WELL COMPLETION REPORT

A.A.O. SUNSET - 1.

A.A.O. MORKALLA - 1.

A.A.O. NADDA - 1. South Aust.

OIL and GAS DIVISION

Report No. SA./V./PEL.3/PEP.64/442

WELL COMPLETION REPORT

A.A.O. SUNSET NO.1

A.A.O. MORKALLA NO.1

A.A.O. NADDA NO.1

By:

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Mines Administration Pty. Limited,
31 Charlotte Street,
Brisbane.

May, 1970.

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CONTENTS.

APPENDICES

Appendix 1	-	Petrological Report.
Appendix 2	-	Palynological Reports.
		A: A.A.O. Sunset No.1. B: A.A.O. Morkalla No.1. C: A.A.O. Nadda No.1.
Appendix 3	-	Water analysis.
Appendix 4	-	Sample Descriptions.
		A: A.A.O. Sunset No.1. B: A.A.O. Morkalla No.1. C: A.A.O. Nadda No.1.
Appendix 5	-	Core descriptions and analyses.
		A: A.A.O. Sunset No.1. B: A.A.O. Morkalla No.1. C: A.A.O. Nadda No.1.
Appendix 6	-	List and Interpretation of electrical and other logs.
		A: A.A.O. Sunset No.1. B: A.A.O. Morkalla No.1. C: A.A.O. Nadda No.1.
Appendix 7	-	Drill Stem Testing.

FIGURES

ENCLOSURES

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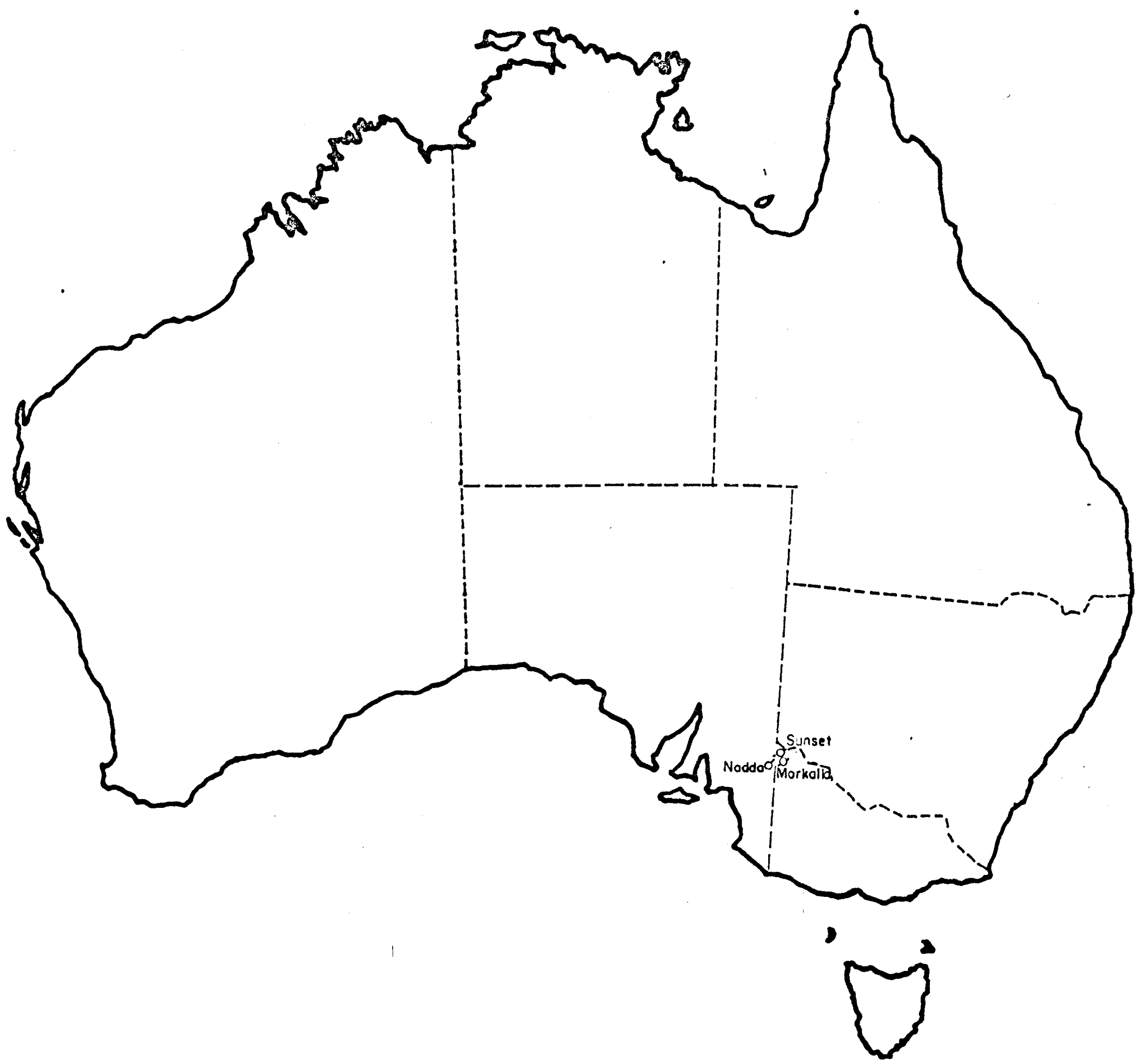


LOCATION MAP

SCALE 1 = 25,000,000

Fig. I.

I. SUMMARY

(1) Drilling

Three wells, A.A.O. Sunset No.1, A.A.O. Morkalla No.1 and A.A.O. Nadda No.1 were drilled in the north-western Murray Basin by the Associated Group.

All wells were drilled under contract by Richter Bawden Drilling Pty. Ltd. using a National T-32 rig.

A.A.O. Sunset No.1, spudded on 8th March 1970, was drilled to a depth of 3284 feet. It was plugged and abandoned as a dry hole on 15th March 1970. A drill stem test of the target "Basal Cretaceous Sand" resulted in the recovery of 2200 feet of salty water. One conventional core was cut in basement. A suite of wire line logs was run from the 9-5/8" casing shoe at 501 feet to total depth. The Gamma Ray was run from 50 feet. 26 side wall cores were recovered between 955 and 3240 feet.

A.A.O. Morkalla No.1, spudded on 20th March 1970, was drilled to a depth of 2570 feet. It was plugged and abandoned as a dry hole on 24th March 1970. One conventional core was cut in basement. A suite of wire line logs was run from the 9-5/8" shoe at 516 feet to total depth. The Gamma Ray was run from 50 feet. 29 side wall cores were recovered between 880 and 2480 feet. No drill stem tests were carried out.

A.A.O. Sunset No.1 and A.A.O. Morkalla No.1 were drilled in Petroleum Exploration Permit 64, Victoria.

A.A.O. Nadda No.1, spudded on 26th March 1970, was drilled to a depth of 3416 feet. It was plugged and abandoned as a dry hole on 5th April 1970. Two conventional cores were cut in the Permian section and one conventional core was cut in basement. A suite of wire line logs was run from the 9-5/8" shoe at 502 feet to total depth. The Gamma Ray was run from 50 feet. 27 side wall cores were recovered between 885 feet and 3359 feet. No drill stem tests were carried out.

A.A.O. Nadda No.1 was drilled in Petroleum Exploration Licence 3, South Australia.

I. SUMMARY (contd.)

(2) Geological

The three wells were drilled in the terminal portions of erosional valleys and were designed to ascertain if the target "basal Cretaceous sand" was present and if so to determine its hydrocarbon potential.

In A.A.O. Sunset No.1, the "basal Cretaceous sand" was penetrated between 2862 and 3030 feet. A test of the interval 2783 to 3287 feet resulted in the nett recovery of 2200 feet of salty water. Hydrocarbon indications were not recorded in the well.

In A.A.O. Morkalla No.1, there was no "basal Cretaceous sand" and there were no indications of hydrocarbons.

In A.A.O. Nadda No.1, the "basal Cretaceous sand" was penetrated between 1823 and 2063 feet. As its log character was similar to that in A.A.O. Sunset No.1, a test was considered unwarranted. An unexpected Lower Permian sequence, 1297 feet thick was penetrated in this well. There were no significant indications in this well.

II. INTRODUCTION

The Associated Group holds Petroleum Exploration Permit 64 Victoria and the contiguous Petroleum Exploration Licence 3 in South Australia. Together the tenements cover the north-western Murray Basin.

Geophysical surveys (Hamley Seismic and Gravity Survey in 1968 and the Sunset Seismic Survey in 1969) were carried out by the Group.

These surveys indicated the presence of a broad area of Cretaceous and Tertiary sediments adjacent to the Palaeozoic Renmark Trough. This area, named the Paringa Embayment is bounded to the west by the Loxton High and to the east by the Meringur High. It is roughly bisected by the Sunset High. Significantly large closed structural features were not found.

A study of the results of previous drilling showed the existence, to the west of the Paringa Embayment, of a fairly widespread basal Cretaceous sandstone, which possessed excellent reservoir character. It was decided therefore to embark on a 3 well drilling programme to firstly, ascertain if this unit was present in the Paringa Embayment as predicted and if so secondly, to ascertain its hydrocarbon potential in a near wedge out position in the distal portions of valleys between the Loxton and Sunset Highs and the Sunset and Meringur Highs.

To implement this programme A.A.O. Sunset No.1 was drilled to establish the presence of the sandstone. This having been established, A.A.O. Morkalla No.1 was drilled at the head of the valley formed between the Meringur and Sunset Highs and A.A.O. Nadda No.1 was drilled in a similar position between the Sunset and Loxton Highs.

To eliminate needless repetition and to present a balanced appreciation of the results,after consultation with officials of the Bureau of Mineral Resources, this common report on the drilling programme has been prepared.

II. INTRODUCTION (contd.)

The wells were subsidised as drilling operations by the Commonwealth Government under the Petroleum Search Subsidy Act 1959 to 1969.

Pexa Oil N.L. contributed 50% of the cost of the wells under a farmin agreement.

III. WELL HISTORY - A: A.A.O. SUNSET NO.1

(1) General Data

(i)	Well Name and Number:	A.A.O. SUNSET NO.1
(ii)	Name and Address of Operator:	Associated Australian Oilfields N.L., 447 Collins Street, Melbourne, Victoria, 3000. Operational address:- 31 Charlotte Street, Brisbane, Queensland, 4000.
(iii)	Name and Address of Titleholder:	Associated Australian Oilfields N.L., 447 Collins Street, Melbourne, Victoria, 3000.
(iv)	Petroleum Title:	Petroleum Exploration Permit 64. Expires 31st August 1970. (Ministerial approval is awaited of an agreement whereby Pexa Oil N.L., by contributing 50% of the cost of exploration will earn a 50% interest in the Permit, subject to a 5% over-riding royalty to Associated).
(v)	District:	MILDURA 1:250,000 Map I 54-11.
(vi)	Location:	34°16'30"S; 141°06'25"E.
(vii)	Elevation:	ground: 170 feet datum: 181 feet (kelly bushing)
(viii)	Total Depth:	3284 feet (driller) 3287 feet (Schlumberger)
(ix)	Date drilling commenced:	8th March 1970. (0000 hours)
(x)	Date total depth reached:	13th March 1970. (0930 hours)
(xi)	Date well abandoned:	15th March 1970. (2100 hours)
(xii)	Date rig released:	16th March 1970. (0800 hours)
(xiii)	Drilling time to total depth:	6 days.
(xiv)	Status:	Plugged and abandoned. Plugs:- 0 to 20 feet 450 to 550 feet 900 to 1050 feet 2700 to 2850 feet
(xv)	Total Cost:	An audited cost statement will be forwarded when available.

III. WELL HISTORY (contd.)

(2) Drilling Data

(i) Name and Address of drilling contractor: Richter Bawden Drilling Pty. Ltd., East Tower, Prince's Gate, Flinders Street, Melbourne, Victoria, 3000.

(ii) Drilling Plant

Make:	National
Type:	T-32
Capacity:	5500 feet with 4½" drill pipe.
Motors:	make:- General Motors
	type:- Series 12107
	bhp:- 356

(iii) Mast

Make:	Lee C. Moore
Type:	97 foot
Capacity:	350,000 lb. (API)

(iv) Pumps (2)

Make:	National
Type:	C-250
Size:	7¼" x 15"
Motors:	make: General Motors
	type: Series 12107
	bhp: 356

(v) Blowout preventers:

Make:	Hydril	Shaffer
Type:	GK	Double Gate
Size:	10"	10"
Series (API):	900	900

(vi) Hole sizes and depths:
12¼ inch to 518 feet.
8-3/4 inch to 3276 feet.
6-1/8 inch to 3284 feet.

(vii) Casing and Cementing details:

size:	9-5/8"
weight:	36lb. per foot.
grade:	J55
range:	2
setting depth:	501 feet.

type and location of:-

float collar -	nil
shoe -	Baker guide shoe @ 501 feet.
plugs -	1 BJ top plug.
centralisers -	1 Baker 'M' at the top of the bottom joint.
scratchers -	nil.

quantity of cement used: 250 sacks.

cemented to: there was no cement to surface. A further 40 sacks were pumped to the annulus.

method used: plug

III. WELL HISTORY (contd.)

(2) Drilling Data (contd.)

(viii) Drilling fluid

type: fresh water - bentonite.
average weight: 9.8 pounds per gallon (U.S.)

A conventional fresh water bentonite mud was used throughout. C.M.C. was used for fluid loss reduction and Q Broxin (ferrochrome lignosulphonate)for viscosity reduction. Until the installation of a desander, the mud had a high sand content.

Average daily analyses.

Date	Weight ppg.	Viscosity Marsh	Fluid Loss m.l.	Cake m.m.	Sand %	pH
8/3/70		Spud mud.				
9/3/70		Heading up BOP's				
10/3/70	9.9	38	4.7	2	3	13
11/3/70	10.0	50	6.0	2	10	10
12/3/70	9.7	36	9.0	2	1/4	7.6
13/3/70	9.5	35	7.2	2	1/8	9.5

Mud and chemicals consumed.

Bentonite	130 sacks	13,000 lb.
Carboxy methyl cellulose	10 sacks	500 lb.
Ferrochrome lignosulphonate	45 sacks	2,250 lb.
Caustic soda	6½ drums	975 lb.

(ix) Water Supply:

Drilling water was transported by a 3000 gallon tanker from Paringa, 22 miles to the west.

(x) Perforation and Shooting record: Nil.

(xi) Plug back and squeeze cementation jobs:

Plugs.

No.	1	2	3	4
Length	20 ft.	100 ft.	150 ft.	150 ft.
Interval	0 to 20 ft.	450 to 550 ft.	900 to 1050 ft.	2700 to 2850 ft.
Type	Cement	Cement	Cement	Cement
No. Sacks	10	30	40	40
Method	Poured	Displacement	Displacement	Displacement
Squeeze pressure	-	-	-	-
Tested	At surface.	Top @ 445 ft.	No.	No.

III. WELL HISTORY (contd.)

(2) Drilling Data (contd.)

(xii) Fishing Operations: Nil.

(xiii) Side tracked hole: Nil.

(3) Location

(i) Site investigations carried out:

The site was visited by representatives of the operator, drilling contractor and bulldozer contractor on 4th February. Various water supply sources were investigated. Paringa was chosen, for although not the nearest source, travel time was minimal.

(ii) Transportation:

The drilling contractor sub-contracted rig transportation to Western Transport Pty. Ltd. The rig was at the Mt. Emu No.1 site in New South Wales. Conventional gin pole trucks and semi trailers were employed in loading, transport and cranes for unloading/rigging up.

Mud was obtained from Adelaide and fuel from Renmark S.A.

Apart from difficulty with loose sand on the actual well site, no transportation problems were encountered.

(4) Formation Sampling

(i) Ditch Cuttings:

Method - Lagged samples at 10 foot intervals were collected from the shaker. These samples were examined and then dried and bagged.

Interval - Surface to total depth.

Repositories - A. Mines Administration Pty. Limited,
31 Charlotte Street,
Brisbane, Qld.

B. Department of Mines,
Core Laboratories,
Turner Street,
Port Melbourne, Victoria.

C. Bureau of Mineral Resources,
Core and Cuttings Laboratory,
Collie Street,
Fyshwick, A.C.T.

III. WELL HISTORY (contd.)

(4) Formation Sampling (contd.)

(ii) Cores:

Core No.	Interval Cored	Recovery	Recovery
1.	3276 to 3284 ft.	8 feet	100%

Repositories: The first 4 inches from each 2 feet are stored at A. The remainder of the core was slabbed with splits stored at B and C above.

(iii) Side wall samples: The following samples were recovered from a Schlumberger sample taker.

Depth	Rec.	Depth	Rec.	Depth	Rec.
955	2"	2395	1-7/8"	2895	1"
1257	2¼"	2446	2"	2925	1¼"
1697	2"	2523	2-1/8"	2980	1¼"
1953	1½"	2555	2"	3040	1½"
2104	2"	2632	2"	3080	1-3/4"
2146	2"	2752	1½"	3142	1¼"
2200	1-5/8"	2805	1-3/4"	3172	3/4"
2303	1-7/8"	2833	1-3/4"	3240	7/8"
2353	2"	2879	1-3/4"		

Repositories: The cores were destroyed in processing to determine their microfloral content.

(5) Logging and Surveys

(i) Electric and other logging:

Induction Electric Log - interval 501 to 3286 feet.
Microlog-Microcaliper - interval 501 to 3285 feet.
Sonic Gamma Ray - interval 501 to 3275 feet.
(The Gamma Ray was continued to 50 ft.)

(ii) Penetration rate logs:

A penetration rate log was recorded from surface to total depth.

(iii) Gas logs:

A continuous gas log was recorded from surface to total depth. The mud gas was continuously monitored by a conventional hot wire detector. The mud gas was continuously analysed by a Core Laboratories Programmed Hydrocarbon Detector (gas chromatograph).

III. WELL HISTORY (contd.)

(5) Logging and Surveys (contd.)

(iv) Deviation surveys:

The following deviation surveys were carried out with an Eastman double recorder.

Depth	Deviation
518	1°
1000	1°
1504	$1/2^{\circ}$
2007	$1\text{-}3/4^{\circ}$
2660	$1\text{-}1/2^{\circ}$
3030	1°
3119	$1\text{-}1/4^{\circ}$

(v) Temperature surveys:

Temperature surveys were not carried out. The following temperatures were recorded.

132° at T.D. (Schlumberger)
130° at T.D. (B.J.)

(vi) Other well surveys: Nil.

(6) Testing

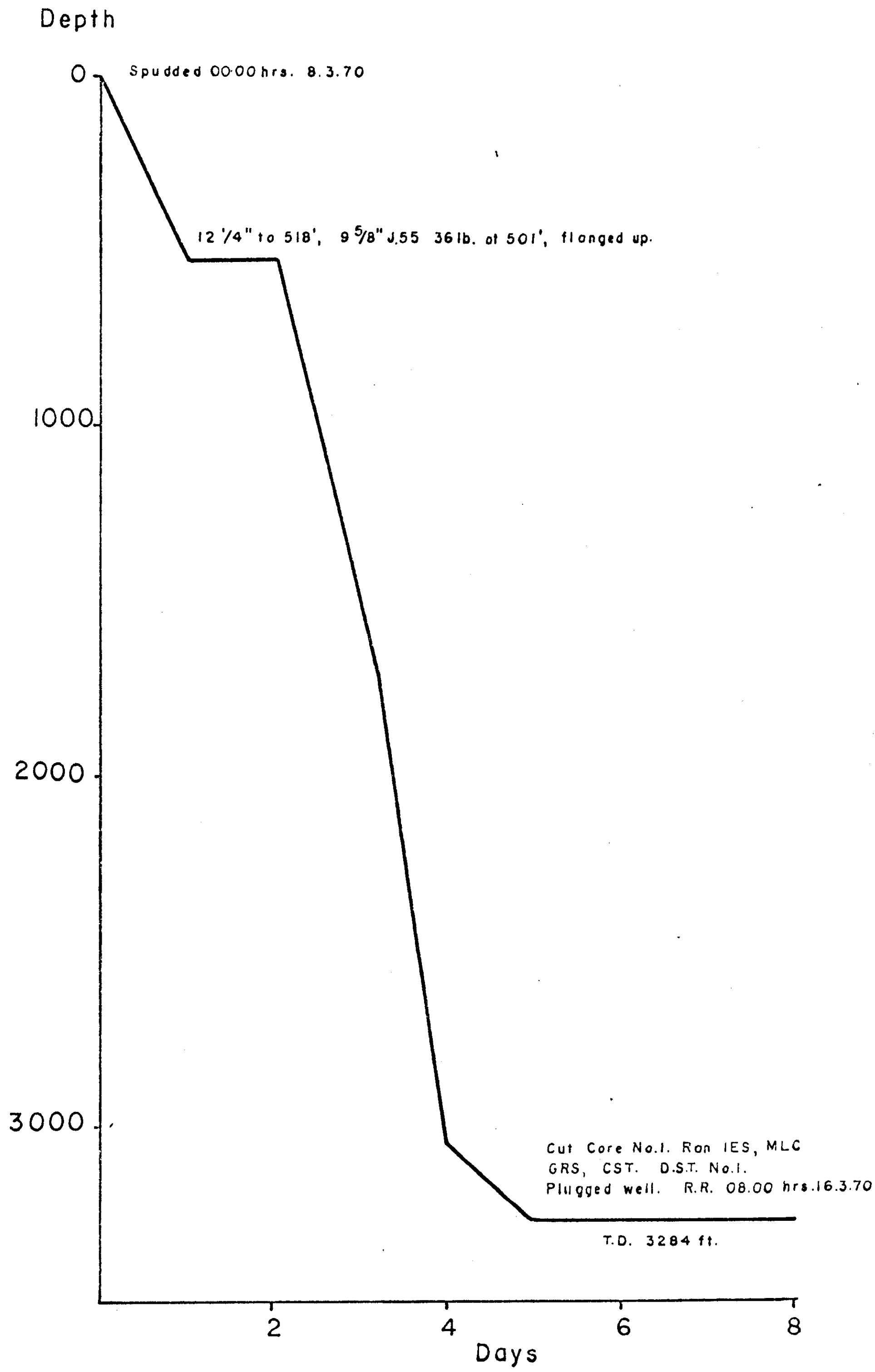
(i) Formation Testing:

Only one drill stem test was carried out in this well.

D.S.T. No.1

Interval:	2783 to 3287 feet.
Method:	Conventional drill stem test.
Results:	No gas to surface. Recovered 400 feet mud plus 2200 feet muddy water. Rw = 0.21 @ 84°F.

(ii) Production Testing: Nil.



WELL HISTORY CHART

A.A.O. SUNSET No. I.

III. WELL HISTORY - A.A.O. MORKALLA NO.1

(1) General Data

(i)	Well Name and Number:	A.A.O. MORKALLA NO.1.
(ii)	Name and Address of Operator:	Associated Australian Oilfields N.L., 447 Collins Street, Melbourne, Victoria, 3000. Operational address:- 31 Charlotte Street, Brisbane, Queensland, 4000.
(iii)	Name and Address of Titleholder:	Associated Australian Oilfields N.L., 447 Collins Street, Melbourne, Victoria, 3000.
(iv)	Petroleum Title:	Petroleum Exploration Permit 64. Expires 31st August 1970. (Ministerial approval is awaited of an agreement whereby Pexa Oil N.L., by contributing 50% of the cost of exploration will earn a 50% interest in the Permit, subject to a 5% over-riding royalty to Associated).
(v)	District:	MILDURA 1:250,000 Map I 54-11.
(vi)	Location:	34°22'25"S; 141°09'55"E.
(vii)	Elevation:	ground: 135 feet datum: 146 feet (kelly bushing)
(viii)	Total Depth:	2570 feet (driller) 2570 feet (Schlumberger)
(ix)	Date drilling commenced:	20th March 1970. (0700 hours)
(x)	Date total depth reached:	22nd March 1970. (2230 hours)
(xi)	Date well abandoned:	24th March 1970. (0045 hours)
(xii)	Date rig released:	24th March 1970. (0430 hours)
(xiii)	Drilling time to total depth:	3 days (60.5 hours)
(xiv)	Status:	Plugged and abandoned. Plugs:- 0 to 50 feet 450 to 550 feet 800 to 950 feet
(xv)	Total Cost:	An audited cost statement will be forwarded when available.

III. WELL HISTORY (contd.)

(2) Drilling Data

(i) Name and Address of drilling contractor: Richter Bawden Drilling Pty. Ltd., East Tower, Prince's Gate, Flinders Street, Melbourne, Victoria, 3000.

(ii) Drilling Plant

Make:	National
Type:	T-32
Capacity:	5500 feet with 4½" drill pipe.
Motors:	make:- General Motors type:- Series 12107 bhp:- 356

(iii) Mast

Make:	Lee C. Moore
Type:	97 foot
Capacity:	350,000 lb. (API)

(iv) Pumps (2)

Make:	National
Type:	C-250
Size:	7¼" x 15"
Motors:	make: General Motors type: Series 12107 bhp: 356

(v) Blowout preventers:

Make:	Hydril	Shaffer
Type:	GK	Double Gate
Size:	10"	10"
Series (API):	900	900

(vi) Hole sizes and depths: 12¼ inch to 535 feet.
8-3/4 inch to 2560 feet.
6-1/8 inch to 2570 feet.

(vii) Casing and Cementing details:

size:	9-5/8"
weight:	36lb. per foot.
grade:	J55
range:	2
setting depth:	516 feet.

type and location of:-

float collar -	nil.
shoe -	Baker guide shoe @ 516 feet.
plugs -	1 BJ top plug.
centralisers -	1 Baker 'M' at the top of the bottom joint.
scratchers -	nil.

quantity of cement used: 200 sacks.

cemented to: there was no cement to surface. A further 15 sacks were pumped to the annulus.

method used: plug.

III. WELL HISTORY (contd.)

(2) Drilling Data (contd.)

(viii) Drilling fluid

type: fresh water - bentonite.
average weight: 9.6 pounds per gallon (U.S.).

A conventional fresh water - bentonite mud was used throughout. C.M.C. was used for fluid loss reduction and Q Broxin (ferrochrome lignosulphonate) for viscosity reduction.

Average daily analyses.

Date	Weight ppg.	Viscosity Marsh	Fluid Loss m.l.	Cake m.m.	Sand %	pH
20/3/70		Spud mud.				
21/3/70	9.2	37	10.0	2	4	10
22/3/70	9.8	45	7.0	2	2	10

Mud and chemicals consumed.

Bentonite	46 sacks	4600 lb.
Carboxy methyl cellulose	6 sacks	300 lb.
Ferrochrome lignosulphonate	13 sacks	650 lb.
Caustic soda	3 drums	450 lb.

(ix) Water Supply:

Drilling water was transported by a 3000 gallon tanker from Paringa, 34 miles to the west.

(x) Perforation and Shooting record: Nil.

(xi) Plug back and squeeze cementation jobs:

Plugs.

No.	1	2	3
Length	50 ft.	100 ft.	150 ft.
Interval	0 to 50 ft.	450 to 550 ft.	800 to 950 ft.
Type	Cement	Cement	Cement
No. Sacks	30	30	40
Method	Poured.	Displacement.	Displacement.
Squeeze pressure	-	-	-
Tested	No.	No.	No.

(xii) Fishing Operations: Nil.

(xiii) Side tracked hole: Nil.

III. WELL HISTORY

(3) Location

(i) Site investigations carried out:

The site was visited by representatives of the operator, drilling contractor and bulldozer contractor on 4th February. Various water supply sources were investigated. Paringa was chosen, for although not the nearest source, travel time was minimal.

(ii) Transportation:

The drilling contractor sub-contracted rig transportation to Western Transport Pty. Ltd. The rig was moved from the Sunset No.1 location, 12 road miles to the west. Cranes and semi trailers were employed in loading, transport and unloading/rigging up.

Mud was obtained from Adelaide and fuel from Renmark, S.A.

Apart from difficulty with loose sand on the Sunset well site, no transportation problems were encountered.

(4) Formation Sampling

(i) Ditch Cuttings:

Method - Lagged samples at 10 foot intervals were collected from the shaker. These samples were examined and then dried and bagged.

Interval - Surface to total depth.

Repositories -

A. Mines Administration Pty. Limited,
31 Charlotte Street,
Brisbane, Qld.

B. Department of Mines,
Core Laboratories,
Turner Street,
Port Melbourne, Victoria.

C. Bureau of Mineral Resources,
Core and Cuttings Laboratory,
Collie Street,
Fyshwick, A.C.T.

(ii) Cores:

Core No.	Interval Cored	Recovery	Recovery
1	2560 to 2570 ft.	10 ft.	100%

Repositories: The first 4 inches from each 2 feet are stored at C. The remainder of the core was slabbed with splits stored at A and B above.

III. WELL HISTORY (contd.)

(4) Formation Sampling (contd.)

(iii) Side wall samples: The following samples were recovered from a Schlumberger sample taker.

Depth	Rec.	Depth	Rec.	Depth	Rec.
880	2"	1910	1-3/4"	2215	1-3/4"
950	2"	1950	2¼"	2270	2"
1002	2"	2000	2"	2330	2¼"
1102	1½"	2057	2-1/8"	2364	1¼"
1202	1½"	2080	2"	2380	2¼"
1250	2½"	2100	1½"	2401	2"
1295	2"	2108	2"	2431	1½"
1343	2"	2155	2"	2450	3/4"
1470	2"	2173	1½"	2480	1½"
1809	2"	2192	1½"		

Repositories: The samples were destroyed during processing to determine their microfloral content.

