

SECTION 2 - GEOLOGICAL DATA

Given the engineering problems encountered in Atree-1 the following discussion is concerned only with Atree-2.

2.1 Geological Summary

Atree-2 was designed as a stratigraphic test to determine the presence of upper Roper Group Sediments below the Cambrian volcanics in Exploration Permit 24. The well location lies along the northern margin of the gravity and magnetically inferred Betaloo Sub Basin and is approximately 50km south west of the Mallupunyah Fault.

The well spudded in Cretaceous claystones that have a highly developed lateritic soil profile. The claystones become sandier towards the base of the section immediately above the Cambrian to Cretaceous unconformity which was penetrated at 52 metres. Below the unconformity the well intersected Limestones of the Cambrian Tindall Limestone, prior to losing circulation. The well was drilled without returns until 104 metres where a seven inch casing string was set.

From the rate of penetration it appears that the well intersected the Cambrian Nutwood Downs Volcanics at 98.5 metres. The seven inch casing shoe was drilled out and basalt with occasional sandstone and siltstone beds was drilled to 320 metres. An additional 5 inch casing string was run to 208.7 metres in response to lost circulation within the basalts.

Below the basalt the hole intersected sediments of the Moroak Sandstone of the upper Roper Group. The boundary between the Sandstone and the basalt was representative of an erosional unconformity. The sandstones pass conformably down into siltstones of the Upper Velkerri formation which was intersected at 391.72 metres. The Middle Velkerri formation was intersected at 672 metres and was found to contain minor oil shows indicative of the unit's oil source potential. Claystones of the Lower Velkerri Formation were intersected at 948.23 metres and exhibited poor oil shows over the interval 1128.5-1129.5 metres and fair oil shows in a basal sand over the interval 1220.4 metres to 1222.2 metres.

The Bessie Creek Sandstone was intersected at 1229.65 metres and contained numerous poor shows in the uppermost 40 metres. No visual porosity was evident. The underlying Corcoran Formation was intersected at 1647.11 metres, however only 41.12 metres was drilled prior to the well intersecting a dolerite sill at 1688.23 metres. The dolerite was drilled to 1699.85 metres at which point drilling ceased.

Wireline logs were run over the intervals 208 metres (seven inch casing shoe) to surface and from 1698 metres to 195 metres.

No drill stem tests were conducted in Atree-2.

TABLE 4

ACTUAL Vs PROGNOSED FORMATION TOPS

ALTREE-2

Age	Formation	Actual	Prognosed	Difference (m)
Cretaceous	Undifferentiated	Surface	Surface	0
Cambrian	Tindall Limestone	52	68	16 high
	Nutwood Downs Volcanics	98.5	150	51.5 high
Proterozoic	Moroak Sandstone	320	264	56 low
	Upper Velkerri Formation	391.72		
	Middle Velkerri Formation	672		
	Lower Velkerri Formation	948.23		
	Bessie Creek Sandstone	1229.65		
	Corcoran Formation	1647.11		
	(Dolerite)	1688.23		
	TOTAL DEPTH	1699.85		

2.2 Well Objectives and Performance

Atree-2 was designed as a stratigraphic test to assess the hydrocarbon potential of sedimentary rocks along the northern margin of the Beetaloo Sub-Basin, defined as a broad gravity depression interpreted to contain a thick section of Proterozoic Roper Group. Prior to drilling, the nature of the sediments below the Cambrian unconformity at the base of the Nutwood Downs volcanics was unknown.

The results from Atree-2 indicated that the Beetaloo Sub-Basin gravity expression is a result of a thick Roper Group section below the Cambrian unconformity. In particular the intersection of the Moroak Sandstone, Velkerri Formation and Bessie Creek Sandstone indicate that the most prospective part of the Roper Group is within drillable depth in EP24 and contains excellent source potential and favourable reservoir potential.

The occurrence of oil shows throughout the Velkerri Formation indicate the unit to be oil generative, adding to the potential of the area.

In light of the above, the results from Atree-2 must be seen as very encouraging for exploration in EP24.

2.3 Stratigraphy

Undifferentiated Cretaceous:

Surface to 52 metres (52 metres thick)

Sandstone with minor claystone. Sandstone is medium grained sub rounded, very soft. Claystone is dark yellow to orange and soft.

