1.13 Well Costs

A summary of costs for the drilling of Jamison 1 is given in Table 3.

TABLE 3

JAMISON 1 WELL COSTS

ITEM	A $
Site Preparation / Rehabilitation	39,999
Water	18,729
Mobilization	75,450
Camp	80,614
Drilling	401,790
Casing and Cement	26,335
Mudlogging	85,814
Wireline Logging/VSP	46,058
Drilling Mud and Services	26,530
DST Rental	57,173
Analysis	26,250
Communications / Office / Courier / Freight	35,987
Site Supervision/ Labour	52,851
Travel	27,183
Equipment Hire / Vehicle Costs / Misc.	3,116
Insurance	2,426
TOTAL	1,006,302

2. GEOLOGICAL DATA

2.1 Geological Summary

Jamison 1 was designed as a stratigraphic test to identify the type, nature and hydrocarbon prospectivity of the stratigraphy in the centre of a large gravity low, informally termed the Beetaloo Sub-basin. Gravity and magnetic modelling had suggested a thickening of the Proterozoic Roper Group of the McArthur Basin into a sub-basin east of the Stuart Highway between Larrimah and Elliott. Three previous wells (Altree 2, Walton 2, and McManus 1) drilled on the northern edge of the gravity low had confirmed this southward thickening. Jamison 1 was drilled near the centre of the gravity low and was sited on an apparent two-way closure on a field stack of the SH90-103 seismic line (Figure 1), almost 100km south of the nearest well control.

The well spudded in unconsolidated to poorly consolidated Cretaceous clay which was red down to 12 metres, then became white to yellowish orange with depth, and sandy over the lowermost eight metres down to the top of the Cambrian Tindall Limestone at 77 metres. The limestone was much

TABLE 4

ACTUAL vs. PROGNOSED FORMATION TOPS

JAMISON 1

Age	Formation	Actual (m)	Prognosed (m)	Difference (m)
Tertiary	Undifferentiated	Surface	Surface	0
Cretaceous	Mullamen Beds	Undifferentiated	10	-
Cambrian	Jinduckin Formation	-	70	-
	Tindall Limestone	77	90	+13
	Antrim Plateau Volcanics	372	100	-272
	Cox Formation	Absent	340	-
	Bukalara Sandstone (equivalent?)	475.62	380	-95.62
Proterozoic	Chambers River Formation	501.46	400	-101.46
	McMinn Formation			
	- Bukalorkmi Sst Mbr	871.04	420	-451.04
	- Kyalla Member	968.80	450	-518.80
	- Moroak Sst Mbr	1714.32	500	-1214.32
	Velkerri Formation			
	- "Upper"	-	700	-
	- "Middle"	-	1000	-
TOTAL DEPTH		1766.85	1500	-266.85

N.B. All depths are measured from the drilling floor, 2.4 metres above ground level.

thicker than prognosed at this locality, persisting down to 372 metres (Table 4), but was also quite cavernous, creating problems with loss of circulation and influx of groundwater. Paucity of sample returns and contamination from cavings prevented the compilation of a detailed lithological profile over much of this interval.

At about 372 metres (picked from geophysical logs) the top of the Antrim Plateau Volcanics was encountered, but the nature of the contact was not observed due to the intermittent sample returns. After setting casing within the volcanics continuous coring commenced at 410.20 metres and showed the lithology to be a mostly very fine grained basalt with occasional, partly altered coarser intervals, thought to be the tops of lava flows.

Below a sharp contact at the base of the basalt (475.62 metres) a patchily cemented, labile sandstone was intersected. This is thought to be of Cambrian age, and is tentatively labelled as a local equivalent of the Bukalara Sandstone. The base of the sandstone (501.46 metres) is also marked by a sharp contact, which is interpreted to represent a major unconformity between the Cambrian and the underlying section, thought to be Proterozoic.

The section intersected between 501.46 and 871.04 metres is characterized by thick, dominantly greenish mudstone with infrequent silty and sandy intervals, and is tentatively labelled as the Chambers River Formation, the uppermost stratigraphic element of the Roper Group.