(5) Logging and Surveys

(i) Electric and other logging:

Induction Electric Log - interval 516 to 2569 feet.
Microlog-Microcaliper - interval 515 to 2568 feet.
Sonic Log - interval 517 to 2566 feet.
Gamma Ray - interval 50 to 2563 feet.

(ii) Penetration rate logs:

A penetration rate log was recorded from surface to total depth.

(iii) Gas Logs:

A continuous gas log was recorded from surface to total depth. The mud was continuously monitored by a conventional hot wire detector. The mud gas was continuously analysed by a Core Laboratories Programmed Hydrocarbon Detector (gas chromatograph).

(iv) Deviation surveys:

The following deviation surveys were carried out with an Eastman double recorder.

Depth	Deviation
245	3/4°
535	3/4°
1004	1°
1491	1-1/4°
2002	3/4°
2520	3/4°

III. WELL HISTORY (contd.)

(5) Logging and Surveys (contd.)

(v) Temperature surveys:

Temperature surveys were not carried out. The following temperature was recorded.

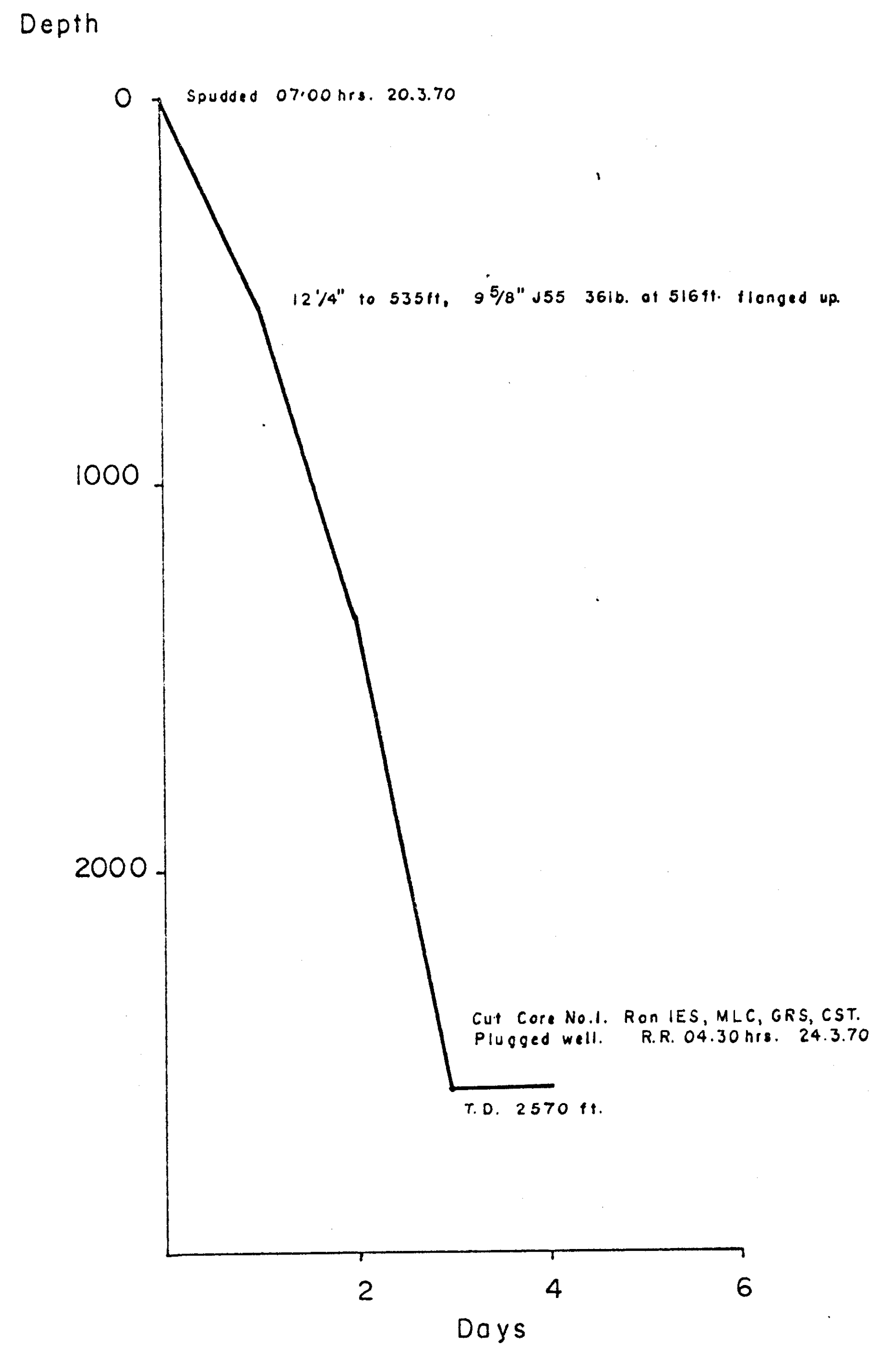
$130^{o}F$ at T.D. (Schlumberger)

(vi) Other well surveys: Nil.

(6) Testing

(i) Formation Testing: Nil.

(ii) Production Testing: Nil.



WELL HISTORY CHART

A.A.O. MORKALLA No.1.

III. WELL HISTORY - C: A.A.O. NADDA NO.1.

(1) General Data

(i)	Well name and number:	A.A.O. NADDA NO.1
(ii)	Name and Address of Operator:	Associated Australian Oilfields N.L., 447 Collins Street, Melbourne, Victoria, 3000. Operational address:- 31 Charlotte Street, Brisbane, Queensland, 4000.
(iii)	Name and Address of Titleholder:	Associated Australian Oilfields N.L., 447 Collins Street, Melbourne, Victoria, 3000.
(iv)	Petroleum Title:	Petroleum Exploration Licence 3. Expires 31st July 1973. (Ministerial approval has been granted of an agreement whereby Pexa Oil N.L., by contributing 50% of the cost of exploration will earn a 50% interest in the Licence, subject to a 5% over-riding royalty to Associated).
(v)	District:	RENMARK 1:250,000 Map I 54-10.
(vi)	Location:	34°38'05"S; 140°53'45"E.
(vii)	Elevation:	ground: 95 feet. datum: 106 feet (kelly bushing)
(viii)	Total Depth:	3416 feet (driller) 3414 feet (Schlumberger)
(ix)	Date drilling commenced:	26th March 1970 (2100 hours)
(x)	Date total depth reached:	3rd April 1970 (1745 hours)
(xi)	Date well abandoned:	5th April 1970 (0230 hours)
(xii)	Date rig released:	5th April 1970 (0600 hours)
(xiii)	Drilling time to total depth:	8 days.
(xiv)	Status:	Plugged and abandoned. Plugs: 0 to 20 feet 450 to 700 feet 1500 to 1650 feet 2200 to 2350 feet
(xv)	Total Cost:	An audited cost statement will be forwarded when available.

III. WELL HISTORY (contd.)

(2) Drilling Data

(i) Name and Address of drilling contractor: Richter Bawden Drilling Pty. Ltd., East Tower, Prince's Gate, Flinders Street, Melbourne, Victoria, 3000.

(ii) Drilling Plant

Make:	National	
Type:	T-32	
Capacity:	5500 feet with 4½" drill pipe.	
Motors:	make:-	General Motors
	type:-	Series 12107
	bhp:-	356

(iii) Mast

Make:	Lee C. Moore
Type:	97 foot.
Capacity:	350,000 lb. (API)

(iv) Pumps (2)

Make:	National	
Type:	C-250	
Size:	7¼" x 15"	
Motors:	make:	General Motors
	type:	Series 12107
	bhp:	356

(v) Blowout preventers:

Make:	Hydril	Shaffer
Type:	GK	Double Gate
Size:	10"	10"
Series (API):	900	900

(vi) Hole sizes and depths: 12¼ inch to 520 feet.
8-3/4 inch to 3413 feet.
6-1/8 inch to 3416 feet.

(vii) Casing and Cementing details:

size:	9-5/8"
weight:	36lb. per foot.
grade:	J55
range:	2
setting depth:	502 feet.

type and location of:-

float collar:	nil.
shoe:	Baker guide shoe @ 502 ft.
plugs:	1 BJ top plug.
centralisers:	1 Baker 'M' at the top of the bottom joint.
scratchers:	nil.

quantity of cement used: 250 sacks.

cemented to: surface.

method used: plug.

III. WELL HISTORY (contd.)

(2) Drilling Data (contd.)

(viii) Drilling fluid

type: fresh water - bentonite.
average weight: 9.9 pounds per gallon (U.S.)

A conventional fresh water bentonite mud was used throughout. C.M.C. was used for fluid loss reduction and Q Broxin (ferrochrome lignosulphate) for viscosity reduction.

Average daily analyses.

Date	Weight ppg.	Viscosity Marsh	Fluid Loss m.l.	Cake m.m.	Sand %	pH
26.3.70.		Spud mud.				
27.3.70.		Spud mud.				
28.3.70.	9.3	43	7.5	2	2	11
29.3.70.	9.8	45	5.0	2	3/4	10
30.3.70.	9.9	46	6.0	2	1	9.5
31.3.70.	10.1	46	6.3	2	1/2	10
1.4.70.	10.1	45	6.0	2	1/2	10
2.4.70.	9.9	39	5.5	2	1/2	9.5
3.4.70.	9.9	39	5.5	2	1/4	9.5

Mud and chemicals consumed.

Bentonite	116 sacks	11600 lb.
Carboxy methyl cellulose	33 sacks	1650 lb.
Ferrochrome lignosulphonate	33 sacks	1650 lb.
Caustic Soda	4½ drums	675 lb.

(ix) Water Supply:

Drilling water was transported by a 3000 gallon tanker from a stop-cock in an Engineering & Water Supply Department main, approximately 1 mile from the well site.

(x) Perforation and Shooting record: Nil.

(xi) Plug back and squeeze cementation jobs:

Plugs.

No.	1	2	3	4
Length	20 ft.	250 ft.	150 ft.	150 ft.
Interval	0 to 20 ft.	450 to 700 ft.	1500 to 1650 ft.	2200 to 2350 ft.
Type	Cement	Cement	Cement	Cement
No. Sacks	10	120	84	82
Method	Poured	Displacement	Displacement	Displacement
Squeeze pressure	-	-	-	-
Tested	At surface.	Top @ 440'	No.	No.

III. WELL HISTORY (contd.)

(2) Drilling Data (contd.)

(xii) Fishing Operations: Nil.

(xiii) Side tracked hole: Nil.

(3) Location

(i) Site investigations carried out:

The site was visited by representatives of the operator, drilling contractor and bull-dozer contractor on 4th February. Arrange-ments were made on 5th February to obtain water from the Engineering & Water Supply Department's main.

(ii) Transportation:

The drilling contractor sub-contracted rig transportation to Western Transport Pty. Ltd. The rig was moved a distance of 50 miles from the Morkalla No.1 site. Cranes and semi trailers were employed in loading, transport and unloading/rigging up. Mud was obtained from Adelaide and fuel from Loxton, S.A.

Apart from some difficulty with loose sand on the actual well site, no transportation problems were encountered.

(4) Formation Sampling

(i) Ditch Cuttings:

Method - Lagged samples at 10 foot intervals were collected from the shaker. These samples were examined and then dried and bagged.

Interval - surface to total depth.

Repositories - A. Mines Administration Pty. Limited, 31 Charlotte Street, Brisbane, Qld.

B. Department of Mines Works Depot, Dalgleish Street, Thebarton, S.A.

C. Bureau of Mineral Resources, Core and Cuttings Laboratory, Collie Street, Fyshwick, A.C.T.

(ii) Cores:

No.	Interval Cored	Feet Cut	Recovery	Recovery
1.	2504 to 2514 ft.	10	7'3"	72%
2.	3140 to 3144 ft.	4	2'3"	62%
3.	3413 to 3416 ft.	3	2'3"	83%

Repositories: The first 4 inches from each 2 feet are stored at C. The remainder of the core was slabbed with splits stored at A and B above.

III. WELL HISTORY (contd.)

(4) Formation Sampling (contd.)

(iii) Side wall samples: The following samples were recovered from a Schlumberger sample taker.

Depth	Rec.	Depth	Rec.	Depth	Rec.
885	2"	1909	2"	2582	1½"
902	1-3/4"	1969	2"	2680	3/4"
1037	1-3/4"	2089	1-3/4"	2820	1¼"
1141	2"	2128	1¼"	2900	1"
1236	2½"	2165	1¼"	2982	3/4"
1340	1-3/4"	2188	1-3/4"	3092	½"
1500	2"	2248	1½"	3265	½"
1600	2"	2350	1½"	3308	1"
1800	1-3/4"	2408	1¼"	3359	½"

Repositories: The cores were destroyed in processing to determine their microfloral content.

(5) Logging and Surveys

(i) Electric and other logging:

Induction Electric Log - interval 502 to 3413 feet
Microlog-Microcaliper - interval 502 to 3413 feet
Gamma Ray - interval 50 to 3412 feet
Sonic Log - interval 496 to 3411 feet

(ii) Penetration rate logs:

A penetration rate log was recorded from surface to total depth.

(iii) Gas Logs:

A continuous gas log was recorded from surface to total depth. The mud gas was continuously monitored by a conventional hot wire detector. The mud gas was continuously analysed by a Core Laboratories Programmed Hydrocarbon Detector (gas chromatograph).

(iv) Deviation Surveys:

The following deviation surveys were carried out with an Eastman double recorder.

Depth	Deviation
100	3/4°
500	3/4°
1034	1°
1505	1°
2003	3/4°
2500	1-1/4°
2840	1°
3390	1/4°

III. WELL HISTORY (contd.)

(5) Logging and Surveys (contd.)

(v) Temperature surveys:

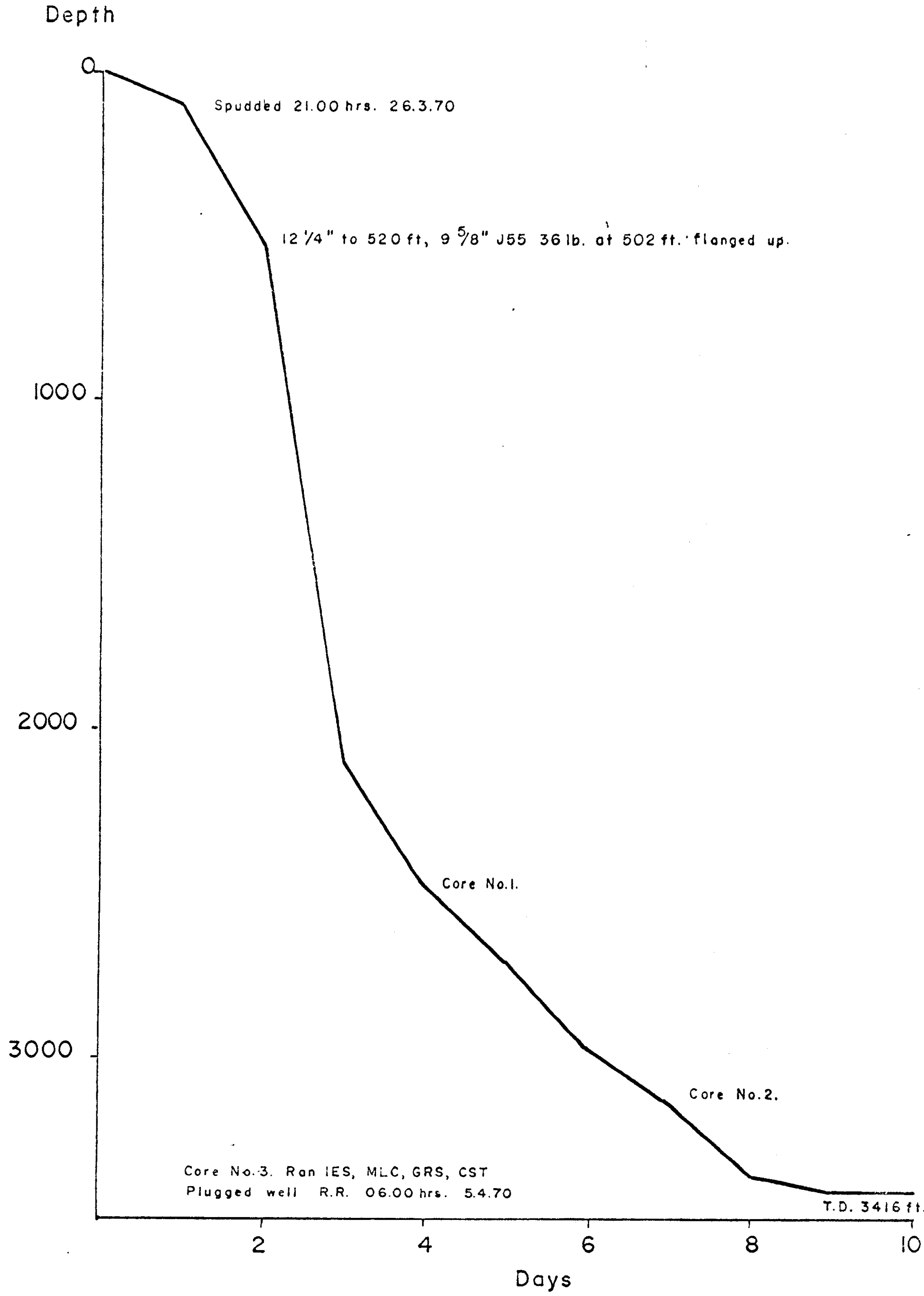
Temperature surveys were not carried out.

A maximum temperature of 125°F was recorded by Schlumberger at total depth.

(6) Testing

(i) Formation Testing: Nil.

(ii) Production Testing: Nil.



WELL HISTORY CHART

A.A.O NADDA No. 1

IV. GEOLOGY

1. Summary of previous work

(i) Geological

Apart from Tertiary rocks exposed in the banks of incised meanders of the Murray River, there are virtually no outcrops of significance in the Murray Basin. Knowledge of the Cretaceous and older rocks is dependent wholly on geophysical and well data.

Detailed studies, particularly on the palaeontology of the marine Tertiary have been made (Ludbrook 1961), but as these have little relevance to the underlying sections they will not be further considered.

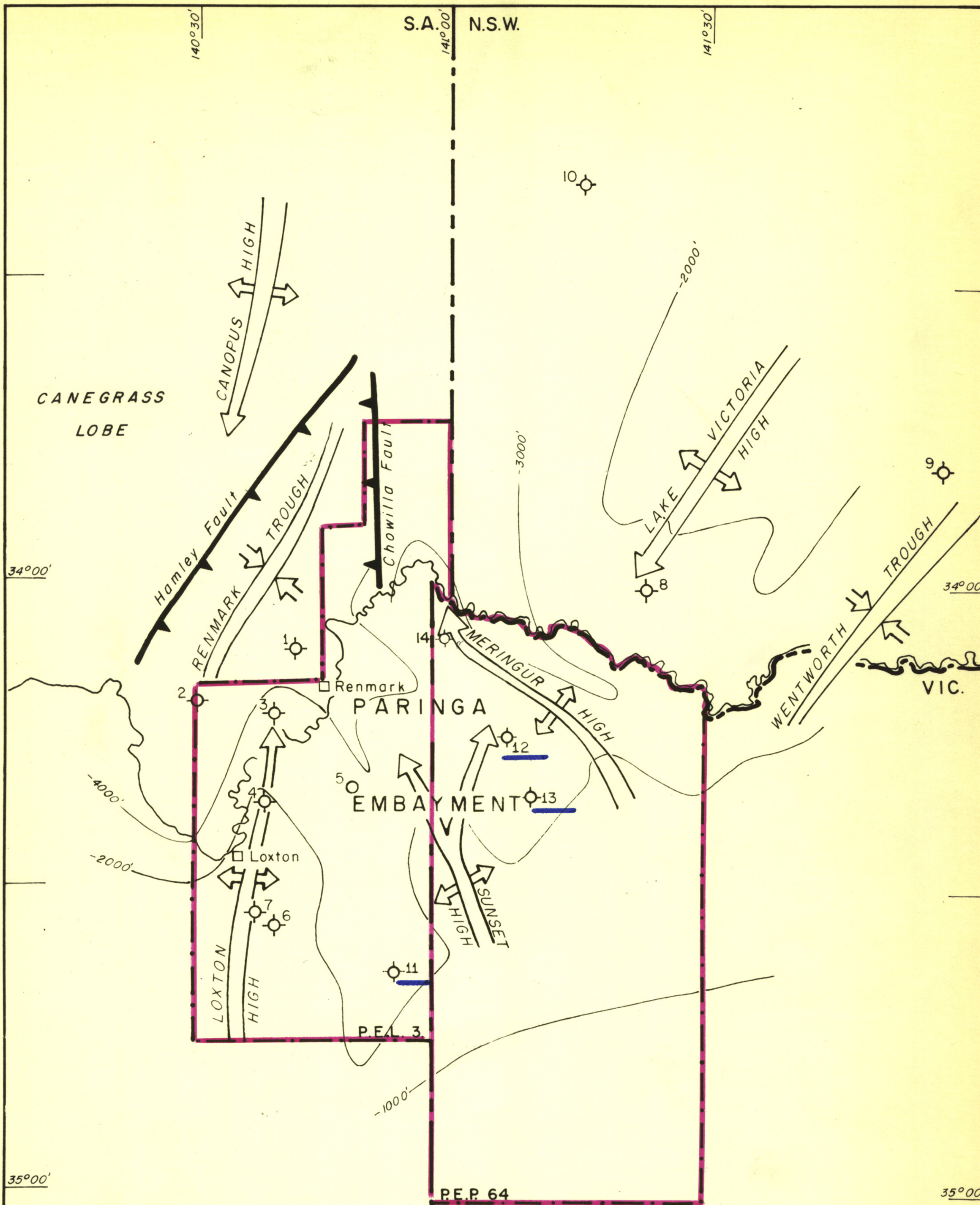
(ii) Geophysical

An intensive seismic reflection coverage was shot in the Loxton-Berri-Renmark area by previous tenants. Record quality was universally poor and the value of much of this surveying limited.

Two surveys have been carried out by the Associated Group. The Hamley Seismic and Gravity Survey was implemented in O.E.L. 39 (S.A.) in 1967 and confirmed the presence of a thick sequence of Upper Palaeozoic and Cretaceous sediments in a major graben structure, the Renmark Trough - with a western offshoot, the Canegrass Lobe.

In 1969, the Group carried out the Sunset Seismic Survey in a previously unexplored area of Tertiary and Cretaceous rocks to the south-east of the Renmark Trough. This survey showed the presence of a Cretaceous and Tertiary section in a south-eastern embayment from the Renmark Trough. This embayment was formed by a pre-Cretaceous valley system draining in a north to north-west direction from a high basement area to the south and east (Enclosure 1 and Figure 3). The recent drilling programme was based on the results of this survey.

902820 033



1 North Renmark No.1.
2 Monash No.1.
3 Berri North No.1.
4 Berri South No.1.
5 Company Bore
6 Loxton No.1.
7 Loxton No.2.
8 Lake Victoria No.1.
9 Wentworth No.1.
10 Tararra No.1.
11 Nadda No.1.
12 Sunset No.1.
13 Morkalla No.1.
14 D.M.V. Olney No.1.

ASSOCIATED AUSTRALIAN OILFIELDS N.L.
Authority to Prospect P.E.L. 3. S.A. & P.E.P. 64. Vic.

WESTERN MURRAY BASIN

STRUCTURAL ELEMENTS
and Well Locations

10 5 0 10 20 30 miles
1:1,000,000

R.J. Paten May, 1970

FIG. 3.

F 37 13327

IV. GEOLOGY (contd.)

1. Summary of previous work (contd.)

(iii) Drilling

Ten exploration wells have been drilled in the north-western part of the Murray Basin by previous tenants (Figure 3). None gave indications of hydrocarbons but three showed the presence of a thick permeable salt-water filled sand at the base of the Cretaceous sequence. There has been no prior drilling by the Associated Group in the area.

2. Summary of regional geology

The regional geology of the western Murray Basin, which includes P.E.L. 3 (S.A.) and P.E.P. 64 (Victoria), has been considered most recently by Swindon (1966), Mines Administration Pty. Limited and Namco Geophysical Co. (1968) and Drew, Paten and Gray (1969).

(i) Depositional Setting

The subject area covers the relatively stable basement shelf which lies to the south-east of the Renmark Trough. The shelf has been deeply dissected into a series of north-west trending valleys separated by sinuous divides,extending from a broad basement high in the south-east and plunging in the direction of the Renmark Trough. The divides have been named from the west the Loxton, Sunset and Meringur Highs. A fourth, poorly known elevated basement feature, the Lake Victoria High lies to the north of P.E.P. 64.

The basement valley system is a south-eastern off-shoot of the Renmark Trough and is herein named the Paringa Embayment. At present, basement lies at depths of less than 1,000 feet to about 5,000 feet.

During the pre-Permian, part of the Paringa Embayment was deeply dissected, possibly in part by glacial action, as the lower Permian sediments deposited in these valleys have glacial affinities. Further erosion occurred prior to the Cretaceous and the Embayment was progressively filled by fluvial, marine and lacustrine Lower Cretaceous sediments. A gentle uplift occurred during later Cretaceous time resulting in some dissection of these

IV. GEOLOGY (contd.)

2. Summary of regional geology (contd.)

sediments. Finally, Tertiary shallow marine, paludal and fluvial deposits were laid down over the whole area.

(ii) Stratigraphy

The stratigraphy has been discussed in detail in other works and is presented here in summary form only.

The stratigraphy of the western Murray Basin is:-

Recent - Pleistocene	Unnamed sands, clays, caliche
Pliocene	Loxton Sands Bookpurnong Beds
Miocene	Pata Limestone Morgan Limestone Mannum Formation
Oligocene	Gambier Limestone Ettrick Formation
Eocene	Knight Group ≡ Renmark Beds
Lower Cretaceous	Unnamed Unit - sands and shales
Permian	Unnamed Unit - sands and shales
Devonian	Unnamed Unit - sands, shales, dolomites
Cambrian	Kanmantoo Group

(after Parkin et. al. 1969)

(a) Cambrian

The Kanmantoo Group of steeply dipping low grade metamorphic rocks constitutes economic basement in the area.

(b) Devonian

Rocks of possible Devonian age were intersected in A.O.G. Tararra No.1 well. Their distribution is largely unknown but they are probably not present in the Paringa Embayment.

(c) Permian

Lower Permian rocks were intersected in Monash No.1, North Renmark No.1, Wentworth No.1 and Tararra No.1 wells. The section is one of shale and sandstone with possible marine and probable glacial affinities. Little is known of the distribution of the Permian in the area, as its seismic contrast with basement

IV. GEOLOGY (contd.)

2. Summary of regional geology (contd.)

is poor. A completely unexpected section 1,297 feet thick was penetrated in A.A.O. Nadda No.1.

(d) Lower Cretaceous

The maximum thickness of lower Cretaceous rocks over most of the area is thought to be no greater than 1,500 feet. Over the greater part of the Paringa Embayment, its thickness will be appreciably less, due to onlap against the basement highs.

From the available well data, three lithologic units can be recognised within the Lower Cretaceous sequence. Similar successions were encountered in the Wentworth and Tararra wells about 80 and 60 miles respectively from North Renmark, suggesting that the Cretaceous sequence is remarkably uniform over the whole region. Within the Cretaceous sequence, the only lithologic unit which appears to offer major hydrocarbon prospects is the basal sandstone.

At Berri North it is at least 330 feet thick and is a well sorted, unconsolidated quartz sandstone. It is probably mainly fluvial in origin, related to drainage passing via the embayment into the Renmark Trough. However shale intercalations at North Renmark contain foraminifera suggesting some marine influence. This influence will probably diminish towards the distal ends of the valleys. The drilling programme was based on the assumption that this sandstone is distributed in the topographic basement lows throughout the area. The assumption is based on the tentative identification of seismic reflectors on Renmark 6 Line A and Mildura 1 Lines A, B and H with the top of the basal sandstone at Berri North.

(e) Tertiary

A fairly uniform blanket of Tertiary fluvial, paludal and marine sediments 1,700 to 1,900 feet thick blanket the Cretaceous rocks. In areas of shallow basement where Cretaceous rocks are absent, the Tertiary succession is expected to be considerably thinner.

IV. GEOLOGY (contd.)

3. Stratigraphic Table

A : A.A.O. Sunset No.1

The section penetrated in this well was:-

Age	Unit	Depth	Elev.	Thick.	Lithology
Recent	Unnamed	surface	+ 170	97	sands, clays, limestone.
Pliocene	Loxton Sand	108	+ 73	278	coarse sandstone
	Bookpurnong Beds	386	- 205	62	sandstone and siltstone.
Miocene	Pata Limestone	448	- 267	82	sandstone and marl.
	Morgan Limestone	530	- 349	410	fossiliferous limestone.
Oligocene	Ettrick Formation	940	- 759	58	mudstone.
Eocene	Upper Knight Group	998	- 817	495	sandstone, mudstone, lignite.
	Lower Knight Group	1493	-1312	611	coarse sandstone.
Lower Cretaceous	Upper unnamed unit	2104	-1923	494	sandstone, siltstone, mudstone.
	Middle unnamed unit	2598	-2417	264	siltstone and mudstone.
	Lower unnamed unit (="basal sand")	2862	-2681	168	coarse sandstone.
Cambrian	Kanmantoo Group	3030	-2849	257+	phyllite

IV. GEOLOGY (contd.)

3. Stratigraphic Table (contd.)

B : A.A.O. Morkalla No.1

The section penetrated in this well was:-

Age	Unit	Depth	Elev.	Thick.	Lithology
Recent	Unnamed	surface	+ 135	75	sands, clays, limestone.
Pliocene	Loxton Sands	86	+ 60	204	coarse sandstone.
	Bookpurnong Beds	290	- 144	80	fine sandstone-fossils.
Miocene	Pata Limestone	370	- 224	70	sandstone, mudstone, limestone.
	Morgan Limestone	440	- 294	413	fossiliferous limestone.
Oligocene	Ettrick Formation	853	- 707	62	siltstone & mudstone.
Eocene	Upper Knight Group	915	- 769	381	sandstone, siltstone, mudstone, lignite.
	Lower Knight Group	1296	- 1150	609	coarse sandstone.
Lower Cretaceous	Upper unnamed unit	1905	- 1759	307	sandstone, siltstone, mudstone.
	Middle unnamed unit	2212	- 2066	221	siltstone, mudstone.
	Lower unnamed unit (="basal sand")	-	-	-	
Cambrian	Kanmantoo Group	2433	- 2287	137+	slate.

