0910	.9958	.477	.475	+.002	.477	.477	11,553	
B-3		5	.034	199'	1023'	+ 76	5511'	.0920	.9958	.471	.469	+.008	.477			14,099
A-1	6641'	10	.035	218'	1020'	+ 98	6505'	.0780	.9969	.538	.536	+.011	.547	.5475	11,881	
B-3		10	.024	138'	1023'	+ 15	6505'	.0770	.9970	.548	.546	+.002	.548			

Elevation Datum = +900' K.B. Elev. = 1036' Distance - Shotpoint to Well = 500' Ve = 9000 ft/sec.

Fig. 4

DIAGRAMMATIC CROSS SECTION
WELL VELOCITY SURVEY
WARRINILLA NORTH No. 1



$$\text{Tan } \Theta = \frac{x}{z + de}$$

$$tc = T\cos\Theta - \frac{de}{Ve}$$

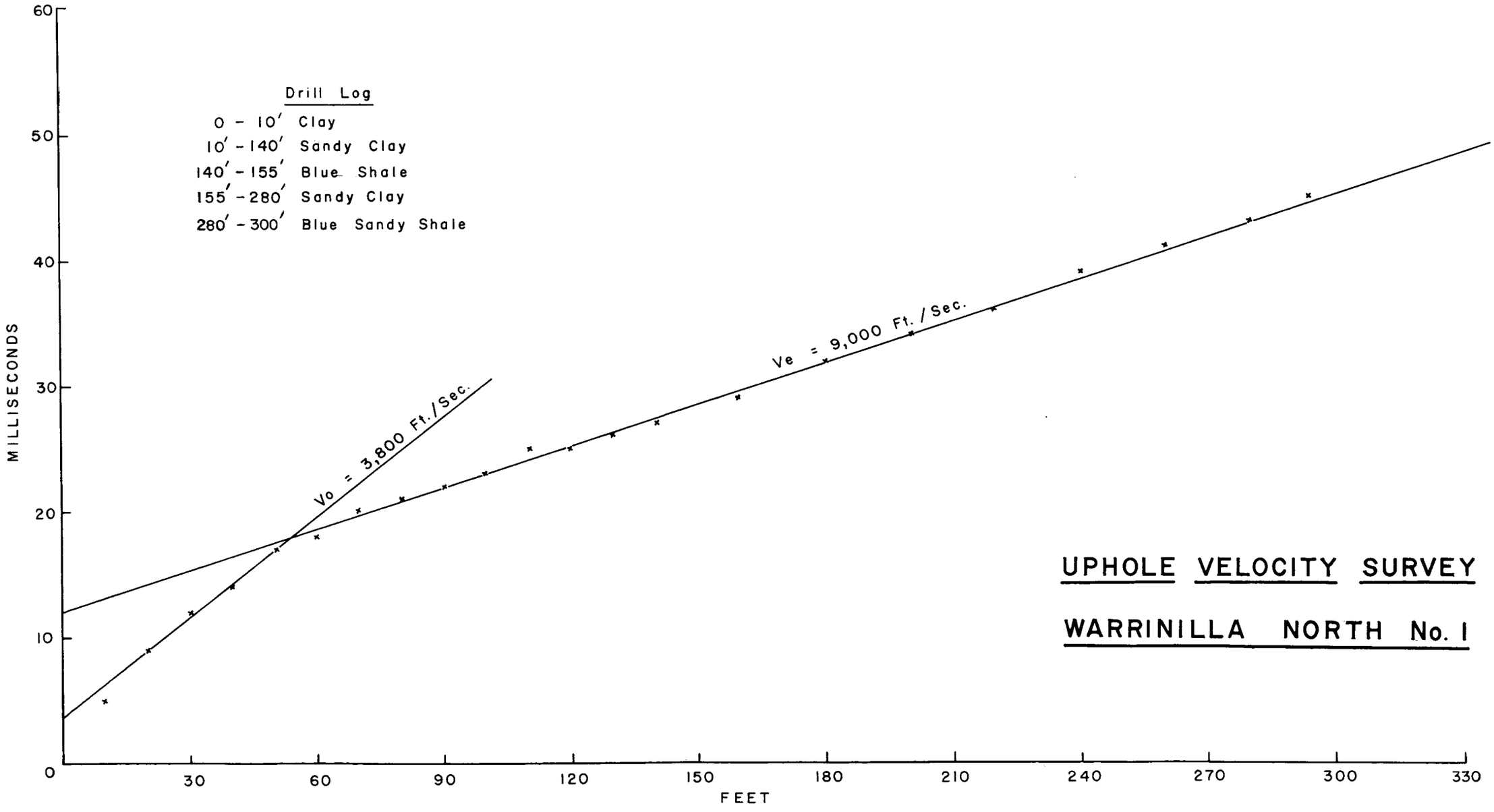
$$Va = \frac{z}{tc}$$

$$Vi = \frac{\Delta z}{\Delta tc}$$

REFERENCE

S.P.	Shotpoint	z	Depth below Datum
G	Well Geophone	x	Distance Shotpoint to Well
ds	Depth of Shot	T	Recorded Travel Time
de	Elevation Correction	Θ	Angle between Well and Travel Path
Ve	Subsurface Velocity		
Va	Average Velocity	tc	Recorded Travel Time corrected to Vertical
d	Depth of Well Geophone	Vi	Interval Velocity