Below 806 metres sand content increases spasmodically with depth, passing gradually into a thick quartzose sandstone with only minor mudstone interbeds (871.04 to 968.80 metres). This is thought to be the Bukalorkmi Sandstone Member, the stratigraphically highest unit of the McMinn Formation.

At the base of this sandstone a pebbly conglomerate occurs, which appears to have been partly embedded in the underlying mudstone, suggesting that the mudstone was not substantially indurated when the conglomerate was deposited. This is interpreted to represent a relatively minor hiatus, which strongly influenced the interpretation of the section above (up to 501.46 metres) as being Proterozoic rather than Cambrian.

The underlying thick mudstone (968.80-1714.32m) is mostly black to dark grey, with variable proportions of silty and sandy interbeds, and has been labelled as the Kyalla Member of the McMinn Formation due to the generally strong lithologic resemblance with Kyalla sections drilled elsewhere and its relative position in the penetrated stratigraphy. Other than an eight metre sandstone (1484-1492 metres) there is no significant development of sandstone within the Kyalla Member until the lowermost 20 metres, where sand content increases towards the underlying Moroak Sandstone Member.

Within this gradual transition the top of the Moroak Sandstone Member is picked at a depth (1714.32 metres), below which the dark mudstones did not persist and thicker sandstone beds became dominant. The Moroak Sandstone Member is substantially different here than in intersections drilled

further north, being almost entirely sandstone (no mudstone interbeds) and frequently medium to coarse grained. In fact, its character is somewhat reminiscent of typical Bessie Creek Sandstone facies.

The well was terminated within the Moroak Sandstone Member at a total depth (TD) of 1766.85 metres.

2.2 Well Objectives and Performance

Jamison 1 was designed as a stratigraphic test of the presence and hydrocarbon prospectivity of a thickened Roper Group section interpreted to be causing an extensive gravity low, informally termed the Beetaloo Sub-basin. Three previous wells, (**Altree 2**, **Walton 2** and **McManus 1**) had confirmed some thickening at the sub-basin's edge, so it was decided to drill near the centre of the gravity low. Final site selection was based on a field stack of a recently acquired seismic section (SH90-103) which appeared to show a small two-way closure. Although primarily a stratigraphic test, **Jamison 1** was located over this feature, which subsequent processing suggests may not be real.

Prior to the drilling of **Jamison 1** the nearest drillholes which penetrated beneath the Cambrian section were the three aforementioned (all about 100km to the north) and the nearest Proterozoic outcrop is the top end of the Tomkinson Creek Beds about 65km to the south-southeast, whose relationship to the Roper Group remains unclear.

The results from **Jamison 1** confirm the presence of the sub-basin and its infilling with a thickened Roper Group section. In fact, the stratigraphy was much thicker than anticipated and the well penetrated the thickest and most complete section of the uppermost Roper Group yet encountered in the subsurface or outcrop, as well as a thicker Cambrian section than drilled before.

Before drilling **Jamison 1** the mid-Velkerri Formation had been the primary focus for hydrocarbon source potential, but this now seems to be buried well below optimal maturity depths over much of the Beetaloo Sub-basin. However, the slightly organic-poorer Kyalla Member is now at sufficient depth and of adequate thickness to provide a suitable alternative source rock, passing from immature (at 970 metres) to overmature (at 1700 metres).

As regards reservoir potential, the Moroak Sandstone Member was much deeper, hotter and more silicified than anticipated, (hence lowering its prospectivity), but hydrocarbon-bearing units in the Bukalorkmi Sandstone and the Chambers River Formation provided a better result than expected. Also, the Cambrian Bukalara (?) Sandstone yielded excellent porosities and permeabilities.

Both the Kyalla Member and the Chambers River Formation displayed excellent seal potential, with an additional (but much less likely) possibility being the Cambrian volcanics.

Thus, despite downgrading the prospectivity of some units due to increased depths, Jamison 1 has succeeded in identifying some very encouraging hydrocarbon potential in the uppermost Roper Group section of the Beetaloo Sub-basin.