IV. GEOLOGY (contd.)

3. Stratigraphic Table (contd.)

C : A.A.O. Nadda No.1

The section penetrated in this well was:-

Age	Unit	Depth	Elev.	Thick.	Lithology
Recent	Unnamed	surface	+ 95	19	sandstone & limestone.
Pliocene	Loxton Sands	30	+ 76	70	coarse sandstone.
	Bookpurnong Beds	100	+ 6	84	fine sandstone-fossils.
Miocene	Pata Limestone	184	- 78	68	sandstone & limestone.
	Morgan Limestone	252	- 146	416	fossiliferous limestone.
Oligocene	Ettrick Formation	668	- 562	62	mudstone & siltstone.
Eocene	Upper Knight Group	730	- 624	309	sandstone, siltstone, mudstone, lignite.
	Lower Knight Group	1039	- 933	435	coarse sandstone.
Lower Cretaceous	Upper unnamed unit	449 1474	-417 -1368	75	sandstone, siltstone, mudstone.
	Middle unnamed unit	1549	-1443	274	siltstone, mudstone.
	Lower unnamed unit (="basal sand")	1823	-1717	240	coarse sandstone.
Lower Permian	Unnamed unit	629 2063	-596 -1957	1297	shale - minor sandstone and siltstone.
Cambrian	Kanmantoo Group	1024 3360	-992 -3254	54+	phyllite
T.D.		3416 ft	-3311 ft		

4. Stratigraphy

Cuttings collected during the drilling were heavily contaminated by caving. Due to the soft nature of the rocks, a significant proportion of the argillaceous fraction was probably lost in washing and although allowances have been made for these features, some inconsistencies in lithological descriptions may persist.

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

Recent - Unnamed unit

The maximum thickness of this unit (97 feet) was penetrated in A.A.O. Sunset No.1.

It comprises sandstone, mudstone and in the top 40 feet, limestone.

Sandstone, white to red, variably very fine to mainly coarse grained, very friable to loose, quartzose. The grains are well rounded, well sorted and mainly of frosted quartz.

Mudstone, white to yellow, very soft.

Limestone, white to off-white to yellow, micro-crystalline, sandy, in part silicified and hard. It is rarely oolitic and pyritic.

It is quite possible that part of this section may range back to the upper Pliocene, but age determinations were not practicable. If this is the case the unit may include a number of formations (vide Parkin et. al. pp. 210 - 217).

Pliocene - (i) Loxton Sands

The thickness of this unit ranges from 278 feet in A.A.O. Sunset No.1 to 204 feet in A.A.O. Morkalla No.1 to 70 feet in A.A.O. Nadda No.1.

This unit comprises mainly sandstone with rare thin mudstone interbeds. It contains pelecypods in its basal 20 feet.

Sandstone, white, coarse to very coarse grained, friable to incoherent, quartzose. The grains are well rounded, well sorted and of clear quartz. Rare pyritic matrix has been observed.

Mudstone, white, in part mottled orange and red, slightly micaceous in part, soft. Rare lignite stringers are present.

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

(ii) Bookpurnong Beds

The unit is approximately 80 feet thick and is dominantly sandstone.

Although the cuttings from this section were logged mainly as a coarse sandstone of the type described in the Loxton Sands above, we believe this was caving and that the lithology was actually Sandstone, light grey, very fine to fine grained, tight, calcareous, felspathic, glauconitic, quartzose with a white clay cement which is in places gypseous. Pelecypod fragments are common.

Miocene - (i) Pata Limestone

The unit, approximately 70 feet thick, comprises sandstone, siltstone, mudstone and limestone in about equal proportions. Some of the coarse grained sandstone logged is quite possibly caving from the Loxton Sands above.

Sandstone (a) white, medium to coarse grained, friable, to incoherent, quartzose. The grains are well rounded, well sorted and of clear quartz.

(b) light grey, fine grained, tight, calcareous, felspathic, kaolinitic, glauconitic, quartzose.

Siltstone, light grey to fawn and rarely green, felspathic, glauconitic, quartzose.

Mudstone, white, light grey and dark grey, very calcareous grading to marl, in part glauconitic and pyritic.

Limestone, light grey, in part glauconitic, in part finely sandy, bioclastic, grading from a calcisiltite to a calcarenite.

(ii) Morgan Limestone

This unit has a near uniform thickness in the three wells (410 feet in A.A.O. Sunset No.1, 413 feet in A.A.O. Morkalla No.1 and 416 feet in A.A.O. Nadda No.1).

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

It is composed entirely of Limestone, white to light grey to fawn, fine grained, ranging from calcisiltite in calcarenite, bioclastic, in part silty, in part glauconitic. It is mainly soft, weakly cemented and porous but in part is hard and recrystallised.

A feature of this unit is the uniformity of the lithology.

Oligocene - Ettrick Formation

The Ettrick Formation is approximately 60 feet thick and comprises mainly mudstone in the upper 30 feet and interbeds of mudstone, siltstone and minor sandstone in the lower 30 feet.

Mudstone, grey, grey green and rarely red grey, soft, plastic, calcareous, glauconitic, locally very silty grading to siltstone, very pyritic.

Siltstone, grey, grey green and brown, soft, sandy, felspathic glauconitic, pyritic, quartzose.

Eocene - Knight Group

As the Knight Group is poorly defined in the literature we have the impression that "Knight Group" and "Eocene" are virtually synonomous. The introduction of the term "Renmark Beds" by Harris (1966) has not helped in clarification.

It is readily apparent that a two fold division of the Knight Group (sl) can be made. We have the impression that both the upper and lower limits of the Upper Knight Group are unconformable and that the lower Knight Group, whilst unconformably overlying the lower Cretaceous sequence, was a blanket sand of reasonably uniform thickness. Palynology supports this view (see Appendix 2).

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

If this conclusion is accepted, the terms Knight Group and "Renmark Beds" presently used are no longer applicable. We suggest that what is herein called the Upper Knight Group may be the Knight Group as originally defined. The Lower Knight Group would therefore have to be defined and renamed as a separate formation. We intend none-the-less to persist with the terms "Upper" and "Lower Knight Group" in this report as we consider the renaming of these units outside our scope.

(i) Upper Knight Group

This unit has a thickness variable from 495 feet in A.A.O. Sunset No.1 to 381 feet in A.A.O. Morkalla No.1 to 309 feet in A.A.O. Nadda No.1. In the first two wells, a rough three fold division is apparent, into an upper mudstone, a middle sandstone and a lower interbedded sandstone, siltstone mudstone. In A.A.O. Nadda No.1, the unit is dominantly sandy throughout and there is some difficulty in fixing its lower boundary. However in this well the upper mudstone and middle sandstone can be recognised.

The upper Mudstone (998 to 1168 feet in Sunset No.1, 915 to 1060 feet in Morkalla No.1, 730 to 830 feet in Nadda No.1) is variably red grey, light to medium grey and grey green, silty in part, slightly to moderately pyritic in part, moderately calcareous in part, soft and plastic throughout. Interbeds of Siltstone, light grey to grey green, soft, slightly sandy, felspathic, quartzose occur towards the base of this interval, particularly in A.A.O. Morkalla No.1.

Lignite beds are common.

The middle Sandstone (1168 to 1220 feet in Sunset No.1, 1060 to 1155 feet in Morkalla No.1, 830 to 1039 feet in Nadda No.1) is white, coarse grained, non cemented, quartzose. The grains are sub-rounded and well sorted.

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

The lower interbedded section (1220 to 1492 feet in Sunset No.1, 1155 to 1296 feet in Morkalla No.1) comprises Sandstone, white, fine to medium and rarely coarse grained, poorly cemented, slightly pyritic locally, slightly micaceous, quartzose. The grains are mainly well rounded and well sorted clear quartz.

Siltstone, medium grey to grey green to grey brown, soft, felspathic, slightly sandy, carbonaceous in part, locally calcareous mainly quartzose.

Mudstone, light to medium grey and grey green, silty, soft and plastic.

Lignite beds are common.

(ii) Lower Knight Group

This unit is approximately 610 feet thick at Sunset No.1 and Morkalla No.1 and comprises Sandstone fine but mainly medium to coarse grained, poorly cemented to incoherent, rare pyritic cement, quartzose. The quartz grains are mainly clear but in places are frosted, well rounded and well sorted. Rare yellow grains occur throughout. In Nadda No.1, where it is 435 feet thick, there are some white, milky quartz grains and the rock is slightly micaceous. Lignite streaks and stringers occur locally.

Lower Cretaceous

Rocks of lower Cretaceous age penetrated in these wells have been divided into three unnamed units. Knowledge of the lower Cretaceous of the Murray Basin is based wholly on subsurface information and formal nomenclature has yet to be proposed.

(i) Upper unnamed unit

As there is a marked unconformity between the top of this unit and the base of the Knight Group, its thickness is variable (494 feet at Sunset No.1, 307 feet at Morkalla No.1 and 75 feet at Nadda No.1). The unit comprises interbeds of sandstone, siltstone and mudstone in about equal proportions.

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

Sandstone (a), white, medium to coarse grained, variably poorly bonded with a white clay matrix to incoherent, quartzose. The quartz grains are clear, well sorted, variably sub-angular to mainly rounded. It is possible that the majority of these cuttings may be cavings from above.

(b), light to medium grey, fine grained, tight, very calcareous, quartzose. The grains are mainly of quartz and are well sorted and subangular. There are rare grains of felspar and dark chert.

Siltstone, medium grey, sandy in part grading to sandstone type (b) above, carbonaceous, quartzose. Rare detrital coal fragments were observed.

Mudstone, light to medium grey and grey brown, soft, rarely glauconitic locally.

(ii) Middle unnamed unit

The unit is approximately 250 feet thick and comprises mainly siltstone and mudstone with some coarse sandstone interbeds.

Siltstone, dark grey and grey brown, soft, carbonaceous, sandy, slightly to moderately pyritic in part, slightly micaceous locally.

Mudstone, dark grey brown, soft.

Sandstone, fine and medium but mostly coarse grained, poorly cemented, quartzose. The grains are well sorted and normally well rounded. The presence of fragments of phyllite may indicate that this sandstone is in places conglomeratic.

At A.A.O. Morkalla No.1, this unit rests unconformably upon Cambrian Kanmantoo Group.

(iii) Lower unnamed unit

This unit, known informally as the "basal Cretaceous sand" was the target in the three wells. It was not present at A.A.O. Morkalla No.1. At A.A.O. Sunset No.1, it was 168 feet thick and at A.A.O. Nadda No.1 240 feet thick.

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

As the informal name implies, it is Sandstone, white, medium to coarse to very coarse grained grading to a conglomerate of pebbles of milky quartz and rare phyllite to 10 m.m. diameter. It has a weak kaolinitic cement in places but is mainly unconsolidated in the main. The quartz grains are well sorted and subrounded when clear but milky grains are angular and fractured and are derived from the conglomeratic beds. Overall the rock is slightly pyritic.

There are very minor interbeds of shale, medium to dark grey and slightly carbonaceous.

Overall, the unit has excellent effective porosity and permeability. Drill Stem Test No.1 in A.A.O. Sunset No.1 shows that formation pressure was reached in 30 minutes.

This unit rests unconformably on Cambrian Kanmantoo Group in A.A.O. Sunset No.1 and disconformably on a Permian section in A.A.O. Nadda No.1.

Permian

(i) Unnamed unit

Again, little is known of the Permian of the Murray Basin and formal nomenclature has yet to be proposed.

Rocks of Permian age were penetrated in A.A.O. Nadda No.1 between 2063 and 3360 feet (1297 feet). They rest unconformably on Cambrian Kanmantoo Group.

This unit is mainly argillaceous with some siltstone and sandstone interbeds increasingly evident basally.

Shale, variably light to mainly dark grey, soft to moderately hard, micromicaceous. The shale grades to Mudstone, medium to dark grey, silty, micromicaceous, non fissile. Both the shale and mudstone contain erratic grains (mainly of coarse sand size) of quartz and rarer granite and schist. These erratic grains are more common in the mudstone.

IV. GEOLOGY (contd.)

4. Stratigraphy (contd.)

Siltstone, white to very light grey, even grained, soft to firm, entirely quartzose. Sand sized erratic grains are present.

Sandstone, white to light grey, mainly very fine grained and tight, but locally medium grained and slightly porous, calcareous in part, rarely biotitic, slightly micaceous, quartzose. The grains are angular and set in a white argillaceous, slightly pyritic matrix. Streaky porosity and permeability are indicated between 3242 and 3302 feet by filter cake build up on the Micro-caliper and positive separation of the Microlog curves. Nett porosity is 21 feet.

Previous workers in the Murray Basin have considered this Permian section to be marine and to have been affected by glacial processes. We have not seen any evidence to point to a marine origin of the section penetrated in A.A.O. Nadda No.1, but the presence of erratic grains throughout the section would tend to confirm the effect of glaciation.

Cambrian

(i) Kanmantoo Group

This unit has been taken as local economic basement. It consists of steeply dipping low grade metapellites, described variously as slate, phyllite and schist.

Correlations between A.A.O. Sunset No.1, A.A.O. Morkalla No.1 and A.A.O. Nadda No.1 together with correlation to wells previously drilled in the Murray Basin, are presented on Enclosure 2.

IV. GEOLOGY (contd.)

5. Structure

The north-western portion of the Murray Basin comprises the following elements from the north-west.

(i) Canegrass Lobe

(ii) Renmark Trough

(iii) Paringa Embayment

The Paringa Embayment is bounded to the west by the Loxton High, to the east by the Meringur High and is nearly bisected by the north-west trending Sunset High (Figure 3).

Within the Paringa Embayment, the Permian, Cretaceous and Tertiary sediments are tectonically undisturbed but exhibit gentle warpings sympathetic with the basement palaeotopography. Closed high structural features have not been found in these overlying sediments.

A Basement contour map (established from the Sunset Seismic Survey) is presented with this report as Enclosure 1. This map has not been changed as a result of drilling, and the depth shown in the P.E.P. 64 portion of the area may be too deep by an error of up to 10%, while in the deep incised valleys in the P.E.L. 3 area, the presence of a low velocity layer within the unexpected Permian section (see section 7), may add up to 350 feet to section below the -2500 feet contour.

6. Relevance to Occurrence of Petroleum

No significant evidence of hydrocarbons was found in the present drilling programme. A few minor shows of methane were recorded in the Permian section in A.A.O. Nadda No. 1 but these are not of any significance.

A representative set of samples from the Cretaceous and the Permian from the three wells was submitted for source rock analysis (Appendix 1).

It was concluded that only the middle unnamed unit of the Lower Cretaceous had the necessary parameters to classify it as a source rock. Rather surprisingly, the Permian samples submitted did not qualify as source rocks.

IV. GEOLOGY (contd.)

6. Relevance to Occurrence of Petroleum (contd.)

The target basal Cretaceous sand was found in both A.A.O. Sunset No.1 and A.A.O. Nadda No.1. A drill stem test of this sand in A.A.O. Sunset No.1 confirmed that it possessed excellent reservoir characteristics and that it contained salty water. The log character of this sand in A.A.O. Nadda No.1 suggests that a drill stem test there would have led to the same results.

7. Contributions to Geological Concepts resulting from Drilling

The section penetrated in the three wells was mainly as anticipated. The target "basal Cretaceous Sand" was penetrated in both A.A.O. Sunset No.1 and A.A.O. Nadda No.1, and in both wells it was porous and permeable as predicted. The sand was not present in A.A.O. Morkalla No.1.

An unexpected section of lower Permian sediments was penetrated in A.A.O. Nadda No.1. The extent of this Permian section is difficult to assess. However, it is reasonable to assume that section deeper than the -2000 feet contour on the basement horizon map is Permian. A low velocity layer, indectable by the refraction seismic method, appears at -2550 feet (approximately). This layer is 360 feet thick at A.A.O. Nadda No.1 and is apparently present in similar valley situations adjacent to the Nadda location.

It does appear that the term "Knight Group" has been applied in the past in too loose a manner. There is little doubt that the section commonly designated "Knight Group" can be divided into upper and lower units which are separated by at least a disconformity and probably by an unconformity. Although the use of this term is continued in this report, it is desirable that the nomenclature be revised.

8. Porosity and Permeability

With the exception of the Permian section penetrated in A.A.O. Nadda No.1, the unconsolidated nature of the sandstone units indicated high porosity and permeability values. Log and pressure data interpretation confirm that this is the case (vide Appendix 6 and 7).

IV. GEOLOGY (contd.)

8. Porosity and Permeability

The major reservoirs are the sandstones of the lower Knight Group and the "basal Cretaceous sand".

		Av.ϕ	Av.k	
(1)	Lower Knight Group	40%	?	
(2)	"basal Cretaceous sand"	38%	2000 md.	(Sunset No.1)
		26%	?	(Nadda No.1)

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APPENDIX 1

SOURCE ROCK EVALUATION

INTRODUCTION

The present report concerns the study of the following ten core samples :

A.A.O. Sunset n° I :
SWC's 23/2I46', 2I/2303', I9/2395', I7/2523', 9/2895'

A.A.O. Morkalla n° I :
SWC's 9/2215', 7/2330', 5/2380'

A.A.O. Nadda n° I :
Core I/25IO', 2/3I4I'

The results are presented as follows :

__Ist section :__ INTERPRETATION :
a) Method
b) Results

__2nd section :__ RESULTS OF ANALYSES (raw results)

__3rd section :__ GLOSSARY (of terms and symbols used in the text and tables)

The interpretation may be summarized as follows :

I) Sunset n° I : None of the samples has enough organic material to be a source rock. However the conditions are right and the organic matter is the only wanting parameter.

2) Markalla n° I : Sample 5/2380 shows a good source rock potential.

3) Nadda n° I : The two samples do not show any source rock potential, they seem to contain rather immature organic material.

I - INTERPRETATION

I - a) METHOD OF INTERPRETATION.

The raw measurements resulting of a series of analyses are first transformed into a set of characteristics depicting the relative amount of organic material, its nature and degree of evolution. The interpretation of the transformed data is a process whereby a number of main parameters are compared to some criteria while secondary parameters are used to clear up ambiguities.

A. MAIN PARAMETERS.

(I) The main parameter is the content in organic matter. If the content in organic material is too low in the formation under study, its interest as a source rock is not worthwhile.

The content in organic matter is measured in term of percentage of organic carbon equivalent. This value is referred to as Ct.

Lower limits for Ct have been set at 0.24 % for carbonated formations and at I.I4 % for shaly formations.

(2) Only a small amount of hydrocarbons generated in a source rock migrates out of the sediment through primary migration. The larger part of the hydrocarbons remains trapped in the source rock. It is therefore important to know the amount of hydrocarbons left in the source rock. These hydrocarbons are extracted with a solvent (namely chloroform which is specific to hydrocarbons).

The content of chloroform soluble organic material is measured in term of percentage of carbon equivalent. This value is referred to as Cs.

Provided that Ct is large enough, the ratio Cs/Ct should be larger than 3 % if a rock is to have good source rock qualities.

(3) NOTE I : During the chloroform extraction, all light hydrocarbons are lost.

NOTE 2 : The maturation of the organic matter under increasing temperature and pressure leads to a cracking (so called cometamorphism) the end product of which are methane and graphite.

(4) Referring to NOTE 2 of paragraph (3) above, any organic matter which has gone through a maturation process, has been partly transformed into a graphite like material.

.../...

The degree of graphitization (or carbonization, or maturation) is measured by the celebrated CR/CT ratio where :

- CT is the amount of carbon equivalent to the organic matter insoluble in chloroform. It is the amount left after the soluble carbon Cs has been extracted,

- CR is the amount of carbon equivalent to the residue remaining after the unsoluble organic matter has been pyrolized. The graphite is not volatile at the pyrolizing temperature, consequently the ratio CR/CT is a carbonization index.

When the unsoluble matter is graphite, then CR/CT = 100 %. A fair degree of maturation is indicated by a value of CR/CT of about 75 %. When an organic matter has reached this state of maturation, one can expect that it has produced a large amount of hydrocarbons, qualitatively (all types) as well as quantitatively.

(5) NOTE 3 : An organic matter deposited in an oxydizing environment would also have a high percentage of graphite like material (e.g. coal seams) hence a high CR/CT ratio, but it would generally be a poor source rock. Thus additional parameters are necessary.

B. SECONDARY PARAMETERS.

(I) As mentioned before, the light (viz. gaseous) hydrocarbons are lost during the chloroform extraction. To compensate for this defect, the so-called sorbed hydrocarbons are extracted. The ratio Cg/Ct is then derived, in a similar way as done for Cs/Ct. It is the ratio of sorbed gas carbon equivalent to total organic carbon.

This ratio has been subjected to less study that the Cs/Ct ratio. Moreover, the amount of gas recovered (and therefore Cg) depends on the lithology of the sediment (e.g. the amount and type of carbonates) and on the origin of the gas (e.g. migratory or in-situ). However, it gives an idea of the relative amount of organic matter which may have evolved into light hydrocarbons.

(2) Two parameters are considered here : C2/CI and C3+/CI, or the ratios of sorbed ethane to sorbed methane and of sorbed propane plus sorbed butanes to sorbed methane. The ratios minimize the effect of the lithology on the desorption process, they show the relative importance of methane in the light hydrocarbon fraction.

Again, these two ratios have been subjected to limited studies. However, they allow to propose working hypotheses of the following type :

- If CR/CT is very large (83 % and above) and C2/CI, C3+/CI are very low (less than 0.00I), then most likely the deposition of the primary organic matter was done in an oxydizing environment.

- If C3+/CI is large, if Cs/Ct is very large (above IO % in shaly or sandy formations) and if there is a poor correlation between Ct and (C2/CI, C3+/CI), then very likely the gas and the liquid hydrocarbons in the sediment are of migratory origin.

I - b) RESULTS OF THE INTERPRETATION.

The set of interpretative characteristics (parameters) which have been derived from the results of the chemical analyses run on the samples, is shown on TABLE N° I.

It should be emphasized that the results presented hereunder constitute the first stage of the interpretation. To obtain the full results, the geological environment and the past geological history of each sample should be taken into account.

A.A.O. SUNSET N° I.

None of the samples taken in SUNSET N° I contain enough organic material to qualify as source rocks.

However, the following interesting remarks can be made :

1) for all the samples, the CR/CT ratio is in the range where good maturation of the organic matter can be expected.

2) the relative amount of chloroform-soluble material is quite high (high Cs/Ct). However, it should be understood that the absolute amount (Cs) is naturally quite low.

3) There is a positive correlation between the variation of CR/CT and the variation of Cs/Ct (correlation coefficient of 0.82). Therefore an increase in CR/CT corresponds to an increase in Cs/Ct.

4) There is a negative correlation between CR/CT and Cg/Ct, that is : an increase for CR/CT corresponds to a decrease for Cg/Ct.

5) From the four above remarks, it can be tentatively concluded that, should the organic matter had been present in larger quantity, the samples would have had a good source rock potential.

6) The CR/CT ratio shows an increase with depth for the first two samples then decreases for the two following ones then increases again. This unusual behaviour can be checked by examining the variation of an independant index viz. the C3+/CI ratio. There is a negative correlation between CR/CT and C3+/CI (when CR/CT increases, C3+/CI decreases that is methane becomes more important). This tends to prove that the observed variation of CR/CT is correct.

.../...

N°	Carb %	Ct %	$\frac{Cs}{Ct}$ %	$\frac{Cg}{Ct}$ %	$\frac{CR}{CT}$ %	$\frac{C2}{CI}$	$\frac{C3+}{CI}$	$\frac{Ct-C}{C}$ %
SUNSET N° I								
23/2I46	I	0.607	7.25	0.0005	73.53	0.I700	0.I029	-46.75
2I/2303	I	0.75I	I0.65	0.0004	76.I5	0.I496	0.0946	-34.I2
I9/2395	I	0.293	7.I7	0.00I0	58.09	0.I93I	0.I93I	-74.30
I7/2523	I	0.I3I	4.58	0.004I	57.80	0.3I96	0.2387	-88.5I
9/2895	I	0.370	9.73	0.0023	78.74	0.2366	0.I946	-67.54
MORKALLA N°I								
9/22I5	I	I.390	0.72	0.000I	69.86	0.I692	0.II70	+2I.93
7/2330	I	I.495	I.34	0.0002	77.49	0.I665	0.2I94	+3I.I4
5/2380	I	I.657	3.92	0.000I	82.I6	0.II96	0.059I	+45.35
NADDA N° I								
I/25I0	I	0.I66	8.43	0.0034	42.76	0.I642	0.0735	-85.44
2/3I4I	I	0.III	I5.32	0.0049	43.62	0.I396	0.0638	-90.26

C = 0.24 Carb ≤ 45 %
C = 0.52 20%≤Carb < 45 %
C = I.I4 20%<Carb <

TABLE I - INTERPRETATIVE DATA

The fact that a relatively immature horizon is imbedded in a zone where maturation increases normally with depth should be related to the geological history of the basin.

A.A.O. MORKALLA N° I.

The three samples from Morkalla n° I have sufficient content in organic material together with an adequate degree of maturation (CR/CT). However only sample 5/2380 shows a good Cs/Ct ratio. Therefore only sample 5/2380 can be deemed to be a source rock.

The following remarks can be made :

1) the CR/CT ratio increases sharply with depth.

2) the highest value for CR/CT corresponds to the lowest value C3+/CI (methane is more important than heavier homologues).

3) Cg/Ct is extremely small (for all samples).

It can be tentatively concluded that the organic material has evolved toward rather heavy oil although the carbonization index is high.

A.A.O. NADDA N° I.

The two samples from Nadda n° I do not have enough organic material to qualify as source rocks. Moreover their CR/CT ratio is on the low side while their C2/CI and particularly C3+/CI ratios are small. This is indicative of immature organic matter and it is quite possible that the chloroform soluble fraction contain more lipidic material than hydrocarbons. It should be noted that the relative amount of soluble matter is rather high.

.../...

RESULTS OF ANALYSES (RAW RESULTS)

The results of the different chemical analyses are shown on TABLE 2 herewith attached.

It is from these figures that the set of interpretative parameters shown in TABLE I has been computed.

N°	C I	C 2	C 3	iC 4	nC 4	Ct	CT	Cv	Carb
SUNSET N° I									
23/2I46	34.70	5.90	2.I7	0.44	0.96	0.607	0.563	0.I49	I
2I/2303	37.43	5.60	2.33	0.43	0.78	0.75I	0.67I	0.I60	I
I9/2395	28.69	5.72	3.43	0.52	I.59	0.293	0.272	0.II4	I
I7/2523	44.08	I4.09	6.85	0.82	2.85	0.I3I	0.I25	0.059	I
9/2895	80.3I	I9.00	8.27	2.34	5.02	0.370	0.334	0.07I	I
MORKALLA N° I									
9/22I5	I3.42	2.27	0.96	0.I9	0.42	I.390	I.380	0.4I6	I
7/2330	3I.36	5.22	3.48	I.28	2.I2	I.495	I.475	0.332	I
5/2380	27.43	3.28	I.08	0.I5	0.39	I.657	I.592	0.284	I
NADDA N° I									
I/25I0	72.78	II.95	3.49	0.40	I.46	0.I66	0.I52	0.087	I
2/3I4I	72.4I	I0.II	3.I6	0.56	0.90	0.III	0.094	0.053	I

TABLE 2 - RESULTS OF ANALYSES

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III - GLOSSARY

The present paragraph is a summary of the symbols encountered in the text and the tables.

Carb	amount of carbonates in sample, expressed in %.
Ct	amount of organic carbon present in sample, expressed in %. *Ct* is proportional to the amount of organic material.
CT	amount of organic carbon present in the organic material which is not soluble in chloroform (expressed in %).
Cv	amount of organic carbon corresponding to the fraction of unsoluble material which is volatile at a pyrolizing temperature of 900° C (expressed in %).
Cs	*Cs = Ct - CT*, amount of organic carbon corresponding to the organic matter soluble in chloroform, that is mainly hydrocarbons and fatty material (expressed in %).
CR	*CR = CT - Cv*, amount of organic carbon corresponding to the organic matter which is not soluble in chloroform and not volatile at 900° C.
CR/CT	maturation ratio showing the degree of carbonization of the unsoluble organic material (expressed in %).
Cs/Ct	relative amount of chloroform extract (expressed in %).
CI, C2, C3, iC4 nC4	amount of sorbed gases, respectively methane, ethane, propane, iso-butane and n-butane (expressed in microliter (of gas) per kilogramme (of sediment).
Cg	amount of organic carbon corresponding to the amount of sorbed gases (that is CI + C2 + C3 + iC4 + nC4)
Cg/Ct	relative amount of gas (expressed in %)
C2/CI	ratio of ethane content to methane content.
C3+/CI	ratio of propane plus butanes to methane content.
C	average organic carbon content of sediments. *C* is 0.25% for carbonates and I.I4% for shales.
(Ct-C)/C	relative organic carbon content with respect to the average When this ratio is strongly positive, the sediment contains a high amount of organic material relatively to the average.