Fig. 5

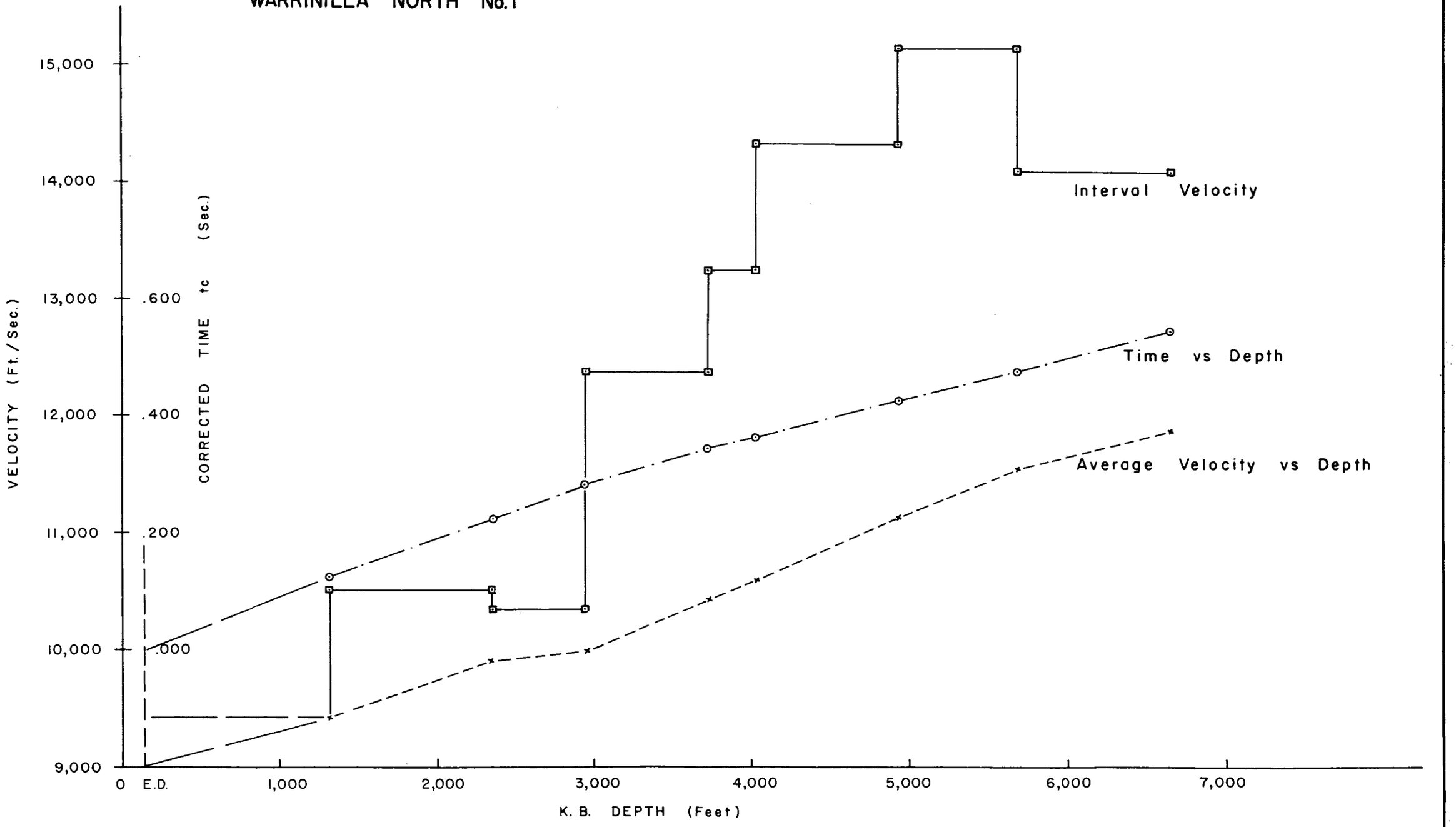


UPHOLE VELOCITY SURVEY

WARRINILLA NORTH No. 1

Fig. 6

TIME-DEPTH CURVES
WELL VELOCITY SURVEY
WARRINILLA NORTH No.1



APPENDIX 7

WARRINILLA NORTH NO. 1

DAILY MUD PROPERTIES

Date	Weight (lb/gal.)	Viscosity (Sec./qt)	Water Loss (cc/30 min.)	pH	Filter Cake (In./32")
28.7.63		Spudded in 4:00 am.			
28.7.63	9.8	62			
29.7.63		Running casing			
30.7.63		Casing and nippling up B.O.P.s			
31.7.63	9.3	35	9.0	9.0	2
1.8.63	9.7	40	6.0	8.5	2
2.8.63	9.9	48	6.0	9.0	1
3.8.63	10.2	61	5.8	9.0	2
4.8.63	10.1	35	6.3	8.5	2
5.8.63	9.8	37	6.2	9.3	1
6.8.63	10.1	41	5.5	9.2	2
7.8.63	10.2	46	4.8	9.5	2
8.8.63	10.2	52	5.0	9.5	1
9.8.63	10.0	49	5.0	9.5	1
10.8.63	10.0	45	5.5	9.3	1
11.8.63	10.2	50	5.0	9.5	2
12.8.63	10.5	78	5.0	8.8	2
13.8.63	10.4	74	5.0	8.5	1
14.8.63	10.6	66	5.0	8.5	2
15.8.63	10.3	58	5.5	8.5	1
16.8.63	10.4	58	5.2	8.5	2
17.8.63	10.5	58	5.5	8.3	1
18.8.63	10.7	70	5.8	8.5	2
19.8.63	10.7	70	5.4	8.0	2
20.8.63	10.6	67	5.4	9.0	2
21.8.63	10.7	68	5.0	8.0	2
22.8.63	10.7	69	5.0	8.5	2
23.8.63	10.7	71	5.0	8.5	2
24.8.63	10.9	54	5.4	9.0	2
25.8.63	10.9	78	5.2	8.0	2
26.8.63	10.9	70	5.0	8.0	2
27.8.63	11.0	72	5.0	9.0	2
28.8.63	11.9	75	5.0	10.0	2
29.8.63		Coring			
30.8.63	10.9	60	5.0	9.0	2
31.8.63	11.0	61	5.0	8.0	2
1.9.63	10.7	52	5.2	8.0	1
2.9.63	10.7	62	5.4	7.5	1
3.9.63	10.7	56	5.4	8.5	2
4.9.63	10.5	62	5.4	8.5	2

Date	Weight (lb/gal.)	Viscosity (Sec./qt)	Water Loss (cc/30 min.)	pH	Filter Cake (In./32")
5. 9.63	10.1	64	5.6	8.0	2
6. 9.63	10.5	62	5.6	8.5	2
7. 9.63	10.6	60	5.6	8.5	2
8. 9.63	10.7	80	5.2	8.5	2
9. 9.63	10.5	51	5.5	8.5	2
10. 9.63	10.7	61	5.5	8.5	2
11. 9.63	10.7	57	5.5	8.5	2
12. 9.63	10.7	65	6.0	8.0	2
13. 9.63	10.8	65	5.6	8.5	2
14. 9.63	10.7	65	6.2	8.5	2
15. 9.63	10.7	54	6.5	8.0	2
16. 9.63		Logging and Testing			
17. 9.63		Testing			
18. 9.63		Testing			
19. 9.63		Testing			
20. 9.63		Testing			
21. 9.63		Testing			
22. 9.63		Testing			
23. 9.63	10.9	72	5.2	8.5	2
24. 9.63	10.8	62	5.6	8.0	2
25. 9.63	10.9	72	5.6	8.5	2
26. 9.63	10.9	70	5.6	8.5	2
27. 9.63	10.9	71	6.0	8.0	2
28. 9.63	10.7	90	5.6	8.5	2
29. 9.63	10.9	72	5.5	8.0	2
30. 9.63	10.9	55	6.2	8.0	2
1.10.63	11.0	49	6.5	8.5	2
2.10.63	10.9	63	6.6	8.5	2
3.10.63	11.0	52	7.6	8.5	2
4.10.63	10.9	58	6.5	8.5	2
5.10.63	11.0	52	5.6	8.5	2
6.10.63	11.0	70	7.0	8.5	2
7.10.63	11.0	76	5.6	8.5	2
8.10.63	11.0	54	6.5	8.2	2
9.10.63		Logging			
10.10.63		Logging and setting casing			

TOTAL ADDITIVES USED

	Sacks	lb.
Caustic soda		3000
Bentonite (Super Col.)	488x50 lb.	24400
Ligno Sulphonate (Kalle 22) (Spersene)	253x50 lb.	12650
Barytes	379x112 lb.	42348
Thinner (Tannathin, Lovis)	29x50 lb.	1450

APPENDIX 8

WARRINILLA NORTH NO. 1

PALYNOLOGICAL REPORT

by

P.R. Evans*

SUMMARY

Palynological examination of twenty-one core samples from the depths listed below in Warrinilla North No. 1 Well was carried out. The main objects of this study were to obtain additional evidence of surface to subsurface palynological correlations in the Permian of the south-western Bowen Basin, and to examine the pre-Ingelara Formation to assist formational correlations.

Core	Depth (feet)	Palynological Unit or Age	Outcrop Correlate
6	2011	? Triassic	Basal Rewan Formation or uppermost
8	2047	Triassic	Bandanna Formation (younger than highest coals)
9	2417	Permian P4	Bandanna Formation
11	2723	Permian P3d	Lower Bandanna Formation (marine)
12	2961	Permian P3b	Un-named, below Bandanna Formation
13	3290	Permian P3b	Un-named, below Bandanna Formation
16	3783	Permian P3b	(?) Catherine Sandstone
18	4000	Permian P3b)	Basal Ingelara Formation, and upper
19	4042	Permian P3b)	Aldebaran Sandstone
20	4070	Permian ?)	
20	4100	Permian P3a)	
21	4340	Permian P3a)	Aldebaran Sandstone
23	4549	Permian P3a)	
24	4611	Permian P3a)	(?) Aldebaran Sandstone
25	4709	Permian ?P3a)	
26	4818	Permian ?P2) or P3a)	
27	5087	Permian P2)	
28	5304	Permian P2)	
31	5529	Barren)	(?) Cattle Creek Formation
32	5781	Permian P2)	
33	6237	Permian P2)	

* Bureau of Mineral Resources

OBSERVATIONS

Core No. 6, 2011 feet

Residue mainly of organic debris with very few spores. Punctatisporites sp. was identifiable; (?) Triassic because of stratigraphic position.

Core No. 8, 2047 feet

Spores fairly common, organic debris forming bulk of the residue.

Todisporites sp.
Apiculatisporis spp.
Thymaspora sp.
Nuskoisporites radiatus
N. triangularis
Large disaccate pollens

Most of these forms have been previously seen in Lower Triassic sections. The association of N. radiatus with the typical Permian N. triangularis implies the very base of the Triassic is represented.

Core No. 9, 2417 feet

Yield abundant.

Leiotriletes directus
Granulatisporites micronodosus
G. trisinus
Baculatisporites sp.
Kraeuselisporites apiculatus
Striatiti spp. (limpidus, cancellatus and amplus types) (common)
Vesicaspora ovata
Nuskoisporites triangularis

This is a typically Permian assemblage. The high proportion of striate pollens, and general absence of the echinate pteridophyte types indicate it is of P4 age.