2.3 Stratigraphy

(see Appendix 6 for detailed descriptions).

Undifferentiated Tertiary/Cretaceous

Surface to 77 metres (77 metres thick)

Red, yellowish orange to white clay and poorly indurated claystone with minor silt and sand increasing towards base.

Tindall Limestone

77 - 372 metres (295 metres thick)

Off-white, light grey and locally brown/orange limestone, fine to coarse crystalline, with variable claystone and sandstone (cavings?).

Antrim Plateau Volcanics

372 - 475.62 metres (103.62 metres thick)

Dark greenish to brownish grey, fine to occasionally coarse, crystalline basalt, locally altered and vuggy.

"Cambrian" (Bukalara Sandstone equivalent?)

475.62 - 501.46 metres (25.84 metres thick)

Light brownish/greyish labile sandstone, poorly sorted, friable, quite porous and permeable, with patchy calcite cement and very poorly-defined bedding.

Chambers River Formation

501.46 - 871.04 metres (369.58 metres thick)

Greyish green to occasionally greyish brown (and rarely dark grey) mudstone, commonly silty, with infrequent intervals of finely interbedded/laminated sandstone becoming more common towards the base. Stratification is generally "massive" to poorly-defined planar lamination, becoming well-defined where sandstone interbeds/laminae occur.

McMinn Formation

Bukalorkmi Sandstone Member

871.04 - 968.80 metres (97.76 metres thick)

White to light grey (occasionally greenish), very fine to coarse quartzose sandstone with a pebbly conglomerate at the base and rare mudstone interbeds. Generally "massive" to poorly-defined bedding, with occasional cross-stratification. Mostly very silicified, with small intervals of moderate porosity and permeability containing hydrocarbons.

Kyalla Member

968.80 - 1714.32 metres (745.52 metres thick)

Medium dark grey to black mudstone and silty mudstone with intervals of variably interbedded light grey siltstone and sandstone. Stratification is dominantly planar to wavy planar with frequent (but sporadic) units of chaotic/slumped bedding and sediment mixing, all containing variably complete upward-fining cycles. Where regular interbedding of sandstone and mudstone occurs, dewatering (sandstone injection) structures, which typify parts of the Kyalla elsewhere, are commonly developed. Variable organic richness and scattered oil and gas bleeds were observed throughout most of this interval.

Moroak Sandstone Member

1714.32 - 1766.85 (TD) metres (52.53 metres thick)

White to light grey (occasionally greenish), fine to very coarse quartzose sandstone with generally "massive" to poorly-defined bedding, occasionally chaotic or cross-bedded. This interval is extensively silicified, but also displays some stylolites (indicating pressure solution). No hydrocarbons were detected.

2.4 Mud Logging

Mud logging services were provided by Halliburton Geodata. Rate of penetration, total gas detection, gas chromatography, pump strokes, fluorescence, calcimetry and H_2S detection were monitored, and a continuous mud log prepared at a scale of 1:500. A copy of the mud log is included in this report as part of Enclosure 1 (PetNTcw 4393). Mud logging personnel also assisted Pacific staff in the recovery of sample, and in the handling, marking and description of core.

2.5 Geophysical Logging

2.5.1 Magnetic Susceptibility

Magnetic susceptibility measurements were taken (using a hand-held meter) from representative cuttings samples every three metres throughout those parts of the hole which were air drilled or rotary drilled with mud. Measurements were taken at two metre intervals over the entire length of core. The magnetic susceptibility log is included in Enclosure 2 (PetNTcw 4397).

2.5.2 Spectral Gamma Ray

Spectral Gamma Ray readings were taken (using a hand-held spectrometer) from representative cuttings samples every three metres throughout those parts of the hole which were air drilled or rotary drilled with mud. Measurements were taken every two metres over the entire length of core. Total Count, Uranium, Potassium and Thorium counts were all sampled four times over a ten second sample window and the results averaged and displayed on the log included in Enclosure 2 (PetNTcw 4397). (Below 479 metres Total Count was recorded at one metre intervals).