Tindall Limestone:

52 - 98.5 metres (46.5 metres thick)

Drilled with only intermittent returns.

Limestone with minor claystone and sandstone. Limestones are white to off white, blocky, hard. Sandstones and Claystones are as described above and may represent caving from that unit.

Nutwood Downs Volcanics:

98.5 - 320 metres (221.5 metres thick)

98.5 - 181 metres

Basalt, dusky brown, occasionally black, hackly fracture, vesicular, with occasional white zeolites in vesicles.

181-209.7 metres.

Sandstone with interbedded siltstone and minor claystone. Sandstones are moderately green to light green, fine grained, lithic, well sorted and sub-rounded. Siltstones are dark brown to olive green, firm and lithic. Claystone, white, soft and firm.

209.7 - 320 metres

Basalt - greyish black to greenish black, fine to medium grained, massive. Very hard, moderately fractured, pyroxene xenocrysts, occasional tuffaceous and chilled intervals.

Moroak Sandstone:

320 - 391.72 metres (71.72 metres thick)

Sandstone - pinkish white to very light green, although light to medium grey at the base, fine to occasionally medium grained, poorly to occasionally well sorted. Sub-angular to angular, poorly bedded minor light greenish grey silt and clay in disrupted laminae. Clay matrix. Strong silica cement in more sorted interbeds. No visible porosity.

STRATIGRAPHY – ROPER GROUP


CHAMBERS RIVER FORMATION		COBANBIRINI FORMATION
McMINN FORMATION	KYALLA MEMBER  MOROAK SANDSTONE MEMBER	
VELKERRI FORMATION		
BESSIE CREEK SANDSTONE		LANSEN CREEK SHALE
CORCORAN FORMATION		
ABNER SANDSTONE	HODGSON/MUNYI SANDSTONE MBR.	
	JALBOI MEMBER	
	ARNOLD SANDSTONE MEMBER	
CRAWFORD FORMATION		
MAINORU FORMATION		
LIMMEN SANDSTONE		

Figure 3



Upper Velkerri Formation:

391.72 - 672 metres (289.28 metres thick)

Siltstone with minor laminated and interbedded claystone and sandy siltstone. Siltstones are medium dark grey to dark grey, laminated with minor small scale slumping, often associated with pyrite nodules. Claystone is white to light grey and thinly interbedded. Sandy siltstones are light grey moderately well sorted, well cemented with quartz. No visible porosity. Scour surfaces and minor dewatering features are common throughout interval. Hydrocarbon shows associated with coarser grained units - over intervals 451.98 - 471.15, 508.2 - 516.3 and 560.82 - 563.34 metres. Shows consist of variable white to very pale yellow fluorescence, streaming white crush cut and live oil associated with core. Intervals exhibit no visible porosity due to strong silicification.

Middle Velkerri Formation:

672 - 948.23 metres (276.23 metres thick)

Siltstone grading to claystone, predominantly dark grey to greyish black but occasionally light to light olive grey. Finely laminated to massive, occasional thin pyrite veins and blebs strongly organic rich. Unit exhibits rare white to very pale yellow fluorescence, strong hydrocarbon odour, and strong white crush cut over entire interval indicating excellent source rock potential. Occasional thin interbeds of dolomitic and pyritic siltstone.

Lower Velkerri Formation:

948.23 - 1229.65 metres (281.42 metres thick)

948.23 - 1127 metres - Claystone, grading to siltstone in parts, light bluish grey to medium bluish grey and medium dark grey at base. Occasional interbeds of dark grey to greyish black claystone. Occasionally grades to siltstone, contains minor flecks of organic matter disseminated throughout.

1127-1130 metres - Sandstone, dark grey occasionally light grey, very fine to fine grained, with abundant siltstone and claystone matrix. Highly micaceous. Occasional fining upward patterns evident in thin interbeds. Hydrocarbon shows between 1128.5 and 1129.5 metres. Live oil on core and strong hydrocarbon odour. No fluorescence but a weak blue-white crush cut. Core evolved small amounts of gas on removal from tube.

1130 - 1229.65 metres - Interbedded medium dark grey to dark grey claystone to light grey very fine sandstone. Small scale fining upward features evident.

