

## SECTION 2 - GEOLOGICAL DATA

2.1 Geological Summary

Lady Penrhyn-1 was spudded in the Kyalla Member of the McMinn Formation of the late Proterozoic Upper Roper Group. Cuttings samples were taken at 2 metre intervals from the top of the hole to a depth of 10m. from where the hole was fully cored.

The well penetrated the most complete Upper Roper Group section drilled to date - from upper Kyalla member to the Corcoran Formation. The section penetrated was very different to that prognosed due to the Kyalla member being interpreted as Velkerri Formation from surface mapping and air photo interpretation. Table 3 summarizes the actual versus prognosed formation tops.

Numerous occurrences of fluorescence and minor oil shows were encountered during the drilling of Lady Penrhyn-1. The fluorescence/shows are detailed in Enclosure 1. The main occurrences of interest are as follows:-

1. Moroak member - Abundant fluorescence over the interval 140-170m. Interbedded F-M sandstones shows-abundant bright yellow-white fluorescence and films of a very light oil on their surfaces.
2. Velkerri Formation - distinct kerosene odour throughout the middle Velkerri.  
- minor oil bleeds/fluorescence associated with carbonate lenses.
3. Bessie Creek Sandstone - Pore-filling bitumen and dead-oil (?) throughout.  
- minor oil bleeds/fluorescence associated with carbonate lenses.

The well was terminated in the Corcoran Formation, the unit directly underlying the primary reservoir target - the Bessie Creek Sandstone (Figure 3 shows porosity/permeability results).

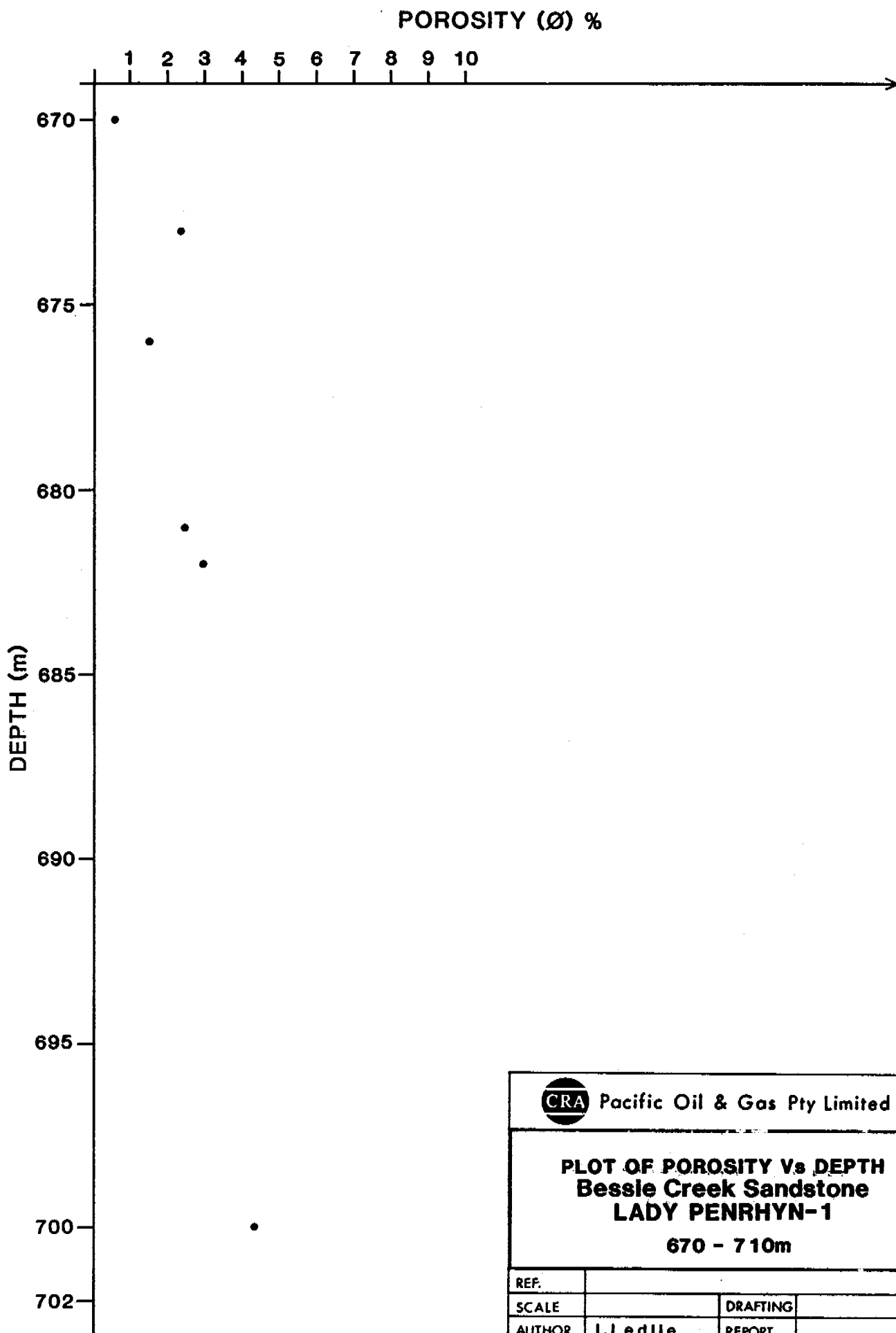
An on-site evaluate of the wireline logs indicated no zones that warranted testing. The well was then plugged and abandoned in the approved manner.