Core No. 11, 2723 feet

Good yield, mainly of disaccate types. Others observed include:

Leiotriletes directus
Calamospora diversiformis
Acanthotriletes tereteangulatus
Kraeuselisporites apiculatus
Marsupipollenites triradiatus
Striatiti spp. undiff.
Veryhachium sp. 2 (common)
V. sp. 2 marks the sample's P3d age.

Core No. 12, 2961 feet

A good yield, microplankton common.

Leiotriletes directus
Granulatisporites micronodosus
G. trisinus
Dulhuntyispora parvithola
Acanthotriletes ericianus
Striatiti spp. undiff.
Micrhystridium sp. 4
M. sp. 5
M. sp. 8

were observed. The microplankton indicate a P3b age.

Core No. 13, 3290 feet

Spores common, microplankton apparently absent.

Acanthotriletes ericianus
A. tereteangulatus
Dulhuntyispora parvithola
Marsupipollenites sinuosus
M. triradiatus
Nuskoisporites triangularis
Striatiti spp. undiff.
aff. Limitisporites
Platysaccus sp.
Ginkocycadophytus vetus

Core No. 16, 3783 feet

Spores relatively common, but somewhat carbonized.

Leiotriletes directus
Granulatisporites micronodosus
G. trisinus
Acanthotriletes ericianus
A. tereteangulatus
Dulhuntyispora parvithola
Marsupipollenites sinuosus
Verrucosisporites cf. V. pseudoreticulatus
Micrhystridium sp. 4
M. sp. 8

Core No. 18, 4000 feet

Leiotriletes directus
Calamospora diversiformis
Granulatisporites micronodosus

Acanthotriletes ericianus
A. uncinatus
Dulhuntyispora dulhuntyi
D. parvithola
Marsupipollenites sinuosus
Striatiti spp. undiff.
Micrhystridium sp.

Core No. 19, 4042 feet

Punctatisporites sp.
Acanthotriletes ericianus
Zonati sp.
Kraeuselisporites apiculatus
Dulhuntyispora parvithola
?Thymaspora cicatricosa
Marsupipollenites sinuosus

The presence of D. parvithola and M. sinuosus at 4042 feet indicates a P3b age to at least that horizon.

Core No. 20, 4070 feet

Residue consisted of much organic debris, rare disaccate pollens and relatively abundant alete circular bodies, possibly algal in origin. The age of this sample cannot be determined.

Core No. 20, 4100 feet

A good yield of spores was obtained from this sample. It included:

Leiotriletes directus
Calamospora diversiformis
Punctatisporites gretensis
Acanthotriletes villosus
A. cf. ericianus
A. tereteangulatus
Dulhuntyispora dulhuntyi
Marsupipollenites sinuosus
Granulatisporites micronodosus
Micrhystridium sp. (very rare)

P3a age. Compares closely with assemblage near top of Aldebaran Sandstone in Sandy Creek.

Core No. 21, 4340 feet

Leiotriletes directus
Calamospora diversiformis
Punctatisporites gretensis

Granulatisporites micronodosus
G. trisinus
Acanthotriletes villosus (fairly common)
?Apiculatisporis cornutus
Kraeuselisporites sp. indet.
Thymaspora cicatricosa
Marsupipollenites sinuosus
M. triradiatus
Disaccites spp. undiff.

P3a because of the presence of A. villosus and M. sinuosus. No microplankton were observed.

Core No. 23, 4549 feet

Residue mainly of organic debris, few spores and apparently no microplankton. The spores included:

Leiotriletes directus
Granulatisporites micronodosus
Nuskoisporites triangularis
Ginkocycadophytus sp.

Core No. 24, 4611 feet

Moderate yield of spores, but not of diverse assemblage.

Leiotriletes directus
Calamospora diversiformis
Nuskoisporites triangularis
Disaccites spp. undiff.

were recognized.

Core No. 25, 4709 feet

Residue of finely disseminated carbonized (?)bituminous material and vegetable debris, with some poorly preserved spores, but common Veryhachium sp. 3 could be recognized.

Core No. 26, 4818 feet

Preservation too poor for specific identifications to be possible. Debris similar to that in Core No. 25.

Core No. 27, 5087 feet

Residue mainly of organic debris. A limited assemblage of spores, including:

Leiotriletes directus
Granulatisporites micronodosus
G. trisinus
Disaccites spp. undiff.

were recognized, with rare specimens of

Veryhachium sp. nov.

Core No. 28, 5304 feet

A relatively abundant yield of microfossils was obtained. It included:

Calamospora diversiformis
Punctatisporites gretensis
Granulatisporites micronodosus
G. trisinus
Kraeuselisporites apiculatus
Thymaspora cicatricosa
Disaccites spp. undiff.
Veryhachium spp. nov. (common)
Micrhystridium sp. 5
M. sp. 14

The species of Veryhachium are as yet uncatalogued, although they have been viewed in a number of localities (see below). The specimens in Core No. 27 are to be compared with at least one form in Core No. 28.

Core No. 31, 5529 feet

Barren.

Core No. 32, 5781 feet

Carbonized, but large yield of micro-organisms, mainly microplankton. The spores included:

Leiotriletes directus
Granulatisporites micronodosus
Nuskoisporites triangularis
Disaccites spp. undiff. (fairly common)

The microplankton included abundant Micrhystridium spp. and Leiosphaeridia sp.; Micrhystridium sp. 15, a typical P2 species was represented by several specimens.

Core No. 33, 6237 feet

Yield very carbonized and individual species were difficult to recognize. They included:

Leiotriletes directus
Granulatisporites micronodosus
Disaccites spp. (incl. Platysaccus sp.)
Micrhystridium spp.

The microplankton indicate the origin of the sample was marine, probably of P2 age.

COMMENTS

Warrinilla North No. 1 has provided an important link between palynological data obtained from outcrop on Reid's Dome and from subsurface in Planet Warrinilla No. 1 and the Associated Group's wells to the south. The last discussions of surface to subsurface correlations were based on data from Warrinilla No. 1.

Observations and sample collections made by the BMR Springsure Field Party and the author since Warrinilla No. 1 Well was drilled necessitate some modifications to the views then expressed.

Triassic

Nothing can be added at present to the problem outlined in the Warrinilla No. 1 well completion report of the Rewan/Bandanna boundary and its relation to the Permian/Triassic boundary. The apparent Triassic age of Warrinilla North No. 1 cores 6 and 8 seems to confirm the Triassic nature of the upper section of Warrinilla No. 1 referred to the Bandanna Formation. That extra section can be fitted between the typical P4 and TR 1 associations has been demonstrated in the Meeleebee - Sunnybank - Combarngo area where a Permo - Triassic unit betweeen P4 and TR 1 is overlapped westwards onto the Roma ridge where the spore units were originally defined. This matter has been discussed by Tissot (I.F.P. Rep. AUS/80, June, 1963), who recognized that a more complete sequence of Upper Permian - Lower Triassic is to be found north of latitude 26°30'S.

Permian

Units P4 and P3d are well represented in Warrinilla North No. 1 by cores 9 and 11 respectively. P3c was apparently not sampled. P3b microplankton in Core No. 12 (2961 feet) probably brings that unit effectively to the top of the containing sandstone, 2945 to 3068 feet. The electric log correlate of the top of this sandstone is at 2477 feet in Warrinilla No.1, i.e. 11 feet below the P3c sample, swc. 2466 feet. Close sampling of the outcrop section in basal "Dry Creek Shale" on the road to the Carnarvon Gorge has shown that the P3c Micrhystridium sp. 3 epibole persists for only 26 to 30 feet above the underlying sandstone. P3c is thus a very thin unit compared with other palynological zones. The 1963 BMR mapping has shown that the sandstone underlying the P3c horizon includes towards its top the Mantuan Productus fauna. This sandstone is stratigraphically higher than and separable from the Catherine Sandstone, and at present is un-named. What was referred to the Catherine Sandstone in Warrinilla No. 1 appears to belong to this un-named unit. In fact, the Catherine Sandstone is probably not present in Warrinilla No. 1, although it could be present in Warrinilla North No. 1 between 3725 and 3850 feet.

Typical P3b assemblages with viz. Dulhuntyispora parvithola were found as low as Core No. 19, 4042 feet, i.e. to about 30 feet below the top of sandstone Unit "A". P3b has been located in outcrop about 14 feet below the top of the Aldebaran Sandstone, where it is underlain by the upper P3a association of Dulhuntyispora dulhuntyi and Marsupipollenites sinuosus. This replacement sequence is also found in Warrinilla North No. 1 where P3b at 4042 feet is underlain by the D. dulhuntyi horizon of P3a at 4100 feet.