Between 1202.5 & 1205.65 metres, claystones are greyish black to black and resemble the Middle Velkerri in terms of hydrocarbon potential. Sandstones become common over the basal 9 metres and exhibited fair hydrocarbon shows between 1220.4 and 1222.20 metres. Shows comprised 80% mottled blue-white fluorescence with a blue-white cut and weak ring residue. Sands have poor visual porosity.

Bessie Creek Sandstone:

1229.65 - 1647.11 metres (417.46 metres thick)

Sandstone, light grey to yellowish grey, occasionally medium dark grey at top and greenish grey at base. Very fine to medium grained with minor coarse-grained interbeds. Sands are often cross bedded and exhibit poorly developed fining upward cycles. Abundant quartz overgrowths and no porosity. Poor shows between 1253.6 - 1257.9 metres and 1259.65 - 1265.8 metres. Shows consist of 10% pin-point to banded yellow fluorescence. Crush cuts range from weak blue-white to pink with a moderate blue-white to pale pink residue. Unit becomes interbedded with medium grey to dark greenish grey siltstones over basal 5 metres as it grades into underlying formation.

Corcoran Formation:

1647.11 - 1688.23 metres (41.12 metres thick)

1647.11 - 1671.14 metres - Interbedded sandstone, siltstone and minor claystone. Sandstone is light grey to greenish grey, fine to medium grained, sub-angular to sub-rounded, silicified and typically fining upward. No visible porosity. Siltstones are dark grey to greyish black, laminated and occasionally slumped. Claystones are bluish white to very light grey and occur at the top of fining upward cycles. Sandstones become less common in the base of the unit.

1671.14 - 1688.23 metres - Siltstone interbedded with silty claystone and minor fine grained sandstone. Similar to above unit but finer grained. Fining upward cycles occur frequently as 2-20 cm units with scoured bases.

Dolerite:

1688.23 - 1699.85 metres (T.D.) (11.62 metres thick)

Dolerite, brownish grey to brownish black, cryptocrystalline chilled margin over upper 0.5 metre. Grades from fine to medium grained at bottom of hole. Occasional sub-vertical fractures.

2.4 Mud Logging

Mud logging services were provided by Gearhart Geodata Pty Ltd. Rate of penetration, total gas detection, gas chromatograph, pump stroke counter, fluorescence and H₂S detection services were provided, as well as lag monitoring and the preparation of a continuous mud log at a scale of 1:100. A copy of the mud log is enclosed in this report as Enclosure 1. Mud logging personnel assisted Pacific Oil and Gas staff in the handling, marking and description of core.

2.5 Electrical Logging and Other Services

The following down hole electrical logs were run by BPB Instruments (Australia) Pty Ltd.

TABLE 5

ELECTRIC LOGS

ALTREE-2

Log	Run	Interval (m)	Date
<u>Suite 1</u>			
Spontaneous Potential	1	209 - 103	13/10/88
Dual Focused Resistivity	2	207 - 103	"
Gamma Ray, Density	3	208 - Surface	"
Caliper, Neutron Porosity	4	207 - Surface	"
Dual Spaced Sonic	5	208 - 87	"
Absolute & Differential Temperature	6	208 - Surface	"
<u>Suite 2</u>			
Spontaneous Potential	1	1698 - 195	8/12/88
Dual Focused Resistivity	2	1698 - 195	"
Gamma Ray, Density	3	1698 - 195	"
Caliper, Neutron Porosity	4	1698 - 195	"
Dual Spaced Sonic	5	1698 - 195	"
Absolute & Differential Temperature	6	1698 - 195	"

Copies of well logs are included with this report as Enclosures Nos. 2 - 4. A bottom hole temperature of 84°C was recorded at 1698 metres.

A 20 level velocity survey was conducted by Velocity Data, with the results being processed by Velseis Pty. Ltd. The velocity survey report is included in this report as Enclosure 7.

2.6 Formation Sampling

2.6.1 Ditch Cuttings:

Rotary drill cuttings from Altree-2 were collected at 2 metre intervals from the surface to 65.0 metres where circulation was lost. The well was drilled without returns to the seven inch casing depth at 105.4 metres. Circulation was then regained and rotary drill cuttings recovered to 167 metres where the well again lost circulation. Circulation was regained at 204 metres and drill cuttings were recovered until 209.2 metres where the five inch casing string was run.