TABLE 3

ACTUAL VERSUS PROGNOSED FORMATION TOPS

WELL: Lady Penrhyn-1  
 PERMIT: EP5, Northern Territory

A G E	FORMATION	DEPTH TO FORMATION TOP		
		ACTUAL DEPTH	PROGNOSED DEPTH	DIFFERENCE
Proterozoic	Kyalla Member	Surface		
	Moroak Sandstone Member	100		
	Velkerri Fm.	171	Surface	+ 171
	Bessie Ck Sst	672	200	+ 472
	Corcoran Fm.	708	230	+ 478
	TD	745.0	580	+ 165




 Pacific Oil & Gas Pty Limited			
<b>PLOT OF POROSITY Vs DEPTH</b> <b>Bessie Creek Sandstone</b> <b>LADY PENRHYN-1</b> <b>670 - 710m</b>			
REF.			
SCALE		DRAFTING	
AUTHOR	I. Ledlie	REPORT	
DATE	Mar 88	PLAN No	PetNTcw 298

Figure 3A

PERMEABILITY (md)

0.1

1

10

670

675

680

685

690

695

700

704

DEPTH (m)

LEGEND

• Horizontal

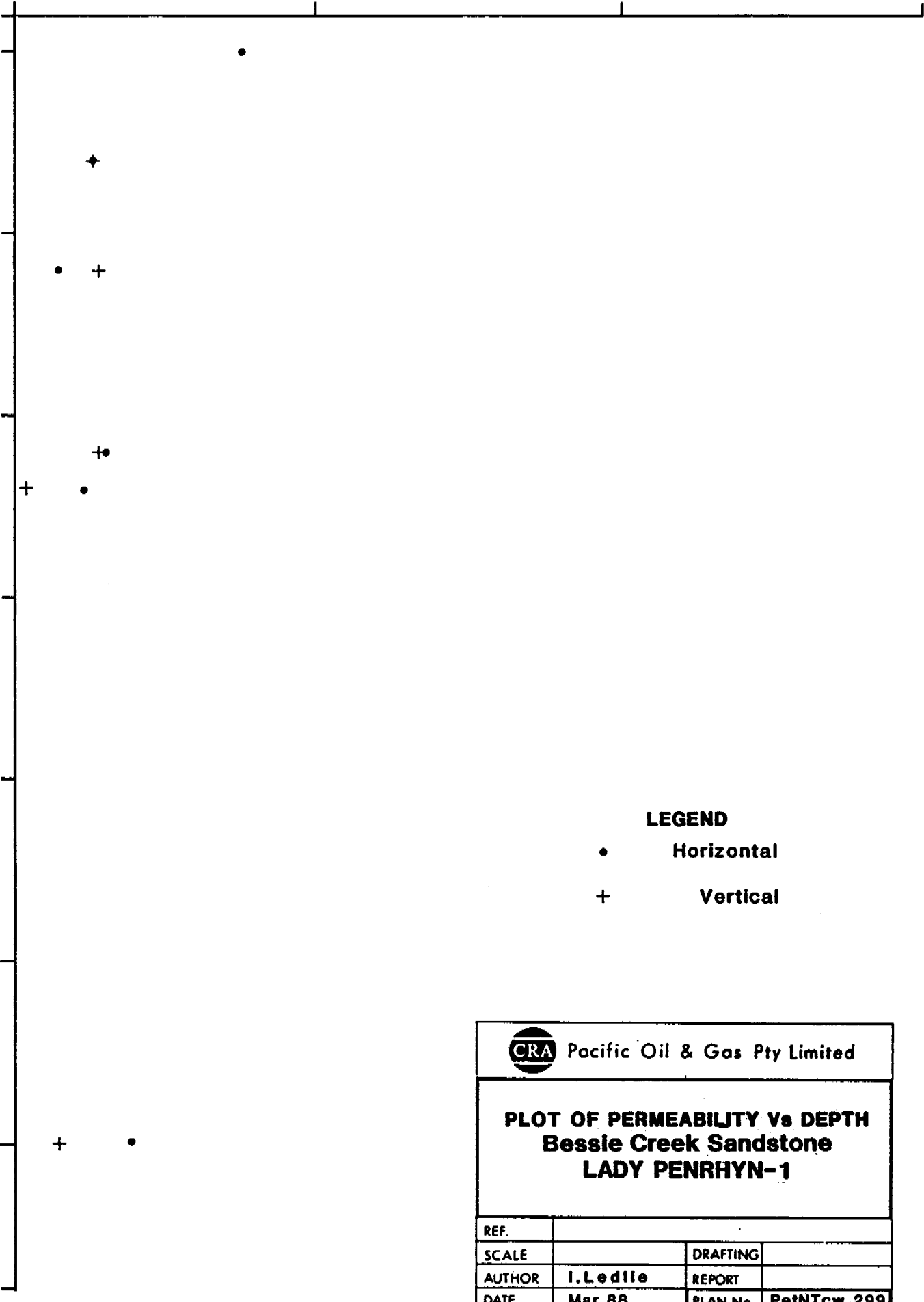
+ Vertical

**CRA** Pacific Oil & Gas Pty Limited

**PLOT OF PERMEABILITY Vs DEPTH  
Bessie Creek Sandstone  
LADY PENRHYN-1**

REF.			
SCALE		DRAFTING	
AUTHOR	I. Liddle	REPORT	
DATE	Mar 88	PLAN No	PetNTcw 299

Figure 3B



## 2.2 Well Objectives

- A. To obtain a full stratigraphic and lithological section of the Upper Roper Group, McArthur Basin.
- B. To obtain a full source rock quality profile (including oil and gas generative potential) through the whole stratigraphic sequence .
- C. To provide preliminary data on reservoir horizons.
- D. To extend stratigraphic data base into EP 5.

## 2.3 Performance vs. Objectives

The performance versus objectives are discussed below using the same subsections as section 2.2 above.

- A. A full stratigraphic and lithological section of the McArthur Basin Upper Roper Group was intersected by Lady Penrhyn-1.
