Pacific Oil & Gas Pty. Limited

MAGEE 1

EP 38, NORTHERN TERRITORY

WELL COMPLETION REPORT

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CRAE Report No. **304715**

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF PLANS

1 SUMMARY AND INTRODUCTION

The **Magee 1** well was drilled by Pacific Oil & Gas Pty. Limited in September and October 1992 in Exploration Permit 38 in the Amadeus Basin, Northern Territory.

The objective of the well was to test the Upper Proterozoic sequence below the evaporites of the Bitter Springs Formation. This well is the first penetration of this stratigraphy at depth in the basin. The well was sited on a fault-related anticline identified by the Exoil Mt Charlotte Seismic Survey (1964), and further investigated by the Pacific Oil & Gas Pty. Limited Depot Hill Seismic Survey (1991). In 1965 the Transoil **Mt Charlotte 1** well tested the upper stratigraphy of the anticline but did not penetrate below the Bitter Springs Formation evaporites. The Heavitree Quartzite was the primary reservoir target at **Magee 1**. The lower part of the Bitter Springs Formation was to be investigated for source potential.

The well was spudded on 22nd September 1992 and reached a TD of 2395.8m on 14th October 1992. The well was drilled with air and foam to TD, then filled with mud for testing and logging. Air drilling allowed excellent drilling rates to be achieved in all hole size sections. The casing program was based on geology from the adjacent **Mt Charlotte 1** and consequently could be kept to a minimum necessary to achieve the target depth safely.

The geological prognosis was based on seismic data and the **Mt Charlotte 1** well and proved to be reliable in the upper section of the well. The target Heavitree Quartzite proved to be 50m high to prognosis, and very thin. The reservoir section was a single clean sandstone 4.5m thick. Porosity was low (9 percent) but significant. Basement was 170m high to prognosis.

A gas flow was noted while air drilling the Heavitree Quartzite. The flow was initially tested at 69Mscfd but stable flow was not achieved. The zone continued to produce gas while basement was drilled, and was retested at TD. The zone achieved stable flow of 63.1Mscfd at a surface flowing pressure of 38psi . The gas produced has a very high component of Nitrogen and Helium.

The well was logged and a DST performed on the gas zone. Logging proved to be very time consuming as the hole reacted badly to the mud and required wiper trips between runs to clean fill from the hole. The drill stem test was run to measure the formation pressure and to derive reservoir characteristics. A ten fold drop in gas flow from that recorded in air filled hole was noted indicating that the mud in the hole had severely damaged the productive formation.

Because the productive zone was thin and the flow rate was low, the well was considered to be non- commercial. The gas and water zones were plugged with cement and the uppermost water zone perforated as a water source for the pastoralist. The rig was released on 21st October 1992.

Relatively lean source rock (TOC 0.5 percent - 0.8 percent) occurs as frequent laminae of carbonaceous shale in the 25m overlying the reservoir. Preliminary thermal maturity studies suggest that the zone is at the base of the oil window. Log evaluation suggests a "nett pay" thickness of 3.6m of clean sandstone with 9 percent total porosity. Evidence of fracturing exists but is inconclusive.

2 WELL HISTORY

2.1 General Data

Well Name:	**Magee No. 1**
CRAE Number:	PD/RD 92AB2
Well Type:	Wildcat Well
Interest Holders:	Pacific Oil & Gas Pty. Limited - 100 percent
Permit:	EP38, Northern Territory
Operator:	Pacific Oil & Gas Pty. Limited 826 Whitehorse Road BOX HILL VICTORIA 3128
Map References:	RODINGA (SG 53-2) 1:250 000 Sheet CHARLOTTE (5648) 1:100 000 Sheet
Seismic Line:	Line DH91-2N VP 2152
Location: (AGD66)	Latitude: 24° 53' 59.87" S Longitude: 133° 59' 22.50" E
AMG Co-Ordinates: (AMG66, Zone 53)	East 397 953 North 7 245 741
Elevation: (AHD)	Ground Level: 373m Kelly Bushing: 378.90m
Total Depth:	Driller: 2395.8m Logger: 2395.8m
Primary Objective:	Heavitree Quartzite
Secondary Objective:	Winnall Beds
Status:	Plugged and Abandoned as water well
Well Cost:	A$1,257,000

Date Drilling Commenced:	22 September 1992 at 0600 hrs	
Date Drilling Completed:	14 October 1992 at 1000 hrs	
Date Well Abandoned:	21 October 1992 at 1300 hrs	
Date Rig Released:	21 October 1992 at 1300 hrs	
Drilling Time to TD:	259.5 hours	
Total Rig Days:	29 days	
Contractors:	Drilling	OD&E Pty. Limited,
	Mud Supplies	Milpark Drilling Fluids
	Mud Logging	Colin Higgins &
Associates		
	Wireline Logging	Schlumberger Seaco Inc.
	DST & Coring	Aust. DST Co. Pty. Ltd.
	Cementing	Halliburton Australia P/L
	Earthworks	R.E. & M.L. Dehne
	Air Services	Oiltools International P/L
Drilling Rig:	Mereenie Joint Venture Rig No. 1	
Rig Details:	OIME SL-5 Complete specifications of Mereenie Joint	
Venture	Rig No. 1 can be found in Appendix XI "Rig Specifications"	

2.2 Drilling Summary

2.2.1 17½" Hole Section

Magee 1 was spudded at 0600 hrs on the 22 September, 1992 after completing rigging up operations. A hole for conductor pipe was air drilled to 41.8m using a tricone bit and Mission Hammerdrill 350 run on one 12" square drill collar and two 8" slick drill collars.

Air consumption while drilling was 3600cfm at 240psi. Hole cleaning was adequate. Drilling had to be interrupted to manually shovel out the cellar and substructure. No water flows or other drilling problems were encountered. The 17½" section was drilled in 6 hours. Tarpaulins were hung to minimise the dust affect on the rig engines.

Three joints of $13\frac{3}{8}$" casing were run and cemented using 125 sacks of Class "A" neat cement mixed with 16 barrels of water with 2 percent $CaCl_2$. Cement was pumped through a 1" stinger line tackwelded onto the $13\frac{3}{8}$" casing. Whilst waiting on cement, the cellar was cleaned, and the hammer serviced.

2.2.2 12¼" Hole Section

The blooie line was made up to the conductor and the rotating head was nippled up. A Drillquip T1120 hammer with a 12¼" flat face hammer bit was picked up and run in with one 12" square drill collar and two 8" drill collars. Drilling parameters were 30rpm and weight on bit 10-15000 lbs. Rotation was reduced to 15rpm at 200m.

The hammer was dressed with a ½"choke. Air consumption was 2400cfm at 220psi-250psi. Water injection at 6bbl/hr with 1 percent foam commenced at 180m. The hammer was oiled at 5 l/hr, increasing to 10 l/hr using an injection pump into the air line. The 12¼" hole was drilled to 237m. Despite heavy water influx below 180m, this section was drilled at an average rate of 23m an hour.

The hole deviation at 229m was ½°. No incidents or hold-ups occurred. The bit was assessed as 5 percent worn on completion of this hole section. The hole made water at very approximately 10,000gal/hour from 180-237m.