It thus seems clear that the "A" sandstone is a correlate of the top of the Aldebaran Sandstone.

Whereas the top of the Aldebaran Sandstone in Warrinilla North No. 1 is sharply defined by palynology the base of that formation cannot be delineated by this means. The problem will always remain as no useful samples have been obtained from outcrops of the formation except towards its base and its top. The only means available of correlating outcrop and subsurface Aldebaran Sandstone is by identifying in both the floras characteristics of the underlying Cattle Creek Formation, but a questionable result is produced by this process through lack of knowledge of the upper limits to the ranges of the chosen marker species.

The acritarchs of cores 25, 27 and 28 are relevant to this problem. The Veryhachium spp. 3 and 4 in Core No. 25, although poorly preserved, are abundant and comparable with forms in Warrinilla No. 1, Core No. 16 (3685 to 3695 feet) and swc. 3713 feet. Similar forms also occur in the outcropping Sirius Shale of Orion Creek. So far they have not been observed in samples of the outcropping Cattle Creek Formation. On the other hand, Veryhachium spp. nov. and Micrhystridium sp. 14 of Warrinilla North No. 1 cores 27 and 28 are identical to forms occurring at several horizons in the outcropping Cattle Creek Formation of Cattle Creek and Consuelo Creek. A similar replacement sequence is also recognizable in A.A.O. Westgrove No. 2 and No. 3. The upper horizon, with Veryhachium sp. 4 is towards the base of P3a; it is underlain by P2 with Veryhachium spp. nov.

Because of Veryhachium sp. 4 in the Sirius Shale, it was suggested that Warrinilla No. 1, Core No. 16, was as old as the pre-Aldebaran, i.e. Cattle Creek Formation. If this is correct, then Warrinilla North No. 1 Core No. 25 is also as old as the Cattle Creek Formation. However, in view of the lithological and electric log characters of the section below Core No. 25, the direct correlations of Core No. 28 and probably No. 27 as well with the Cattle Creek Formation may be the key to the problem. This would suggest perhaps that the base of the Aldebaran Sandstone could be taken at about 4900 feet. It also implies that the Sirius Shale may be somewhat younger than the type Cattle Creek Formation, i.e. a correlate of part of the basal Aldebaran Sandstone of Reid's Dome. However, these implications cannot be satisfactorily proved until the Veryhachium sp. 4 horizon is located in outcrop on Reid's Dome.

APPENDIX 9

WARRINILLA NORTH No. 1

ADDITIONAL DATA FILED IN THE BUREAU OF MINERAL RESOURCES

The following additional data relating to Planet Warrinilla North No. 1 have been filed in the Bureau of Mineral Resources, Canberra, and are available for reference:

(i) Daily drilling reports for period 28th July, 1963 to 11th October, 1963.

(ii) Schlumberger well logs including the following:

(a) Electrical Log

Run 1, 543 - 3375 feet (1", 5" = 100 ft)
Run 2, 3265 - 4578 feet (1", 5" = 100 ft)
Run 3, 4440 - 6878 feet (1", 5" = 100 ft)

(b) Microlog

Run 1, 543 - 3375 feet (1", 5" = 100 ft)
Run 2, 3265 - 4578 feet (1", 5" = 100 ft)
Run 3, 4478 - 6878 feet (1", 5" = 100 ft)

(c) Sonic-Gamma Ray Log

Run 1, 543 - 3345 feet (1", 5" = 100 ft)
Run 2, 543 - 6868 feet (1", 5" = 100 ft)

(d) Continuous Dipmeter

Run 1, 3500 - 6878 feet (1.2" = 100 ft)

(e) Cement Bond Log

Run 1, 2900 - 5660 feet (1" = 100 ft)
Run 2, 2900 - 5670 feet (1" = 100 ft)

(iii) Halliburton formation test data sheets and charts.

COMPOSITE WELL LOG

COMPANY : PLANET EXPLORATION COMPANY PTY. LTD.

WELL NUMBER : WARRINILLA NORTH No. 1

PETROLEUM TENEMENT: A.P. 100 P | STATE : QUEENSLAND | 4 - MILE SHEET : TAROOM | BASIN : BOWEN | WELL STATUS : DRY & ABANDONED

LOCATION : Lat. 24° 52' 49"S. Long. 148° 31' 50"E.

ELEVATION : 1020' A.S.L.(Ground)
1036' A.S.L.(K.B)

Date Spudded : July 28th. 1963
Date Drilling Stopped : October 8th. 1963
Date Well Abandoned : October 25th. 1963
Date Rig Off : October 30th. 1963
Total Depth Driller : 6873'
E.Log : 6879'

Hole Size	In.	From	To
1	12¼"	0	547' (Reamed to 17½")
2	8¾"	547'	6879'

Cement Retainers (Baker) Set At 5575' & 5589'

Casing	In.	Wt.	Gr.	Depth	Cmt.	Cmt'd To
	13⅜"	48 lb.	H-40	543'	400 sks.	Surface
	5½"	17 lb.	J-55.LTC.	5707'	815 sks.	2960'

Bridge Plugs	In.	Depth
(Baker)	5½"	4188' & 4589'

Cement Plugs	From	To	Sacks
1	5800'	5900'	60 sks.
2	850'	1000'	20 sks.

Perforations From : 5609', 5590', 5581', 5548', 5520-5', 4538', 4526', 4087', 4077', 4066', 4047'.
To : 5616', 5592', 5585', 5563', 5528', 4548', 4532', 4100', 4081', 4070', 4062'.
N.B. : All perforations are 4 X ½" shaped charge shots per foot.

Well Head Fittings : 12"casing housing. 12"x 10" spool. 5½" casing hanger & seal.
Drilled By : Delta Drilling Co.
Logged By : Schlumberger Seaco Inc.
Drilling Method : Rotary
Cemented By : Halliburton.
Mud Logging By : Core Laboratories
Lithology By : N. A. Meyers
Date : December 1963

ELECTRIC LOG DATA				MICROLOG	CALIPER		SONIC-GAMMA RAY LOG DATA			GAMMA-RAY LOG DATA
RUN NUMBER	1	2	3	1	2	3	1	2	3	1
Date	August 13th, 1963	August 31st, 1963	October 9th, 1963	August 13th, 1963	August 31st, 1963	October 9th, 1963	August 13th, 1963	October 9th, 1963	October 9th, 1963	October 13th, 1963
First Reading	3375'	4578'	6878'	3375'	4578'	6878'	3345'	S.6868' G.R.6848'	S.6868' G.R.6848'	5669'
Last Reading	543'	3265'	4440'	543'	3265'	4478'	543'	S.543' G.R.100'	S.543' G.R.100'	3600'
Interval Measured	2832'	1313'	2438'	2832'	1313'	2400'	2802'	S.6325' G.R.6748'	S.6325' G.R.6748'	2069'
Casing Schlumberger	543'	–	–	543'	–	543'	543'	543'	543'	543'
Casing Driller	543'	543'	543'	543'	543'	543'	543'	543'	543'	543'
Depth Reached	3376'	4579'	6879'	3376'	4579'	6879'	3350'	6879'	6879'	5676'
Bottom Driller	3371'	4573'	6873'	3371'	4573'	6873'	3371'	6873'	6873'	5670'
Mud Nature	GEL	GEL	GEL	GEL	GEL	GEL	GEL	GEL	GEL	GEL
Density | Viscosity	10·5 | 71	10·9 | 60	11 | 56.	10·5 | 71	10·9 | 60	11 | 56.	10·5 | 71	11 | 54	11 | 54	11 | 54
Mud Resistivity	1·9 @ 58°F	1·6 @ 60°F	1·68 @ 64°F	1·9 @ 58°F	1·6 @ 60°F	1·68 @ 64°F	1·9 @ 58°F	1·68 @ 64°F	1·68 @ 64°F	2·60 @ 80°F
Mud Resistivity BHT	1·0 @ 115°F	0·75 @ 130°F	0·62 @ 164°F	1·0 @ 115°F	0·75 @ 130°F	0·62 @ 164°F	1·0 @ 115°F	0·62 @ 164°F	0·62 @ 164°F	@
pH | Fluid Loss	9 | 5 CC/30 min.	9 | 5 CC/30 min.	8·2 | 6·2 CC/30 min.	9 | 5 CC/30 min.	·9 | 5 CC/30 min.	8·2 | 6·2 CC/30 min.	9 | 5 CC/30 min.	8·2 | 6·2 CC/30 min.	8·2 | 6·2 CC/30 min.	8·2 | 6·2 CC/30 min.
Origin of Sample	F.L.	F.L.	F.L.	F.L.	F.L.	F.L.	F.L.	F.L.	F.L.	F.L.
Rmf	1·6 @ 58°F	1·37 @ 60°F	1·33 @ 70°F	1·6 @ 58°F	1·37 @ 60°F	1·33 @ 70°F	1·6 @ 58°F	1·33 @ 70°F	1·33 @ 70°F	2·04 @ 82°F
Rmc	1·3 @ 115°F	1·1 @ 130°F	0·9 @ 164°F	1·3 @ 115°F	1·1 @ 130°F	0·9 @ 164°F	1·3 @ 115°F	0·9 @ 164°F	0·9 @ 164°F	@
Bit Size 1	8¾ To T.D.	8¾ To T.D.	8¾ To T.D	8¾ To T.D.	8¾ To T.D.	8¾ To T.D.	8¾ To T.D.	8¾ To T.D.	8¾ To T.D.	8 ⅜ To T.D.
Bit Size 2										
Casing Size	13⅜	13⅜	13⅜	13⅜	13⅜	13⅜	13⅜	13⅜	13⅜	13⅜
Opr. Rig Time	2	2	3	2	2	2	4	4	4	2·30
Truck Number	6611	6611	4503	6611	6611	4503	6611	4503	4503	2513
Recorded By	BUCKLEY — KOHUT	KOHUT	KOHUT — MECHIN	BUCKLEY — KOHUT	KOHUT	KOHUT — MECHIN	BUCKLEY — KOHUT	KOHUT — MECHIN	KOHUT — MECHIN	KOHUT — MECHIN
Witness	MEYERS	MEYERS	MEYERS	MEYERS	MEYERS	MEYERS	MEYERS	MEYERS	MEYERS	NANCARROW