- B. A full source rock profile was obtained over the entire stratigraphic sequence in Lady Penrhyn-1. Samples were taken at five metre intervals through all potential source horizons (Kyalla member/Velkerri Formation/Corcoran Formation). All samples were analysed for TOC, and those samples with a TOC > 0.4% were analysed by the Rock-Eval pyrolysis technique. Results are located in Appendix III.

Based on the results of the geochemical analyses, it was possible to highlight organic-rich oil-prone source horizons. The middle part of the Velkerri Formation and the Kyalla Member appeared to be the best source horizons.

- C. The reservoir horizon intersected (namely the Bessie Creek Sandstone) was tested for porosity/permeability.

Figure 3. shows a graphical representation of the results. These results can be found in Appendix IV.

- D. The stratigraphy in EP5 was much advanced by the results of this well - particularly by the intersection of a thick Kyalla member section in the top of the hole.

## 2.4 Stratigraphy

### LATE PROTEROZOIC

#### Kyalla Member

Surface to 100 metres (thickness 100m) silty mudstone.

Thinly interbedded silty mudstone, sandstone and mudstone. Glauconitic sandstone, dykes, scour and load structures.

Brecciated fault zones. Mudstone with occasional sandstone interbeds increasing at depth.

Colours: dark reddish brown, moderate red, pale yellow brown, pale brown; medium dark grey to dark grey with some greenish grey; dark grey to greyish black, brownish black and occasional black.