The 13³/₈" casing was cut and the 13⁵/₈" casing bowl welded on, 20 joints of K55 9⁵/₈" 36# casing were run to bottom without incident and cemented with 242 sacks of Class "A" neat cement mixed with 30 barrels of water (15.6ppg slurry). Cement returns to surface were achieved. The 9⁵/₈" slips were dropped immediately and the 9⁵/₈" casing was cut and dressed. Blow out preventers were nippled up and pressure tested successfully to 250psi and 1500psi for 10 minutes.

2.2.3 8½" Hole Section

The drilling assembly for the 8½" hole section was one 8" square collar, 17 x 6¼" drill collars, and 6 hevi-water drillpipe. The shoe and 2m of new formation was drilled with a re-run J22 bit and the hole was blow-dried. Air drilling commenced in dry hole however a strong water flow (10,000+ gal/hr) was struck immediately necessitating foam injection. Average ROP of the tricone bit was 12m/hr. The bit was changed to an Ingersol Rand 380 hammer and 8½" flat face hammer bit at 284m.

Percussion drilling was used from 284m to 738m. Air consumption was 1600cfm at 350psi to 440psi, until 500m where a third compressor was brought on line. From 500m to 738m air consumption was 2400cfm at 530psi to 600psi. Foam injection at 6bbls/hr with 1 percent soap was used initially, but was discontinued as unnecessary due to the very high water flows encountered. Neat soap slugs were poured into the drill pipe during connections to aid hole cleaning. At 481m, 2 percent foam injection was commenced but again discontinued.

The booster was utilised on the low side throughout this hole section. The high side was required to unload the hole after connection. Water flows calculated from hole fill-up rates was 15,000gal/hr at base of this hole section. Pressures required to unload the hole exceeded 1000psi and caused potentially hazardous damage to the sample catcher and blooie line valves.

Two flat face hammer bits were required to reach the top of the Chandler Formation halite. Average rate of penetration was 9.4m/hr. Drilling parameters were 5000 lbs-8000 lbs at 20rpm. The first hammer bit was damaged in the gauge area and could not be re-sharpened. The second bit was 15 percent worn and was re-sharpened and stored for re-use. Hole deviation was 2¾° at the end of the hammer run at 738m but was reduced to 2° at casing point. A Smith F3 tricone was used for the salt section as penetration rates could be expected to be high, and the hammer could be preserved for use in the underlying Winnall Beds siltstone if required. Drilling parameters for the F3 run were weight on bit 15000 lbs at 90rpm. Air consumption was 2400cfm at 330psi. Average rate of penetration was 9.8m/hr. The 8½" hole section was terminated at 1008m inside the top of the Winnall Beds.

The drill pipe was strapped out without depth correction. To allow the BOP to be dismantled with the hole uncased a RTTS packer and SSV (storm valve) was run and set at 30m in the 9⅝" casing. The stack was removed and the spacer spool was then replaced with the B section of the wellhead. The packing was energised and tested to 3000psi. The 4½" drillpipe and BHA were laid down.

Eighty four joints of 7" K55 26# BTC casing was run to bottom and cemented with a 270 sack Class "A" fly ash and bentonite extended 13.2ppg lead slurry and a 100 sack neat Class "A" 15.9ppg slurry tail. A 15 percent NaCl mix water was used. Excess was calculated to be 30 percent. Cement returns were not observed. Displacement pressure indicated that the top of cement was at approximately 130m KB inside the 9⅝" casing. The 7" casing was landed in the wellhead with 50,000lbs. The BOP stack was re-nippled and tested to 500psi and 1500psi.

2.2.4 6⅛" Hole Section

The new BHA, 18 4¾" spiral collars and 24 HWDP was picked up and run in the hole. Total time spent changing drill string and BHA was approximately 18hrs. The shoe and 1 metre of new formation was drilled with a Reed HP51AJ 6 ⅛" bit. A formation integrity test was carried out to a mud weight equivalent of 17ppg. The formation did not leak off. The hole was dried out and air drilling commenced.

Drilling rate was 10.2m/hr with weight on bit of 10000 lbs and 90rpm. Air consumption was 1600cfm at 300psi. The hole remained dry throughout this bit run. Dust returns presented minor problems to motors, requiring regular filter changes. No injection was used. The tricone bit was pulled after 367m and was suitable for re-use later in well.

A flat face hammer was made up on a Drillquip T36 hammer with ⅛" choke and run in. In dry hole conditions a penetration rate of 10.9m/hr in tight Bitter Springs Formation dolomite was achieved.

A formation change at the top of the Gillen Member, with a small influx of very salty water required foam injection at 4bbl/hr of 2 percent foam. Foam injection mobilised scale from the rented 3½" drill pipe causing the hammer to become plugged.

When the pipe was pulled one drill collar was plugged with pipe scale. The pipe was cleared and the hammer was rerun but became blocked immediately. The hammer was removed and the previous 6¹/₈" rotary bit was rerun to allow the drill pipe to be cleaned by circulation. This bit drilled a further 44m and the T36 hammer was again run in with an open choke. A bridge was encountered which required reaming through. When the bit was on bottom very high torque was experienced and the bit could not drill. The bit proved to be severely damaged.

A Reed HP53 6¹/₈" rotary bit was run in and made an average ROP of 9.2m/hr. This section of hole was completed using rotary bits. Drilling parameters were weight on bit 12000 lbs - 15000 lbs and 70rpm - 90rpm. Air consumption was 1600cfm at 325psi-450psi during normal drilling. Water and foam injection at 5bbl/hr 2 percent foam was required to disperse cuttings and to prevent cuttings build up around the low rate water zone at 1513m. This injection rate was maintained for the remainder of the well.

A change in formation at 1502m initiated a deviation in the well which built to 15½° before being corrected. An unconformity is mapped at this depth on seismic, with relatively steep formation dips below the unconformity.

Reduction in weight on bit and increased rpm did not appear to be reducing deviation so a pendulum assembly was made up at 1916m. Hole angle dropped from 14½° to 3¼° over 150m. This depth range coincided with a gradual return of formation dips to subhorizontal.

The rapid drop in hole angle produced a minor dog leg at 2040m which caused problems during logging.

A build up of cuttings around the stabiliser caused the drill pipe to become stuck at 2206m. The pipe was worked for four hours to free it. The stabiliser was removed at 2209m.

2.2.5 6" Hole Section

Air rotary drilling was continued in 6" hole size from 2209m to TD.
No stabilisation was used to avoid hole-sticking problems. Drilling parameters and BHA were kept constant. Air consumption was 1600cfm at 360psi with 6bbl/hr of 2 percent foam injection.

At 2344m a gas flow was encountered while drilling. The gas flow was tested through a 2" critical flow prover with ¼" choke at 69Mcfd however the flow rate did not stabilise. Because the zone was very thin no attempt to core the formation was made.

An attempt was made to hammer the basement section of the hole however the hammer was again blocked by pipe scale and no progress was made. The hole was completed with a rotary bit. Penetration rate in the unweathered basement was less than 1 metre per hour.

During drilling the gas flow remained constant. Gas was drawn away from the wellhead area using the primary jet during times when air circulation was stopped. The gas flow was put through the flow prover at TD and measured during a 20 minute stable flow period at 63.1Mscfd.

To prepare for running wireline logs the hole was mudded up with 20 percent NaCl polymer mud. The hole reacted badly to the mud and several wiper trips were required during the logging runs.