WELL SYMBOLS

- ◊ Fluorescence
- Core interval, number and recovery
- ► Sidewall core
- Casing Shoe
- Plugged interval
- Formation test, interval and no.

FOSSILS

- Macro
- Plant

LITHOLOGIC REFERENCE

- Quartz sandstone
- Claystone
- Siltstone
- Shale
- Limestone
- Conglomerate
- Tuff
- Coal
- Mi Micaceous
- Cal Calcareous
- Py Pyritic
- C Carbonaceous

BIT TYPES & REMARKS | DRILLING RATE (Min. / Ft.) 0 4 8 12 16 20 24 28 | DEVIATION | CASING AND PLUGS | CORE Recovery and Dip | MUD GAS DETECTION — HOT WIRE SCALE 0 5 10 15 20 25 30 35; CHROMATOGRAPH SCALES: Methane 0 10 20 30 40 50 60 70 80; Ethane and Propane 0 10 20 30 40 50 60 70 80 90; Butane 10 20 30 40 50 60 70 80 90 100 | DRILL STEM TEST | DEPTH Feet | POROSITY | LITHOLOGY % of cuttings | SPONTANEOUS POTENTIAL −10+ millivolts | INTERPRETED LITHOLOGY | RESISTIVITY ohms - m²/m: AM = 16" 0 10 / 0 50; AM = 64" 0 500 / 0 50; RESISTIVITY ohms - m²/m: AO = 18'8" 0 50 / 0 500 | MICROCALIPER Hole diameter in inches 6 7 8 9 10 11 12 13 14 | MICROLOG Resistivity — ohms - m²/m: Micro inverse 1"x 1" 0 20; Micro normal 2" 0 20 | LITHOLOGIC DESCRIPTION | STRATIGRAPHIC COLUMN

① Reed YT3 12¼" & ② Reed YT3 17½" — Reed HF
③ Hughes OSC 3J 8¾" — Reed HF
3RR Hughes OSC 3J 8¾" — Reed HF

Deviation: ¼° 1° 1½° 2° 1° 2° 1½° 2°

Casing & Plugs: 13⅜" I; 1 Rec. 13' Dip 10°; 2 Rec. 1.5' Dip 10°; 3 Rec. 75' Dip 0°-20°; 4 Rec. 90' Dip 0°-8°; 5 Rec. 0' Dip 0°?

RUN 1.

16'- 55' CLAY & SHALE
Clay, white, rarely yellow, orange and mottled with red, slightly silty, soft; interbedded with siltstone, light grey and grey-brown, argillaceous, clayey & soft; shale, red, blocky, in part slightly silty & soft. Trace of coal.

55'- 1315' SHALE
Shale, red, medium to dark reddish-brown, and trace mottled with green, blocky, rarely fissile, slightly to very silty and sandy micaceous, occasional carbonaceous specks and rare trace of calcite and andesite.
Between 340' & 680', these shales are mottled and interbedded with shale, green, grey-green, and grey, blocky to slightly fissile, slightly to very silty and carbonaceous, trace of carbonized plant fragments, there are occasional thin interbeds of siltstone, red-brown, green and green-grey, very argillaceous and clayey, micaceous and carbonaceous; sandstone, light to dark green, greenish grey and red-brown, very fine to medium grained, occasionally coarse grained, poor to well sorted, angular to sub-angular, quartz and feldspar, with green, red, yellow and black lithic rock fragments and minerals in a matrix of clay and white kaolinitic specks with mica and carbonaceous specks.

1315'- 1704' SHALE & SANDSTONE
Shale, grey-green, green and greenish grey, with minor red, blocky, slightly to very silty, micaceous and occasional fine carbonaceous specks. Interbedded with sandstone, light to medium green, very fine to fine grained, angular to well sorted quartz, feldspar, with green and red lithic rock fragments and minerals. Trace of mica and carbonaceous specks. The basal 40' are more carbonaceous, generally tight with a trace of poor porosity.