APPENDIX 2

MINES ADMINISTRATION PTY. LIMITED

PALYNOLOGIC LABORATORY

REPORT NO. 134-136/1

A.A.O. SUNSET NO.1, A.A.O. MORKALLA NO.1, A.A.O. NADDA NO.1.

By:

R.J. Paten & P.L. Price

I. INTRODUCTION

Seventy-five sidewall and two conventional cores from A.A.O. Sunset No.1, A.A.O. Morkalla No.1 and A.A.O. Nadda No.1 were submitted for palynologic examination. Seventy-two samples were considered suitable for processing; of these, sixty-two yielded microfloral assemblages. The presence of Lower Cretaceous and Lower Tertiary sequences was confirmed in all three wells while Lower Permian rocks were identified from beneath the Cretaceous sequence at Nadda No.1.

The Tertiary and Cretaceous sediments were poorly consolidated but sidewall cores taken in them remained coherent. This permitted successful removal of mudcake and no contamination by mud-borne microfossils was recognised in these sections. Some contamination by Tertiary elements was observed in assemblages from sidewall cores from the Lower Permian unit at Nadda. Presumably this was caused by mud invasion of microfractures in the samples. This contamination was exaggerated by the extremely low microfossil yields obtained from this unit.

Most samples from the Cretaceous and Tertiary sequences yielded abundant palynomorphs with the assemblages containing a wide variety of species. All samples from the Upper Palaeozoic rocks gave very low yields with restriction in the number of species present.

APPENDIX 2 (contd.)

I. INTRODUCTION (contd.)

The Cretaceous and Tertiary microfossils were generally well preserved. Those from arenaceous and coaly strata displayed slight corrosion and included a high proportion of fractured grains. Microfossils from the Permian rocks were mostly well preserved with the more robust forms showing a slight increase in pigmentation.

II. MICROFLORAL DISTRIBUTION

The distribution of plant microfossils observed in this study is outlined in Figures 1, 2 and 3. Where practicable described species only have been recorded although many new forms were present particularly in the Tertiary and Cretaceous sequences.

Saccate pollen were common in all samples from Cretaceous and Tertiary strata, but were not identified as little floristic change was observed within each section.

No attempt was made to identify the dinoflagellates present. Those from the Cretaceous of the Murray Basin have been recorded elsewhere (Evans and Hawkins, 1967) and the assemblages isolated in the present study appear to be compatible with the earlier observations. Those from the base of the Knight Group appear morphologically similar to Deflandrea while the dinoflagellates from the Ettrick Formation are mainly hystrichosphaerids.

III. DISCUSSION

(i) Basement

The five sidewall cores taken in basement rocks at Sunset No.1 proved barren of microfossils. Consequently no estimate of the age can be given from this study.

(ii) Lower Permian

An Upper Palaeozoic microflora was recorded from the unnamed sediments overlying basement and underlying the Lower Cretaceous sequence at Nadda No.1. Sixteen sidewall and two conventional core samples were studied giving a detailed coverage of the whole section (Figure 3).

APPENDIX 2 (contd.)

III. DISCUSSION (contd.)

The following features of the microflora from the unit are noteworthy: (a) the very low yield of microfossils from all of the samples and the lack of specific diversity in the assemblages, (b) the prominence of large monosaccate pollen, mainly Parasaccites, (c) the common occurrence of monocolpate pollen including one very large fusiform species, (d) the abundance of acritarchs attributable to the Sphaeromorphitae in most samples and (e) the rarity of striate bisaccate pollen which were present in one sample only (S.W.C. 2248') towards the top of the section.

The character of the microflora changes little throughout and an age somewhere in the range uppermost Carboniferous to early Permian is indicated. As such, the sequence is referred to some part within stages 1 and 2 of Evans (1967). As outlined by Evans, the boundary between stages 1 and 2 is defined by the introduction of striate bisaccate pollen (i.e. the palynologic expression of the incoming of the Glossopteris Flora). This is taken also as the Carboniferous/Permian boundary.

Thus by applying Evans' parameters, the section above the apparent incoming of striate bisaccate pollen, i.e. above 2248 feet, is Lower Permian in age and the sequence below 2248 feet could be Upper Carboniferous. We are reluctant to accept the Upper Carboniferous age in this case. It is considered likely that the presence or absence of striate pollen may be related to the low yield and restricted nature of the microflora or to environmental influences rather than to evolutionary changes within the flora. In support of this no striate pollen were observed in the four samples above 2248 feet. The whole of the sequence therefore is referred tentatively to the Lower Permian and stage 2 pending positive evidence that the lower part is Upper Carboniferous.

APPENDIX 2 (contd.)

III. DISCUSSION (contd.)

Sequences with a similar microflora to that at Nadda appear to be widespread beneath the Murray Basin and have been discussed by various authors. Evans (1967) referred these sequences to the Lower Permian and stage 2 also. He noted the presence of Sphaeromorphitae (leiosphaerids) and foraminifera which he accepted as indicating "ephemeral brackish or marine" conditions. These conditions appear to have prevailed at Nadda.

The closest recorded occurrences of comparable rocks to Nadda are at North Renmark No.1 (Harris in Grasso (1963)) and B.P.N.L. Monash No.1 (Harris 1965). It is not possible using the available palynology to propose detailed correlations between the Nadda, North Renmark and Monash Permian sequences. However the assemblage recorded by Harris from 4010 feet near the base of the North Renmark section (incomplete) appears more diverse than those at Nadda. From its general character it may be from a slightly younger horizon. If so, this part of the sequence is absent at Nadda, presumably removed by up-dip truncation.

(iii) Lower Cretaceous

A Lower Cretaceous microflora was recovered from the Lower, Middle and Upper Unnamed Units in Sunset, Morkalla and Nadda. These are overlain by the Knight Group (Lower Tertiary) and overlie basement except at Nadda where they succeed Lower Permian rocks. The Lower Cretaceous palynostratigraphy of the Murray Basin was reviewed by Evans and Hawkins (1967) and the findings of the present study conform in general with their observations. They discussed the section in terms of the informal palynologic units (K1, K2 etc.) proposed by Evans (1966). In this report we have chosen to use the formal nomenclature proposed by Dettmann and Playford (1969). The relationship between the two nomenclatures is given in Dettmann and Playford (1969 Table 9.3).

APPENDIX 2 (contd.)

III. DISCUSSION (contd.)

From data presented by Dettmann and Playford (1969) it appears that the sequence sampled ranges from Aptian to Albian in age. It is considered most unlikely that any of the sequence is pre-Aptian in age contrary to the suggestion in Parkin (1969, p. 159).

Dettmann and Playford (1969) erected a series of Spore-Pollen Zones for the Australian Cretaceous sequence. In the present study the Cyclosporites hughesi and Crybelosporites striatus Subzones of the Dictyotosporites speciosus Zone and the Coptospora paradoxa Zone have been identified. The relationship between these biostriatigraphic zones and the lithostratigraphy is shown in Enclosure 2 of the main report.

Cyclosporites hughesi Subzone

Dettmann and Playford (1969 Table 9:5) did not record this Subzone from the Murray Basin. This study has shown it to be present in all three wells. It is characterised by the presence of C. hughesi and D. speciosus in the absence of Crybelosporites stylosus and C. striatus. It is the oldest Cretaceous palynostratigraphic unit so far recognised in the Murray Basin, and unconformably overlies Palaeozoic rocks in the three wells. It is much thicker at Nadda and Sunset than at Morkalla reflecting the absence of the basal sandstone unit in the latter well.

Crybelosporites striatus Subzone

This Subzone is defined on the occurrence of D. speciosus and C. striatus in the absence of C. paradoxa. It is present in all three wells and succeeds the C. hughesi Subzone and underlies the C. paradoxa Zone without obvious hiatuses. As far as can be resolved the unit shows no marked variation in thickness in the three wells studied. Furthermore its boundaries approximately parallel those of the lithostratigraphic units.

APPENDIX 2 (contd.)

III. DISCUSSION (contd.)

Coptospora Paradoxa Zone

In the area studied the Zone can be recognised by the presence of C. paradoxa. The upper part of the Zone is missing in the three sections investigated. It is the youngest palynostratigraphic unit so far recognised in the Murray Basin and is succeeded unconformably by the Lower Tertiary Knight Group. Truncation of the Cretaceous rocks at the unconformity has removed the Zone almost completely at Nadda, partially from Morkalla and to a lesser extent from Sunset. This erosion pattern, although established from limited control, points to gentle upwarping in the southern part of the area after the deposition of the C. paradoxa Zone and before the beginning of Tertiary sedimentation.

Dinoflagellates were recorded from the Middle Unit and the uppermost part of the Lower Unit of the Cretaceous sequence (Enclosure 2 of the main report) indicative of a probable marine environment of deposition from this part of the succession. This is supported by the presence of dinoflagellates and foraminifera in comparable positions in other wells in the Murray Basin.

(iv) Lower Tertiary

From a detailed study of the microflora of the Knight Group in the Company Bore (18 miles west-south-west of Sunset No.1), Harris (pers. comm.) concluded that the unit was Lower Tertiary (Paleocene to Eocene) in age. The present study covered both the Knight Group and the succeeding Ettrick Formation (Enclosure 2 in the main report). Our observations agree fairly closely with those of Harris although we were unable to find firm evidence of Paleocene strata. Harris regarded the basal part of the Group as Paleocene following his recognition of the Gambierina edwardsii Zonule (M.S.) in that part of the section. This may mean that the base of the Group is older at the Company Bore than in the section studied herein. However our failure

III. DISCUSSION (contd.)

to record this Zone may have resulted from inadequate sample coverage.

Harris (1970) has defined a series of palynologic zonules through the Tertiary succession in the Otway Basin which clearly includes correlatives of the Knight Group and Ettrick Formation. We have been unable to apply this system to the present investigation partly because of sample distribution, but mainly because it relies heavily on as yet undescribed species. Several of these species were tentatively identified from photographs provided by Harris e.g. Proteacidites confragosus but in the absence of supporting diagnoses it was felt unwise to persevere with the system for the time being. Accordingly, pending publication of Harris' paper, the microfloras are considered in terms of the containing formations.

Knight Group

Three broad microfloral associations have been recognised on the basis of gross characters. The lower association seen in S.W.C. 1809 feet at Morkalla and S.W.C. 1953 feet at Sunset in the basal part of the unit contains proteaceous elements with characteristically few Nothofagidites. Both these samples contained a swarm of identical Deflandrea-like dinoflagellates which may prove to have correlative value in future studies. The middle association was observed in the remainder of the Lower Knight Group and the lower half of the Upper Knight Group in Morkalla and Sunset. In Nadda it was apparently restricted to the Lower Knight Group. The microflora is characterised by an extremely abundant and diverse proteaceous and Nothofagidites content. The upper association occurs in the remainder of the Upper Knight Group. It witnesses an increase in diversity of pteridophytic elements. Nothofagidites remain fairly common and diverse, but the proteaceous elements decline in importance. It is emphasised that these

APPENDIX 2 (contd.)

III. DISCUSSION (contd.)

associations are extremely subjective but it is worth noting that Harris (pers. comm.) has observed similar broad relationships for the Eocene of the Otway Basin.

While no detailed microfloral zonation has been attempted, one feature of the microflora of the Knight Group appears to have stratigraphic importance. A zone containing a form comparable, if not conspecific with, *Triorites magnificus* was recognised within the lower part of the Upper Knight Group in all three wells. This species differs from the figured specimens of *T. magnificus* in being slightly smaller and in having a thinner exine showing finer ornamentation of its outermost layer. The zone represented by the range of this species probably corresponds with the *T. magnificus* Zonule of Harris (1970).

The distribution of this zone is shown on Enclosure 2 of the main report. As illustrated, it shows strong thinning from Morkalla to Nadda, being identified in only one sample in the latter well. This sample is believed to represent an upper part of the zone not recognised in either Sunset or Nadda because of poor sample distribution. This belief is founded on the appearance in the Nadda sample of *Kulyisporites* sp. cf. *K. waterbolki* in the upper pteridophytic association outlined above. This species was not identified in samples from the other wells. Accepting this argument, the lower portion of the zone as identified at Sunset and Morkalla is absent at Nadda. This suggests an hiatus within the Knight Group in the area studied corresponding with the change in facies from sandstone in the Lower Knight Group to interbedded sandstone, claystone and lignite in the Upper Knight Group. This suggestion is strongly supported by log correlation between the three wells.

APPENDIX 2 (contd.)

III. DISCUSSION (contd.)

Ettrick Formation

The establishment of marine conditions in the Ettrick Formation witnessed a dramatic change in the microflora. The abundant land-derived microfossils of the Knight Group were replaced by a marine hystrichosphaerid dinoflagellate assemblage with few spores and pollen. Foraminifera were observed in the samples prior to processing. The dinoflagellates present are long-ranging but from foraminiferal evidence from elsewhere in the basin Ludbrook (1961) concluded that the formation was Oligocene in age.

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APPENDIX 2 (contd.)

IV. REFERENCES (contd.)

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CORE LABORATORIES, INC.
Petroleum Reserve Engineering
DALLAS, TEXAS
WATER ANALYSIS

File ~~CL-E255~~

Company MINES ADMINISTRATION Well Name A.A.O. SUNSET NO. 1 Sample No.

Formation Depth 2783-3287 Sampled From ~~D.S.T. NO. 1~~

Location Field WILDCAT County VICTORIA State AUSTRALIA

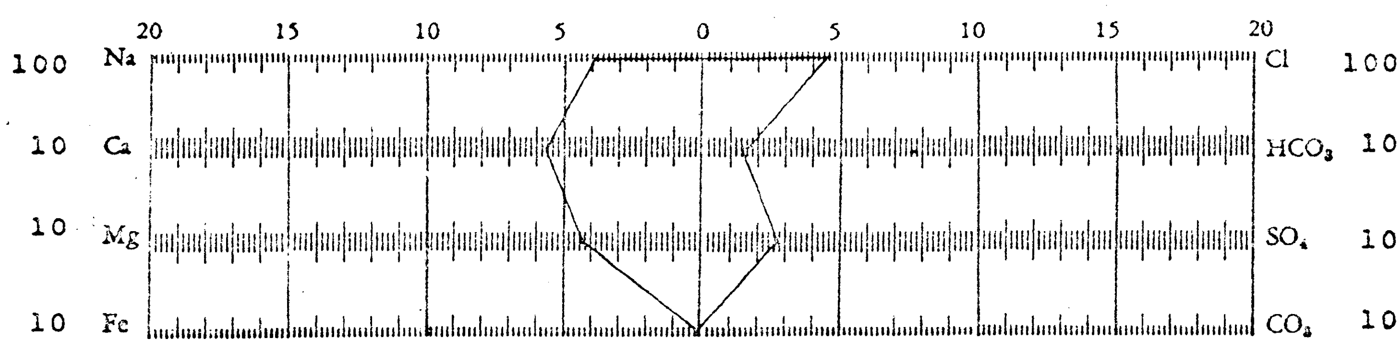
Date Sampled Date Analyzed 22 APRIL 1970 Analyst AAL

Total Dissolved Solids 30,000 mg/L CALC. Specific Gravity 1.0184 @ 71 °F.

Resistivity 0.3 ohm-meters @ 70 °F. Hydrogen Sulfide ABSENT

pH 7.9 @ 71 °F.

* Constituents	meq/L	mg/L	Constituents	meq/L	mg/L
Sodium	401.88	9223.00	Chloride	460.56	16,326.11
Calcium	57.20	1146.29	Bicarbonate	15.80	964.07
Magnesium	44.80	544.59	Sulfate	27.85	1,337.60 (Grav.)
Iron	0.43	12.00	Carbonate	--	--
Barium	--	-- (Grav.)	Hydroxide	--	--



Scale: meq/L

* All analyses except iron determination performed on a filtered sample.

APPENDIX 3 (contd.)

WATER ANALYSIS

Carried out by Bureau of Mineral Resources

Well Name:	Sunset No.1
Test No.:	D.S.T. No.1
Depth interval (feet):	2783 - 3287 feet.
pH:	6.5
Resistivity (OHM-meters @ 74^{o}F):	0.22
Salinity (ppm NaCl):	28000
Total dissolved solids (ppm):	32000

APPENDIX 4

SAMPLE DESCRIPTIONS

A : A.A.O. SUNSET NO.1

Depth	%	Description
0 - 10		-
10 - 20	60	Sandstone - very fine to coarse, individual quartz grains, mostly well rounded and frosted. The very fine grains are red iron stained.
	40	Limestone yellow, microcrystalline with abundant fine angular quartz grains in part. Rare gastero-pod fragments.
30	70	Sandstone) as above.
	30	Limestone) as above.
40	20	Sandstone - as above.
	70	Mudstone - light yellow to white, very soft and friable; even grained.
	10	Limestone.
	Trace	Large euhedral pyrite crystals, large white mica flakes. Some dark (?)quartzite fragments from (?)conglomerate.
50	70	Sandstone white, fine to coarse, rounded, individual quartz grains; some frosted; some red iron stained.
	30	Limestone white to light yellow; consists entirely of medium to coarse grained spheres with concentric structures. Some built around quartz grains ?oolites.
60	60	Sandstone fine to coarse, individual, rounded, frosted quartz grains.
	40	Mudstone light yellow to dirty white; very soft.
70	90	Sandstone) as above.
	10	Mudstone) as above.
80	70	Sandstone) as above.
	30	Mudstone) as above.

Depth	%	Description
90	10	Sandstone - as above.
	90	Mudstone - dirty white, translucent, fairly hard to soft with some sand grains.
100	20	Sandstone) as above.
	80	Mudstone)
110	100	Sandstone mainly clear coarse individual well rounded well sorted, frosted grains of quartz.
120	100	Sandstone - as above.
130	100	Sandstone - as above.
140	100	Sandstone - as above.
150	100	Sandstone - as above.
160	100	Sandstone - as above.
170	100	Sandstone - as above.
180	100	Sandstone - as above.
190	100	Sandstone clear, coarse, well rounded, well sorted, frosted quartz grains.
200	100	Sandstone - as above.
210	100	Sandstone - as above.
220	100	Sandstone - as above.
230	100	Sandstone - as above.
240	100	Sandstone - as above.
250	100	Sandstone - as above.
	Trace	Mudstone white, very soft.
260	100	Sandstone) as above.
	Trace	Mudstone
		(Mudstone has patchy orange-red colouration in part).
270	100	Sandstone - as above.
280	100	Sandstone - as above.
290	100	Sandstone - as above.
300	100	Sandstone - as above.
310	100	Sandstone - as above.

Depth	%	Description
320	100	Sandstone - as above.
330	100	Sandstone - as above.
340	100	Sandstone - as above.
	Trace	Shell fragments (non-calcareous).
350	100	Sandstone coarse to very coarse grained. Fair sorting of the subrounded clear to grey quartz grains.
	Trace	Shell fragments - pelecypods etc. (calcareous).
360	100	Sandstone - as above.
	Trace	Shells.
370	100	Sandstone coarse to very coarse, mainly well rounded, well sorted, individual grains of clear quartz.
380	100	Sandstone as above with rare yellow coated quartz grains.
	Trace	Shell fragments ?echinoid.
390	100	Sandstone - as above.
	Trace	Shells.
400	100	Sandstone - as above.
410	100	Sandstone - as above - becoming slightly finer grained.
420	100	Sandstone coarse, well sorted, sub-rounded to rounded, individual grains of clear quartz.
430	100	Sandstone - as above.
440	100	Sandstone - as above.
	Trace	Green calcareous siltstone.
450	100	Sandstone - as above.
460	100	Sandstone - as above.
	Trace	Very rare shell fragments.
470	100	Sandstone as above with trace of very fine grained well cemented "salt & pepper" sandstone.

Depth	%	Description
480	100	Sandstone - as above with traces of "salt & pepper" sandstone as above.
	Trace	Green siltstone.
	Trace	Shell fragments including pelecypods.
490	100	Sandstone - as above.
	Trace	Shells, calcareous "salt & pepper sandstone", green claystone and possible forams.
500	100	Sandstone - as above.
	Trace	?Foraminiferal coquinite, shells.
	Trace	Pyrite cement.
510	100	Sandstone - as above.
520	100	Sandstone - as above.
530	30	Mudstone dirty white to light grey, very calcareous some red sand or garnets, fossiliferous, soft in part.
	70	Limestone light fawn grey, silty, fine grained, very fossiliferous.
540	20	Mudstone - as above, some medium to dark grey, fossiliferous.
	80	Limestone - as above, fossils include bryozoans, forams.
550	100	Limestone - as above, very fossiliferous.
560	100	Limestone - composed almost entirely of fossil fragments with a silty calcareous matrix.
570	100	Limestone as above; a higher percentage of fine grained silt sized material in a hard matrix, some recrystallisation in places.
580	100	Limestone as above; higher percentage of harder fragments.

Depth	%	Description
590	100	Limestone light grey, composed mainly of silt to very fine sand sized fossil fragments set in a fairly hard calcareous matrix. Abundant fragments of bryozoans, some forams and pelecypod shells, glauconitic.
600	100	Limestone - as above, some black ?carbonaceous fragments.
610	100	Limestone - as above, some black specks of ?carbonaceous matter.
620	100	Limestone - almost entirely made up of bryozoan fragments.
630	100	Limestone - as above; about 50% bryozoans.
640	100	Limestone - as above, some apple green grains of ?mudstone.
650	100	Limestone - as above.
660	100	Limestone - as above. Some forams have glauconitic filling.
670	Trace	Mudstone medium grey, soft, grading to siltstone.
	100	Limestone - as above.
680	100	Limestone mostly bryozoan fragments with pelecypods and forams.
690	100	Limestone - as above.
700	100	Limestone - as above.
710	100	Limestone - as above.
720	100	Limestone light grey, composed partly of silt or fine sand sized grains set in a hard calcareous matrix; some glauconite and fossil fragments (mainly bryozoans and some forams and pelecypods).
730	100	Limestone - as above.
740	100	Limestone - as above.
750	100	Limestone - as above.

Depth	%	Description
760	100	Limestone - as above; some medium grey, silty and fossiliferous.
770	100	Limestone - as above.
780	100	Limestone - as above.
790	100	Limestone - as above.
800	100	Limestone - as above.
810	100	Limestone - as above.
820	100	Limestone - as above, fewer fossils.
830	100	Limestone - as above.
840	100	Limestone - as above.
850	100	Limestone - as above.
860	100	Limestone - as above, very fossiliferous.
870	100	Limestone light grey, composed of silt and sand sized grains cemented with calcite, soft to fairly brittle. Abundant fragments of bryozoans; some pelecypods and forams. Some glauconite.
880	100	Limestone - as above.
890	100	Limestone - as above.
900	100	Limestone - as above.
910	100	Limestone - light to medium grey similar to above but with abundant small black rounded particles giving a "peppery" appearance.
920	100	Limestone as above but samples have a lot of sticky clay.
930	30	Limestone, as above.
	70	Mudstone - grey, soft and sticky enclosing the limestone fragments.
940	30	Limestone)) as above.
	70	Mudstone)
950	30	Limestone - as above.
	70	Mudstone - reddish grey as above.

Depth	%	Description
960	10	Limestone)
		) as above.
	90	Mudstone)
970	10	Limestone fragments of white fossil material.
	90	Mudstone red grey, very soft and sticky enclosing limestone fragments.
980	10	Limestone)
		) as above.
	90	Mudstone)
990	20	Sandstone fine to coarse individual quartz grains, some pyrite matrix in part.
	10	Limestone - as above.
	50	Mudstone - as above.
	20	Coal - black, very soft and dull.
1000	100	Mudstone medium grey, very silty, some fine sand, very soft and sticky.
1010	100	Mudstone - as above.
1020	100	Mudstone - as above.
1030	100	Mudstone as above becoming more consolidated.
1040	20	Siltstone medium grey, very soft and sticky. Abundant white particles of silt size calcareous material.
	70	Mudstone - as above.
	10	Limestone - fossil fragments mainly as above.
1050	90	Mudstone light to medium grey, very soft.
	10	Limestone - as above
1060	Trace	Sandstone - fine to medium quartz grains.
	80	Mudstone - as above.
	20	Limestone - as above.
1070	10	Sandstone medium to coarse individual quartz grains.
	80	Mudstone medium grey very soft and sticky.
	10	Limestone mainly grains of fossil fragments. Trace pyrite.

Depth	%	Description
1080	10	Sandstone.
	80	Mudstone - as above.
	10	Limestone. Trace pyrite.
1090	10	Sandstone) as above.
	80	Mudstone)
	10	Limestone. Trace pyrite.
1100	10	Sandstone)
	80	Mudstone) as above and pyrite.
	10	Limestone)
1110	100	Mudstone - as above and very plastic.
	Trace	Sandstone, Limestone.
1120	100	Mudstone - as above.
	Trace	Sandstone, Limestone and Coal.
1130	100	Mudstone - as above.
	Trace	Sandstone, Limestone, Coal and Pyrite.
1140	70	Mudstone as above.
	30	Lignite - brown black, very soft and friable, dull.
	Trace	Sandstone & Limestone.
1150	60	Mudstone light grey plastic, grading to pale grey green, slightly to moderately calcareous.
	40	Lignite as above.
1160	50	Mudstone) as above.
	50	Lignite)
		Trace pyrite.
1170	60	Mudstone, pale grey, plastic, soft.
	10	Mudstone, pale grey green, more compacted than above.
	20	Sandstone, clear, medium to coarse well rounded quartz grains - no apparent matrix.
	Trace	Pyrite.
	10	Lignite.

Depth	%	Description
1180	100	Sandstone,coarse, clear, sub-rounded, well sorted, quartz grains - no trace of cement.
1190	100	Sandstone as above, grading to very coarse grained.
1200	100	Sandstone as above, grains grading to well rounded - rare soft clay cement - rare yellow and orange quartz grains.
1210	100	Sandstone as above.
	Trace	Pyrite.
1220	20	Sandstone - as above.
	80	Mudstone - as above.
1230	100	Sandstone - as above.
	Trace	Mudstone as above.
1240	100	Sandstone - as above.
1250	80	Sandstone, medium to very coarse individual, well rounded quartz grains; trace of white clay matrix.
	10	Siltstone grey green, speckled, slightly sandy.
	10	Mudstone, as above.
	Trace	Pyrite.
1260	20	Sandstone clear, medium to coarse, rounded quartz grains.
	30	Siltstone medium grey, fairly even grained, some whitish felspar grains, calcareous in part.
	50	Mudstone dark grey, soft and plastic grading to clay.
1270	10	Sandstone - as above, some pyrite matrix.
	40	Siltstone)
		) as above.
	50	Mudstone)

Depth	%	Description
1280	10	Sandstone)
	10	Siltstone) as above.
	80	Mudstone)
1290	10	Sandstone)
	50	Siltstone) as above.
	40	Mudstone)
1300	30	Sandstone)
	50	Siltstone) as above.
	20	Mudstone)
1310	70	Sandstone, as above, some grains fine to very fine grained, some pyrite.
	20	Siltstone) as above.
	10	Mudstone)
1320	80	Sandstone)
	10	Siltstone) as above.
	10	Mudstone)
1330	20	Sandstone - as above, mainly fine to medium grained.
	10	Siltstone) as above.
	70	Mudstone)
1340	10	Sandstone)
	10	Siltstone) as above.
	80	Mudstone)
1350	10	Sandstone mainly clear, fine to medium grains of well rounded quartz. Some white mica and pyrite.
	50	Siltstone - light grey green, felspathic, very soft, some harder, some carbonaceous fragments.
	40	Mudstone - medium-dark grey grading to a clay.

Depth	%	Description
1360	Trace	Sandstone)
	20	Siltstone) as above.
	10	Mudstone)
	70	Lignite, brown - black, soft, friable.
1370	10	Siltstone) as above.
	90	Lignite)
1380	Trace	Sandstone, siltstone) as above.
	100	Lignite.)
1390	Trace	Sandstone) as above.
	100	Lignite)
1400	10	Siltstone) as above.
	90	Lignite)
1410	10	Siltstone) as above.
	90	Lignite)
1420	40	Sandstone - fine to coarse clear individual quartz grains; rounded pyrite in places.
	60	Lignite, as above.
1430	40	Sandstone) as above.
	20	Siltstone)
	40	Lignite.)
1440	60	Sandstone) as above.
	10	Siltstone)
	30	Lignite)
1450	10	Sandstone fine to coarse, clear, individual well rounded quartz grains; some pyrite.
	80	Siltstone - medium to light grey, sandy in part; some felspathic grains.
	10	Mudstone light grey green, waxy in part, soft to clayey.
1460	30	Siltstone) as above.
	70	Mudstone)

Depth	%	Description
1470	20	Sandstone as above with fairly abundant pyrite.
	70	Siltstone - light greenish grey, fairly firm and waxy; some as above.
	10	Mudstone as above.
	Trace	Limestone mainly fragments of fossil material.
1480	10	Sandstone as above, some broken grains and a fair amount of pyrite ?conglomeratic.
	80	Siltstone - light green-grey with felspar grains, very soft.
	10	Mudstone light grey as above.
	Trace	Pyrite and limestone as fossil fragments.
1490	10	Sandstone - mainly fine to medium grained.
	80	Siltstone) as above.
	10	Mudstone)
	Trace	Pyrite, fossils.
1500	20	Sandstone)
	60	Siltstone) as above.
	20	Mudstone)
1510	60	Sandstone fine to coarse well rounded, mainly clear quartz grains. Some very fine grained with abundant pyrite matrix. Some yellow grains.
	20	Siltstone light grey, felspathic, soft.
	20	Mudstone light grey, soft to very soft.
	Trace	Pyrite, lignite.
1520	100	Sandstone as above, mainly medium grained without matrix.
1530	100	Sandstone mainly coarse grained.
1540	100	Sandstone as above.
1550	100	Sandstone as above.
1560	100	Sandstone as above.
1570	100	Sandstone as above.
	Trace	Carbonaceous material.