#### Moroak Sandstone

100-171m (thickness 71m)

100-140m interbedded sandstone and mudstone with subordinate silty mudstone and siltstone. Brittle fracture deformed sandstone beds displaying compactional sandstone dykes. Sandstone fine - very fine grained mudstone - massive to finely laminated.

140-171m interbedded sandstone and mudstone with minor silty mudstone. Mudstone either as interbeds or fine laminations within sandstone lenses; contorted bedding and soft sediment deformation.

Colours: Mudstone - dark grey to greyish black, brownish grey. Sandstones - light grey to light olive grey, light brownish grey to light olive grey. Zones of bright yellow - blue white fluorescence present.

Velkerri Formation

171-672 metres (thickness 501)

Interbedded mudstone, siltstone and sandstone (minor).

The Velkerri can be divided into three sections as follows:-

1. Upper Velkerri - 171 -> 337 metres (thickness 166m)

171-190m

Interbedded sandstone and mudstone. Mudstone massive to finely laminated, deformed sandstone lenticules, augen, wisps, and blebs. Occasional organic matter, mudstone content decreases from top to base. Greyish black, dark grey and light brownish grey.

Sandstone: bedding disrupted by soft sediment deformation. Cross bedding and glauconite. Flame structures, ball and pillow structures. Brittle fracture. Pyrite present in mudstone beds.

Medium light grey to medium grey. Light brownish grey.

190-256m

Interbedded mudstone, siltstone and minor sandstone. Micromicaceous glauconitic mudstone very thinly and regularly interbedded with sandstone. Disseminated pyrite in glauconitic mudstones. Rare carbonate beds. Dark grey to greyish black, brownish brown.

Homogenous to finely laminated sandstone exhibiting soft sediment deformation. Light-medium grey.

256-300m

Interbedded finely laminated mudstone and massive siltstone, silty mudstone and massive mudstone.

Units same as above containing minor carbonate lenses and localised hairline fracture zones. Pyrite abundant as nodules and disseminated.

300-337m

Mudstone and silty mudstone. Mudstone and sandstone have typically sub-cm scale laminae. In equal proportions generally with sandstone dominant in the centre of the unit. Unit contains pyrite and has a petroliferous odour in some intervals. Greyish black - greenish grey.

2. Middle Velkerri 337-462m (thickness 125m)

337-378m

Mudstone: massive to finely laminated containing limestone and carbonate beds mm-10cm thick. Brownish black to black.

378-383m

Mudstone to silty mudstone. Very occasional fine grained sandstone. Mudstone - finely laminated to massive. Brownish black. Silty mudstone - finely laminated pinkish grey to light brownish grey.

383-422m

Interbedded mudstone dominant at top of unit; silty mudstone, finely laminated with darker mudstone and calcareous mudstone interlaminae.

Minor thin (0.5cm) coarse to medium grained sandstone with calcareous cement.

Pyrite nodules present.

422-457m

Mudstone - massive to thinly bedded minor silty mudstone and carbonate beds (1cm) micromicaceous and disseminated pyrite through out the unit with minor medium to coarse glauconitic sandstone, and regular occasional fractures, calcite-filled.

Brownish black to black.

Carbonate beds in lower unit contain minor oil bleeds with blue-white fluorescence.

3. Lower Velkerri 462-672m (thickness 210m)

462-545m

Mudstone, thinly bedded and brittle fractured. Mudstone to claystone - variable in colour with minor greyish black organic layers.

Massive beds with occasional soft sediment deformation.

Greenish - olive - dark grey. Massive claystone with distinct bedding occasionally highlighted by organic rich, dark grey layers.

Carbonate filled fractures are common.



545-568m

Mudstone - silty mudstone.

Regularly bedded with thin-medium beds of greenish grey mudstone. Carbonaceous laminae - greyish black and medium dark grey. Fracture zones filled with carbonate.

568-603m

Interbedded mudstone and silty mudstone.

Finely laminated and chaotically bedded with flakes and fragmented layers of organic material towards the base of unit.

603-608m

Mudstone - brownish black to black.

608-661m

Minor mudstone, siltstone and ferruginous sandstone.

Silty mudstone - variable bed thickness, appears micaceous and graded. Dark greenish grey - olive grey. Siltstone - thinly interbedded with other lithologies - greenish grey - dark greenish grey. Minor mudstone occasionally at top of graded beds.

Soft sediment deformation.

661-672m

Interbedded mudstone, silty mudstone and sandstone.