STRATIGRAPHIC COLUMN: QUATERNARY | REWAN FORMATION | TRIASSIC

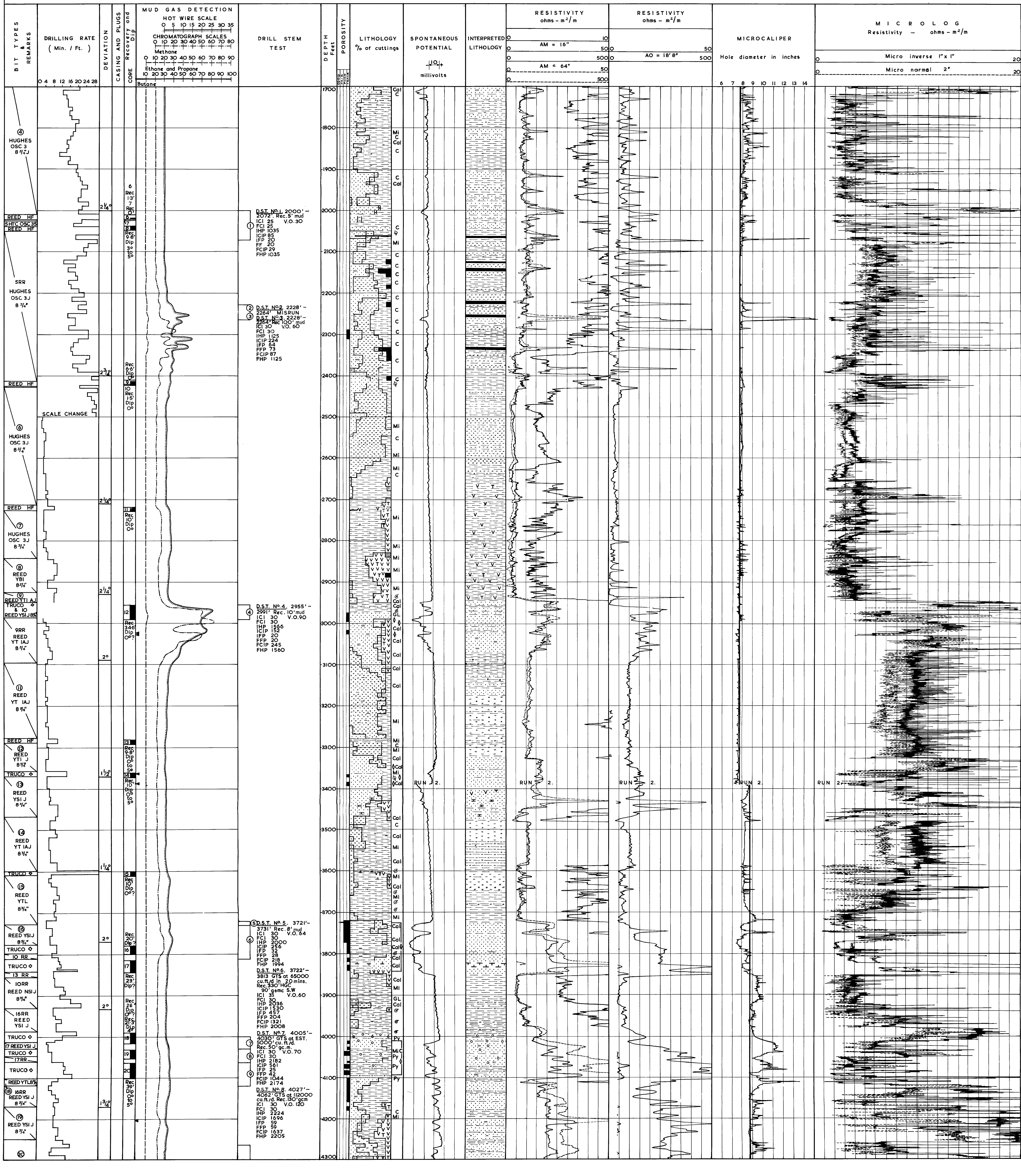
PLATE I
SHEET 2

COMPOSITE WELL LOG

PLANET WARRINILLA NORTH No. 1 WELL

1700' - 4300'

SHEET 2 OF 3



LITHOLOGIC DESCRIPTION

1704'-2070' SHALE, SANDSTONE & SILTSTONE
Shale, green and grey-green at the top grading to green-grey and medium to dark grey near the base, blocky, slightly to very silty, micaceous, slightly to very carbonaceous, with coaly laminations and plant fragments. Interbedded with sandstone, light green to white grey-green and brown-grey, very fine grained, occasionally medium grained, medium sorted, angular to sub-angular, quartz, weathered feldspar with green, yellow and black lithic rock fragments and minerals becoming tuffaceous below 1900'. The matrix is a slightly calcareous clay with white kaolinitic specks, generally tight. Commonly micaceous, and carbonaceous and Siltstone, grey-brown, grey, and grey-green, sandy, micaceous and carbonaceous. Between 1960' and 1980' there is a trace of limestone, green-grey and brownish-grey, cryptocrystaline, very argillaceous with algal like structures.

2070'-2349' SILTSTONE, COAL, SANDSTONE & SHALE
Siltstone, light tan and white to medium grey, sandy, slightly argillaceous, micaceous with thin carbonaceous laminae and inclusions interbedded with Coal, black, soft to brittle, shiny, conchoidal fracture, sometimes shaly; Sandstone, light tan and white fine grained to medium grained, poorly sorted, sub-angular to angular, quartz and feldspar with tuffaceous fragments and finely disseminated carbonaceous fragments in a white clay matrix, firm to friable and tight; shale, light to medium grey and grey-green, blocky, silty and sandy, micaceous and slightly carbonaceous.

2349'-2656' SHALE & SILTSTONE
Siltstone, light to medium grey and light grey-brown, firm, sandy, carbonaceous laminations and inclusions, grading to medium dark grey near the base; interbedded with sandstone, light tan and white fine grained, silty, poorly sorted, sub-angular to angular quartz, feldspar and tuffaceous fragments in a clayey matrix, friable and tight; and shale, light to medium grey, blocky, silty and sandy micaceous and moderately carbonaceous, trace of calcite.

2656'-2945' SHALE & TUFF
Shale, dark grey, fissile to blocky, micro-micaceous, carbonaceous and in part slightly silty, interbedded with Tuff and Tuffaceous shale, white, light green, grey, brown-green and light brown, splintery to fissile, soapy texture, containing fragments and shards of volcanic glass and crystals of biotite, sometimes siliceous and cherty, and, occasionally calcareous.

2945'-3068' SANDSTONE & SHALE
Sandstone, light grey, very fine grained to fine grained and occasionally medium to coarse grained, fair sorted, angular to sub-angular quartz, chert and feldspar, with fragments of green and orange minerals and lithic rock fragments in a white, slightly to moderately calcareous clay matrix with traces of glauconite and large flakes of biotite as well as carbonaceous laminae and specks. Generally tight with a trace of poor porosity interbedded with lesser amounts of shale, dark to medium grey, blocky, micaceous, silty and sandy, in part very sandy, very fossiliferous including brachiopods, bryozoa and pelecepods with some tuffaceous shale interbeds.

3068'-3326' SILTSTONE & SHALE
Siltstone, light to medium grey, grading to very fine grained sandstone, argillaceous to shaly, firm, occasionally slightly calcareous with finely disseminated specks and laminations of carbonaceous material with a trace of mica and tuff; interbedded with shale, dark grey, firm, blocky and fissile, slightly to very silty and sandy, micaceous, in part very carbonaceous. Trace of sandstone, light grey and tan, very fine grained, silty, fair sorted in a slightly calcareous kaolinitic and siliceous matrix, they are quite feldspathic and tuffaceous, firm and tight.

3326'-3450' SANDSTONE
Sandstone, light grey to white, fine to medium grained and occasionally coarse grained and silty, fair sorted, sometimes well sorted, sub-angular to angular quartz, grey chert with some feldspar and fragments of grey-brown and grey-green tuff and green minerals with occasional white specks of kaolinite. The matrix is calcareous and kaolinitic, carbonaceous and generally tight with rare, thin poorly porous streaks. There are occasional laminae of shale, dark grey, fissile, very micacaceous and carbonaceous and moderately arenaceous. From 3420'-3450', the sandstone is brown, med. to fine grained fair sorted, angular quartz and weathered feldspar in a brown limy matrix, it is hard and tight.

3450'-3725' SHALE & SILTSTONE
Shale, medium to dark grey-brown, blocky, in part fissile, very silty, slightly calcareous, laminations of carbonaceous material micaceous, and a trace of calcite interbedded with siltstone, medium to dark grey-brown, and light grey, very argillaceous and carbonaceous, in part arenaceous and calcareous, with rare interbeds of dolomite, medium grey-brown, micro to cryptocrystaline, moderately argillaceous, dense and hard and limestone, brown cryptocrystaline, fossiliferous with fragments of bryozoa, brachiopods and corals. There are occasional laminations of tuff and tuffaceous shale, which are green and grey-green, have a soapy texture, and finely disseminated fragments of volcanic glass.

3725'-3850' SANDSTONE
Sandstone, light grey to white, generally fine grained occasionally medium grained, well sorted, sub-angular, quartz and weathered feldspar with rare traces of lithic rock fragments and minerals in a slightly calcareous kaolinitic matrix. There are occasional argillaceous inclusions and shale laminations which are dark grey to black, fissile, very carbonaceous, arenaceous, and micaceous with large flakes of brown and white mica and possible pelecypod fossils. Between 3824' & 3830', the sandstone matrix is brown, limy, hard and tight. Otherwise the sandstone is poorly porous with some fair poros..

3850'-3920' SHALE
Shale, dark grey, firm, blocky, slightly silty, and calcareous, micaceous and traces of glauconite and calcite interbedded with tuffaceous shale.

3920'-4010' SHALE & SILTSTONE
Shale, dark grey, as above, more glauconitic, trace of pyrite, with grains, granules and pebbles of quartz scattered through the shale, and fossils which include the bryozoa, brachiopods, corals and commonly crinoid stems. Interbedded with the shale is siltstone, medium to dark grey-brown, very argillaceous, in part slightly sandy, very slightly calcareous, micaceous with a trace of glauconite and carbonaceous material. The basal ten feet are conglomeratic.

4010'-4104' SANDSTONE
Sandstone, light grey, medium and fine grained, occ. coarse and very coarse grained, poorly sorted, angular quartz with some weathered feldspar and a trace of green and black lithic rock fragments in a white kaolinitic and clayey matrix, sometimes grey and argillaceous with irregular shaly inclusions and laminations. It has some poor and rarely fair porosity. The top 14' is interbedded with conglomerate comprised of granules, pebbles and cobbles of vitreous quartz, quartzite, sandstone, siltstone and shale. There are occasional very thin beds of shale, med. to dk. grey and grey-brown, blocky, silty and sandy with a good trace of pyrite.

4104'-4112' SHALE
Shale, medium to dark grey-brown, blocky, silty, slightly sandy, stringers and blebs of pyrite, carbonaceous, thinly interlaminated with siltstone, light grey argillaceous, sandy and micaceous.