Depth	%	Description
1580	100	Sandstone as above.
1590	100	Sandstone as above.
1600	100	Sandstone as above.
1610	100	Sandstone as above.
1620	100	Sandstone as above.
1630	100	Sandstone as above.
1640	100	Sandstone some fine but mainly medium to coarse, well rounded, well sorted, individual clear qyartz grains. Trace pyrite.
1650	100	Sandstone as above.
	Trace	Pyrite.
1660	100	Sandstone as above.
	Trace	Pyrite.
1670	100	Sandstone as above.
	Trace	Pyrite.
1680	100	Sandstone as above.
	Trace	Pyrite.
1690	100	Sandstone as above.
	Trace	Pyrite.
1700	100	Sandstone as above.
1710	100	Sandstone as above.
	Trace	Lignite fragments.
1720	100	Sandstone as above.
	Trace	Lignite fragments.
1730	100	Sandstone as above with some more pyrite.
1740	100	Sandstone as above with more of the fine grained fraction.
	Trace	Lignite and pyrite.
1750	100	Sandstone as above mostly coarse grained, trace pyrite.
1760	100	Sandstone as above.
1770	100	Sandstone as above.

Depth	%	Description
1780	100	Sandstone as above.
1790	100	Sandstone as above.
1800	100	Sandstone medium to coarse, rounded, well sorted, individual quartz grains. Grains are mostly clear; rare yellow.
1810	100	Sandstone as above.
	Trace	Pyrite (rare).
1820	100	Sandstone as above.
1830	100	Sandstone as above.
1840	100	Sandstone as above, some very coarse grained.
1850	100	Sandstone as above.
1860	100	Sandstone as above.
1870	100	Sandstone as above.
1880	100	Sandstone as above.
	Trace	Pyrite.
1890	100	Sandstone as above.
1900	100	Sandstone as above.
1910	100	Sandstone as above.
1920	100	Sandstone as above.
1930	100	Sandstone as above.
1940	100	Sandstone as above.
1950	100	Sandstone as above.
1960	100	Sandstone medium to coarse, fairly well rounded and sorted individual clear quartz grains. Some angular broken grains, small amount of felspar grains, rare pyrite.
1970	100	Sandstone as above more angular and felspathic.
1980	100	Sandstone as above.
1990	100	Sandstone as above.
2000	100	Sandstone as above.
2010	100	Sandstone as above.
	Trace	Lignite, brown, black, soft and friable.
2020	100	Sandstone as above.
	Trace	Lignite.

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Depth	%	Description
2030	100	Sandstone as above.
2040	90	Sandstone as above.
	10	Lignite.
2050	90	Sandstone as above.
	10	Lignite.
2060	100	Sandstone as above.
	Trace	Lignite.
2070	100	Sandstone as above.
	Trace	Lignite.
2080	100	Sandstone as above.
	Trace	Lignite.
2090	100	Sandstone as above.
		2104' - Lower Cret
2100	100	Sandstone as above.
2110	100	Sandstone some fine but mainly medium to coarse, well sorted, individual clear quartz grains. Some broken and yellow grains, rare felspar grains.
	Trace	Lignite and pyrite.
2120	100	Sandstone) as above.
	Trace	Lignite) as above.
2130	100	Sandstone as above.
	Trace	Lignite.
2140	100	Sandstone as above.
	Trace	Lignite.
2150	100	Sandstone as above.
2160	100	Sandstone as above. Some rare fine grained, felspathic with pyrite matrix.
	Trace	Siltstone light green grey, soft.
2170	100	Sandstone as above.
	Trace	Lignite, bryozoan cavings.
2180	90	Sandstone as above.
	10	Lignite.

Depth	%	Description
2190	90	Sandstone as above.
	10	Lignite.
	Trace	Pyrite.
2200	80	Sandstone as above.
	20	Siltstone grey, carbonaceous specks.
	Trace	Lignite, pyrite.
2210	90	Sandstone)
		) as above.
	10	Siltstone)
2220	50	Sandstone)
		) as above.
	50	Siltstone)
	Trace	Lignite.
2230	100	Sandstone medium, subrounded to rounded, well sorted, individual clear quartz grains; many grains fractured.
	Trace	Siltstone, grey, carbonaceous specks.
	Trace	Lignite, quartzite.
2240	100	Sandstone - as above.
	Trace	Siltstone, lignite as above, bryoza.
2250	100	Sandstone as above.
	Trace	Lignite, pyrite.
2260	50	Sandstone - as above.
	50	Mudstone light grey, very soft and clayey, carbonaceous specks, swells and breaks down in water. This fraction ignored in section 2230'-2250'.
2270	70	Sandstone)
		) as above.
	30	Mudstone)
2280	30	Sandstone)
		) as above.
	70	Mudstone)
2290	80	Sandstone as above - minor fine grained sandstone with black and red grains and argillaceous matrix, tight.
	20	Mudstone as above.
2300	80	Sandstone)
		) as above.
	20	Mudstone)
	Trace	Pyrite, bryozoans.

Depth	%	Description
2310	90	Sandstone as above.
	10	Mudstone as above.
	Trace	Bryozoans, lignite, pyrite.
2320	80	Sandstone as above.
	20	Mudstone as above.
	Trace	Bryozoans and lignite.
2330	40	Sandstone.
	60	Mudstone.
	Trace	Bryozoans and lignite.
2340	80	Sandstone, fine, subrounded to rounded, fair sorted, individual clear quartz grains; many grains fractured.
	20	Mudstone, grey. very soft to clayey, carbonaceous, swelling.
	Trace	Lignite, bryozoans.
2350	70	Sandstone) as above.
	30	Mudstone) as above.
	Trace	Lignite, bryozoans, pyrite.
2360	50	Sandstone) as above.
	50	Mudstone) as above.
	Trace	Lignite, bryozoans.
2370	50	Sandstone) as above.
	50	Siltstone) as above.
	Trace	Lignite, bryozoans.
2380	80	Sandstone) as above.
	20	Siltstone) as above.
	Trace	Lignite, bryozoans.
2390	80	Sandstone) as above.
	20	Mudstone) as above.
	Trace	Lignite, bryozoans, pyrite.
2400	80	Sandstone) as above.
	20	Mudstone) as above.
	Trace	Lignite, bryozoans, pyrite.

Depth	%	Description
2410	50	Sandstone)
		) as above.
	40	Mudstone)
	10	Siltstone, grey, carbonaceous.
	Trace	Lignite, bryozoans.
2420	50	Sandstone)
		) as above.
	50	Mudstone)
	Trace	Green siltstone, lignite, bryozoans.
2430	50	Sandstone)
		) as above.
	50	Siltstone)
	Trace	Lignite, bryozoans.
2440	100	Sandstone medium, subrounded to rounded, fairly to well sorted, individual clear quartz grains.
	Trace	Lignite, bryozoans etc.
2450	80	Sandstone as above.
	10	Mudstone, grey, soft and clayey, carbonaceous, swelling.
	10	Siltstone, light grey to green, carbonaceous.
2460	80	Sandstone)
		) as above.
	20	Mudstone)
2470	60	Sandstone)
		) as above.
	40	Mudstone)
	Trace	Siltstone grey brown.
2480	90	Sandstone, medium, sub-angular - sub-rounded, well sorted individual clear quartz grains: rare green lithic grains.
	10	Mudstone as above.
2490	80	Sandstone)
		) as above.
	20	Mudstone)
2500	90	Sandstone)
		) as above.
	10	Mudstone)
2510	30	Sandstone)
		) as above.
	70	Mudstone)

Depth	%	Description
2520	10	Sandstone as above.
	90	Siltstone, light grey, carbonaceous streaks, slightly swelling, remains in discrete flakes in contrast to swelling clay mudstone above.
2530	100	Siltstone as above.
2540	20	Sandstone as above with trace argillaceous matrix.
	80	Siltstone as above.
2550	20	Sandstone as above.
	80	Mudstone ?glauconitic.
	Trace	Pyrite.
2560	10	Sandstone, medium, sub-angular to sub-rounded, fairly sorted, individual clear quartz grains.
	90	Mudstone, grey, carbonaceous ?glauconitic, dark inclusions, slight swelling.
2570	Trace	Sandstone as above.
	100	Mudstone to siltstone as above.
2580	Trace	Sandstone.
	100	Siltstone/Mudstone as above.
2590	30	Sandstone as above.
	70	Siltstone/Mudstone as above.
2600	Trace	Sandstone as above.
	100	Siltstone as above.
2610	10	Sandstone as above with minor sandstone, fine grained, carbonaceous, tight.
	90	Siltstone/Mudstone as above.
2620	10	Sandstone, fine grained, carbonaceous, quartzose, tight; trace individual grains as above.
	90	Siltstone/Mudstone.
2630	10	Sandstone as above.
	20	Siltstone as above.
	70	Mudstone as above.
2640	100	Siltstone as above.
2650	60	Sandstone as above.
	40	Siltstone as above.

Depth	%	Description
2660	90	Siltstone as above.
	10	Sandstone as above.
2670	40	Sandstone as above with many fine grains.
	30	Siltstone as above.
	30	Mudstone as above.
2680	10	Sandstone fine to medium mostly rounded quartz grains, some frosted and clear.
	90	Siltstone dark grey brown, soft, carbonaceous, some very fine sand, some pyrite in part.
2690	20	Sandstone) as above.
	80	Siltstone)
2700	10	Sandstone) as above.
	20	Siltstone)
	70	Mudstone dark grey brown, very soft and plastic, carbonaceous.
2710	10	Sandstone)
	10	Siltstone) as above.
	80	Mudstone)
2720	10	Sandstone)
	10	Siltstone) as above.
	80	Mudstone)
2730	30	Sandstone)
	30	Siltstone) as above.
	40	Mudstone)
2740	20	Sandstone) as above.
	80	Mudstone)
2750	40	Sandstone) as above.
	60	Mudstone)
2760	30	Sandstone) as above.
	70	Mudstone)
2770	100	Mudstone, as above; trace sand grains.

Depth	%	Description
2780	30	Sandstone)
		) as above.
	70	Mudstone)
	Trace	Quartzite fragments.
2790	20	Sandstone, quartzose, coarse grained, sub-rounded to sub-angular, well sorted mainly individual grains.
	80	Mudstone grey, carbonaceous fragments, swelling to non-swelling.
2800	30	Sandstone)
		) as above.
	70	Mudstone)
2810	40	Sandstone as above.
	60	Mudstone.
	Trace	Pyrite, phyllite, quartzite.
2820	10	Sandstone as above.
	90	Mudstone swelling as above.
2830	10	Sandstone as above.
	90	Mudstone as above.
	Trace	Pyrite, shale, lignite.
2840	10	Sandstone)
		) as above.
	90	Mudstone)
	Trace	Pyrite, green ?phyllite, shale.
2850	20	Sandstone)
		) as above.
	80	Mudstone)
	Trace	Pyrite and some hard schist from conglomerate pebbles, rare fossils.
2860	10	Sandstone)
		) as above.
	90	Mudstone)
	Trace	Pyrite and hard schist and some dark grey, soft, fissile shale. The schist is mostly greenish and has small amounts of mica present.
2870	30	Sandstone)
		) as above.
	70	Mudstone)

Depth	%	Description
2880	20	Sandstone)
		) as above.
	80	Mudstone)
2890	20	Sandstone)
		) as above.
	80	Mudstone)
2900	100	Sandstone medium to coarse, sub-rounded, fairly well sorted, individual clear and milky quartz grains. Rare pyrite matrix.
2910	70	Sandstone.
	20	Mudstone, medium grey, very soft and sticky.
	10	Lignite.
2920	20	Sandstone)
		) as above.
	80	Mudstone)
2930	100	Sandstone as above.
	Trace	Pyrite, rare forams (?cavings).
2940	100	Sandstone as above.
2950	80	Sandstone)
		) as above.
	20	Mudstone)
2960	80	Sandstone)
		) as above.
	20	Mudstone)
2970	100	Sandstone, medium to very coarse grained to conglomeratic similar to above. The coarse fraction is mostly broken grains of milky quartz.
2980	100	Sandstone, medium to very coarse grained as above.
2990	60	Sandstone as above.
	10	Siltstone medium to dark grey, fairly soft but not sticky, slightly carbonaceous.
	30	Shale medium to dark grey, soft but not sticky, slightly carbonaceous.

Depth	%	Description
3000	80	Sandstone mostly medium to very coarse grained to conglomeratic. Grains mainly milky quartz; sub-rounded to angular and broken. Trace pyrite.
3030' ↓ Cambrian (Kanmantoo Gp)	20	Shale very dark grey, soft but compacted, not very fissile, some small aggregates of fine grained pyrite (rare). Very finely disseminated in part.
3010	90	Sandstone as above; some hard white ?clay material sticking to some quartz grains; possibly concretions of matrix material.
	10	Shale as above - glauconitic.
3020	90	Sandstone) as above.
	10	Shale)
3030	90	Sandstone mainly fine to medium grained, some coarse. Mainly sub-rounded; some broken grains. A higher percentage of grains are of clear quartz.
	10	Shale as above.
3040	100	Sandstone as above.
	Trace	Fossil material, higher proportion than previous samples but probably cavings from slow drilling.
3050	100	Sandstone as above, some weathered felspar grains.
	Trace	Fossil material.
3060	100	Sandstone fine to coarse individual quartz grains. Mostly well rounded, the higher percentage are clear quartz; some milky. Some fine grains with red staining (possibly from surface sand) traces of pyrite matrix, some cream felspar.
3070	90	Sandstone as above.
	Trace	Siltstone medium to dark grey, soft, carbonaceous.
	10	Shale medium to dark grey, slightly carbonaceous soft.

Depth	%	Description
3080	80	Sandstone)
	10	Siltstone) as above.
	10	Mudstone)
3090	80	Sandstone)
	10	Siltstone) as above.
	10	Shale)
	Trace	Green phyllite, soft with well developed lustre.
3100	70	Sandstone as above with many grains in the finer grain size.
	Trace	Siltstone medium grey, very soft, finely disseminated pyrite in part, carbonaceous.
	30	Shale medium to dark grey, very soft, slightly carbonaceous with finely disseminated pyrite in part.
3110	60	Sandstone) as above.
	40	Shale)
3120	90	Sandstone, medium to coarse, sub-angular to rounded, many fractured, clear quartz grains.
	10	Mudstone, light grey, carbonaceous.
	Trace	Pyrite, green ?phyllite, vein quartz with pyrite inclusions.
3130	70	Sandstone as above.
	30	Mudstone as above.
	Trace	Phyllite green, milky vein quartz, lignite.
3140	60	Sandstone) as above.
	20	Mudstone)
	20	Phyllite green.
3150	60	Sandstone as above.
	10	Siltstone light to medium grey, soft, carbonaceous, pyritic in part, some mica. Rock is compacted.
	30	Mudstone light to dark grey, soft carbonaceous, with finely disseminated pyrite in part. Rock is compacted.

Depth	%	Description
3160	10	Sandstone.
	20	Siltstone.
	70	Mudstone.
	Trace	Large pyrite aggregates, coal.
3170	10	Sandstone.
	30	Siltstone as above with fairly large particles of detrital coal.
	60	Mudstone as above.
3180	10	Sandstone fine to medium, fairly well rounded, individual, mainly clear quartz grains.
	20	Siltstone light to dark grey, soft but compacted, some mica, carbonaceous with some large detrital coal grains. Pyritic in part.
	70	Mudstone medium to dark grey, carbonaceous, some mica, soft and compacted, pyritic in part (finely disseminated).
3190	10	Sandstone) as above.
	20	Mudstone) as above.
	70	Phyllite, green with pearly lustre, micaceous, soft.
3200	10	Sandstone) as above.
	10	Siltstone) as above.
	20	Mudstone) as above.
	60	Phyllite) as above.
3210	10	Siltstone) as above.
	20	Mudstone) as above.
	70	Phyllite) as above.
3220	10	Siltstone) as above.
	10	Mudstone) as above.
	80	Phyllite) as above.

Depth	%	Description
3230	10	Siltstone)
	20	Mudstone) as above.
	70	Phyllite)
3240	10	Mudstone)
	90	Phyllite) as above.
3250	10	Mudstone) as above.
	90	Phyllite)
3260	10	Mudstone) as above.
	90	Phyllite)
3260 - 3268		Core No.1

Note: Pipe tally after coring shows that the hole was actually 3276 feet deep; not 3260 feet as shown above.

APPENDIX 4

SAMPLE DESCRIPTIONS

B : A.A.O. MORKALLA NO.1

Depth	%	Description
20		No sample.
30	10	Sandstone coarse clear rounded quartz grains.
	60	Mudstone white, silicified hard and brittle.
	30	Limestone light yellow, soft with some sand grains - oolitic.
40	10	Sandstone) as above.
	60	Mudstone) as above.
	30	Limestone) as above.
50	40	Sandstone - fine to very coarse as above.
	40	Mudstone) as above.
	20	Limestone) as above.
60	100	Sandstone - fine to coarse, individual rounded grains - many with bright red iron staining.
70	100	Sandstone - as above.
80	100	Sandstone mainly medium to coarse,individual well rounded quartz grains - rare red grains.
90	100	Sandstone - as above.
100	100	Sandstone - as above.
110	100	Sandstone - as above with a trace of dark staining on the grains.
120	100	Sandstone - as above, some very coarse grains.
130	100	Sandstone mainly coarse to very coarse grains of well rounded quartz, trace of pyrite matrix in places. Trace white mica.
140	100	Sandstone - as above.
150	100	Sandstone - as above.
160	100	Sandstone - as above.
170	100	Sandstone - as above.

Depth	%	Description
180	100	Sandstone - as above, some grains up to 4 mm.
190	100	Sandstone - as above.
	Trace	Lignite with a fair amount of pyrite in the woody tissue.
200	100	Sandstone) as above.
	Trace	Lignite)
210	90	Sandstone) as above.
	10	Lignite)
220	100	Sandstone) as above.
		Lignite)
230	100	Sandstone) as above.
	Trace	Lignite)
240	100	Sandstone) as above.
	Trace	Lignite)
250	100	Sandstone - as above.
260	100	Sandstone - as above.
270	100	Sandstone - as above.
280	100	Sandstone - medium to coarse, clear, well rounded quartz grains with a trace of pyrite matrix in places. Abundant pelecypod (?) fragments, white and chalky, some clear.
290	100	Sandstone - as above.
300	100	Sandstone - as above. Fossils.
310	100	Sandstone - as above. Fossils.
320	100	Sandstone - as above. Fossils.
330	100	Sandstone - as above with grains up to 6 mm.
	Trace	Fossils.
340	100	Sandstone - as above, some fine grained. Some very dark, round, soft grains ?glauconite.
350	100	Sandstone - as above, fairly abundant ?glauconite, fossils.

Depth	%	Description
360	100	Sandstone - as above with a fair amount of coarse clear gypsum.
370	100	Sandstone - as above.
380	30	Sandstone - as above.
	60	Siltstone - light grey - fawn, even grained, quartz, abundant feldspar and some glauconite.
	10	Mudstone light greenish grey, soft, some pyrite grains and sand.
	Trace	Fossils, pyrite and glauconite.
390	10	Sandstone fine to coarse, loose, clear, rounded quartz grains.
	70	Limestone light grey, composed of mainly silt sized detrital grains of shell fragments, fairly hard. Very glauconitic in part, silty.
	20	Mudstone green-grey, very soft with some sand grains, glauconite and rare pyrite.
	Trace	Shell fragments and pyrite and gypsum.
400	70	Sandstone) as above.
	30	Limestone)
		Some large bryozoan fragments.
410	20	Sandstone)
	80	Limestone) as above.
	Trace	Mudstone)
420	20	Sandstone) as above.
	80	Limestone)
430	10	Sandstone.
	90	Limestone - fossil fragments making up 20% of sample.
440	10	Sandstone.
	90	Limestone - mainly light grey, very fine grained with some recrystallisation, 20% fossil material.

Depth	%	Description
450	100	Limestone - mainly white bryozoan fragments.
460	100	Limestone - as above.
470	100	Limestone - as above.
480	100	Limestone - dirty white ,composed of very fine grained material (50%) and fossil fragments. The fossils are mainly bryozoans with some forams and pelecypod particles.
490	100	Limestone - as above.
500	100	Limestone - as above.
510	100	Limestone - as above.
520	100	Limestone - as above.
530	100	Limestone - as above.
540	100	Limestone - as above.
550	100	Limestone - as above.
560	100	Limestone - as above;most of sample is bryozoan fragments, some pelecypods.
570	100	Limestone - as above.
580	100	Limestone - as above.
590	100	Limestone - as above.
600	100	Limestone - as above.
610	100	Limestone - as above.
620	100	Limestone - as above.
630	100	Limestone dirty white, composed almost entirely of bryozoan fragments. Some pelecypods and rare forams. Traces of glauconite.
640	100	Limestone - as above.
650	100	Limestone - as above.
660	100	Limestone - as above.
670	100	Limestone - as above.
680	100	Limestone - as above.

Depth	%	Description
690	100	Limestone - as above, some fine grained made up of small shell fragments.
700	100	Limestone - as above.
710	100	Limestone - as above.
720	100	Limestone - as above, 30% light brown, fine grained and hard.
730	100	Limestone - as above.
740	100	Limestone - as above.
750	100	Limestone - as above.
760	100	Limestone - as above.
770	100	Limestone - as above.
780	100	Limestone - as above.
790	100	Limestone dirty white to light brown. Composed of bryozoan fragments (40%) also fine grained, glauconitic, fairly hard.
800	100	Limestone - as above.
810	100	Limestone - above.
820	100	Limestone - as above - fossil fragments about 20%.
830	100	Limestone - as above.
840	100	Limestone mainly light brown, fine grained, cemented and hard; some bryozoan fragments.
850	100	Limestone - as above.
860	80	Mudstone light grey-green, very soft and silty,calcareous(?contamination from limestone) glauconitic.
	20	Limestone - as above.
870	90	Mudstone) as above.
	10	Limestone)
880	90	Mudstone) as above.
	10	Limestone)
890	90	Mudstone) as above.
	10	Limestone)

Depth	%	Description
900	10	Sandstone - clear, fine, subrounded quartz grains, pyrite matrix in places.
	70	Siltstone medium-grey-green, soft, sandy, very pyritic.
	20	Mudstone - as above.
910	10	Sandstone clear quartz grains, fine to medium grained, rounded, pyritic.
	60	Siltstone medium grey-green, sandy, soft and sticky, very pyritic, glauconitic.
	30	Mudstone medium grey-green, very soft, grading to siltstone, glauconitic, pyritic.
920	10	Sandstone)
	10	Siltstone) as above.
	10	Mudstone)
	70	Lignite, soft, black, pyritic. Pyrite makes up about 30% of sample.
930	30	Siltstone)
	10	Mudstone) as above.
	60	Lignite)
940	10	Sandstone)
	10	Siltstone)
	20	Mudstone) as above.
	60	Lignite)
950	20	Sandstone)
	20	Siltstone) as above.
	60	Lignite)
960	10	Sandstone)
	20	Siltstone) as above.
	60	Mudstone)
	10	Lignite)
970	30	Siltstone)
	70	Mudstone) as above.
	Trace	Lignite)

Depth	%	Description
980	10	Sandstone clear quartz grains, fine to coarse,rounded,mainly loose but some with pyrite matrix.
	80	Mudstone light grey green, some reddish, silty,very soft and sticky.
	10	Limestone as fossil fragments - cavings.
990	20	Sandstone) as above.
	80	Mudstone)
1000	10	Sandstone.
	20	Siltstone - light grey green, very soft and friable, felspathic.
	70	Mudstone as above.
	Trace	Pyrite as large aggregates.
1010	20	Sandstone)
	20	Siltstone) as above.
	60	Mudstone)
	Trace	Pyrite,limestone.
1020	10	Sandstone)
	40	Siltstone) as above.
	50	Mudstone)
	Trace	Pyrite, limestone.
1030	10	Sandstone)
	60	Siltstone) as above.
	30	Mudstone)
1040	10	Sandstone)
	20	Siltstone) as above.
	30	Mudstone)
	40	Lignite)

Depth	%	Description
1050	10	Sandstone fine to coarse, clear, rounded quartz grains, pyritic.
	20	Siltstone light grey green, friable and soft, felspathic.
	40	Mudstone light grey green, soft and sticky.
	30	Lignite.
1060	10	Sandstone) as above.
	80	Siltstone) as above.
	10	Lignite) as above.
1070	70	Siltstone) as above.
	10	Mudstone) as above.
	20	Lignite) as above.
1080	80	Sandstone mainly clear, loose quartz grains fine to coarse grained, mostly medium to coarse, well rounded; some pyrite.
	20	Siltstone - as above.
1090	90	Sandstone) as above.
	10	Siltstone) as above.
1100	100	Sandstone - as above.
1110	100	Sandstone - as above.
1120	100	Sandstone - as above.
1130	100	Sandstone - as above.
1140	100	Sandstone - as above.
1150	100	Sandstone - as above.
1160	100	Sandstone - as above.
1170	100	Sandstone clear loose quartz grains, mainly medium to coarse grained, well rounded and sorted.
1180	70	Sandstone - as above.
	30	Mudstone - dark brown, silty, soft and sticky, carbonaceous to very carbonaceous.
1190	20	Sandstone) as above.
	80	Mudstone) as above.

Depth	%	Description
1200	60	Mudstone - as above, more chocolate brown.
	40	Lignite.
1210	20	Sandstone)
	50	Mudstone) as above.
	30	Lignite)
1220	10	Sandstone - as above.
	20	Siltstone light green grey, soft, felspathic, dark brown carbonaceous, friable.
	10	Mudstone - as above.
	60	Lignite.
1230	30	Siltstone) as above.
	70	Lignite)
1240	60	Siltstone - dark brown, soft and friable, carbonaceous with pieces of detrital coal.
	10	Mudstone) as above.
	30	Lignite)
1250	80	Siltstone.)
	10	Mudstone.) as above.
	10	Lignite.)
1260	100	Sandstone - clear loose quartz grains. Mainly medium to coarse, well rounded and sorted, frosted.
1270	100	Sandstone - as above.
1280	100	Sandstone - as above, trace of pyrite matrix.
1290	100	Sandstone - as above.
1300	100	Sandstone - as above.
1310	100	Sandstone - as above.
1320	100	Sandstone - as above.
1330	100	Sandstone - as above.
1340	100	Sandstone - as above.
1350	100	Sandstone - as above.
1360	100	Sandstone - as above.
1370	100	Sandstone - as above.
1380	100	Sandstone - as above.

Depth	%	Description
1390	100	Sandstone - as above.
1400	100	Sandstone - as above.
1410	100	Sandstone - as above.
1420	100	Sandstone - as above.
1430	100	Sandstone - medium to coarse,loose,clear quartz grains - well rounded,frosted and well sorted. Trace of pyrite matrix in places.
1440	100	Sandstone - as above.
1450	100	Sandstone - as above.
1460	100	Sandstone - as above.
1470	100	Sandstone - as above.
1480	100	Sandstone - as above.
1490	100	Sandstone - as above.
1500	100	Sandstone - as above.
1510	100	Sandstone - as above.
1520	100	Sandstone - as above.
1530	100	Sandstone - as above.
1540	100	Sandstone - as above.
1550	100	Sandstone - as above.
1560	100	Sandstone - as above.
1570	100	Sandstone - as above.
1580	100	Sandstone - as above.
1590	100	Sandstone mainly clear-loose quartz grains; medium to coarse, well rounded, well sorted, frosted. Some yellow grains.
1600	100	Sandstone - as above.
1610	100	Sandstone - as above.
1620	100	Sandstone - as above.
1630	100	Sandstone - as above.
1640	100	Sandstone - as above.
1650	100	Sandstone - as above.
1660	100	Sandstone - as above.
1670	100	Sandstone - as above.

Depth	%	Description
1680	100	Sandstone - as above.
1690	100	Sandstone - as above.
1700	100	Sandstone - as above.
1710	100	Sandstone - as above.
1720	100	Sandstone - as above.
1730	100	Sandstone - as above.
1740	100	Sandstone - clear, loose quartz grains. Medium to coarse grained, well rounded and sorted, frosted; some yellow grains. No matrix.
1750	100	Sandstone - as above.
1760	100	Sandstone - as above.
1770	100	Sandstone - as above.
1780	100	Sandstone - as above, many broken grains.
1790	100	Sandstone -as above.
1800	100	Sandstone - as above.
1810	100	Sandstone - as above.
1820	100	Sandstone - as above.
1830	100	Sandstone - as above.
1840	100	Sandstone - as above.
1850	100	Sandstone - as above.
1860	100	Sandstone - as above.
1870	100	Sandstone - as above.
1880	100	Sandstone - as above.
1890	100	Sandstone - as above.
1900	100	Sandstone - mainly clear, loose quartz grains. Medium to coarse grained, well rounded and sorted, frosted. Trace pyrite matrix in places.
1905' Lower Cretaceous ↓	↓	
1910	100	Sandstone - as above.
1920	100	Sandstone - as above.
1930	100	Sandstone - as above.