2.2.6 Lost Time

OPERATION	TIME (hrs)
Hole Problems:	
Wiper trips for logging	23
Downhole problems	0.5
Stuck in hole	4
Equipment Problems	
Blocked Hammer	32.5
Rig repairs	6
TOTAL	66

Table 1: Lost Time - **Magee 1**

2.2.7 Water Supply

Water for drilling purposes was obtained from a soak dug in the bed of the Finke River, 6.5km southeast of the drillsite. The soak was dug prior to the commencement of drilling operations, and water was pumped to the wellsite via a 2" polythene pipeline. Potable water for camp purposes was trucked to the camp from the Maryvale Homestead. During occupation of the site a flow of the Finke River inundated and damaged the pump. Onsite storage was sufficient to prevent any delays to the operation.

2.2.8 Deviation Surveys

Deviation surveys were taken approximately every 100m during drilling operations. From 6-1008m, a Totco survey tool with a 0-8° range and a single shot survey barrel was used. From 1008m-TD, a Sperry-Sun survey tool with 0-16° range and an electronic survey barrel was used. Maximum deviation recorded was 15½° at 1740m. Deviations could not be measured during the section where hole angle built rapidly due to damage to the survey barrel on the previous misrun. Deviation survey results are tabulated below.

DEPTH (m)	DEVIATION	DEPTH (m)	DEVIATION
29	¾°	1191	2½°
123	1°	1497	1¾°
229	½°	1649	MISRUN
322	1°	1740	15½°
427	1°	1856	14½°
475	1°	1894	14½°
572	1¾°	1951	12½°
629	1½°	2027	8°
917	2°	2066	3¼°
1003	2°	2133	2°
		2346	2¼°

Table 2: Deviation Surveys

2.2.9 Completion Summary

Magee 1 was plugged and converted to a water well on the 21 October, 1992. Four abandonment plugs were set. Completion details can be found in Plan PetNTcw5175, Abandonment Schematic. Plug details were as follows:

Plug No. 1	40Sx	2378-2320m KB
Plug No. 2	40Sx	1556-1506m KB
Plug No. 3	60Sx	1018- 945m KB
Plug No. 4	40Sx	295- 220m KB

Plug No. 1 leaked off to the formation to 2354m KB. This plug was reset (40Sx) and tagged at 2320m KB. Cementing records are found in Appendix XI.

The casing was perforated at 186-189m for the waterwell conversion. OD&E Rig No. 1 was released at 1300hrs on 21 October, 1992.

Fresh water flows were not sustained from the perforated zone when pumping operations were commenced by the pastoralist. It is probable that the perforation charges did not effectively perforate the water sand.

2.2.10 Air Drilling Equipment

Compressors

2 x Sullair 900cfm 350psi compressors powered by 12v-71t GM Detroit diesel engines.
2 x Sullair 900cfm 250psi compressors powered by Caterpillar 3408 DITA diesel engines.

Booster

1 x Joy WB-12 single or two stage booster. Single stage 3400scfm 500psi, two stage 2400scfm 1500psi.

Injection unit

1 x Wheatley triplex P323 pump Deutz diesel engine and 2 x 10bbl foam tanks.

Ancillary Equipment

Tool house, manifold, primary jet, blooie line, rotating BOP, hammer oil injection pump.

General performance

The air package was operated by two personnel working 12 hour shifts. No equipment downtime was recorded. The booster could not operate above 1200psi without the pressure relief valve operating, and could not cope with three compressors while operating in two stage mode. This was no handicap during problem free drilling but limited flexibility during attempts to make the T36 hammer work in the lower section of the hole.

Fuel consumption for a full day's drilling was approximately 1600 litres per major machine. Total fuel used was approximately 73,000 litres.

Foam injection was required through the lower parts of the 8½" and in the 6⅛" 6" sections. Total foam consumption was 2700 litres which was less than predicted.

The 7⅝" blooie line proved to be adequate but undersized for the large air volumes in the 17½" 12¼" and 8½" hole sections. It is recommended that this be replaced prior to further use of this rig.

No problems were experienced with the rotating head. The primary jet was used to draw gas from the well head area during trips and connections. It is recommended that the primary jet be used to draw dust from the cellar during surface hole drilling to save time and prevent dust damage to motors.

2.3 Formation Evaluation

2.3.1 Mudlogging

Mudlogging services were provided by Colin Higgins & Associates. The mudlogging unit was staffed 24 hours a day for the duration of the well and instruments monitored depth, rate of penetration, pit level and both total and chromatographic gas. A hydrogen sulphide (H_2S) gas detector was also in operation at all times during drilling operations.

Air/gas returns were sampled continuously whilst circulating air, mist or foam via a gas sniffer in the blooie line during air drilling operations. Drilling mud was sampled using an air driven gas trap whenever mud was being circulated.

Chip samples were caught, washed and described at 10m intervals from surface to the 7" casing depth and at 3m intervals from base of 7" casing to T.D. All cuttings samples were examined under ultraviolet (UV) light for the present of hydrocarbons. Cuttings descriptions can be found in Appendix I.

ROP, gas, and lithology are summarised graphically on the 1:500 scale Colin Higgins and Associates Mudlog (PetNTcw5195).

Splits of cuttings samples were retained for -
(a) Pacific Oil & Gas Pty. Limited
(b) Northern Territory Department of Mines and Energy.

2.3.2 Testing

One dual-packer bottom hole conventional closed chamber DST. was conducted after the drilling of **Magee 1**. The test was run to determine the reservoir properties of the Heavitree Quartzite and to test for liquid hydrocarbons. Open hole flow tests were conducted when the gas zone was penetrated and at TD.

<u>DST 1 2340m-2395.8m</u>

Date Run:	18 October, 1992
Bottom:	2343m
IHP:	3982.4 psia
IFP:	N/R
ISIP:	N/R
FFP:	167.9/190.1 psia
FSIP:	3354.2 psia
FHP:	3967.9 psia

Times:	Initial Flow: N/R
Initial Shut-in:	N/R
Final Flow:	100 mins
Final Shut-in:	270 mins

Temperature: 165.5°F (74.2° C)

Recovery: 91.44m (2.2 bbls) of rat hole mud. No oil. No water. Rmf of recovery 0.048 ohm-m at 75° C Rm 0.051 ohm-m at 75° C.

Remarks: The tool skidded 14m to bottom after the hydrospring opened. High rotary torque while rotating the shut-in tool resulted in the tool turning through the shut-in position to the second open position. Therefore no initial flow or shut-in was recorded.

Open Hole Flow Test No. 1

Date: 12 October, 1992

Depth: 2367m

The well was shut in at the surface and gas was allowed to flow into the closed in well. The surface pressure build up was measured, and the rate of the pressure build up indicated a gas influx of between 50Mcfd and 100Mcfd. The well was then allowed to flow through a 2" critical flow prover with a ¼" orifice plate. The flowing pressure did not stabilise during this test. At the conclusion of the test, the flowing pressure was 40psig and dropping at a rate of approximately 1psi/15minutes. A flow rate of 69Mcfd was calculated.

Open Hole Flow Test No. 2

Date: 14 October, 1992

Depth: 2395m

This test was carried out after the well had reached TD, the well stabilised at a flowing pressure of 38psig through a ¼" plate. Using the hydrocarbon breakdown measured on site and the measured temperatures of gas and ambient temperatures (108°F and 98°F respectively) the calculated gas flow was 64.9Mscfd. Using the lab analysis of the gas a final figure of 63.1Mscfd was calculated after completion of the well.