4112'-4375 SANDSTONE
Sandstone, light to medium grey and grey-brown, very fine to coarse grained, poorly sorted, angular, quartz and weathered feldspar with green and black mafic minerals and lithic rock fragments in a very clayey often shaly matrix, generally tight

STRATIGRAPHIC COLUMN

PERMO-TRIASSIC
- BANDANNA FORMATION
  - SANDSTONE - COAL UNIT
  - SHALE SILTSTONE UNIT
  - SHALE TUFF UNIT

PERMIAN
- MANTUAN PRODUCTUS BED
- CATHERINE SANDSTONE
  - SHALE SILTSTONE UNIT
  - SANDSTONE
- INGELARA FORMATION
  - SHALE SILTSTONE UNIT
  - SANDSTONE
  - SHALE
  - SH. - SILT.
- ALDEBARAN SST.
  - SANDSTONE & SHALE

COMPOSITE WELL LOG

PLANET WARRINILLA NORTH Nº.1 WELL

4300' – 6900'

SHEET 3 OF 3

BIT TYPES & REMARKS

DRILLING RATE (Min. / Ft.) 0 4 8 12 16 20 24 28

DEVIATION

CASING AND PLUGS

CORE Recovery and Dip

MUD GAS DETECTION
HOT WIRE SCALE 0 5 10 15 20 25 30 35
CHROMATOGRAPH SCALES
Methane 0 10 20 30 40 50 60 70 80
Ethane and Propane 0 10 20 30 40 50 60 70 80 90
Butane 10 20 30 40 50 60 70 80 90 100

DRILL STEM TEST

DEPTH Feet

POROSITY

LITHOLOGY % of cuttings

SPONTANEOUS POTENTIAL -|0|+ millivolts

INTERPRETED LITHOLOGY

RESISTIVITY ohms – m^2/m
AM = 16" 0 10 50 500
AM = 64" 0 50 500

RESISTIVITY ohms – m^2/m
AO = 18' 8" 0 50 500

MICROCALIPER Hole diameter in inches 6 7 8 9 10 11 12 13 14

MICROLOG Resistivity —— ohms – m^2/m
Micro inverse 1" x 1" 0 20
Micro normal 2" 0 20

RUN 3

BIT TYPES & REMARKS	DEVIATION	CASING AND PLUGS	CORE Recovery and Dip
REED YSI J 8¾"			
TRUCO ◇		21	Rec. 10' Dip 0°
REED YSI J	1½°		
21 21RR REED YSI 8¾"			
22 REED YSI 8¾"			
23 REED YMT 8¾"		22	Rec. 7.5' Dip 0°
TRUCO ◇	1°	23	
SEC M4L 8¾"			Rec. 10' Dip?
25 25RR SEC M4L 8¾"			
TRUCO ◇		24	
26 SEC M4N 8¾"			Rec. 10' Dip 0°
27 HTC W7 8¾"	1°		
28 REED YM			
TRUCO ◇		25	
28RR 29 HTC W7			Rec. 20' Dip 14°
30 REED YH 8¾"			
TRUCO ◇		26	Rec. 10' Dip 0°?
31 REED YH J 8¾"	1½°		
32 SEC M4N 8¾"			
33 SEC M4N 8¾"			
34 SEC M4N 8¾"			
TRUCO ◇		27	
35 HTC OWC J 8¾"			Rec. 24' Dip ?
36 SEC M4N 8¾"			
37 HTC OWC 8¾"			
38 38RR SEC M4N 8¾"			Rec. 88' Dip 0° to 4°
39 REED YH 8¾"			
TRUCO ◇		28	Rec. 10' Dip 0° to 4°
40 REED YH 8¾"			
41 REED YM			
TRUCO ◇		29	
41RR			
TRUCO ◇		30	Rec. 24' Dip 0° to 15°
41RR 42 REED YM J			
43 HTC W7J 8¾"	1°		
TRUCO ◇		31	
44 REED YMJ			Rec. 28' Dip 0°
44RR REED YMJ 8¾"			
45 HTC OWC 8¾"			
46 REED YMJ 8¾"			
47 SEC M4N	¾°	32	
TRUCO ◇			Rec. 25' Dip 0° to 15°
48 REED YM			
49 REED YMJ 8¾"			
50 REED YSI J 8¾"			
51 REED YSI J 8¾"			
52 SEC M4N 8¾"			
53 SEC M4N 8¾"	1¼°		
54 SEC M4N 8¾"			
TRUCO ◇		33	
55 SEC M4N 8¾"			Rec. 10' Dip 0°?
56 SEC M4N 8¾"			
	2°		
57 SEC M4N 8¾"			
58 SEC M4N			
59 SEC M4N 8¾"			
60 SEC M4N 8¾"			
TRUCO ◇		34	Rec. 9' Dip 0° to 10°
61 REED YTM 8¾"			
62 HTC OWV J 8¾"			Dip 0° to 15°
TRUCO ◇ & 63 SEC M4N	3¼°	35	Rec. 32'

DRILL STEM TEST

(10) D.S.T. No. 9. 4061'–4120' GTS at EST. 10000 cu.ft/d. 30 gcm.
ICI 30 V.O. 90
FCI
IHP 3238
(11) ICIP 311
IFP 44
FFP 53
FCIP 1482
FHP 2230

D.S.T. No. 10. MISRUN 4263'–4360'

D.S.T. No.11. 4342'–(12) 4410' Rec. 75' mud
ICI 30 V.O. 30
FCI 15
(13) IHP 2437
(14) ICIP 80
(15) IFP 53
FFP 54
FCIP 72
FHP 2437

D.S.T. No.12. 4460'–4542' MISRUN
D.S.T. No.13. 4503'–4542' MISRUN
D.S.T. No.14. 4535'–(16) 4553' GTS at 44000 cu.ft/d. Rec. 125 gcm.
ICI 30 V.O. 133
FCI 30
IHP 2642
ICIP 1667
IFP 25
FFP 59
FCIP 1901
FHP 2642

D.S.T. No. 15. 4510'–4573' GTS est. at 5000 cu.ft/d. Rec. 120' gcm.
ICI 15 V.O. 61
FCI 15
IHP 2556
ICIP 398
IFP 64
FFP 68
FCIP 672
FHP 2556

D.S.T. No. 16. 4686'–4716' Rec. 210' gcm.
ICI 30 V.O 32
FCI 30
IHP 2577
ICIP 216
IFP 91
FFP 102
FCIP 188
FHP 2571

D.S.T. No. 17. 5123'–5233' Rec. 200' mud
ICI 30 V.O. 31
FCI 30
IHP 2839
ICIP 400
IFP 83
FFP 100
FCIP 248
(17) FHP 2833

D.S.T. No. 18. 5363'–5381' Rec. 15' mud
ICI 30 V.O. 67
FCI 0
IHP 3009
ICIP 2069
(18) IFP 38
(19) FFP 52
FHP 3003

D.S.T. No. 19. 5374'–(20) 5414' Rec. 350' mud
ICI 30 V.O. 60
FCI 30
IHP 2988
ICIP 1960
IFP 87
FFP 149
FCIP 1499
FHP 2983

D.S.T. No. 20. 5410'–(21) 5467' Rec. 70' gcm.
ICI 30 V.O. 60
FCI 30
IHP 3038
ICIP 57
IFP 23
(22) FFP 23
FCIP 36
FHP 3038

D.S.T. No. 21. 5510'–5575' GTS IO2000 cu.ft/d. Rec 3000gcm
ICI 30 V.O. 96
FCI 30
IHP 3098
ICIP 975
IFP 85
FFP 95
FCIP 1987
FHP 3098

D.S.T. No. 22. 5574'–5644' GTS at 250000 cu.ft/d WTS 60 min Rec. 675' brw
ICI 30 V.O. 64
FCI 30
IHP 3159
ICIP 2344
IFP 318
FFP 462
FCIP 2109
FHP 3150

D.S.T. No. 23. 6350'–6438' Rec 10' mud
ICI 30 V.O. 38
FCI 30
(23) IHP 3622
ICIP 57
IFP 25
FFP 23
FCIP 34
FHP 3622

STRATIGRAPHIC COLUMN

LITHOLOGIC DESCRIPTION

4112'–4375' SANDSTONE (Cont.)
or very poorly porous, interbedded and interlaminated with shale, medium to dark grey, blocky, in part slightly fissile, silty and sandy, occasionally very sandy, micaceous, pyritic and carbonaceous with lenses of coal and siltstone, medium to light grey-brown, sandy, slightly to very argillaceous, micaceous and carbonaceous. Between 4180' and 4330' there are beds of tuff and tuffaceous shale light grey, light brown and light green, soft, splintery, soapy, micaceous and have fragments of volcanic glass disseminated throughout.