Depth	%	Description
1940	100	Sandstone - as above.
1950	100	Sandstone - as above.
1960	100	Sandstone - as above.
1970	100	Sandstone - as above.
1980	100	Sandstone - as above.
1990	70	Sandstone - as above.
	30	Mudstone - medium to light grey, very soft and sticky (?some lost from preceeding samples).
2000	80	Sandstone) as above.
	20	Mudstone)
2010	60	Sandstone) as above.
	40	Mudstone)
2020	20	Sandstone) as above.
	80	Mudstone)
2030	10	Sandstone) as above.
	90	Mudstone)
2040	30	Sandstone, mainly medium grey, fine grained, tight, very calcareous, quartzose. Grains are sub-angular and well sorted. Some grains of dark chert, and felspar; some coal fragments. Some fine to coarse individual rounded quartz grains.
	40	Siltstone medium grey, carbonaceous, soft and friable grading to sandstone as above.
	30	Mudstone light to medium grey, soft and waxy.
2050	70	Sandstone - mainly medium to coarse, loose, rounded quartz grains.
	10	Siltstone) as above.
	20	Mudstone)

Depth	%	Description
2060	60	Sandstone, fine grained calcareous as above; also loose grains (50%).
	30	Siltstone) as above.
	10	Mudstone)
2070	100	Sandstone - as above. (70% loose grains).
2080	10	Sandstone - as above.
	90	Mudstone - light grey, very soft and sticky.
2090	10	Sandstone - as above.
	90	Mudstone - some firm mostly as above.
2100	30	Sandstone) as above.
	70	Mudstone)
2110	20	Sandstone fine to medium, rounded, loose, clear quartz grains.
	80	Mudstone medium grey-brown, soft and very sticky.
2120	10	Sandstone) as above.
	90	Mudstone)
2130	90	Sandstone mainly medium to coarse, loose, clear rounded quartz grains.
	10	Mudstone - as above.
2140	60	Sandstone - as above.
	20	Siltstone medium grey, soft and friable, carbonaceous, very sandy, some detrital coal fragments.
	20	Mudstone - medium grey, soft and waxy.
2150	80	Sandstone)
	10	Siltstone) as above.
	10	Mudstone)
2160	70	Sandstone)
	10	Siltstone) as above.
	20	Mudstone)
2170	70	Sandstone - as above.
	30	Siltstone - same as above, some light grey-green, felspathic, friable.
2180	60	Sandstone)
	30	Siltstone) as above.
	10	Mudstone)

Depth	%	Description
2190	50	Sandstone)
	20	Siltstone) as above.
	30	Mudstone)
2200	60	Sandstone - medium to coarse, loose, rounded, clear quartz. grains.
	10	Siltstone medium grey, soft and friable, carbonaceous.
	30	Mudstone light grey, very soft and sticky.
2210	20	Sandstone)
	20	Siltstone) as above.
	60	Mudstone)
2220	10	Sandstone)
	10	Siltstone) as above.
	80	Mudstone)
2230	70	Siltstone - medium to dark grey, soft and friable, carbonaceous with sand size detrital coal, pyritic in part (slightly).
	30	Mudstone - light grey, soft and friable, carbonaceous, pyritic in part (slightly).
2240	10	Sandstone)
	60	Siltstone) as above.
	30	Mudstone)
2250	60	Siltstone)
	40	Mudstone)as above.
2260	70	Siltstone)
	30	Mudstone) as above.
2270	60	Siltstone)
	40	Mudstone) as above.
2280	30	Siltstone)
	70	Mudstone) as above.

Depth	%	Description
2290	30	Siltstone dark grey, soft and friable, very carbonaceous with sand size fragments of detrital coal, some mica and rare pyrite.
	70	Mudstone - medium to dark grey, soft and friable, carbonaceous.
2300	10	Siltstone) as above.
	90	Mudstone)
2310	40	Siltstone) as above.
	60	Mudstone)
2320	70	Siltstone) as above.
	30	Mudstone)
2330	40	Siltstone) as above.
	60	Mudstone)
2340	30	Siltstone) as above.
	70	Mudstone)
2350	20	Siltstone) as above.
	80	Mudstone)
2360	40	Siltstone) as above.
	60	Mudstone)
2370	10	Siltstone) as above.
	90	Mudstone)
2380	30	Siltstone) as above.
	70	Mudstone)
2390	70	Sandstone mainly loose, clear, quartz grains, subrounded to angular, some broken, rare phyllite fragments.
	20	Siltstone) as above.
	10	Mudstone)
2400	80	Sandstone)
	10	Siltstone) as above.
	10	Mudstone)

Depth	%	Description
2410	20	Sandstone - mainly medium to coarse, clear, loose quartz grains, rounded to subangular. Rare phyllite fragments.
	40	Siltstone - dark grey, soft and friable, very carbonaceous with detrital coal fragments.
	40	Mudstone - medium to dark grey, soft and waxy.
	Trace	Pyrite.
2420	30	Sandstone) as above.
	40	Mudstone)
	30	Siltstone)
2430	60	Sandstone) as above.
	10	Siltstone)
	30	Mudstone)
2440	50	Sandstone) as above.
	20	Siltstone)
	30	Mudstone)
2450	60	Sandstone) as above.
	20	Siltstone)
	20	Mudstone - as above, some whitish, very soft and sticky.
2460	70	Sandstone) as above.
	10	Siltstone)
	20	Mudstone)
2470	60	Sandstone fine to coarse grained as above, some large broken grains, some phyllite fragments.
	10	Siltstone) as above.
	30	Mudstone)
2480	50	Sandstone) as above.
	20	Siltstone)
	30	Mudstone)

2433' Kanmantoo Gp (Cambrian)

Depth	%	Description
2490	80	Sandstone fine to coarse,loose,quartz grains - rounded to angular. Some phyllite fragments some of them fresh green. ?Basement.
	10	Siltstone - dark grey, carbonaceous, soft and friable.
	10	Mudstone - dark grey, soft, friable, sticky, in part carbonaceous.
2500	100	Sandstone - as above, with some more fresh phyllite.
	Trace	Siltstone, shale.
2510	100	Sandstone - as above.
	Trace	Siltstone, shale.
2520	100	Sandstone as above.
	Trace	Siltstone, shale.
2530	100	Sandstone, as above.
	Trace	Siltstone, shale.
2540	100	Sandstone, more phyllite.
	Trace	Siltstone, shale.
2550	100	Sandstone - as above, more phyllite.
2560	100	Sandstone - as above.
2560 - 2570		Core No.1

APPENDIX 4

SAMPLE DESCRIPTIONS

C : A.A.O. NADDA NO.1

Depth	%	Description
20-30	90	Sandstone - medium to very coarse, loose, subrounded quartz grains. Some yellow colouration on some grains.
	10	Limestone - yellow, hard, sandy caliche.
40	100	Sandstone - as above.
	Trace	Limestone - as above.
50	100	Sandstone - as above.
60	100	Sandstone - as above.
70	100	Sandstone - as above.
80	100	Sandstone - as above.
90	100	Sandstone - as above.
100	100	Sandstone - as above, some rare white mica grains.
110	100	Sandstone - as above, some rare fossil (pelecypod) fragments.
120	100	Sandstone - as above.
130	100	Sandstone - as above, fossils abundant.
140	100	Sandstone - as above, abundant fossils.
150	100	Sandstone - as above; some light grey fine grained, felspathic, clay and calcareous matrix, soft. Abundant fossils.
160	100	Sandstone - as above.
170	100	Sandstone fine to very coarse loose grains, clear and milky, well rounded. Some fine grained, felspathic, calcareous and fairly tight with large numbers of black, small, rounded shiny grains. They are fairly soft and also occur loose. (?carbonaceous.) Abundant fossil fragments. Some glauconite.

Depth	%	Description
180	100	Sandstone - as above.
190	80	Sandstone - as above.
	20	Limestone - as pelecypod and gastropod fragments mainly.
200	60	Sandstone) as above.
	40	Limestone)
210	100	Limestone light grey, fine sand grain sized, some calcareous cement, fairly hard; fairly abundant fossils as above with bryozoa, forams and hollow calcareous tubes.
220	100	Limestone - as above.
230	100	Limestone - as above.
240	40	Sandstone) as above.
	60	Limestone)
250	100	Limestone - as above but mainly bryozoan fragments.
260	100	Limestone - as above, some fine grained, hard and cemented.
270	100	Limestone - as above.
280	100	Limestone dirty white, composed mainly of fossil fragments (bryozoa, pelecypods some forams). Some glauconite. Also fine grained, hard and cemented.
290	100	Limestone - as above.
300	100	Limestone - as above.
310	100	Limestone - as above.
320	100	Limestone - as above.
330	100	Limestone - as above.
340	100	Limestone - as above.
350	100	Limestone - as above.
360	100	Limestone - as above.
370	100	Limestone - as above.

Depth	%	Description
640	100	Limestone - as above.
650	100	Limestone - as above.
660	100	Limestone - as above.
670	80	Mudstone - medium to light grey, very soft and sticky.
	20	Limestone - as above.
680	90	Mudstone) as above
	10	Limestone)
690	20	Siltstone - light grey to grey brown, felspathic, very soft and friable, glauconitic.
	80	Mudstone - as above, very pyritic. (Pyrite is abundant-30% of washed sample).
	Trace	Lignite, Limestone.
700	10	Siltstone)
	80	Mudstone) as above, very pyritic.
	10	Limestone)
	Trace	Lignite)
710	100	Mudstone - very pyritic as above.
	Trace	Siltstone, Limestone, Lignite.
720	50	Siltstone - medium grey, felspathic, very soft and sticky.
	50	Mudstone - medium grey, very soft and sticky. Sample contains about 20% large crystalline pyrite aggregations.
730	50	Mudstone - as above, pyritic.
	50	Lignite - brown - black, soft and friable.
740	20	Mudstone) as above.
	80	Lignite)
750	80	Sandstone loose clear quartz grains. Mainly fine grained ,well sorted, subrounded. Some coarse grains. Rare pyrite matrix.
	10	Siltstone light grey green ,felspathic ,soft and friable.

Depth	%	Description
380	100	Limestone - as above.
390	100	Limestone - as above.
400	100	Limestone - as above.
410	100	Limestone - as above.
420	100	Limestone - as above.
430	100	Limestone - as above.
440	100	Limestone - as above.
450	100	Limestone dirty white, composed mainly of fossil fragments, mostly bryozoan. Some pelecypods, forams. Rare glauconite. Some fine sand size detrital material, weakly cemented and porous.
460	100	Limestone - as above.
470	100	Limestone - as above.
480	100	Limestone - as above.
490	100	Limestone - as above.
500	100	Limestone - as above.
510	100	Limestone - as above.
520	100	Limestone - as above.
530	100	Limestone - as above (some cement contamination).
540	100	Limestone - as above.
550	100	Limestone - mainly fine grained, as above, some harder and cemented.
560	100	Limestone - as above.
570	100	Limestone - as above.
580	100	Limestone - as above.
590	100	Limestone - as above.
600	100	Limestone - as above.
610	100	Limestone - dirty white, composed of fossil fragments mainly bryozoan, pelecypods and forams. Some fine sand sized detrital material weakly cemented, porous. Some glauconite.
620	100	Limestone - as above.
630	100	Limestone - as above, mainly fine sand size as above.

Depth	%	Description
	10	Mudstone - medium grey, some dark chocolate, soft and sticky. Pyrite aggregates.
760	100	Sandstone - as above.
	Trace	Siltstone, mudstone, pyrite.
770	80	Sandstone) as above, very pyritic.
	10	Siltstone)
	10	Lignite)
780	70	Sandstone) as above.
	10	Siltstone)
	20	Lignite)
790	60	Sandstone) as above.
	20	Siltstone)
	20	Lignite)
800	80	Sandstone clear,loose quartz grains,fine to coarse grained, rounded to subrounded. Trace pyrite matrix; trace brown staining on grains.
	10	Siltstone light grey green, felspathic, soft and friable.
	10	Lignite - black brown, soft ,pyritic.
810	70	Sandstone) as above.
	30	Siltstone)
820	60	Sandstone) as above.
	40	Siltstone)
830	100	Sandstone loose clear quartz grains, some milky, medium to coarse, rounded, well sorted.
840	100	Sandstone - as above.
850	100	Sandstone - as above, trace pyrite matrix.
860	100	Sandstone - as above.
870	100	Sandstone - as above.
880	100	Sandstone - as above.
890	100	Sandstone - as above, fairly abundant pyrite matrix in part.
900	100	Sandstone - as above.

Depth	%	Description
910	60	Sandstone)
		) as above.
	40	Siltstone)
920	40	Sandstone)
		) as above.
	60	Siltstone)
930	80	Sandstone - fine to coarse loose quartz grains, mostly clear, subrounded to rounded, abundant pyrite matrix in places.
	20	Siltstone light grey green, felspathic, soft and friable.
940	90	Sandstone)
		) as above, pyrite.
	10	Siltstone)
950	90	Sandstone)
		) as above, pyrite.
	10	Siltstone)
960	90	Sandstone)
		) as above, pyrite.
	10	Siltstone)
970	100	Sandstone - as above, some pyrite matrix.
980	100	Sandstone - as above.
990	100	Sandstone - as above.
1000	100	Sandstone - as above.
1010	100	Sandstone - as above.
1020	100	Sandstone - as above.
1030	100	Sandstone - as above.
1040	60	Sandstone)
		) as above.
	40	Siltstone)
1050	80	Sandstone)
		) as above.
	20	Siltstone)
1060	90	Sandstone)
		) as above.
	10	Siltstone)
1070	100	Sandstone - as above.
1080	100	Sandstone - loose clear and milky quartz grains, medium to coarse, well rounded; some pyrite matrix in places, some white mica.
1090	100	Sandstone - as above.
	Trace	Lignite.

Depth	%	Description
1100	100	Sandstone)
		) as above.
	Trace	Lignite)
1110	100	Sandstone - as above.
1120	100	Sandstone - as above.
1130	100	Sandstone)
		) as above.
	Trace	Lignite)
1140	100	Sandstone - as above.
1150	100	Sandstone - as above.
1160	100	Sandstone - as above.
1170	100	Sandstone)
		) as above.
	Trace	Lignite)
1180	100	Sandstone)
		) as above.
	Trace	Lignite)
1190	70	Sandstone)
		) as above.
	30	Lignite)
1200	90	Sandstone)
		) as above.
	10	Lignite)
1210	100	Sandstone - as above.
1220	100	Sandstone - as above.
1230	100	Sandstone - as above, some up to very coarse, higher % milky quartz.
1240	100	Sandstone - as above.
1250	100	Sandstone - loose clear and milky quartz grains, some yellowish; medium to coarse grained,well rounded. Some white mica.
1260	100	Sandstone - as above, trace pyrite matrix.
1270	100	Sandstone - as above, some very coarse.
1280	100	Sandstone - as above.
1290	100	Sandstone - as above, higher % very coarse.
1300	100	Sandstone - as above.
1310	100	Sandstone - as above.
1320	100	Sandstone - as above.

Depth	%	Description
1330	100	Sandstone - as above.
1340	100	Sandstone - as above.
1350	100	Sandstone - as above.
1360	100	Sandstone - as above.
1370	100	Sandstone - as above.
1380	100	Sandstone - as above.
1390	100	Sandstone - as above.
1400	100	Sandstone - as above.
1410	100	Sandstone medium to coarse, rounded, loose quartz grains; some pyrite matrix in places.
1420	100	Sandstone - as above.
1430	100	Sandstone - as above.
1440	100	Sandstone - as above.
1450	100	Sandstone - as above, some fine grained.
1460	100	Sandstone - as above.
1470	100	Sandstone - as above.
1480	100	Sandstone - as above. 1474' Lower Cretaceous
1490	90	Sandstone - as above.
	10	Mudstone - light grey, very soft and sticky.
1500	100	Sandstone - as above.
1510	60	Sandstone - as above.
	30	Siltstone - medium grey, soft, carbonaceous with sand size coal fragments (detrital).
	10	Mudstone - light grey, soft, carbonaceous.
1520	40	Sandstone) as above.
	40	Siltstone) as above.
	20	Mudstone) as above.
1530	30	Sandstone) as above.
	60	Siltstone) as above.
	10	Mudstone) as above.

Depth	%	Descriptions
1540	20	Sandstone loose quartz grains, fine to coarse, subrounded to rounded;pyritic in part.
	50	Siltstone medium to dark grey, soft and friable, carbonaceous with detrital coal grains.
	30	Mudstone medium grey to dark brown, carbonaceous, soft.
1550	70	Siltstone.
	30	Mudstone - as above, some soft and sticky.
1560	50	Siltstone) as above.
	50	Mudstone)
1570	80	Siltstone) as above.
	20	Mudstone)
1580	90	Siltstone) as above.
	10	Mudstone)
1590	20	Sandstone)
	50	Siltstone) as above.
	30	Mudstone)
1600	10	Sandstone) as above.
	60	Siltstone)
	30	Mudstone)
1610	10	Sandstone)
	60	Siltstone) as above.
	30	Mudstone)
1620	10	Sandstone)
	60	Siltstone) as above.
	30	Mudstone)
1630	10	Sandstone)
	60	Siltstone) as above.
	30	Mudstone)

Depth	%	Description
1640	10	Sandstone mainly fine grained loose quartz grains, subangular, pyrite matrix in part. Rare phyllite grains.
	60	Siltstone medium grey, soft, carbonaceous.
	30	Mudstone light to medium grey soft, slightly carbonaceous.
1650	30	Sandstone)
	40	Siltstone) as above.
	30	Mudstone)
1660	60	Sandstone)
	20	Siltstone) as above.
	20	Mudstone)
1670	90	Sandstone - fine to coarse loose quartz grains, subangular-some broken. Some yellowish fairly fresh felspathic grains. Some large black mica books and some phyllite grains.
	10	Siltstone - as above.
1680	90	Sandstone) as above.
	10	Siltstone)
1690	100	Sandstone - as above, some very coarse milky quartz grains.
1700	100	Sandstone - as above, mainly coarse to very coarse.
1710	100	Sandstone - as above.
1720	100	Sandstone - as above.
1730	100	Sandstone - as above.
1740	100	Sandstone - as above.
1750	10	Sandstone fine to coarse loose sand grains, angular to subangular, some mica and phyllite.
	10	Siltstone - medium to dark grey, carbonaceous, soft.
	80	Mudstone medium grey-very soft and sticky. (Most of mudstone is lost in washing sample - impossible to determine accurately).

Depth	%	Description
1760	10	Sandstone)
	10	Siltstone) as above.
	80	Mudstone)
1770	30	Sandstone)
	10	Siltstone) as above.
	60	Mudstone)
1780	20	Sandstone)
	20	Siltstone) as above.
	60	Mudstone)
1790	50	Sandstone)
	10	Siltstone) as above.
	40	Mudstone)
1800	50	Sandstone)
	10	Siltstone) as above.
	40	Mudstone)
1810	50	Sandstone) - more phyllite fragments (fresh).
	10	Siltstone) as above.
	40	Mudstone)
1820	50	Sandstone)
	10	Siltstone) as above.
	40	Mudstone)
1830	20	Sandstone fine to coarse loose quartz grains. A few phyllite grains, some mica; pyrite matrix in part.
	20	Siltstone medium to dark grey, carbonaceous, soft and friable.
	60	Mudstone dark to medium grey, soft and sticky.
1840	20	Sandstone) Sample % doubtful due to
	20	Siltstone) softness of mudstone.
	60	Mudstone)

Depth	%	Description
1850	100	Sandstone medium to coarse loose grains - mainly quartz, some fresh felspar, books of weathered biotite and green phyllite fragments; subangular, some broken. Some pyrite.
1860	100	Sandstone - as above.
1870	100	Sandstone - medium to very coarse as above, rare pyrite matrix.
1880	100	Sandstone - as above.
1890	100	Sandstone - as above.
1900	100	Sandstone - as above.
1910	100	Sandstone - as above.
1920	100	Sandstone - as above.
1930	100	Sandstone - as above.
1940	100	Sandstone - as above.
1950	100	Sandstone - medium to very coarse, mainly quartz, some felspar, phyllite and mica. Angular; some broken grains.
1960	100	Sandstone.
1970	100	Sandstone coarse to very coarse grained loose grains of milky quartz. Some dark mica and weathered phyllite grains; conglomeratic.
1980	100	Sandstone - as above.
1990	100	Sandstone - as above.
2000	100	Sandstone - as above.
2010	100	Sandstone - as above. Pebbles up to ½" diameter.
2020	100	Sandstone - as above. Fairly common phyllite fragments.
2030	100	Sandstone - as above.
2040	100	Sandstone - as above.
2050	100	Sandstone - as above - very conglomeratic (up to ½" pebbles).

Depth	%	Description
2060	100	Sandstone - as above.
2070	100	Sandstone - as above, not as many pebbles; percentage of phyllite higher. 2063' Lower Permian
2080	100	Sandstone - fine to very coarse, largely cavings.
2090	80	Sandstone - fine to coarse, loose, rounded to angular grains of clear and milky quartz; some phyllite fragments.
	20	Shale light to medium grey, fairly even grained, soft with erratic round, clear, fine to medium quartz grains; soft micromicaceous. Some dark grey, carbonaceous.
2100	50	Sandstone) as above. Shale has rare carbonaceous fragments, some calcite veining.
	50	Shale)
2110	70	Sandstone) as above.
	30	Shale)
2120	30	Sandstone) as above.
	70	Shale)
2130	80	Sandstone - as above - also some white, fine to very fine grained, quartzose with angular grains, well sorted, with sugary texture, clay matrix, tight.
	20	Shale - as above.
2140	80	Sandstone) as above.
	20	Shale)
2150	80	Sandstone) as above.
	20	Shale)
2160	80	Sandstone) as above.
	20	Shale)
2170	40	Sandstone) as above.
	60	Shale)

Depth	%	Description
2180	70	Sandstone)
		) as above.
	30	Shale)
2190	20	Sandstone fine to medium, loose, clear, quartz grains, well rounded, some yellow grains.
	80	Shale - light grey, soft, even grained except for some fine, well rounded, clear quartz grains, micromicaceous. Rare pyrite.
2200	20	Sandstone)
		) as above.
	80	Shale)
		Some hard phyllite and greywacke fragments - ?pebbles rare black mica, rare granite (orange felspar) grains.
2210	30	Sandstone)
		) as above, some metamorphic grains.
	70	Shale)
2220	20	Sandstone)
		) as above.
	80	Shale)
2230	20	Sandstone)
		) as above.
	80	Shale)
2240	60	Sandstone)
		) as above.
	40	Shale)
2250	70	Sandstone)
		) as above.
	30	Shale)
2260	60	Sandstone)
		) as above.
	40	Shale)
2270	60	Sandstone)
		) as above.
	40	Shale)
2280	70	Sandstone - as above.
	30	Shale - as above, some medium grey, carbonaceous (?cavings).
2290	70	Sandstone - as above.
	30	Shale - as above, some reddish brown.

Depth	%	Description
2300	50	Sandstone) as above.
	50	Shale)
2310	60	Sandstone mainly loose quartz grains, fine to coarse, clear, well rounded grains, rare granitic fragments.
	40	Shale light to medium grey, even grained, micro-micaceous, rare black mica flakes. Erratics of fine, clear, rounded quartz grains. Darker mudstone, carbonaceous ?cavings.
2320	80	Sandstone) as above.
	20	Shale)
2330	10	Sandstone - as above.
	90	Shale - as above, some fissile without visible erratics.
2340	10	Sandstone - as above.
	90	Shale - medium to dark grey, very even grained, soft and quite fissile; breaks to sharp flakes. No visible irregularities (i.e. erratics or carbonaceous material).
2350	10	Sandstone) as above.
	90	Shale)
2360	10	Sandstone) as above.
	90	Shale)
2370	10	Sandstone) as above.
	90	Shale)
2380	100	Shale - as above.
2390	100	Shale - as above.
2400	100	Shale medium to dark grey, soft, fissile, micromicaceous; no carbonaceous material.
2410	100	Shale - as above.

Depth	%	Description
2420	20	Siltstone - white, even grained, almost entirely quartz grains, soft to firm;occurs as interbeds in part within shale.
	80	Shale - as above.
2430	20	Siltstone) as above.
	80	Shale)
2440	20	Siltstone) as above.
	80	Shale)
2450	20	Siltstone
	80	Shale
2460	100	Shale - light to dark grey as above, some fine round clear quartz erratics.
2470	10	Sandstone.
	90	Shale - as above, some dark grey, firm with erratic sand grains, non fissile.
2480	10	Sandstone) as above.
	90	Shale)
2490	10	Sandstone) as above.
	90	Shale)
2500	20	Sandstone) as above.
	80	Shale)
2504 - 2514		Core No.1
2510		See description Core No.1.
2520	20	Sandstone fine to coarse grained,loose rounded quartz grains ?cavings.
	80	Mudstone medium to dark grey,firm, micromicaceous, silty. Erratic grains of fine sand to pebbles. Some metamorphic and granite.
2530	40	Sandstone) as above.
	60	Mudstone)

Depth	%	Description
2540	40	Sandstone)
		) as above, more granite fragments.
	60	Mudstone)
2550	30	Sandstone)
		) as above.
	70	Mudstone)
2560	50	Siltstone - light grey, quartzose,even grained, some sand sized erratics.
	50	Mudstone - as above.
2570	30	Sandstone)
		) as above.
	70	Mudstone)
2580	30	Sandstone some as above, some light grey, fine to very fine grained, well sorted, mainly quartzose, calcareous in part, sugary texture-no visible porosity, grading to siltstone as above.
	10	Siltstone)
		) as above.
	60	Mudstone)
2590	60	Sandstone - very fine grained as above.
	20	Siltstone)
		) as above
	20	Mudstone)
2600	20	Sandstone)
		)
	20	Siltstone) as above.
		)
	60	Mudstone)
2610	20	Sandstone - some fine to coarse grained,well rounded,clear quartz grains; mainly fine to very fine grained, tight,grey, sugary,well sorted quartz grains;some calcareous matrix. Some metamorphic fragments and granite.
	80	Mudstone, medium to dark grey, micromicaceous, silty in part with erratic sand grains.
2620	20	Sandstone)
		) as above.
	80	Mudstone)

Depth	%	Description
2630	60	Sandstone - mainly individual grains as above.
	40	Mudstone - as above.
2640	100	Sandstone - mainly fine, loose, rounded, clear quartz grains; some orange, some dark, well sorted.
2650	90	Sandstone - fine to medium grained as above.
	10	Mudstone - as above.
2660	90	Sandstone) as above.
	10	Mudstone)
2670	70	Sandstone - as above.
	30	Shale - medium grey, very even grained, fissile, micromicaceous, no erratics.
	Trace	Mudstone - as above.
2680	20	Sandstone) as above.
	80	Shale)
2690	10	Sandstone) as above.
	90	Shale)
2700	10	Sandstone fine to medium, clear, rounded quartz grains.
	90	Shale light to dark grey, even grained, micromicaceous, fairly fissile; some mudstone with sand size erratics. Some metamorphic and granite pebbles.
2710	10	Sandstone) as above.
	90	Shale)
2720	10	Sandstone) as above.
	90	Shale)
2730	10	Sandstone) as above.
	90	Shale)
2740	10	Sandstone) as above.
	90	Shale)
2750	10	Sandstone) as above.
	90	Shale)

Depth	%	Description
2760	10	Sandstone - as above.
	10	Siltstone - light grey, quartzose, hard, some erratic sand grains.
	80	Shale - as above.
2770	10	Sandstone)
	10	Siltstone) as above.
	80	Shale)
2780	10	Sandstone)
	20	Siltstone) as above.
	70	Shale)
2790	20	Sandstone)
	10	Siltstone) as above.
	70	Shale)
2800	10	Sandstone fine to coarse, loose, rounded, clear quartz grains.
	10	Siltstone light grey, quartzose.
	80	Shale light to dark grey, fissile to non-fissile, some erratic quartz grains, micaceous, fairly hard.
2810	10	Sandstone) as above.
	90	Shale)
2820	10	Sandstone) as above.
	90	Shale)
2830	20	Sandstone) as above.
	80	Shale)
2840	10	Sandstone) as above.
	90	Shale)
2850	10	Sandstone) as above.
	90	Shale)
2860	10	Sandstone) as above.
	90	Shale)
2870	10	Sandstone) as above.
	90	Shale)
2880	10	Sandstone - as above.
	10	Siltstone - as above, some calcareous.