2.5.3 Wireline Logging

Prior to setting seven-inch casing after drilling to 163 metres, an attempt was made to acquire a Spontaneous Potential Log (to aid in the assessment of surface electrical methods), but the hole was packed off at 110 metres with a standing water level at 105 metres. A Gamma Ray tool was run from 110 metres to surface.

After reaching Total Depth (TD) at 1766.85 metres a full suite of wireline logs, comprising Spontaneous Potential, Dual Focused Resistivity, Gamma Ray, Bulk Density, Neutron Porosity and Sonic were run up to 400 metres. These appear on the Composite Log (Enclosure 1, PetNTcw 4393) at 1:1000 scale, and copies of each log at 1:500 scale are provided in Enclosure 3 (PetNTcw 4398, 4399 & 4400).

2.5.4 Bottom Hole Temperature

Bottom hole temperatures were recorded on each wireline run. A maximum bottom hole temperature of 90 degrees Celsius was recorded during the final logging run at 1769 metres. Assuming a 25°C surface temperature this equates to a geothermal gradient of 36.7 degrees Celsius per kilometre.

2.5.5 Well Velocity Survey

A 16 level velocity survey was recorded in **Jamison 1** by Velocity Data Pty Ltd, a full report of which is provided in Appendix 8.

2.5.6 Synthetic Seismograms

Check shot, sonic and density data recorded in Jamison 1 have been used to produce synthetic seismograms, on which a full report is provided in Appendix 9.

2.5.7 Vertical Seismic Profile

A 39 level survey was recorded and a full report on the vertical seismic profile produced for Jamison 1 is provided in Appendix 10.

2.6 Formation Sampling

2.6.1 Ditch Cuttings

Cutting samples were collected every three metres; from below the centrifuge when drilling with air, and from the shale shakers when rotary drilling with mud. All samples were washed, described and split into two bags, one of which was submitted to the Northern Territory Department of Mines and Energy, and one retained by Pacific Oil & Gas. Cuttings were not collected during coring.

2.6.2 Continuous Core

From 410.20 metres below the drilling floor the well was drilled using a wireline continuous coring technique. Upon recovery the core was pieced together and cleaned with a damp rag. The core was then indelibly marked with a blue line and a red line (red to the right when looking up the core) and the marked on the core every twenty centimetres (annotated every metre). A core block with the drillers depth was placed at the end of each run and a chip sample was taken every two metres for the mudlog description and then stored in a Samplex tray. The core was then photographed (both wet and dry) and laid out for further description prior to being packaged for dispatch to the CRAE core storage facility in Darwin. A core tally summarizing amounts of core cut and recovered is provided in Appendix 7.

Notes: (1) Except for intervals where core was obviously lost from one run and recovered subsequently, each core interval is marked using the driller's depth (marked on the previous block) as the next datum to avoid compounding minor discrepancies from each core run.

(2) In some intervals core recovery is consistently greater than 100%. This was found to be due to a combination of decompaction (due to release from lithostatic pressure) and expansion (due to hydration of clays).

2.7 Hydrocarbon Shows

Numerous hydrocarbon shows were encountered in Jamison 1 and are summarized below. More detailed descriptions are given in Appendix 6 and gas detection data is shown on Enclosure 1 (PetNTcw 4393).

Chambers River Formation

Total gas began to exceed 100 ppm below 710 metres (thin, very tight sandstone interbeds).

806 - 812 metres

Intermittent, solid to patchy, golden/greenish yellow to white fluorescence with a slow streaming cut and Total Gas readings up to 1800 ppm.

Bukalorkmi Sandstone Member

Intermittent, solid to patchy, blue-white to yellowish fluorescence with streaming to instant cut and associated increases in Total Gas (up to 3000 ppm) over the following intervals;

871-874, 878-883, 887-888, 894-896 and 898-901 metres.

Fluorescence between 894 and 901 metres is also associated with a distinct yellow staining on the core.

Similar, but generally patchier and sparser shows were observed below about 940 metres, especially 950-952 metres and 959-960 metres.