A washed sample of all cuttings was described and a portion submitted to the Northern Territory Department of Mines and Energy.

2.6.2 Conventional Core:

Altree-2 was fully cored from the 5 inch casing shoe at 208.7 metres to the well's total depth of 1699.85 metres. The core was logged and chip samples taken at 2 metre intervals for microscopic examination. A detailed description of the core is given in Appendix 3.

The core from Altree-2 is stored at the CRA Exploration Pty Ltd yard in Darwin.

2.7 Hydrocarbon Shows

Hydrocarbon shows indicative of a formation with excellent source potential were noted throughout the Middle Velkerri Formation, and comprised high gas readings on the gas chromatograph, a strong hydrocarbon odour and a streaming blue white cut with a moderate ring residue.

Towards the base of the Velkerri Formation a number of sandier units were found to contain poor to fair oil shows. Details of the hydrocarbon indicators are given in Appendix 4 but in summary consist of the following:

1128.5m - 1129.5m

Olive grey to dark grey, very fine grained sandstone interbeds within the Lower Velkerri Formation. The sands are well sorted, sub-angular to sub-rounded with abundant coarse flakes of mica and clay matrix. Shows comprised strong bituminous staining, with the core evolving a minor amount of gas on removal from the core tube. Very minor (less than five percent) dull yellow-orange fluorescence with a slow blue-white crush cut was also noted, along with an increase in gas readings immediately adjacent to the sand unit. Poor visible porosity.

1220.4 - 1222.20 metres

Fair oil shows in sands at the very base of the Lower Velkerri Formation. Sandstone interbeds are very light grey, medium grained, well sorted, sub-angular to sub-rounded, with abundant clay matrix and quartz overgrowths. Shows consist of brown hydrocarbon staining with 80% bright blue-white fluorescence and a moderate blue-white cut and weak ring residue. Elevated gas readings were also noted. Poor visible porosity.

The above intervals were not tested owing to the limited hydrocarbon column encountered and the low porosity and permeability observed.

A number of other small isolated oil bleeds were encountered within the top of the Bessie Creek Sandstone. Details of these can be found in the core log in Appendix 3.

2.8 Geochemistry

A total of 161 core samples from Altree-2 were sent to ANALABS in Western Australia for geochemical analyses. Samples were selected from the section 393.15 to 1120m at random intervals. Every sample was analysed for Total Organic Carbon (TOC) and then analysed by the Rock-Eval pyrolysis technique.

The analytical results from ANALABS are included as Appendix 5.

2.9 Core Analysis

Six core plugs were analysed from the base of the Lower Velkerri Formation in Altree-2. Analysis was conducted for permeability, helium injected porosity, residual oil and water saturation, and grain density. The results of these analyses are given in Table 6.

TABLE 6

CORE ANALYSISLOWER VELKERRI FORMATIONALTREE-2

Sample No.	Depth Metres	Permeability Millidarcys K.A.	Porosity % He inj	Residual Saturation % Pore		Grain Density
				Oil	Water	
1	1128.90	0.204	9.3	25.2	29.1	2.54
2	1129.05	0.160	8.8	23.3	27.6	2.54
3	1220.50	0.003	0.7	2.8	2.8	2.62
4	1221.90	0.014	1.7	1.2	55.8	2.64
5	1220.00	0.031	2.2	3.0	0.0	2.64
6	1222.15	0.024	1.4	1.0	0.0	2.64

2.10 Magnetic Susceptibility

Magnetic susceptibility measurements were made at 2 metre intervals along the entire length of core recovered from Altree-2. A magnetic susceptibility log is included as Enclosure 5.

2.11 Contributions to Geological Knowledge

Altree-2 has added greatly to our knowledge of the Beetaloo Sub-basin in EP24. The recognition of prospective upper Roper Group sediments below the Cambrian unconformity and the excellent nature of the middle Velkerri Formation as a source unit indicate that the southern part of EP24 is prospective for hydrocarbon exploration. The presence of oil shows in the lower-most Velkerri Formation gives great encouragement, given that the well was not designed to test a hydrocarbon-trapping feature.

Keywords

Petroleum, Proterozoic, Drill Stratigraphic, Hydrocarbon Potential.

Location

Altree-1 & 2, Maryfield 1:100,000 Map Sheet, EP24, McArthur Basin,
Northern Territory.