4375'–4403' SHALE & SILTSTONE
Shale, medium to dark grey-brown, blocky, silty, firm, in part slightly carbonaceous and micaceous, interbedded with siltstone, light brown, firm, blocky, sandy, argillaceous very carbonaceous, a trace of mica.

4403'–4560' SANDSTONE
Sandstone, light grey, fine to medium grained, sometimes coarse to very coarse grained, fair to well sorted, angular quartz and feldspar with occasional green and black minerals and lithic rock fragments in a clayey, sometimes calcareous matrix. The quartz is vitreous though sometimes milky and smokey. Below 4460' the sandstone becomes quite coarse grained and conglomeratic. It is generally poorly porous though there is some fair to rarely good porosity below 4520'. There are thin interbeds of shale, medium to dark grey, blocky, silty and sandy, slightly carbonaceous and micaceous and some siltstone, medium grey, firm, sandy, slightly argillaceous, carbonaceous and micaceous and rare, thin interbeds of limestone mottled brown-white, micro-crystaline and sandy.

4560'–4627' SHALE, SILTSTONE & SANDSTONE
Mainly shale, medium to dark grey, firm, blocky, in part fissile, sandy, micaceous, silty, slightly micaceous with a trace of carbonized plant fragments, thinly interlaminated with siltstone, light grey, micaceous, firm, sandy, slightly argillaceous and sandstone, light to medium grey brown, fine grained, angular, well sorted quartz, weathered feldspar and lithic rock fragments in kaolinitic shaly matrix.

4627'–4900' CONGLOMERATE & SANDSTONE
Conglomerate, granules, pebbles, cobbles and rare boulders of phyllites, quartzite, quartz, slate, chert, tuffs, sandstones, tuffaceous sandstone, siltstones and shales which are variously coloured, poorly sorted, sub-rounded to sub-angular in a sandstone matrix and interbedded with a similar sandstone, light grey and light to medium grey-brown, very fine to very coarse grained, poorly sorted angular quartz, chert with some feldspar, green and black lithic rock fragments in a siliceous, sometimes calcareous kaolinitic matrix. They are slightly micaceous, pyritic and carbonaceous and generally tight, with a rare trace of poor porosity. There are occasional interbeds of shale and siltstone as above. There are rare thin beds of limestone, brown, crypto to microcrystaline, argillaceous and arenaceous, tight, fossiliferous with brachiopods, bryozoa and corals.

4900'–4932' SHALE, SILTSTONE & SANDSTONE
The shales are medium to dark grey-brown, firm, blocky, silty, very slightly calcareous with a trace of mica and carbonaceous material. Siltstone, medium grey, firm, blocky sandy and carbonaceous. Sandstone, light grey and light tan, fine to medium grained, angular to poorly sorted quartz, feldspar in a kaolinitic matrix.

4932'–5185' SANDSTONE
Sandstone, light to medium grey-brown, occasionally white and dark grey, very fine to very coarse grained, poorly sorted, angular quartz, feldspar, with some green lithic rock fragments in a moderately argillaceous and siliceous and clayey matrix that is rarely calcareous. It is slightly to very carbonaceous. It is interbedded with minor siltstone, medium to dark grey-brown, moderately to very argillaceous and carbonaceous and shales dark grey, firm, blocky, very silty and sandy, pyritic and micaceous, slightly to very carbonaceous.

5185'–5250' SHALE & SHALY SANDSTONE
Shale, dark grey and black, firm, blocky, carbonaceous, silty, and sandy, trace of pyrite interbedded with sandstone medium to dark grey-brown, very fine to fine grained, and silty, poorly sorted quartz, feldspar and a trace of green lithic rock fragments in a very shaly matrix.

5250'–5316' SANDSTONE
Sandstone, light grey and tan, very fine to fine grained, fair sorted, angular quartz and feldspar with a trace of chert and green lithic rock fragments in a siliceous, slightly kaolinitic matrix. The top 20'is very clayey. It is generally hard and tight, becoming conglomeratic towards the base, and is interbedded with minor shale and siltstone above.

5316'–5342' SHALE, SANDSTONE & SILTSTONE
Interbedded, shale, dk. grey, blocky, micaceous, silty, sandy, very carbonaceous; siltstone, light grey, coarse grained and sandy, feldspathic, slightly micaceous, moderately argillaceous and carbonaceous, and sandstone, medium to dk. grey-brown, very fine grained and silty, poorly sorted, angular quartz and feldspar in a clayey, shaly matrix.

5342'–5450' SANDSTONE
Sandstone, light grey, fine to very coarse grained poorly sorted angular quartz with a trace of feldspar, grey chert, green and dk. grey lithic fragments and minerals in a siliceous kaolinitic cement. It is in part conglomeratic. Generally tight with a few streaks of poor porosity and rarely fair porosity. There are thin laminations of dark grey and black shale.

5450'–5520' SHALE & SANDSTONE
Interbedded, dark grey, firm, blocky, silty shale and sandstone similar to the overlying unit except that they are very conglomeratic hard and tight.

5520'–5645' SANDSTONE
Sandstone, light grey, fine to medium grained, and rarely coarse grained, well sorted, angular to sub-angular, quartz and weathered feldspar with some grey-green and black lithic fragments and mingrals in moderately calcareous mainly kaolinitic matrix, generally friable and poorly porous with some fair porosity. Some dk. grey shale laminations.

5645'–5970' SILTSTONE, SHALE & SANDSTONE
Predominantly siltstone, medium to dark grey-brown, in part light grey, blocky, firm, moderately to very argillaceous and carbonaceous, with cooly material, slightly micaceous, in part sandy and feldspathic and a trace of pyrite interbedded with dk. grey, blocky, silty and sandy, carbonaceous and micaceous shale and sandstone light to medium grey and lt. brown very fine to coarse grained, poorly sorted, angular quartz, feldspar and grey lithic fragments in a siliceous, slightly to very argillaceous matrix which is tight. Trace of fossils near the base.

5970'–6180' LIMESTONE, SILTSTONE & SHALE
Between 5970' and 6045', and again between 6100' and 6180', there is limestone, medium to dark brown, crypto-crystaline, coquinoidal, with abundant brachiopod fragments. Generally argillaceous and silty, interbedded with siltstone and shale.
Between 6045' and 6100' siltstone, medium to dark grey-brown, firm, blocky, very argillaceous and sandy, is interbedded shale, dark grey, blocky, firm, silty, carbonaceous & micaceous.

6180'–6643' SILTSTONE, SHALE & SANDSTONE.
Siltstone, medium to dark brown-grey, as above, interbedded with shale, dark grey brown, slightly to moderately silty, slightly calcareous, moderately carbonaceous and sandstone light to medium grey, very fine to fine grained, well sorted, angular, quartz and feldspar with a rare trace of lithic fragments in a kaolinitic and siliceous matrix, generally firm, and tight. The unit is quite fossiliferous, with brachiopods, bryozoa and pelecypods.

6643'–6879' CONGLOMERATE, SANDSTONE, SHALE & SILTSTONE.
Conglomerate, vari-coloured, granules, pebbles and cobbles of mainly lithic tuffs, breccias and crystaline volcanics, as well as chert, quartz and metamorphics in a sandstone matrix and often interbedded with similar sandstone, which is light to medium brown, fine to very coarse grained, poorly sorted, angular to sub-angular grains of lithic rock fragments and quartz with some feldspar. The matrix is moderately to slightly calcareous and siliceous, often tuffaceous and argillaceous with cooly fragments. It is hard and tight. Interbeds of medium to dark grey-brown and black, blocky, silty, very carbonaceous shale and siltstone, medium to dark grey-brown, firm, sandy and tuffaceous, argillaceous, are common. Abundant plant fossils are common in the shales and there are often thin laminations of coal.

STRATIGRAPHIC COLUMN

SILTSTONES, SHALES AND SANDSTONES
CONG., SAND., SHALE & SILTST.
PRE-CATTLE CREEK BEDS
CATTLE CREEK FORMATION
SILTSTONES, SHALES AND SANDSTONES
ALDEBARAN SANDSTONE
SILTSTONE, SANDSTONE & SHALE
CONGLOMERATE & SANDSTONE

P E R M I A N