Kyalla Member

Generally very sparse pin-point oil bleeds associated with exuding gas from around very tight sandstone/siltstone interlaminae occur throughout much of this interval, most notably between 970-1095, 1145-1165, 1255-1285 and 1430-1465 metres.

2.8 Analyses

2.8.1 Source Rock Geochemistry

Fifty eight small (30-50 gram) samples were taken at frequent intervals throughout the core (with emphasis on the darkest and finest-grained units to assess source rock potential and maturity levels. All samples were submitted to Amdel (Adelaide) and, following determination of Total Organic Carbon (TOC) content, those reporting greater than 0.4% TOC were subjected to Rock-Eval Pyrolysis using a Girdel IFP-Fine Mark 2 instrument. Results of these analyses are given in Appendix 4.

2.8.2 Reservoir Analysis

Seventy six core samples from Jamison 1 were submitted for reservoir analysis. For most a one-inch plug was cut and ambient analysis was conducted for horizontal permeability, helium-injected porosity and grain density. Two full-diameter core samples were analysed for horizontal and vertical porosity and permeability, one at both ambient and overburden pressures. Retorted residual fluid saturations were also obtained for most samples. Results of these analyses are given in Appendix 5.

2.8.3 Water Analysis

Water samples taken from the water bore and Drill Stem Test intervals were submitted for standard water analysis and a full set of these results are provided in Appendix 11.

Note: Water bore samples (ie. make-up water) are filed with DST-1 results.

2.8.4 Gas Analysis

Gas samples were collected from the bubble hose in gas bombs prior to and/or during the venting of gas collected from closed chamber Drill Stem Tests. Results of analysis of these samples are presented in Appendix 11.

2.8.5 Oil Analysis

Samples of liquid hydrocarbons were taken from fluids recovered during Drill Stem Tests and extraction from core samples. Results of these analyses are presented in Appendices 11 and 12.

2.8.6 Palynology

In an attempt to provide a broad temporal constraint on the stratigraphy penetrated in Jamison 1 palynological analyses were requested on two suites of mudstone samples to determine whether they were of Cambrian or Proterozoic age. As shown in resulting reports (Appendix 13) the answer is somewhat equivocal.

2.9 Contributions to Geological Knowledge

Jamison 1 has provided a major contribution to the knowledge of the Beetaloo Sub-basin, as well as having wider implications for the distribution and stratigraphy of the uppermost Roper Group. It has;

(1) shown the gravity-inferred sub-basin to consist of greatly thickened Cambrian and uppermost Proterozoic section, indicating a broad basinal low in this region during those geologic intervals.

(2) in conjunction with seismic data, confirmed the southward extension and continued thickening of upper Roper Group beneath Cambrian rocks.

(3) provided the thickest and most complete section yet seen (in either outcrop or the subsurface) of the uppermost Roper Group stratigraphy.

(4) provided the first indications of the Kyalla Member being a viable source rock with sufficient quality and maturity to generate hydrocarbons.

(5) demonstrated that migration of generated oil and gas from a Proterozoic source into a Proterozoic reservoir has taken place, and

(6) proven that oil and gas reservoired in Proterozoic sediments can be sufficiently sealed and preserved to warrant viable exploration targets.

KEYWORDS

Petroleum, Proterozoic, Drill Stratigraphic, Hydrocarbon Potential.

LOCATION

Approximately 40km east-southeast of Dunmarra

AMG: E 368 483
N 8 144 776

Latitude: 16° 46' 34.7" S
Longitude: 133° 45' 57.5" E

1:100,000 Sheet: Warramban 5664
1:250,000 Sheet: Tanumbirini SE53-2

LIST OF DPO'S

49460, 49462, 49464, 67757, 67758, 67759, 67760, 67761, 67762, 67763, 67764, 67765, 67766, 67767, 67771, 67772, 67773, 67774, 67776, 67777, 67778, 67779, 67780, 67781, 67782, 67783, 67784, 67785, 67786, 67787, 67788.