Depth	%	Description
	80	Shale - as above.
2890	10	Sandstone)
	20	Siltstone) as above.
	70	Shale)
2900	10	Sandstone)
	10	Siltstone) as above.
	80	Shale)
2910	10	Sandstone)
	10	Siltstone) as above.
	80	Shale)
2920	10	Sandstone white, very fine grained, quartzose, sugary texture, well sorted, fairly angular calcareous in part,tight - occurrs as thin interbeds in the shale. Some loose grains.
	20	Siltstone white,quartzose,similar to sandstone above, some light grey, quartzose with rare argillaceous material.
	70	Shale - mainly dark grey,fissile to non-fissile, fairly hard with erratic sand grains in the non-fissile material mainly.
	Trace	Metamorphic and granite fragments.
2930	20	Sandstone)
	10	Siltstone) as above.
	70	Shale)
2940	30	Sandstone)
	30	Siltstone) as above.
	40	Shale)
2950	50	Sandstone)
	30	Siltstone) as above.
	20	Shale)
2960	30	Sandstone)
	30	Siltstone) as above.
	40	Shale)

Depth	%	Description
2970	40	Sandstone)
	30	Siltstone) as above.
	30	Shale)
2980	20	Sandstone)
	20	Siltstone) as above.
	60	Shale)
2990	10	Sandstone mainly fine to medium, loose, clear quartz grains; rounded.
	10	Siltstone light grey, quartzose, some argillaceous.
	80	Shale light to dark grey; the lighter is non fissile with sand size erratics, the dark is more fissile. The light is harder than the dark grey shale.
	Trace	Metamorphic and granite fragments.
3000	10	Sandstone)
	20	Siltstone) as above.
	70	Shale)
3010	20	Sandstone - as above.
	20	Siltstone - as above, some red-brown with erratics.
	60	Shale as above.
3020	10	Sandstone)
	10	Siltstone) as above.
	80	Shale)
3030	30	Sandstone - as above, conglomeratic; rare. metamorphics and granitic pebbles.
	20	Siltstone) as above.
	50	Shale)
3040	60	Sandstone - as above, some fine to very fine grained, white, fairly hard, quartzose, argillaceous matrix, tight. High % conglomerate pebbles - gran[illegible]e some metamorphics.
	10	Siltstone) as above.
	30	Shale)

Depth	%	Description
3050	10	Sandstone) as above.
	10	Siltstone) as above.
	80	Shale) as above.
3060	60	Sandstone mainly fine to medium ,loose, rounded, clear quartz grains. Some fine to very fine grained, white,quartzose, clay matrix, tight. Abundant granite and metamorphic fragments - from conglomeratic pebbles.
	10	Siltstone light to medium grey, largely quartzose and argillaceous some sand erratics.
	30	Shale medium to dark grey, non fissile to fissile, some erratics ,fairly hard where non-fissile.
3070	80	Sandstone fine to very fine grained, light grey, hard. Grains mostly quartz ,some orange felspar, subangular. White clay matrix, tight.
	10	Siltstone) as above.
	10	Shale) as above.
3080	20	Sandstone) as above.
	10	Siltstone) as above.
	70	Shale) as above.
3090	20	Sandstone) as above.
	10	Siltstone) as above.
	70	Shale) as above.
3100	20	Sandstone - mainly loose grains as above.
	10	Siltstone) as above.
	70	Shale) as above.
3110	10	Sandstone) as above.
	10	Siltstone) as above.
	80	Shale) as above.
3120	20	Sandstone - loose grains, also very fine grained hard.
	10	Siltstone) as above.
	70	Shale) as above.

Depth	%	Description
3130	40	Sandstone some fine to medium, loose quartz grains - cavings? More light grey-white, fine to very fine grained, hard, quartzose with minor orange felspar, rare black mica, fairly well sorted, subangular, white clay matrix, tight. Pyritic in part.
	20	Siltstone light grey quartzose, similar to sandstone above.
	40	Shale medium to dark grey, non fissile to fissile, fairly hard. Some erratic sand grains.
3140	20	Sandstone) as above.
	10	Siltstone) as above.
	70	Shale) as above.
3150	20	Sandstone mainly fine to coarse loose quartz grains.
	80	Shale medium to dark grey, hard, non-fissile with sand size quartz erratics - numerous metamorphic and granite grains from erratics.
3160	30	Sandstone) as above.
	70	Shale) as above.
		more abundant granite and metamorphics.
3170	40	Sandstone - as above.
	10	Siltstone - light grey-white, quartzose and hard grading to very fine sand.
	50	Shale - as above.
3180	10	Sandstone) Very abundant metamorphic grains and some granite.
	90	Shale) Very abundant metamorphic grains and some granite.
3190	10	Sandstone) as above.
	90	Shale) as above.
3200	10	Sandstone) as above.
	90	Shale) as above.
3210	10	Sandstone) as above.
	90	Shale) as above.

Depth	%	Description
3220	20	Sandstone - as above, some fine to very fine grained, quartzose, some orange felspar, clay matrix, hard and tight.
	80	Shale - as above.
3230	20	Sandstone) As above, fairly common orange granite grains.
	80	Shale)
3240	40	Sandstone) Abundant orange granite.
	60	Shale)
3250	60	Sandstone white, fine to medium grained, some coarse, quartzose, orange felspar, hard, rounded to subangular, clay matrix, tight.
	40	Shale - as above.
3260	70	Sandstone white, very fine to coarse grained, hard, quartzose, some orange felspar. Poorly sorted, white clay matrix, tight, calcareous in part.
	30	Shale medium to dark grey, hard, non fissile (some fissile cavings?) with sand erratics, fairly abundant orange felspar and granite grains.
3270	20	Sandstone) as above.
	80	Shale)
3280	60	Sandstone) as above - abundant orange felspar and granite grains.
	40	Shale)
3290	80	Sandstone) as above.
	20	Shale)
3300	80	Sandstone) as above.
	20	Shale)
3310	50	Sandstone) as above trace large aggregates of pyrite.
	50	Shale)
3320	20	Sandstone) as above.
	80	Shale) Pyrite.
3330	20	Sandstone) as above.
	80	Shale) Pyrite.

Depth	%	Description
3340	20	Sandstone)
		) as above.
	80	Shale) Pyrite.
3350	70	Sandstone)
		) as above.
	30	Shale)
3360	10	Sandstone 3360' Cambrian Kanmantoo Gp
	90	Shale - abundant metamorphic grains and some granite.
3370	50	Sandstone)
		) as above.
	50	Shale)
3380	40	Sandstone)
		) as above.
	60	Shale)
3390	30	Shale medium to dark grey, hard, silty.
	70	Schist - dark brown, hard, composed of quartz and dark mica, fresh.
3400	30	Shale)
		) as above.
	70	Schist)
3410	30	Shale)
		) as above.
	70	Schist)

APPENDIX 5

CORE DESCRIPTIONS & ANALYSES.

A : A.A.O. SUNSET NO.1

(a) Conventional Core Descriptions

Core No.1 3260 - 3268 feet. Recovery 8 feet (100%)

The interval consists of Phyllite light to dark green, talcose and fairly soft. Foliation varies from 70° to vertical. There is some remnant bedding planes which show dislocation and folding. The core is strongly fractured around 3263 feet and in the bottom 6". There are rare thin calcite and quartz veins with a 3/4" vein at 3267.2 feet. It dips at about 20° from horizontal.

APPENDIX 5

A : A.A.O. SUNSET NO.1

(b) Sidewall Core Description

S.W.C. 955' Recovery 2"

Claystone greenish grey; abundant shelly fossils and ?forams.

S.W.C. 1257' Recovery 2¼"

Mudstone silty, dark greyish brown, slightly carbonaceous; minor light grey to light greyish brown, very fine to fine grained irregular sandstone laminations; possible worm burrows.

S.W.C. 1697' Recovery 2"

Siltstone brownish black very carbonaceous, earthy, minor clay pellets?

S.W.C. 1965' Recovery 1½"

Laminated very fine grained off-white quartz sandstone with little or no matrix interlaminated with mid-greyish brown siltstone; minor very fine carbonaceous flecks; laminations parallel to core axis.

S.W.C. 2104' Recovery 2"

Siltstone mid-grey, slightly micaceous and Sandstone very fine grained, silty, interlaminated minor carbonaceous flecks and lamellae.

S.W.C. 2146' Recovery 2"

Siltstone mid-grey, slightly micaceous; minor irregular light grey very fine grained sandstone lamellae.

S.W.C. 2200' Recovery 1-5/8"

Siltstone mid-grey, slightly micaceous.

S.W.C. 2303' Recovery 1-7/8"

Siltstone mid-grey, slightly micaceous with minor light grey, very fine grained sandstone lamellae.

S.W.C. 2353' Recovery 2"

Mudstone mid-grey, micaceous.

S.W.C. 2395' Recovery 1-7/8"

Siltstone mid-grey, slightly micaceous.

S.W.C. 2446' Recovery 2"

Mudstone mid-grey.

S.W.C. 2523' Recovery 2-1/8"

Sandstone mid-grey, fine grained, quartzose, clay matrix, poorly consolidated moderately well sorted angular clasts; minor carbonaceous flecks.

S.W.C. 2555' Recovery 2"

Sandstone Silty very fine grained, quartzose, lithic; minor carbonaceous flecks.

S.W.C. 2632' Recovery 2"

Mudstone mid-grey, slightly micaceous, minor carbonaceous flecks and lamellae; numerous light grey, fine grained, quartz sandstone laminations, slightly oblique to core axis.

S.W.C. 2752' Recovery 1½"

Mudstone mid to dark grey slightly micaceous; minor carbonaceous flecks.

S.W.C. 2805' Recovery 1-3/4"

Mudstone Silty dark grey micaceous with scattered subangular quartz pebbles to ½" and medium grained sand clasts; abundant carbonaceous flecks.

S.W.C. 2833' Recovery 1-3/4"

Mudstone dark grey, sandy, soft; scattered angular medium to fine grained quartz clasts.

S.W.C. 2879' Recovery 1-3/4"

Sandstone silty fine to medium grained, subangular quartz grains with minor lithic fragments, silty matrix; minor carbonaceous flecks, poorly consolidated; interlaminated with fine grained light grey quartz sandstone.

S.W.C. 2895' Recovery 1 ??

Sandstone medium grained, quartzose, sub-rounded to sub-angular, poor sorting; thin coal laminae; bedding horizontal.

S.W.C. 2925' Recovery 1¼"

Coal black, dull, brittle.

S.W.C. 2980' Recovery 1¼"

Sandstone fine grained quartzose clear, sub-angular, poorly sorted, interlaminated with Sandstone fine grained quartzose, sub-angular and poorly sorted, carbonaceous.

S.W.C. 3040' Recovery 1½"

Sandstone greyish green, very fine to medium grained, subangular, very poor sorting, no bedding apparent, clay matrix, moderate amount of mica, a few coarse grains of greenish quartz.

S.W.C. 3080' Recovery 1-3/4"

Sandstone greenish grey, fine grained with scattered medium to coarse grains; micaceous, argillaceous, quartz, lithic.

S.W.C. 3142' Recovery 1¼"

Phyllite as for S.W.C. 3240'. Cleavage approximately 30° to core axis; minor coarse mica laths.

S.W.C. 3172' Recovery 3/4"

Phyllite as for S.W.C. 3240'.

S.W.C. 3240' Recovery 7/8"

Phyllite? light green, very fine grained; abundant very fine mica flecks parallel to an indistinct cleavage.

APPENDIX 5

A : A.A.O. SUNSET NO.1

(c) Core Analyses

Core analyses were not carried out.

APPENDIX 5

CORE DESCRIPTIONS & ANALYSES.

B : A.A.O. MORKALLA NO.1

(a) Conventional Core Descriptions

Core No.1 2560 - 2570 feet. Recovery 100%

Slate dark grey green, fine grained, fairly soft. Cleavage dips at 70-90° with few quartz veins 1/4" wide almost vertical. There is not much fracturing in the core.

Hydrocarbon shows - nil.

APPENDIX 5

B : A.A.O. MORKALLA NO.1

(b) Sidewall Core Description

S.W.C. 880' Recovery 2"

Mudstone mid grey; abundant broken foraminifera tests.

S.W.C. 950' Recovery 2"

Sandstone mid grey, fine grained, quartzose with very minor lithic fragments; silt matrix; poorly consolidated; irregular carbonaceous lamellae and siltstone laminae.

S.W.C. 1002' Recovery 2"

Siltstone mid grey, sandy.

S.W.C. 1102' Recovery 1½"

Sandstone medium grained, light grey, quartzose; little or no matrix; unconsolidated.

S.W.C. 1202' Recovery 1½"

Sandstone fine grained; mid grey quartzose; silty matrix; few siltstone laminations parallel to core axis; poorly consolidated.

S.W.C. 1250' Recovery 2½"

Mudstone black, carbonaceous; lenticular fine grained quartzose sandstone with pyrite cement.

S.W.C. 1295' Recovery 5"

Sandstone mid brownish grey fine grained quartzose, silt matrix; interlaminated with dark grey mudstone slightly carbonaceous in part; very poorly consolidated.

S.W.C. 1343' Recovery 2"

Siltstone mid brownish grey; numerous carbonaceous flecks; soft, puggy.

S.W.C. 1470' Recovery 2"

Siltstone mid grey, slightly carbonaceous in part; micaceous; irregularly interlaminated with light brown fine grained quartzose Sandstone; few scattered quartz pebbles to 5 mm.

S.W.C. 1809' Recovery 2"

Mudstone mid grey.

S.W.C. 1910' Recovery 1-3/4"

Laminated very fine grained off white sandstone interlaminated with light grey slightly carbonaceous very fine grained silty sandstone; rare pebbles of medium grained quartzose sandstone with pyrite matrix.

S.W.C. 1950' Recovery 2¼"

Sandstone silty mid grey, fine grained; minor carbonaceous flecks.

S.W.C. 2000' Recovery 2"

Mudstone mid grey; minor irregular, off white, very fine sandstone laminations.

S.W.C. 2057' Rec. 2-1/8"

Sandstone silty very fine grained mid grey; very minor carbonaceous flecks.

S.W.C. 2080' Rec. 2"

Siltstone light grey.

S.W.C. 2100' Rec. 1½"

Sandstone silty, very fine grained, mid grey, quartzose.

S.W.C. 2108' Rec. 2"

Siltstone mid grey, sandy with minor carbonaceous flecks; minor very fine grained light grey to off white sandstone laminations forming laminite in part.

S.W.C. 2155' Rec. 2"

Sandstone fine to medium grained, mid grey; silty matrix; minor carbonaceous flecks.

S.W.C. 2173' Rec. 1½"

Sandstone medium grained; quartzose, silt matrix; carbonaceous lamellae; poorly consolidated.

S.W.C. 2192' Rec. 1½"

Sandstone mid grey, very fine grained, quartzose, silt matrix, slightly micaceous.

S.W.C. 2215' Rec. 1-3/4"

Mudstone mid to dark grey, slightly micaceous.

S.W.C. 2270' Rec. 2"

Mudstone mid to dark grey; irregular laminations of light grey very fine grained sandstone.

S.W.C. 2330' Rec. 2¼"

Laminite interlaminated very fine grained light grey, quartzose sandstone and dark grey slightly carbonaceous siltstone.

S.W.C. 2364' Rec. 1¼"

Siltstone mid grey, slightly micaceous.

S.W.C. 2380' Rec. 2¼"

Siltstone mid grey, sandy, micaceous.

S.W.C. 2401' Rec. 2"

Sandstone Silty mid to light grey, fine grained quartzose, micaceous.

S.W.C. 2431' Rec. 1½"

Sandstone pebbly off white, quartzose, medium grained; quartz pebbles to 10 mm.; very fine white sand matrix; interbanded with granular coaly bands including scattered quartz grains and white, very fine grained sandstone laminations.

S.W.C. 2450' Rec. 3/4"

Siltstone light grey, soft, puggy.

S.W.C. 2480' Rec. 1½"

?Phyllite light green; thin quartz veins.

APPENDIX 5

B : A.A.O. MORKALLA NO.1

(c) Core Analyses

Core analyses were not carried out.

APPENDIX 5

CORE DESCRIPTIONS & ANALYSES

C : A.A.O. NADDA NO.1

(a) Conventional Core Descriptions

Core No.1 2504 - 2514 feet. Recovery 7 feet 3 inches.

Mudstone, medium to dark grey, firm, non fissile, silty with erratic grains from fine sand size up to 3/4" pebbles. The pebbles are mainly hard hornfels. There is very little visible bedding or any other sedimentary structures. At 2510 feet there is some very fine grained light grey limestone occurring as irregular platey blocks in the core.

The core shows some fracturing with minor slickensided surfaces.

Dip - approximately flat.

Oil or gas shows - nil.

Some pebbles show flat surfaces with striations - ice scratchings.

Core No.2 3140 - 3144 feet. Recovery 2 feet 3 inches.

The core consists entirely of Shale - dark grey, hard, non fissile with a brittle fracture. Bedding is poorly developed. The lower 6 inches of the core containing some thin discontinuous silty beds. There are erratics ranging from fine and medium sand (common) up to granite pebbles 1½" long (rare). There are high angle calcite and pyrite veins about 1/4" thick.

Bedding is approximately flat. There are no plant or marine fossil fragments present.

Hydrocarbon shows - nil.

A.A.O. NADDA NO.1

CORE DESCRIPTIONS (contd.)

Core No.3 3412 - 3415 feet. Recovery 2 feet 3 inches.

Phyllite dark green, hard, unweathered with high angle veins containing quartz, calcite and pyrite. The veins exhibit ptygmatic structure in places and are lenticular. Oil and gas shows - nil.

APPENDIX 5

C : A.A.O. NADDA NO.1

(b) Sidewall Core Description

S.W.C. 885' Recovery 2"

Mudstone very dark grey to dark brown with thin discontinuous sand layers.

S.W.C. 902' Recovery 1-3/4"

Mudstone very dark grey with scattered fine sand grains.

S.W.C. 1037' Recovery 1-3/4"

Siltstone very dark grey brown with a few scattered sand grains, micaceous, plastic.

S.W.C. 1141' Recovery 2"

Mudstone dark grey brown, grading locally into reddish brown siltstone and fine sandstone; micaceous.

S.W.C. 1236' Recovery 2½"

Siltstone dark brown with laminations of reddish brown fine sandstone; micaceous, ?carbonaceous.

S.W.C. 1340' Recovery 1-3/4"

Mudstone greyish brown; plastic.

S.W.C. 1500' Recovery 2"

Siltstone grading into Sandstone very fine grained, dark grey, micaceous, rare large green quartz fragments.

S.W.C. 1600' Recovery 2"

Siltstone brownish green, some red brown iron oxide staining.

S.W.C. 1800' Recovery 1-3/4"

Siltstone dark grey, grading into sandstone, fine grained, micaceous.

S.W.C. 1909' Recovery 2"

Sandstone grey, quartzose, fine to coarse grained, angular to very well rounded, sorting poor.

S.W.C. 1969' Recovery 2"

Sandstone, grey, very fine grained, angular, poorly sorted, micaceous.

S.W.C. 2089' Recovery 1-3/4"

Siltstone grey, micaceous.

S.W.C. 2128' Recovery 1¼"

Siltstone grey, micaceous

S.W.C. 2165' Recovery 1¼"

Sandstone dark to light grey, very fine grained, subangular to subrounded, poorly sorted, argillaceous matrix.

S.W.C. 2188' Recovery 1-3/4"

Siltstone grey with some subrounded fine quartz grains including a quartzite pebble ½" x ¼" x ¼".

S.W.C. 2248' Recovery 1½"

Siltstone puggy light grey.

S.W.C. 2350' Recovery 1½"

Siltstone grey with pockets and laminae of Sandstone, fine grained.

S.W.C. 2408' Recovery 1¼"

Siltstone dark grey.

S.W.C. 2582' Recovery 1½"

Siltstone dark grey.

S.W.C. 2680' Recovery 3/4"

Mudstone grey.

S.W.C. 2820' Recovery 1¼"

Siltstone grey with white siltstone-sandstone laminations.

S.W.C. 2900' Recovery 1"

Shale grey with white laminae, micaceous.

S.W.C. 2982' Recovery 3/4"

Siltstone grey with fine sand-size quartz and biotite grains.

S.W.C. 3092' Recovery ½"

Sandstone light grey, fine grained, subangular, fair sorting, argillaceous.

S.W.C. 3265' Recovery ½"

Sandstone light grey, very fine grained, subangular, fair sorting, argillaceous, thin band of siltstone, grey, trace of mica.

S.W.C. 3308' Recovery 1"

Sandstone very light grey, fine grained, subangular, poor sorting.

S.W.C. 3359' Recovery ½"

Sandstone grey, very fine grained, angular, poor sorting, argillaceous grains of calcite and biotite in pockets.

APPENDIX 5

C : A.A.O. NADDA NO.1

(c) Core Analyses

Core analyses were not carried out.

APPENDIX 6

LIST AND INTERPRETATION OF ELECTRICAL AND OTHER LOGS

A : A.A.O. SUNSET NO.1

(a) List of Logs

Induction Electrical Log	Run 1	interval	501 to 3286 feet.
Microlog-Microcaliper	Run 1	interval	501 to 3285 feet.
Sonic Gamma Ray	Run 1	interval	498 to 3275 feet.

(The Gamma Ray was continued to 50 feet)

(b) Log interpretation by Hugh Crocker, Schlumberger Seaco Inc.

Logs Available

Induction Electrical Log	501' - 3286'
Microlog/Caliper	501' - 3285'
BHC Sonic/Gamma Ray	498' - 3275'

Borehole Fluids Gel Mud

Rm = 1.91 at 78°F	or	1.1 at 132°F.
Rmf = 1.59 at 80°F	or	0.95 at 132°F.
Rmc = 2.38 at 73°F	or	1.3 at 132°F.

General

Readings are taken opposite cleanish sands as indicated by positive separation on the microlog and from the SP or Gamma Ray.

Formation Water

From the SP we read a maximum of - 50 mV and using Rmf of 0.95 at 132°F we get Rmfe = 0.85x Rmf = 0.8. Chart SP1 gives Rmfe/Rwe = 4.4 and hence Rwe = 0.18.

Chart SP2 would suggest Rw = 0.2 but from past experience we expect Rwe = Rw = 0.18.

We have made the crossplot of Sonic versus Induction (Fig. 1). We note the progressive shift to the left with increasing depth. This clearly corresponds to increased compaction influence upon the sonic. A best fit line through the upper points would suggest Δtma = 50 and Rw = 0.24 but we have also plotted in the shale area at bottom (maximum compaction) and it is clear that this results in a slight shift towards higher Δtms. Hence we have redrawn the line for the lowermost gamma ray values and get Δtma = 55 which is the usual value and Rw = 0.17 which agrees well with the SP value.

APPENDIX 6 (contd.)

Porosity

Clearly from Fig. 1 the sonic may not be used for porosity for points above 16 and probably not even down till 19. For these shallower sands the density log is required for accurate porosity measurement.

No attempt has been made to correct the reported sonic porosities ϕs for shale so that real porosities will be less and could be considerably so.

Hydrocarbons

From Fig. 1 it seems most unlikely that any hydrocarbons are present but the displacement due to hydrocarbons would be below the line hence the lack of compaction influence on the sonic could mask any potential hydrocarbons.

As another check we have calculated Rxo from chart Rxo 1 and the micrology and thence found Rxo/RT assuming RIL=RT. Fig. 2 is a crossplot of log Rxo/RT versus SP. We note that all the points fall along a well defined trend line and none sufficiently below to suggest any possible hydrocarbons. A microlaterolog would be a better Rxo tool for this purpose.

Conclusions

1. There are no hydrocarbons evident.

2. Formation water appears to be 0.18 ohm at 132°F or 19,000 p.p.m. NaCl.

3. Formation Porosities are difficult to estimate. A Density log is necessary and a Neutron also if shale effects are to be removed.

4. For Rxo values a microlaterolog is necessary.

INTERPRETATION: SUNSET 1

Chart Rxo-1

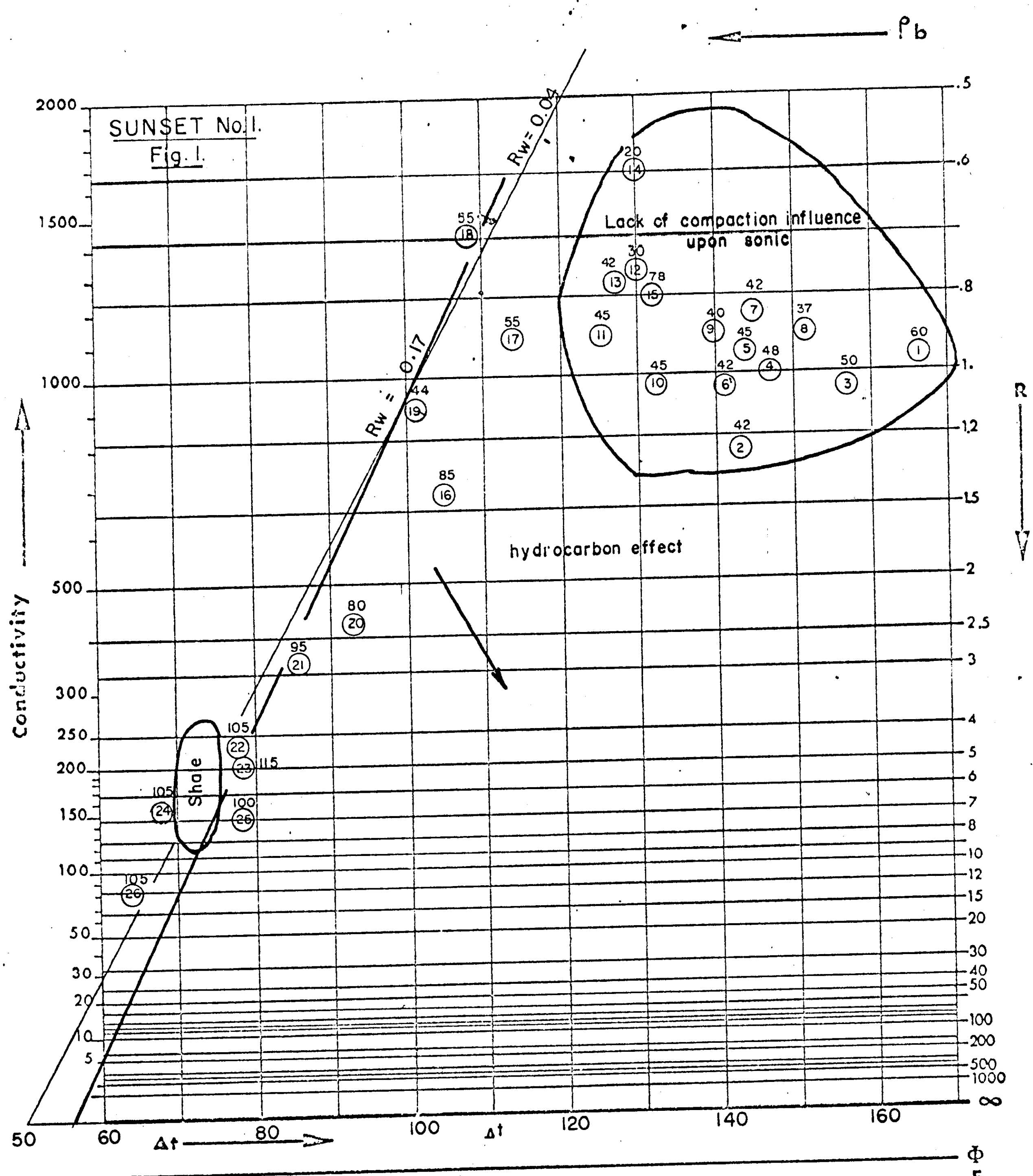
No.	IES DEPTH	RIL	R1"	R2"	SP	GR	t	φs	Rxo	Rxo/Ril
1	1036	0.95	3.4	2.9	-38	60	166	φs too high due to lack of compaction		
2	1180	1.3	3.4	3.4	-36	42	143		4.7	3.6
3	1214	1.05	3.0	2.6	-33	50	157			
4	1370	1.0	2.6	2.4	-32	48	146		3.9	3.9
5	1440	0.95	3.0	3.0	-36	45	144		4.05	4.3
6	1515	1.05	4.2	4.0	-36	42	142		5.4	5.1
7	1520	0.85	2.8	2.9	-36	42	145		3.9	4.5
8	1597	0.9	2.8	3.0	-38	37	152		4.3	4.7
9	1674	0.9	2.2	2.5	40	40	140		4.3	4.7
10	1790	1.05	3.5	3.5	45	45	133		4.7	4.4
11	2011	0.9	2.4	2.4	-50?	45	126		3.5	3.8
12	2080	0.75	2.4	2.0	-45	30	130			
13	2434	0.78	2.3	1.9	-30?	42	127			
14	2531	0.6	1.3	1.0	-38	60	130?			
15	2800	0.8	1.0	1.0	-32	78	132			
16	2870	1.4	3.0	3.3	-45	85	105	37	6.75	4.8
17	2936	0.75	3.0	3.6	-50	55	114	44	5.2	6.9?
18	2954	0.75	2.8	3.1	-50	55	109	40	5.0	6.5
19	2994	1.1	3.1	3.7	-50	44	101	31	6.75	6.1

INTERPRETATION:

Chart Rxo-1

NO.	IES DEPTH	RIL	Ri"	R2"	SP	GR	t	Φ s	Rxo	Rxo/Ril
20	3040	2.5	2.8	3.8	-25	80	93	28	8.6	3.4
21	3077	2.9	2.6	3.6	-25	95	86	25	3.3	8.1
22	3146	4.5	3.7	4.6	-15	105	78	17	9.8	2.15
23	3184	5.0	3.0	4.0	-12	115	79	17.5	10.1	2.0
24	3211	6.6	-	-	-3	105	67	8.5	-	-
25	3223	6.2	3.0	4.2	-12	100	78	17	11.9	1.9
26	3256	12			-6	105	64	6.5	-	-

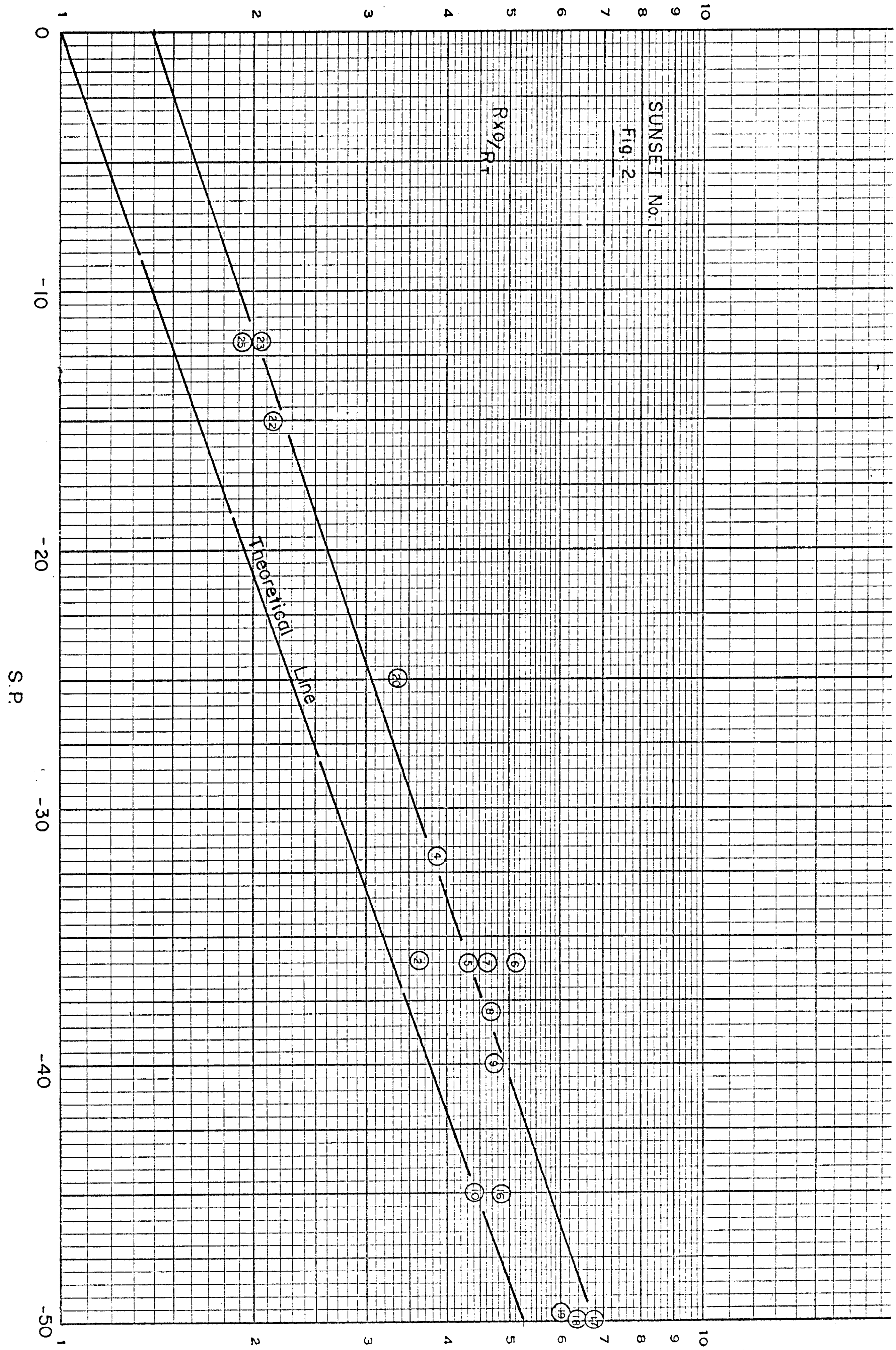
GRID FOR SONIC — RESISTIVITY OR FD — RESISTIVITY PLOTS



Grid for Resistivity vs Sonic or vs Formation Density Plot

$F = \frac{.62}{\Phi^{2.15}}$

Numbers above circles are gamma ray readings and hence indicate probable shaliness



SUNSET No. 1
Fig. 2
R_{xo}/R_T
Theoretical Line
S.P.
0
-10
-20
-30
-40
-50
1
2
3
4
5
6
7
8
9
10

APPENDIX 6

B : A.A.O. MORKALLA NO.1

(a) List of Logs

Induction Electrical Log	Run 1	interval	516 to 2569 feet.
Micrelog-Microcaliper	Run 1	interval	515 to 2568 feet.
Sonic Log	Run 1	interval	517 to 2566 feet.
Gamma Ray	Run 1	interval	50 to 2563 feet.