2.3.3 Electric Logging

Wireline logging services were provided by Schlumberger Seaco Inc. All downhole data was recorded digitally on magnetic tapes. No intermediate logs were run. Logs are presented in plans PetNTcw5202-5209 inc.

A super combo string composed of DLL-LDL-CNL-MLT-MSFL-GR-ARRAY SONIC was run, but the tool became stuck in the hole at 2050m and was only freed after pulling the string at maximum overpull. The second log run was a MSFL-DLL-GR run but this tool did not reach the bottom of the hole because of fill. A wiper trip was performed and the DLL MSFL GR run successfully.

A LDL-CNL-GR-AS string was then run. The tool became stuck at 2050m and had to be worked free. It was decided not to risk further problems so logging recommenced at 2040m leaving 10m unlogged, one channel on the Array Sonic failed. The WST failed downhole. DST 1 was carried out, the hole was then cleaned out. The WST was replaced and run successfully.

Final run was the ARRAY SONIC - G.R. tool. To obtain better data than when the tool was run previously.

The tool was to be run to acquire waveforms over the zone of interest and travel time for the remainder of the hole. The poor hole quality did not allow travel time to be processed from the signal at the wellsite consequently the waveforms for the full interval were acquired. Travel time was subsequently processed from the waveform data at a processing data centre. Mechanical properties of the zone of interest were calculated to identify the presence of fractures.

Details of the logging suite are listed below:

DATE	LOG/EVENT	REMARKS	INTERVAL
15 October 1992	Supercombo	Stuck while running in hole	
	DLL-MSFL-GR	Fill on bottom, unsuccessful	
	Wiper trip		
16 October 1992	DDL-MSFL-GR	Successful	2378-1004m
	Wiper trip		
	LDL-CNL-GR-AS	Partly Successful (missed data at 2050)	2380-1004m
17 October 1992	WST	Failed downhole	
	Wiper trip		
18 October 1992	DST 1		
	Wiper trip		
19 October 1992	WST	Successful	2350-100m
	Array Sonic	Sonic log processed from waveforms	2370-1004m
20 October 1992	Casing perforation	?unsuccessful	

Table 3: Logging Summary

The logging program was shortened considerably from that programmed due to the hole problems. The FMS and MLT could not be run as the diameter of these tools increased the risk of getting stuck in the hole. The CST was not run as previous log data indicated that the bullets would not have penetrated the reservoir lithology.

2.3.4 Geothermal Gradient

Temperature measurements were made at TD during DST 1 and the wireline logging runs. Because wiper trips had to be made between each logging run bottom hole temperatures could not equilibrate. The maximum temperature reached was 163°F.

During DST 1 the bottom hole temperature stabilised at 165.5°F (74.2°C). Surface temperature data for Central Australia of 25.5°C was obtained from the CSIRO. From these figures a geothermal gradient of 20.8°c/km may be calculated.

2.3.5 Synthetic Seismogram

From the WST data a geogram synthetic was produced (PetNTcw5197).

2.3.6 Water flows and Chemistry

Water flows were recorded from the Finke Group, Stairway Sandstone, and Gillen Member. The Finke Group was a copious producer from two zones at 180m and 240m. Flow rates could only be visually estimated while air lifting the water but rates in excess of 10,000gl/hr were probable. Estimating productivity of zones in the Stairway Sandstone and Jay Creek Limestone was not attempted due to the overwhelming flow from above. At the end of the 8½" section, flow had increased to 15000 - 18000 gal/hour.

Below the 7" casing shoe one low rate water zone was encountered at the unconformity between the Loves Creek and Gillen Members of the Bitter Springs Formation. Water chemistry results are included in Appendix III.

2.3.7 Sample Analysis

A representative sample of each 10m cuttings sample and a composite split of 9m (obtained from the combination of 3x3m samples), where reserved for elemental analysis. A total of 245 cuttings samples of around 50g weight each were sent to Australian Laboratory Services Pty. Limited (ALS), in Brisbane for analysis of 20 different elements. The routine analysis of all samples was carried out using the ICP technique for Cu, Pb, Zn, As, Ag, S, Ba, Ti, V, Al, P, Co, Ni, Fe Ca, Mg, K, and fire assay for Au Pt and Pd. A number of samples were also analysed for U, Th to investigate anomalous gamma ray peaks in the Stairway Sandstone and Heavitree Quartzite.

Thirteen samples were submitted for source rock analysis and two for petrological examination. Two gas samples from flow test No. 1 were analysed. Eight water samples were analysed. Results are presented in Appendixes III to VIII. Laboratory determinations of density and magnetic susceptibility were carried out on a basement sample.

2.4 Occupational Health and Safety

The rig was inspected prior to commencement by the NTDME. All matters raised in the inspection report were dealt with promptly by the contractor and duly reported to the NTDME.

A number of accidents and incidents occurred during the operation as follows:

21/9/92 Driller Brett Smith suffered a puncture wound from a frayed loose end of wire rope while working on adjacent equipment. He was driven to Alice Springs for a tetanus injection and was able to resume work. Changes in procedures to wire rope installation were instigated.

25/9/92 Floorman David Nelson, was injured while laying out drill pipe. The cause was identified as unnecessary obstruction to free movement on the rig floor. A change was made to rig floor house keeping procedures to prevent repetition. The injured worker was driven to Alice Springs hospital for x-rays as a precaution but was allowed to return to work immediately.

27/9/92 While unloading the hole after a deviation survey air pressure in the blooie line caused a rupture in the sample catching cyclone. No personnel were injured but potential for severe injury was present. The sample catcher and other weak points in the blooie line were removed.

29/9/92 Head floorman Robert Oakley broke his left wrist in a fall from a truck he was helping unload. The cause was identified as the worker selecting an insecure hand hold on the truck load while climbing up. The injured worker was treated in Alice Springs, and could not return to work. The work crews were instructed to think out, then stick to safe work plans for all activities.

This run of accidents was unprecedented for this rig and prompted a renewed emphasis on safety from crews. No further accidents occurred during drilling.

21/10/92 Floorman Damien Huxtable suffered a bruised wrist when his arm was caught between equipment being lifted during rigging down operations. This accident occurred in spite of explicit instruction to the worker to stand clear. The worker was driven to Alice Springs for x-rays and returned to work.

Throughout the well five-minute safety meetings were carried out at the beginning of each shift to discuss safety topics and for crews to bring up safety issues. BOP drills were held weekly for each shift. BOP equipment was function tested when practical and pressure tested after casing operation. Fire equipment was function tested and drills held. Cement pumping lines and surface manifold equipment was pressure tested prior to cementing and DST operations.

2.5 Environmental Protection

As the preferred location for **Magee 1** would have required disturbance of a sand dune and a stand of desert oak the site was moved approximately 50m south.
Earthworks on site were modified to prevent damage to trees. As a result no trees had to be removed or major alteration of ground surface performed.

No well bore fluids were allowed to escape to the environment. Used mud and cuttings material was buried in the sump and blooie line pit after drying. Garbage was burnt on site and buried.

Compacted ground was deep ripped and topsoil removed during site preparation and was respread over ripped ground and the site was re-contoured. At the request of the pastoral lease holder a small cleared area and loading ramp were left for use for cattle yards.

Access to the site was via existing roads. Where these roads were regraded for access the windrows have been removed in areas of rapid water run off.

3 GEOLOGY

3.1 Objectives

The primary objective was to test the Heavitree Quartzite for hydrocarbons reservoired in the Mt Charlotte Structure. A regional objective of the well was to assess the Proterozoic sequence below the Bitter Springs halite for source rocks and evidence of migration of hydrocarbons.