Greenish - grey silty mudstone dominates. Sandstone - 1cm bands regularly throughout (lenticular sandstone beds). Glauconite content increases towards the base. Silty mudstone - greenish black to olive black interbedded regularly with dominantly fine sandstone. Carbonaceous mudstone - showing dewatering or compaction features dark grey - grey black.

Bessie Creek Sandstone: 672 - 709m (thickness 37m)

Massively bedded sandstone, alternating fine to medium and medium to coarse sandstone. Stylolites and vertical fractures.

Medium dark grey - dark grey.

Some thinly bedded sandstone with mudstone interbeds and intraclasts.

30cm thick transitional boundary into lower sandstone - massive - fine to coarse grained, medium dark grey to brownish grey. Cross bedding at base.

Contains minor mudstone, organic content increases towards the base.

Poor visible porosity.

Corcoran Formation

709-745m (thickness 36m plus)

709-713m

Thinly interbedded mudstone, silty mudstone and fine to medium grained sandstone.

Olive grey - light grey.

712-745m

Thinly interbedded mudstone and siltstone.

Soft sediment deformation - finely laminated overall. Medium light grey to dark grey.

745m EOH

TABLE 4

STRATIGRAPHIC COLUMN

2.5 Mud Logging

No mud logging services were contracted for Lady Penrhyn-1.

2.6 Electrical Logging and Other Surveys

At total depth, the following logs were run by BPB Instruments (Australia) Pty Limited.

L O G	R U N	INTERVAL (m)	D A T E
Gamma, density, caliper and porosity	3, 4	1 - 742	8/11/88
Self potential, dual spaced focussed	1, 2	81 - 743	
Gamma, caliper, sonic	3, 5	1 - 743	

Copies of all well logs are included as Enclosure 2.

2.7 Bottom Hole Temperature

Bottom hole temperature recorded at 743.0m (logger) was 63°C.

2.8 Formation Sampling2.8.1 Ditch Cuttings

Ditch cuttings were collected at two metre intervals down the hole from 0 metres to 10 metres. A washed sample from each interval was described by the company geologist in detail and a portion of the sample submitted to the mines branch.

2.8.2 Conventional Cores

Lady Penrhyn-1 was a fully cored hole from 10.1m to 743.0m (T.D.). Core is stored at the CRA Exploration Pty Limited core shed in Darwin.

## 2.9 Petrology

Routine petrographic analysis was undertaken for each reservoir sample. Descriptions are summarized in Appendix V.

## 2.10 Reservoir Potential

Details are contained in Appendix IV and Figure 3 for the twelve samples submitted for reservoir analysis to AMDEL from Lady Penrhyn-1.

## 2.11 Hydrocarbon Shows

Numerous fluorescence and a few very minor oil shows were encountered during the drilling of Lady Penrhyn-1. Results are detailed in Enclosure 1.

## 2.12 Geochemistry

### 2.12.1 Analyses

A total of 53 core samples from Lady Penrhyn-1 were sent to AMDEL in Adelaide for geochemical analyses. Samples were selected from the section 30 to 745m. at approximately five metre intervals. Every second sample was analysed for Total Organic Carbon (TOC), if this was  $\geq 0.4$  then the sample was analysed by the Rock-Eval pyrolysis technique.

The analyses provided by AMDEL were internally consistent and the service excellent.

The analytical results from AMDEL are included as Appendix III and a diagrammatically represented as Enclosure 3.

## 2.13 Geophysics

### 2.13.1 Core Gamma Ray

Core gamma ray measurements were taken over the entire interval from 0 - 745m in Lady Penrhyn-1. Results can be found as Enclosure 4.

### 2.13.2 Magnetic Susceptibility

The entire core from Lady Penrhyn-1 was measured for magnetic susceptibility. Results are included as Enclosure 5.

2.14 Contributions to Geological Concepts

Prior to the drilling of Lady Penrhyn-1 there was a paucity of hard data available in the McArthur Basin.

Lady Penrhyn-1 provided a full stratigraphic sequence through Upper Roper Group of the McArthur Basin, evaluation of its hydrocarbon potential is now possible.

Lady Penrhyn-1 demonstrated that fair to reasonable quality reservoirs exist in the Upper Roper Group, and that excellent quality source rocks are present in both the Velkerri Formation and the Kyalla member of the McMinn Formation.