(b) Log interpretation by Hugh Crocker, Schlumberger Seaco Inc.

Logs Available

Induction Electrical Log	Run 1	516' - 2569'
Gamma Ray Log	Run 1	50' - 2563'
Microlog	Run 1	515' - 2568'
B.H.C. Sonic Log	Run 1	517' - 2566'

General

Readings have been taken opposite negative SP deflections, low gamma ray readings and where the micrOlog suggests the presence of permeable beds, a quick qualitative check shows -
516' - 850' uniform water filled sand
850' - 1060' generally shaly with occasional thin sands and silts.
1060' - 1158' relatively clean water filled sand.
1158' - 1360' mostly shaly with occasional sands.
1360' - 1804' general clean water filled sands.
1804' - 2110' shale.
2110' - 2180' dirty sands, silt and shales.
2180' - 2355' shale.
2355' - 2565' dirty sands, silt and shales.

Discussion

We note from the SP that there is a shale baseline shift between the shale at 1200' and that at 1950'. Hence we have treated this section as containing essentially different formation waters above and below the shale at 1900'.

1. We have made the usual Sonic Resistivity crossplot attached to this report. Points 1 to 8 corresponding to the upper water zone develop a reasonable trend but it would be difficult to determine Δtm. Points 9 to 12 show a well defined trend and establish Δtm of 50 mspf and an Rw of 0.15. The SP gives Rwe = 0.18 and hence Rwe $\simeq$ Rw as found frequently in Australia. If we assume that Δtm is the same throughout this well we get Rw for points 1 - 8 of 0.3 and again this agrees with Rwe from the SP of 0.31. At this depth the sonic is influenced by lack of compaction and we have used the shale value of 140 mspf to correct the sonic porosity.

$$\phi = \phi_s \frac{100}{140}$$

As is well known this correction is not very accurate and a density log ought to be used to obtain better porosities in these shallow sands. However the agreement with the SP encourages us to believe that the compaction correction is approximately valid.

APPENDIX 6 (contd.)

Assuming this compaction correction we have calculated sonic derived porosities. We note that many are very high indeed. Perhaps we need an even higher compaction correction or that Δtm should be slightly higher. However we note that these sands have often washed out more than the shales and therefore they are probably very friable and unconsolidated. As such porosities of 35% are not unlikely although 45% would be somewhat too high.

2. Another approach to detection of any possible hydrocarbons would be to compare Rxo from the microlog (Chart Rxo 1) with RIL. In water zones the ratio Rxo/RT should be approximately equal to Rmf/Rw. The microlog does not give good Rxo values and a microlaterolog or proximity log ought to be used for this purpose. However the calculated Rxo/RT is approximately 4 throughout. Please note that if Rmf = 0.75 then Rw should be 0.19 which agrees with the points 9 - 12 but not with those 1 - 8. Clearly in this latter case we have not taken enough compaction correction into account.

Summary

These sands are water filled and very porous.

Conclusions

The present logging programme is satisfactory for the detection of hydrocarbons but could be considerably improved by substituting the Density log for the sonic and the microlaterolog/microlog combination tool for the microlog.

MORKALLA 1

	IES DEPTH	RIL	Ri"	R2"	Δt	Rxo	Rxo/RT	cΔtsh-140 ϕ_s
1	1126	1.6	2.8	2.8	143	4	2.5	43
2	1310	1.0	2.5	2.6	148	3.8	3.8	45
3	1432	0.9	2.7	2.7	145	3.9	4.3	44
4	1485	1.1	2.7	2.8	143	4	3.6	43
5	1650	0.95	3.2	3.2	140	4.5	4.7	42
6	1704	1.4	3.0	3.6	124	6.5.	4.6	34
7	1744	1.1	2.5	2.9	132	5.2	4.7	38
8	1847	1.0	2.6	3.0	135	5.0	5.0	39.5
9	2173	<0.5	1.5	1.5	147	1.8	>3.6	45
10	2420	1.0	2.6	2.8	118	4.1	4.1	32
11	2454	3.0	3.8	4.7	84	10.3	3.4	16
12	2480	4.0	2.9	3.5	79	6.5	1.6	13.5

BOREHOLE FLUIDS

Rm	=	1.76	at 75°F
	=	1.0	at 130°F
		1.0	at BHT (mudlog)
Rmf	=	1.3	at 74°F
	=	0.75	at 130°F
Rmc	=	2.48	at 69°F
		1.3	at 130°F

At 1300' BHT = 110°F Rmf = 0.9 Rm = 1.2

2500' BHT = 130°F

FORMATION WATER

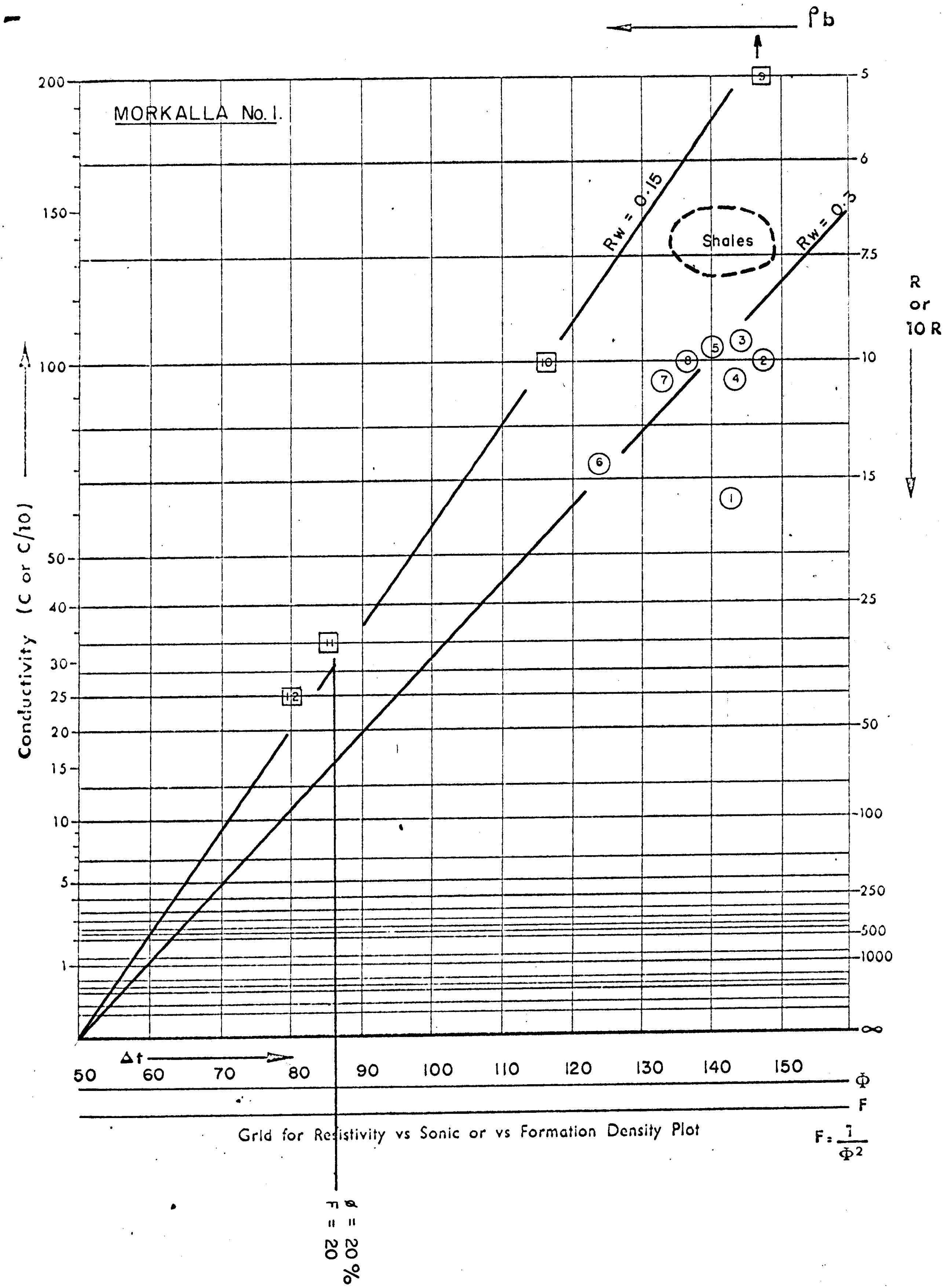
At 1500'

SP	=	- 30 mV	
Rmfe	=	0.85 x 0.9 = 0.77	
Rmfe/Rwe	=	2.5	Chart SP-1
Rme	=	0.31	
Rw	=	0.4	Chart SP-2

At 2500'

SP	=	- 43 mV	
Rmfe	=	0.85 x 0.75 = 0.64	
Rmfe/Rwe	=	3.5	Chart SP-1
Rwe	=	0.18	
Rw	=	0.21	Chart SP-2

GRID FOR SONIC — RESISTIVITY OR FD — RESISTIVITY PLOTS



APPENDIX 6

C : A.A.O. NADDA NO.1

(a) List of Logs

Induction Electrical Log	Run 1	interval	502 to 3413 feet.
Microlog-Microcaliper	Run 1	interval	502 to 3413 feet.
Sonic Log	Run 1	interval	496 to 3411 feet.
Gamma Ray	Run 1	interval	50 to 3412 feet.

(b) Log interpretation by Hugh Crocker, Schlumberger Seaco Inc.

Logs Available

Induction Electrical Log	502' - 3413'
BHC Sonic/Caliper	496' - 3411'
Gamma Ray	50' - 3412'
Microlog/Caliper	502' - 3413'

Borehole Fluids

Gel Mud

Rm	=	3.02 at 58°F	=	1.45 at 125°F
Rmf	=	3.6 at 81°F	=	2.2 at 125°F
Rmc	=	6.87 at 53°F	=	3.0 at 125°F

General

These formations consist of sands, silts and shales. The sands are rarely very clean as indicated by, SP, Gamma Ray and Microlog.

Readings have been taken from the logs opposite beds that are cleanest.

Formation Water

It is clear from the SP that formation water increases in salinity with depth.

The SP below 1800' slows a maximum of - 32mV.

If Rmf = 2.2 at 125°F
then Rmfe = 0.85 Rmf = 1.9
since Rmfe/Rwe = 2.6
Rwe = 0.7

Porosity

The Sonic values are clearly affected by lack of compaction and derived porosity is then too high at least above 2900'.

We have made the usual Sonic/RIL crossplot of Fig. 1. There is wide scatter but a pronounced tendency for the points to move to the lower left with depth of reading. This tendency reflects

1. The increasing water salinity with depth.
2. The lack of compaction particularly for the shallow points.

APPENDIX 6 (contd.)

Under the circumstances little can be derived from the plot. The deepest points 10 to 13 fall on a well defined line and if compaction has been reached these indicate a matrix travel time of 48 m.s.p.f. which would appear to be very low for sands. Also indicated is a formation water of 0.03 which is greatly different from the value derived from the SP. Hence if normal saturations are computed using Rw = 0.7 and tm = 56 then hydrocarbons will be found in all sands.

Hydrocarbon Detection

The basic variables in this case are at least:

1. Formation Water resistivity
2. Shale Content
3. Compaction

Unfortunately we have little if any control for interpretation purposes and hence we must reply upon comparative methods to indicate any hydrocarbons. From Fig. 1 it seems highly improbable that points 10 to 13 contain hydrocarbons since a formation water substantially less than 0.03 would be necessary.

To investigate the remaining points we have calculated Rwa values where:

$$Rwa = RIL/_{Fs}$$

where Fs is sonic derived resistivity formation factor using charts C20 and C10 but allowing no correction for compaction.

If we then crossplot log Rwa versus SP we should get a trend line and any possible hydrocarbons should fall above this line (due to increased Rwa). Fig.2 is this plot and we have indicated probable effects of

1. Compaction
2. Hydrocarbons
3. Shale

For points 1 to 8 a good trend line is developed. The only point indicating any possible hydrocarbons is 4 and in all probability this is due to a poor choice on our part of the proper SP shale base line.

Point No.9 is intermediate between the trend line just discussed and those of points 10 to 13, and shows negative separation on the microlog so is probably impermeable.

Hence we conclude that no hydrocarbons are likely to be present.

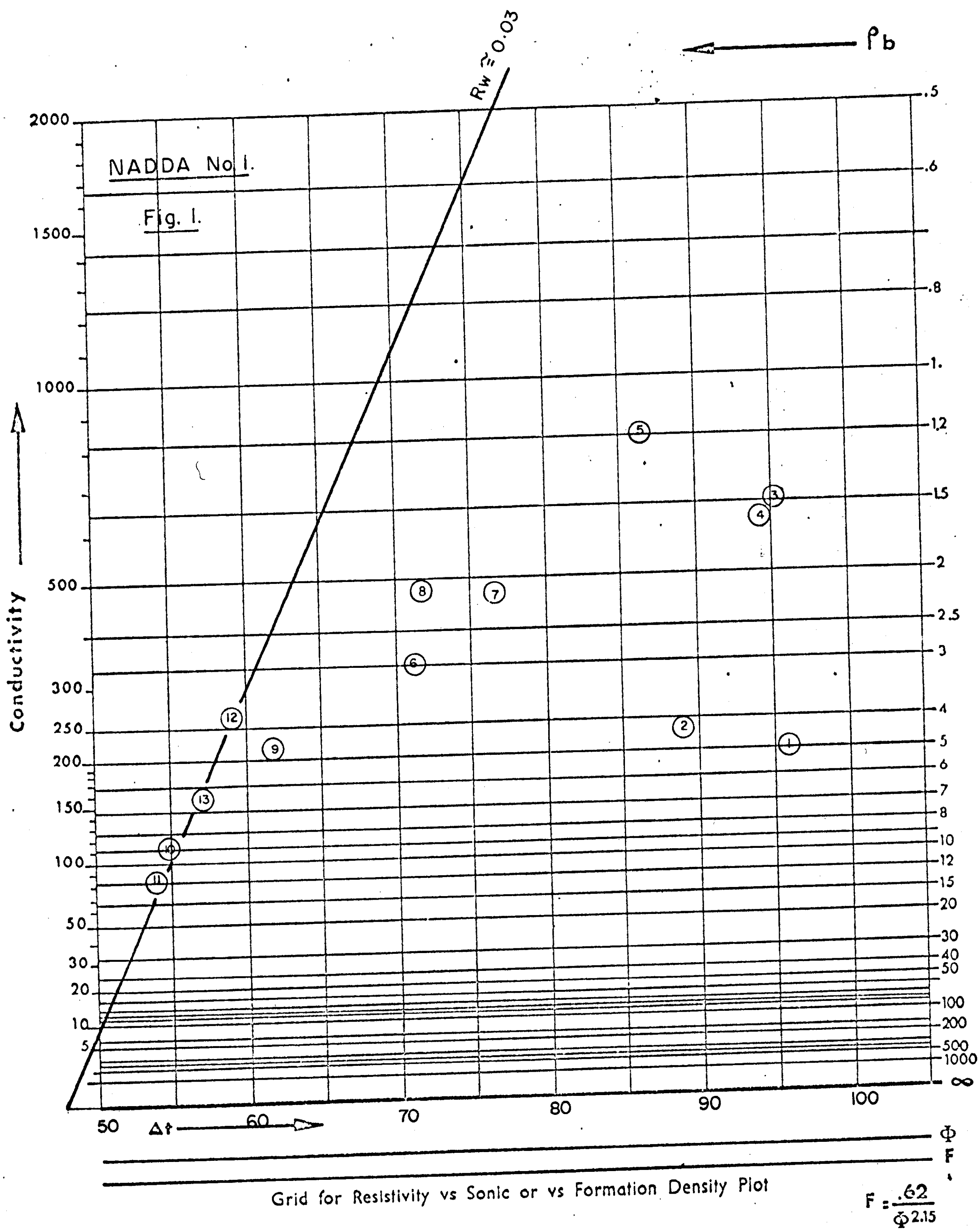
We have also tried the Rxo versus RIL approach but the microlog is not really able to produce reliable Rxo values but rather is used to show positive separation and hence permeable formations. Where Rxo can be determined we get approximately Rxo/RT values of between 2.4 and 4.5 which is approximately consistent with the SP derived Rmf/Rw ratio and hence we conclude again that these formations only contain water.

NADDA NO. 1 TABLE 1

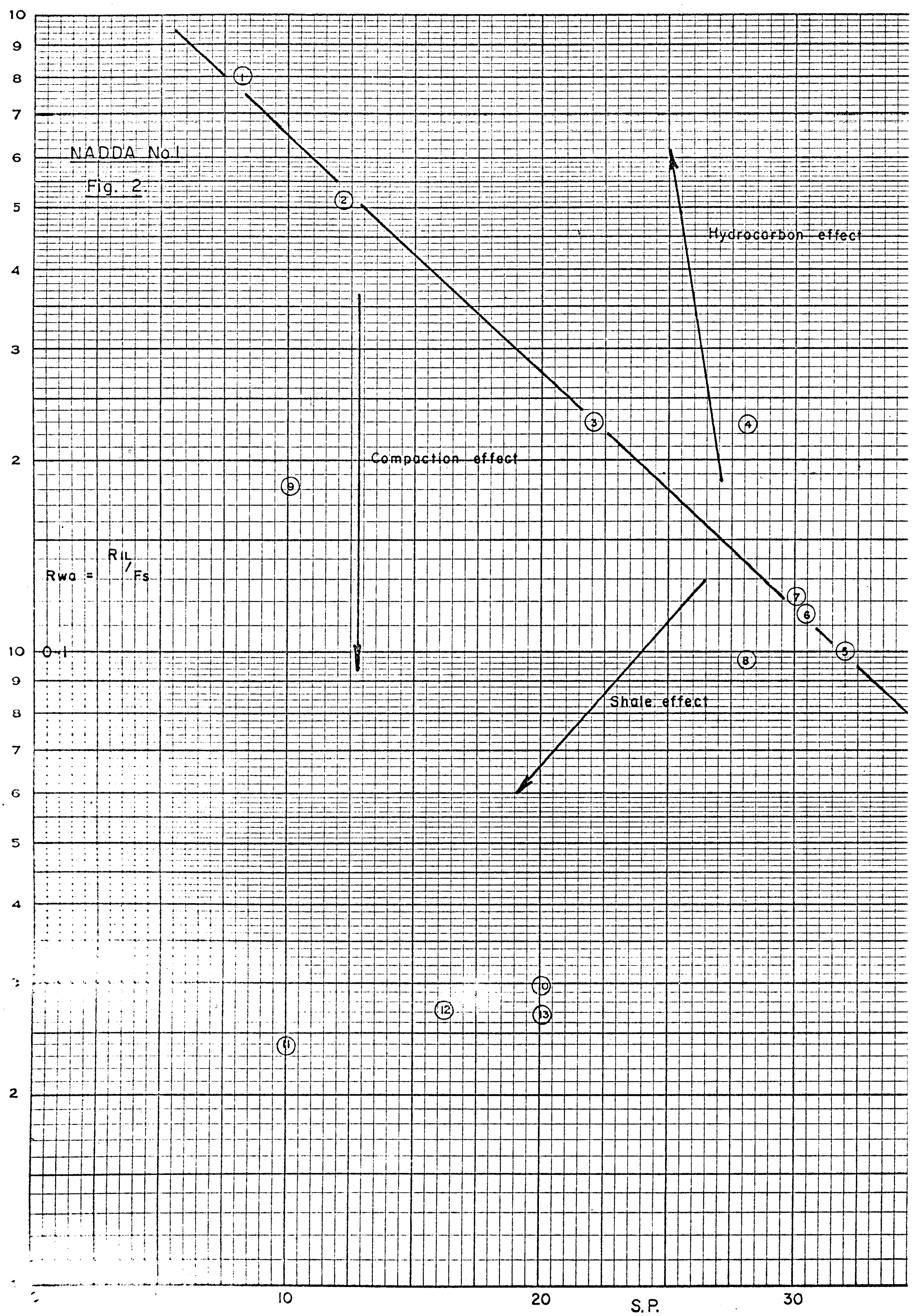
IES DEPTH	NO	RIL	SP	t	GR	Ri"	Ri	Φs	Fs	Rxo	Rwa
1205	1	5	-8	96	22	4.1	4.6	34	6.2	6.5	0.8
1458	2	4.3	-12	89	50	3.8	4.2	29.5	8.5	6.0	0.5
1737	3	1.5	-22	95	42	2.8	2.8	33.5	6.4		0.23
1866	4	1.5	-28	95	48	4.5	4.5	33.5	6.4		0.23
1895	5	1.2	-30	86	42	3.5	3.5	27	10.3		0.12
1984	6	3.0	-32	71	44	4.8	6.0	16.5	30	10.5	0.1
2045	7	2.2	-30	77	75	3.8	4.8	21	18	9	0.12
2142	8	2.1	-27	72	53	4.4	4.9	17.5	22		0.095
2664	9	4.8	-10	62	53	tve	tve	10	27		0.18
2949	10	9	-20	55	64	-	-	5.5	310		0.029
3055	11	12	-10	54	70	-	-	4.5	500		0.024
3256	12	3.8	-16	59	42	3.6	4.5	8	140	9	0.027
3350	13	6.7	-20	56	53	-	-	6	250		0.027

Rm =
Rmf = 2.2 at 125°F
Rmc = 3.0 at 125°F

GRID FOR SONIC — RESISTIVITY OR FD — RESISTIVITY PLOTS



902820 170



NADDA No.1
Fig. 2
Hydrocarbon effect
Compaction effect
Shale effect
Rwa = RIL/Fs
0·1
10
20
30
S.P.

APPENDIX 7

DRILL STEM TESTING.

Only one drill stem test was carried out during the drilling programme. This test was of the "basal Cretaceous sand" over the interval 2783 to 3287 feet in A.A.O. Sunset No.1.

Type of test: Conventional bottom hole.

Down hole assembly: refer to attachment in Enclosure 5.

Top hole assembly:
Rotating flow head.
Chiksan hose.
Floor manifold - twin wing with 3/4" fixed and 3/4" variable chokes.
200 feet of 2-3/8" J55 4.7 lb. tubing flow line.
A separator was not used.

Test Data:
Refer to Enclosure 5.
Refer to attached drill stem test data sheet.

Results:
No gas to surface.
Recovered (400 feet of mud.
2200 feet of water.)

Interpretation:
The "basal Cretaceous sand" was 168 feet thick in this well.

Application of the standard formula -

$$\frac{Kh}{\mu} = \frac{162.5Q}{m.}$$

where
K = permeability (md)
h = sand thickness (ft)
μ = viscosity (cp)
Q = production rate(BPD)
m = transmissibility factor

K = 2000 md. (very approximately).

As this is an average figure, permeability locally is expected to be much higher.

DRILL-STEM TEST DATA

Well Name SUNSET	Test No. 1
Well Number 1	Zone Tested Basal Cretaceous Sand
Company Associated Australian Oilfields N.L.	Date 15-3-70
Comp. Rep. J.C. ANDERSON	Tester B.J. Services (Thrupp)

Hanging Weight 75,000

Recorder No. 1876	Clock Range 12 hour	Recorder No. 1885	Clock Range 24 hour
Depth	2766	Depth	2807
Initial Hydro Mud Press.	1451	Initial Hydro Mud Press.	1437
Initial Shut - in Press.	1215	Initial Shut - in Press.	NR
Initial Flow Press.	1149 1215	Initial Flow Press.	NR
Final Flow Press.	1215 1215	Final Flow Press.	NR
Final Shut - in Press.	1215	Final Shut - in Press.	NR
Final Hydro Mud Press.	1444	Final Hydro Mud Press.	1437
Temperature (BH)	130°F	Packer Set with	30000 lb. @ 1113 hrs.
Mud Drop	3'	Tool Open Before I.S.I.	30 Mins. from 1115 to 1145
Mud Weight 9.4	Viscosity 35	Initial Shut - in	30 Mins. from 1145 to 1215
Fluid Loss	6.8	Flow Period	30 Mins. from 1215 to 1245
Interval Tested	2783 - 3287	Final Shut - in	30 Mins. from 1245 to 1315
Nett Pay Tested	170 ft.	Packer Pulled with	82000 lb. @ 1315 hr.
Top Packer Depth	2777	Surface Choke Size	$\frac{3}{4}$"
Bottom Packer Depth	2783	Bottom Choke Size	$\frac{1}{2}$"
Total Depth	3287	Main Hole Size	$8\frac{3}{4}$"
Drill Pipe Size $4\frac{1}{2}$" F.H.	Wt. 16.6	Rat Hole Size	$6\frac{1}{8}$"
Drill Collar I.D. $2\frac{7}{8}$"	Ft. Run 360	Feet of Rat Hole	8
Anchor Size	$4\frac{3}{4}$"	Type of Test	Dual bottom hole
Recovery—Total Feet	2600	Cushion Amount—Type	Nil
Recovery—Barrels		Rubber Size	$7\frac{3}{4}$"
		Increase in Hanging Weight	5000 lb.

Recovered 400 Feet Of Mud

Recovered 2200 Feet Of Muddy water Rw = 0.21 @ 84°F

Recovered Feet Of

Recovered Feet Of

Flow Measurements

Gas No gas to surface

Time	Orifice	Temp.	Diff.	Static	Temp. Fac.	Or. Fac.	S.G.	Flow

Oil

Water

REMARKS : Strong air blow decreasing to nothing at end of test.