Due to the presence of gas below the Chandler Formation salt in **Dingo 1** and other exploration wells the Winnall Beds were considered secondary objectives of the well.

3.2 Regional Setting and Structure

The Amadeus Basin is an asymmetrical, east-west trending, intracratonic depression covering 155 000 sq km of central Australia.

Up to 14km of sediments are locally preserved, ranging in age from Late Proterozoic to Late Devonian (PetNTcw5106). The sediments are almost entirely shallow marine and terrestrial, including two episodes of evaporite deposition and minor glacial deposits.

The basin is one of a number of similar intracratonic Australian basins initiated during the Late Proterozoic, probably as the result of the break-up of a Proterozoic supercontinent (Lindsay & Korsch, 1989).

The earliest Proterozoic units of the Amadeus Basin are very restricted in their known extent. These units consist of clastic sedimentary rocks and basalts along the south-western margin of the basin (Mount Harris Basalt, Bloods Range Beds, Dixon Range Beds) and an unnamed succession of sedimentary rocks, basalt and dacite near Kintore in the north-west. The units have been interpreted as a rift sequence marking the opening of the Amadeus Basin (Lindsay & Korsch, 1989).

The fluvio-volcanic rift sediments are unconformably overlain by epeirogenic clastics of the Heavitree /Dean Quartzites, followed by carbonates and evaporites of the Bitter Springs Formation.

The Bitter Springs Formation is terminated by an erosional surface upon which shallow marine and glacigene sediments of the Inindia Beds and its equivalents in the northern Amadeus Basin were deposited. An unconformity surface within the Bitter Springs Formation at or near the top of the Gillen Member, can be mapped on seismic data across Pacific's permits.

The top of the Inindia Beds is marked by a flooding surface upon which deeper water pelagic and turbiditic sediments accumulated. This deeper marine sequence is known as the Winnall Beds in the south and the Pertatataka Formation in the north. It shallows upward into shallow marine and fluvial clastics in the south-west and oolitic platform carbonates of the Julie Formation in the north. The Inindia Beds are thickest in the west and centre of the basin and are absent from the eastern margin of the basin.

The Late Proterozoic phase of deposition was terminated in the south by the Petermann Ranges Orogeny, a period of mountain building, recumbent folding and northward overthrusting (Wells et al. 1970). Molasse sediments were shed north and north-east from uplifted areas and accumulated in a foreland style basin immediately before the rising orogen (Mt Currie Conglomerate, Ayers Rock Arkose), bypassed the middle and eastern fringes of the basin, and accumulated as a prograding deltaic sequence in the north (Arumbera Sandstone).

The Petermann Ranges Orogeny shaped the framework of the Palaeozoic basin, and a northern trough initiated at this time persisted through most of the Palaeozoic. The southern central and south eastern parts of the basin remained uplifted. Paleozoic sequences in these areas are generally thin with common significant breaks in accumulation.

During the early Cambrian, continental sedimentation persisted in the north-west (Cleland Sandstone) while shallow marine shales, carbonates and evaporites were deposited in the north east (Shannon, Giles Creek and Chandler Formations). A widespread transgressive cycle in the Late Cambrian resulted in the deposition of the Goyder Formation.

Two transgressive cycles during the Ordovician resulted in the alternating deposition of tidal flat/barrier bar sands and deeper marine, euxinic muds and silts (Pacoota Sandstone, Horn Valley Siltstone, Stairway Sandstone, Stokes Siltstone). These sediments form the source-reservoir-seal sequence of the Mereenie and Palm Valley hydrocarbon fields in the north-western Amadeus Basin. Of this Larapinta Group, only the Stairway Sandstone persists into the centre and southeast of the basin.

Marine deposition was terminated by the Late Ordovician Rodingan Movement. Uplift of the north-eastern basin resulted in the erosion of up to 3000m of Cambro-Ordovician sediments. This area became the source region for the Early Devonian Carmichael and Mereenie Sandstones. Arid climatic conditions prevailed with sediments transported by both aeolian and fluvial action into a shallow sea transgressing from the west.

Major uplift of the Arunta block along the present northern margin of the basin commenced
in the Middle Devonian. Continental deposition continued as thick molasse sediments accumulated south of the uplifted area. High depositional loading at this time contributed to movement of the Bitter Springs Formation and Chandler Formation evaporites.

A lacustrine siltstone (Parke Siltstone) was laid down conformably on the Mereenie Sandstone, and after uplift, coarser sediments were deposited (Hermannsburg Sandstone, Brewer Conglomerate). These three units, comprising the Pertnjara Group, thin and become finer grained to the south.

Uplift of the Musgrave Province and deformation of the southern Amadeus sequence culminated in the Early-Middle Devonian Finke Movement (Polly Conglomerate), after which fluvial sands of the Langra Formation and estuarine silts of the Horseshoe Bend Shale accumulated. These sediments comprise the Finke Group, which is the southern time equivalent of the Pertnjara Group, although the former sequence fines upward in contrast.

Regional deposition was terminated in the Late Devonian-Early Carboniferous by the Alice Springs Orogeny. Some earlier structures were reactivated during this period of deformation. Substantial uplift of the basement Arunta Block along the current northern margin initiated movement of thrust sheets in the Alice Springs and Altunga regions, and resulted in significant structuring of the basin. North over south thrusting and reverse faulting is typical of Alice Springs orogeny deformation.

3.3 Results of Drilling

3.3.1 Stratigraphic Table

FORMATION	AGE	PROGNOSIS	CUTTINGS	WIRELINE	THICKNESS
Surface Seds	Quaternary	NP	6	6	4
Finke Group	Devonian	6	10	10	350
Stairway Sst	Ordovician	386	370	360	135
Jay Creek Lst	Cambrian	486	490	495	224
Chandler Fm	Cambrian	726	736	719	235
Winnall Beds	U.Proterozoic	946	970	954	439
Bitter Springs Fm	U.Proterozoic	1396	1395	1393	
Loves Creek Mbr	U.Proterozoic	1396	1395	1393	109
Gillen Member	U.Proterozoic	1576	1513	1502	
Upper Gillen	U.Proterozoic	1576	1513	1502	330
Gillen Salt	U.Proterozoic	1836	1832	1832	388
Lower Gillen	U.Proterozoic	2096	2078	2220	121.7
Heavitree Qte	U.Proterozoic	2296	2345	2341.7	6.3
Basement	M.Proterozoic	2526	2349	2348	50+
Total Depth		2600	2395.8	2380*	

Table 4: Stratigraphic Table

* Log could not reach TD

3.3.2 Stratigraphy and Depositional Environment

Finke Group

Age	Range	(Thickness)
Lower Devonian	10-360m	(350m)

The Finke Group consists of an upper massive siltstone unit, and a lower unit of interbedded sandstone and siltstone. The massive upper siltstone is yellowish to reddish-brown with occasional grey to greyish-green mottled patches. Thin micaceous and calcareous laminae with common biotite are pervasive. Occasional black, well rounded lithic grains and isolated very well rounded coarse quartz grains occur throughout the section. The siltstone (10-170m) has minor sandstone beds up to 1.0m thick. The sand is colourless to very pale brown and medium to coarse grained. The grains are sub-angular to sub-rounded with yellowish grey siliceous cement. This siltstone is mapped as the Horseshoe Bend Shale.

The lower sandstone section of the Finke Group is the Langra Formation. The sandstone in the upper part of this unit is colourless to light yellowish brown, very fine to coarse grained, predominantly medium grained, and poorly sorted. Grains are sub-rounded to very well rounded, and occasionally indented and faceted. In cuttings loose grains predominate with occasional firm, silica cemented aggregates. Rounded black lithic grains are common. Visible porosity is fair to good. Brackish water flowed from this sand at a rate of up to 500 bbl/hr.

This sandstone overlies a 50m thick siltstone unit. Siltstone is reddish brown, mottled as for the Horseshoe Bend Shale. Sandstone below the siltstone unit are colourless, pale brown, pale orange, yellow to white. The grains are fine to very fine, becoming predominantly fine to medium at the base of the interval. The finer sand is mainly sub-rounded to rounded, but occasional well rounded, coarse grains are present. Traces of metamorphic and dark opaque lithic grains, felspar, and mica occur. Sand grains are moderately sorted. The matrix is slightly silty, occasionally cemented with a silica and/or dolomitic cement. Visible porosity is poor to good, predominantly fair. The basal 50m of the interval shows the cement becoming increasingly calcareous, and the sands interbedded with brown to light orange-brown, blocky, firm to hard micaceous siltstone. Lithic grains are present as a trace in the siltstone.

The contact with the underlying Stairway Sandstone is picked at a change in colour of the sandstone and the presence of phosphate indicated by high gamma ray activity in clean sandstones.

Stairway Sandstone

Age	Range	(Thickness)
Devonian	360-495m	(135m)

The upper 10m of the Stairway Sandstone consist of frosted white, coarse to medium, occasionally very coarse grained sandstone. The grains are rounded, moderately to well sorted, and predominantly loose with traces of crystalline quartz cement adhering to some grains. Occasional well cemented aggregates occur. Pyrite and possibly galena occur in very small quantities.

The remainder of Stairway Sandstone is composed of interbedded sandstone, siltstone, and shale. This sequence is upward fining. The upper 30m of this section shows equal proportions of sand, silt, and clay, with minor dolomite. The sandstone in this section is white to light grey, very fine grained, and moderately to well sorted. Cement is siliceous, and matrix where present, is clayey. Trace lithic grains appear throughout the sand. Porosity is poor. Light grey to light greenish-grey, occasionally reddish-brown siltstone grades to subfissile, micaceous shale which is interbedded with the sandstone, and occasionally dolomite.

Between 400-460m, colourless to white, pale grey, and occasionally yellowish grey, very fine grained, well sorted, subrounded sandstone is interbedded with siltstone. The sand forms firm siliceous aggregates and is also seen as loose grains with quartz overgrowths. Trace quantities of mica are present in the sand. The siltstone is medium grey to greenish-grey, occasionally reddish-brown or purplish grey. Traces of pyrite were identified.

From 460-495m, sandstone is clear colourless to very pale pink, and white/frosted. Grainsize is fine, becoming medium to coarse at the base of the interval. The sand is moderately sorted, subrounded to rounded, with silica cement adhering to loose grains. Visible porosity is fair to good.

Jay Creek Limestone

Age	Range	(Thickness)
Cambrian	495-719m	(224m)

The Jay Creek Limestone is predominantly siltstone thinly interbedded with sandy anhydritic dolomite, and with rare, fine grained sandy layers. Siltstone is brown, reddish-brown to pinkish-brown, less often purplish-grey and mottled greenish-grey, occasionally sandy, slightly dolomitic, with dolomite and anhydrite nodules 1-5 mm in size and occasional pyrite. Siltstone grades to splintery, purplish-brown to brown shale. The shale is hard, fissile to splintery, micaceous, and dolomitic in part.

One to two metre thick interbeds of white to light grey, fully recrystallised, microcrystalline, hard, silty dolomite are present through the formation. The dolomite exhibits bright yellow/gold mineral fluorescence. Rare anhydrite nodules can be seen in the dolomite. In places the dolomite contains traces of carbonaceous stylolites associated with chert. Chert is found at the base of the interval (720-735m) and is pale yellowish-grey to orange, translucent, angular and hard.

The Jay Creek Limestone has been subdivided and renamed as the Shannon Fm and the Hugh River Shale overlying the Giles Creek Dolomite. As the interval of Cambrian in this well is relatively thin and not representative of the complete Cambrian section this subdivision has not been adopted here. The lower part of this formation from 560m to 719m has similar lithology to the Giles Creek Dolomite and may be considered its equivalent.

Chandler Formation

Age	Range	(Thickness)
Cambrian	719-954m	(235m)

The Chandler Formation is an evaporitic sequence containing massive halite and thin siltstone and dolomite units. The upper contact is gradational over 5 metres. On the basis of gamma ray log character the contact has been interpreted as 719m. Halite returns were not noted until 735m. The top of the formation is picked at the first evidence of halite on wireline logs.

Halite is colourless to yellowish grey in colour and coarsely crystalline. Halite is massive in the upper section but becomes interbedded with siltstone below 770m. The siltstone is orange to reddish-brown with common greenish-grey mottling. Halite pseudomorphs, pyrite traces and elemental sulfur are present in the siltstone.

Below 910m, siltstone interbeds are more common. The siltstone grades to sub-fissile shale, with pale green mottling and laminations. Slickenside surfaces on larger cuttings are indicative of deformation. Traces of yellowish-grey to brown, fine grained, very poorly sorted sandstone, with a silty, siliceous matrix and abundant lithic grains are present.

Winnall Beds (Pertatataka Formation)

Age	Range	(Thickness)
Proterozoic	954-1393m	(439m)

The Winnall Beds are a sequence composed predominantly of siltstone, with occasional thin sandstone streaks in the top part of the formation, and rare dolomite bands at the base of the formation near the contact with the Bitter Springs Formation. The uppermost 20m of siltstone below the base Cambrian unconformity are oxidised to a reddish brown colour.

Below this zone, siltstone is medium grey, it is firm, subfissile, and grades to shale. Glauconite is present as traces. The shale is grey, to dark grey, hard, generally blocky, but fissile in parts. Thin laminae of pale grey, fine grained, moderately to well sorted, hard sandstone occur. The grains are silicified, the matrix is silty, and traces of carbonaceous lithics and glauconite present.

Siltstone varies in colour becoming brownish to medium brownish grey, occasionally greenish to bluish grey. Traces of fine pyrite nodules were detected in the siltstone below 1153m. The rock is slightly micromicaceous, with very finely divided muscovite and rare, large, discrete grains of biotite.

The siltstone between the depths 1269 - 1350m is medium grey, monotonous, sub-fissile to blocky, firm to hard, clayey and micaceous. The siltstone is sandy in parts, contains rare, very thin laminae of light grey quartzose silt and occasionally grades to shale.

From 1350m to the base of the formation, the siltstone is dusky reddish brown to brownish grey, occasionally purplish grey, grading to medium grey as for previous interval. Reddish colouration is lost at the base of the formation towards the bottom of the interval. The siltstone becomes slightly dolomitic. Rare thin stringers of yellowish grey, very hard, cryptocrystalline dolomite occur in the siltstone, increasing towards the bottom of the interval.

Bitter Springs Formation

Age	Range	(Thickness)
Upper Proterozoic	1393-2341.7m	(948.7m)

The Bitter Springs Formation is divided into the Loves Creek Member and the Gillen Member.

Loves Creek Member

Age	Depth	(Thickness)
Upper Proterozoic	1393-1502m	(109m)

The dolomite of the Loves Creek Member is clean, white to pale yellow, very pale grey, hard, blocky, and microcrystalline. Stylolites are present in part, as are a trace of cherty fragments and disseminated pyrite. In the upper 33m the dolomite is interbedded with thin (< 1m) siltstone beds. The siltstone in these beds is medium to dark reddish brown, with a trace of greenish grey mottling, slightly to very dolomitic, and micromicaceous in part. Occasional chert and dolomite fragments give the siltstone a microbrecciated appearance.

Over the basal 12m the Loves Creek Member again becomes increasing silty. Siltstone is grey to greyish brown with a trace of pyrite. Thin streaks of purplish grey to greyish brown shale also occur. The contact with the underlying Gillen Member is marked by a distinctive change in lithology and log character, and by a low rate water zone indicating some porosity is present. Based on the seismic data, and the strong hole deviation originating here, this contact is an unconformity surface.

Gillen Member

Age	Depth	(Thickness)
Upper Proterozoic	1502-2341.7m	(832m)

On the basis of seismic character the Gillen Member has been informally divided into three sections, a central halite unit "Gillen Salt" and an upper and lower dolomite unit. Lithological breaks corresponding to the seismic unit boundaries were identified in the section. The central halite unit was recognised in seismic as a zone of disturbed discontinuous reflectors resulting from salt tectonism. In the well, a second evaporite zone occurred below this zone of disturbance. The "Gillen Salt" unit has been expanded to include this lower evaporite cycle. Units are described individually below.

"Upper Section" of Gillen Member

Age	Depth	(Thickness)
Upper Proterozoic	1502-1832m	(319m)

This unit consists of thinly interbedded dolomite, siltstone, anhydrite and sandstone. The dolomite is white to pale grey to yellowish grey, hard-brittle, blocky, cryptocrystalline, silty in part, occasionally stylolitic. Traces of pyrite, occasional anhydrite, and a trace of orange-yellowish to orange, chert are present. This sandstone is pale yellowish white to light brown, very fine to fine grained, occasionally medium grained, well sorted, sub-rounded. Grains have siliceous overgrowths, porosity is poor, and no fluorescence is present. The siltstone is greyish brown to dark greyish brown to dark grey, micromicaceous, dolomitic in part, contains a trace of pyrite, and grades to shale. The anhydrite is clear to translucent, finely to medium crystalline, soft and is cemented with dolomite. Occasionally the anhydrite occurs as loose fractured grains, and in veins and vugs in the dolomite.

This particularly heterogeneous lithology becomes more predominantly dolomite prone with increasing depth. The upper contact is distinctive on logs as a sudden change from massive dolomite to thinly bedded multiple lithologies including anhydrite and ?siderite.

A massive dolomite layer lies between 1582 - 1594m. This dolomite is light yellowish brown to light brown to brownish grey to off-whitish grey, blocky, hard to brittle, cryptocrystalline, occasional concoidal fracture, very slightly silty in part, and contains traces of stylolites.

From 1640 - 1750m, dolomite is the main constituent, but decreases towards the base of this section, interbedded with other lithologies as for the previous interval. The dolomite is translucent pale yellowish grey to light brown to light greyish brown to light grey, cryptocrystalline to occasionally finely crystalline. The finely to micro-crystalline dolomite is soft to firm, sucrosic and contains intracrystalline porosity noted in cuttings and indicated by an increase in ROP.

Minor sandstone occurs as loose, unconsolidated grains which are clear to frosted, medium to coarse, spherical to elongated, and moderately well sorted. Siltstone is medium grey to brownish grey to light greyish brown. The siltstone is micromicaceous with dolomitic cement. Minor lithics, traces of pyrite, chlorite, occur. The shale is medium light grey to medium grey to brownish grey, occasionally greenish grey, moderately hard, sub-fissile to sub-blocky.

The interval 1750 - 1832m is predominantly siltstone and dolomite interbeds with the amount of dolomite increasing towards the base of the section. The siltstone colour is reddish brown to orange brown, greyish green to light greyish green, grey to medium grey, greyish brown to light grey, occasionally with a purplish tinge, with a trace of pyrite.

Minor shale is light greyish green to light grey, occasionally light brown. It is fissile, dolomitic, micromicaceous in parts, contains a trace of pyrite. Dolomite is mottled light greyish brown, light grey, light greenish grey, cream, pinkish brown, occasionally purplish grey and pyritic. The anhydrite is white to light brown, soft, massive, contains loose, fine crystals, and is dolomitic in part. Occasional sandstone interbeds are distributed throughout the interval. The sandstone is pale yellowish

white to off white, very fine grained, well sorted, sub-angular grains, siliceous cement and matrix, and quartzose. There were no indications of fluorescence or porosity. The basal part of the upper section of the Gillen Member contains trace quantities of chert. The chert is white with black mottlings, or clear to brown. The base of this section is picked as the first appearance of halite.

"Gillen Salt Section" of Gillen Member

Age	Depth	(Thickness)
Upper Proterozoic	1832-2220m	(388m)

This unit consists of evaporitic units in two major cycles. The top of the unit is picked at a thin halite stringer overlying 10 metres of massive anhydrite. The anhydrite overlies a massive halite unit 190m thick which in turn overlies 20m-30m of massive anhydrite. This upper evaporite cycle was defined on seismic data on the basis of a strongly disturbed character to the reflectors.

A lower cycle, of massive halite overlain by massive anhydrite grading up to interlaminated dolomite and siltstone occurs from 2078 - 2220m. This sequence, on the seismic evidence, is not tectonised but is here included in the "Gillen Salt" informal unit due to the predominance of evaporite minerals.

The dolomite is pale grey, translucent to greenish grey, yellowish grey, occasionally mottled, hard to firm cryptocrystalline, microcrystalline and sucrosic, occasionally with intracrystalline anhydritic cement. Anhydrite occurs as massive bedsand also fills irregular vugs and veins. A trace of siltstone, greyish to greenish brown, reddish brown, occasionally purplish brown, blocky, slightly dolomitic, firm to very hard, silicified in places, and subfissile, is present. The siltstone grades to light greyish green, to medium grey, or light brown, micromicaceous shale.

The halite is clear, very pale yellow to yellowish brown, brittle, blocky, soft to firm, massive, coarsely crystalline, with occasional euhedral crystals.

The top of the lower evaporite cycle is predominantly dolomite, with 1-4m thick beds of anhydrite and less common interbeds of siltstone. The dolomite is light olive grey to olive grey, very pal green, massive cryptocrystalline, hard to very hard, blocky, with occasional vugs and veins of anhydrite. Dolomite is interlaminated with carbonaceous siltstone dark brown, hard fissile, occasionally sandy. Toward the base of the interval anhydrite becomes more dominant. A massive bedded anhydrite overlies the basal halite horizon. The basal halite is 20m thick.

Below a depth of 1960m, samples were washed in a supersaturated salt solution to retain as much of the halite present as possible. This method of sample washing was reasonably successful.

"Lower Gillen Section" of Gillen Member

Age	Depth	(Thickness)
Upper Proterozoic	2220-2341.7m	(121.7m)

The interval 2220 - 2292m is made up primarily of dolomite, interbedded with minor anhydrite and, less often, siltstone. The dolomite is massive to finely laminated, yellowish to olive green, towards the base of this interval The dolomite contains occasional carbonaceous material. Siltstone is dark grey to dark brownish grey to brownish black, laminated in part, argillaceous, common to abundant dolomite, a trace pyritic, and grades in places to silty dolomite. Chert traces are present in this section.

Interbedded dolomite, and siltstone occur in the interval 2292 - 2345m. The dolomite is olive grey, dark grey to occasionally dark brown, cryptocrystalline to finely crystalline, sometimes sucrosic, blocky to platy, hard, pyritic, massive to very finely laminated with minor carbonaceous matter interbedded with siltstone. The siltstone is medium to occasionally dark grey, brown and occasionally pale bluish grey, blocky, clayey, very carbonaceous and pyritic in places, and grades to shale. The siltstone content increases to up to 50 percent at the base of the interval. The "Lower Gillen" section is readily distinguished on wireline logs by the increased clay content, the absence of halite and subordinate presence of anhydrite.

Heavitree Quartzite

Age	Depth	(Thickness)
Upper Proterozoic	2341.7-2348m	(6.3m)

This unit is predominantly sandstone, overlying a thin shale above basement. The sandstone is quartzose, clear, frosted, very pale yellowish grey, fine to very coarse, but predominantly medium grained. Grains are subrounded to rounded, sometimes indented, loose, poorly sorted, occasionally joined with minor amounts of siliceous and carbonate cement, traces of argillaceous matrix, and pyritic cement. Some grains show traces of angular quartz overgrowths, and occasional, well cemented, fine grained aggregates are present. A trace of feldspar is present. Porosity from visual estimation is poor due to the presence of silica cement. On the basis of log character bedding is massive. The thin shale overlying basement is dark grey and fissile.

The Heavitree Quartzite, the primary objective of **Magee 1**, was much thinner than prognosed (6.3m as opposed to 230m). The petrography of the sand is similar to that described from outcrop samples of the Heavitree Quartzite.

Metamorphic Basement (Musgrave Block)

Age	Depth	(Thickness)
Middle Proterozoic	2349-2396m	(47m +)

Basement is a metamorphic sequence consisting of compositionally zoned gneiss and biotite schist. The gneiss is formed of muscovite, biotite, quartz and feldspar, and is light brown to pale pinkish brown. Gneissosity is well developed on a millimetre scale. Quartz grains are fine to coarse in size and fully interlocking. Biotite and muscovite occur disseminated throughout the quartz, and as discrete layers with well developed preferred orientation. The schist is a biotite schist, and is black, friable, and is composed of approximately 80 percent biotite. The schist occurs in metre scale bands or zones within the gneiss.

3.3.3 Porosity and Hydrocarbon Show Summary

Porosity in **Magee 1** was confined to two zones. The upper zone is composed of the Finke Group Sands and the Stairway Sandstone. The lower zone is the Heavitree Quartzite gas reservoir.

The upper zone is a substantial aquifer, supporting flow of brackish water in excess of 10,000 gal/hour. Visual assessment of porosity is fair to occasionally good. The lower Finke Group sandstones appear to be more porous than the Stairway Sandstone.

Background gas of 100 ppm was recorded while air drilling the upper silty part of the Stairway Sandstone. This gas show did not result in any sustained flow into the wellbore and was probably derived from gas released from the fine grained components of the formation by the action of the bit. The gas background returned to nil below this zone.

No significant porosity was observed in thin sandstones of the Winnall Beds, or carbonates of the Bitter Springs Formation. Trip gas and connection gas began to occur in the Gillen Member and continued to TD. Trace amounts of background gas were present from the top of the Gillen Member and increased to approximately 20 ppm (C_1 only) toward the base of the Gillen Member.

Gas peaks while drilling were recorded at 1835m, below the first stringer of halite, and at 2268m within thinly bedded dolomite and siltstone in the lower Gillen Member.

Porosity in the Heavitree Quartzite occurs over 4.5m. The sand appears to be cemented by both silica and carbonate cements however some primary porosity was present. Porosity was visually assessed as poor. Log analysis of the zone indicates that of the 4.5m gross interval, 3.6m is permeable and is classed as "net pay". A "tight" streak within the sand is excluded from the net pay. Porosity estimate for the zone based on density, neutron and sonic log and laboratory grain density measurements is 9 percent.

The Heavitree Quartzite flowed wet gas at 63.1 Mscfd. The gas had a very high proportion of Nitrogen and Helium. The zone flowed at this rate for approximately two days during air drilling operations. After the hole was displaced to mud for logging the gas flow rate measured during DST 1 had reduced to approximately 5 Mscfd indicating very significant formation damage.

DEPTH m KB	TOTAL GAS (units)	C_1 ppm	C_2 ppm	C_3 ppm	C_4 ppm	POROSITY	COMMENTS
380-420	2.1	149	tr	-	-	Poor	Stairway Ss
1835	38	3120	420	260	-	Nil	Gillen Mbr
2342-2347	112	11183	1440	425	220	9%	Heavitree Q

Table 5: Hydrocarbon Show Summary

Gas analyses for the Heavitree Quartzite are provided in Appendix V.

3.4 Discussion

Geological information derived from the drilling and evaluation of **Magee 1** can be summarised as follows:

1. The Heavitree Quartzite has reservoired hydrocarbons in the Mt Charlotte Structure, however the trapping mechanism and height of the hydrocarbon column in the structure are unknown.

2. The Heavitree Quartzite has thinned to 4.5m of sand from its normal thickness of approximately 200m.

3. The Heavitree Quartzite is not fully cemented by silica cement or by over-compaction. Log evaluation suggests porosity is around 9 percent.

4. Organic rich rocks are present in the basal part of the Bitter Spring Formation. Their distribution at the current location is sparse and richness is low. It is unlikely that substantial volumes of hydrocarbon have been generated at the Magee location. The maturity of the organic rich rock suggests that EP38 is at or just past the close of oil generation.

5. The rapid and economical drilling of **Magee 1** is encouraging for the area and suggests that targets in excess of 3500m could be reached by application of the same technology.

6. The formation pressures derived from DST 1 in the Heavitree Quartzite are in excess of that predicted from a water gradient hence the Bitter Springs halite is sealing a column of gas and/or oil.

7. The high Helium content of the gas suggests that the seal has been effective over very long periods of time and/or is particularly effective.

8. The hydrocarbon gas chemistry indicates that the gas accumulated is contiguous with or derived from an oil accumulation.

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KEYWORDS

Petroleum, Oil, Gas, Proterozoic, Structural Trap, Stratigraphy, Geophysical Interpretation, Geophysical Logs, Seismic Survey, Hydrocarbons, Drilling, Percussion Drilling, Conservation, Well logs, Rotary, Drilling mud, Drilling methods, Quaternary, Devonian, Cambrian, Proterozoic Alluvium, Carbonate, Evaporite, Sandstone, Dolomite, Geophys Borehole, Analysis Source Rock, Geothermal, Petrology, Porosity, Permeability, Temperature, Geochem Rock, Well Data, Water.

LOCATION

EP38 (Pinnacle Hills), Northern Territory, RODINGA 1:250 000 SG53-2.

DESCRIPTOR

This report details the general data, drilling data, geology and analytical results for petroleum exploration well **Magee 1**, drilled in EP38 Amadeus Basin NT September/October 1992 by Pacific Oil & Gas Pty.
Limited.