IMPERIAL OIL & GAS PTY LTD
Australian Office
Level 7, 151 Macquarie Street
Sydney NSW 2000 Australia
T: +61 2 9251 1846
F: +61 2 9251 0244

Well Completion Report

Well BCFSC03

EP 184

McArthur Basin

Northern Territory, Australia

Document Number	EP184-BCFSC03-XPN-DR-WCR-REP-007

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0	Final	Geoff Hokin	Geoff Hokin	19/06/2015
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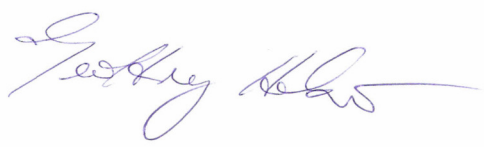

Changes to previous version

Section	Page	Change
	18	Inclusion of drilling fluids table
	18	Inclusion of Cementing Operation table
	18	Inclusion of Bit records table

Contents

Figures:

Table(s):

License and operator details

Operator	Imperial Oil & Gas Ltd
Licence Holder	Imperial Oil & Gas Ltd
Project Management	Imperial Oil & Gas Ltd
Report Date	June 2015
Report Author	G. Hokin
Licence Area	EP184
Map References	Map sheet name and graticular block number

- 1:250K Map Sheet Name: Urapunga-Roper River Special
- 1:100K Map Sheet Name: Urapunga
- 5 Minute Graticular Block Number: SD53 2482
- 1 Minute Graticular Block Number: L

Stratigraphic Units Nagi Formation
St Vidgeon Formation

Keywords Shale, organic, drilling, geophysical, wireline logging.

WELL DATA CARD

Well name BCFSC03	
Location: 0473 968 m E, 8355 030 m N (GDA94 Zone 53L) Elevation: RL: 29.0 m KB: 0.89 m Map: 1:250K Urapunga – Roper River Datum: GDA 94 Zone 53 L Grid: Easting: 0473 968.862 Northing: 8355 030	Type Structure: St Vidgeon Formation Status : Plugged and abandoned Rig : Hydco 1200 G Driller : Drillstralis Pty ltd Date spudded : 23/07/2014 Date TD : 24/07/2014 Date rig release: 26/07/2014 Total Depth Driller : 119.95 m MD Logger : 119.40 m MD Deviation : 6 degrees Casing: Size Shoe a)Conductor PVC 8" 6.7 m a) Surface HWT $4^1/_2$ " 50.67 m b) Intermediate N/A

Prognosed Stratigraphic units penetrated

Age	Formation	MDGL (m)		SS (m)		Thickness
		from	to	from	to	(m TVD)
Quaternary	Undifferentiated	0	10	-29	-19	
Palaeo Proterozoic	Nagi Formation	10	50	-19	31	
Palaeo Proterozoic	St Vidgeon Formation	50	100	31	69	

Well prognoses

Well Name:	**BCF SC 03**		
250k map sheet:	**Urapunga**		
Operator:	**Imperial Oil and Gas**		
Type of Well:	**Wildcat**		
Spud date:	**24/07/2014**		
Target:	**Saint Vidgeon Fm**		
Location Coordinates:	**14°52'44.72"S**	**134°45'28.81"E**	
Grid/Zone:	**GDA 94, Zone 53**		
Petroleum Title:	**EP 184**		
Landholder:	Parks Wildlife Service		
Proposed TD:	**100 ± 20m**		
Drilling Contractor:	**Drillstralis**		
Logging Company	**ACS Mining Services**		
Elevation in Mtrs: GL.	**29**	**KB:**	**0.89m**

Estimated Tops			Drilled Thickness [m]	Lithologic desciption
Formation	MD [m]	SS (m)		
Quaternary	**0**	**-29**	**10**	
Nagi Fm	**10**	**-19**	**40**	Dolomitic and feldspathic sandstone, dolomitic siltstone, dolarenite.
Saint Vidgeon Fm	**50**	**31**	**50+**	Carbonaceous-pyritic shale and dolomitic siltstone, dolostone; minor pink chert beds (tuff?).
Total Depth:	**100**	**69**	**100 +**	
Base of oxidation/weathering	**50**			
Water table	**49**			

Geological Justification
The proposed well location is picked between two outcrops of Saint Vidgeon Fm. The well will be collared in the Quaternary sediment cover which is estimated to have a thickness of ~10m, then penetrate the Nagi formation for about 40m, before entering the Saint Vidgeon Fm at 50m MD.
Geological Wellsite Program
Sample Program: C*hip samples will be caught in ~5 m intervals from Conductor Casing Point to start of coring.*
Photograph chip samples and describe in detail.
Responsible Sample Catcher(s): well site geologist
Sample Set(s): *Catch, label, scale and bag as much cuttings as possible; keep in cool place (not refrigerated)*
Coring: during coring operations the entire core has to be described in detail, samples for further analysis are being taken on the ground if target formation is encountered.
Bag and seal without delay once dry

Drilling Objective(s)
The oxidised zone (first 40 m ± 20 m) will be drilled with a 6-1/4" (= 159 mm) bit.
Check for signs of weathering/oxidation in the chip samples.
After no more signs of weathering can be identified drilling is to be switched to HQ coring
[Hole (outside) diameter: 96 mm; Core (inside) diameter: 63.5mm]
Reporting
Morning geology report to NT government by 10 am
All gas and oil shows to be recorded accurately and reported as soon as possible.
Reference: NT Contacts Tab
Completion Report*- end of well report to be compiled to meet regulatory requirements for the NT*
Logging
Logging Company: ACS Mining Services
Total Tool Length
Parameters measured; Gamma, calliper, Density, full wave sonic, neutron, resistivity, SP and deviation where possible
Desorption canisters
Not applicable
Comment(s):
Cultural heritage induction to be done on all personnel prior to entering site
Mud logger/Wellsite Geologist has the flexibility to stop drilling at anytime
Safety First

Location and access

Well location

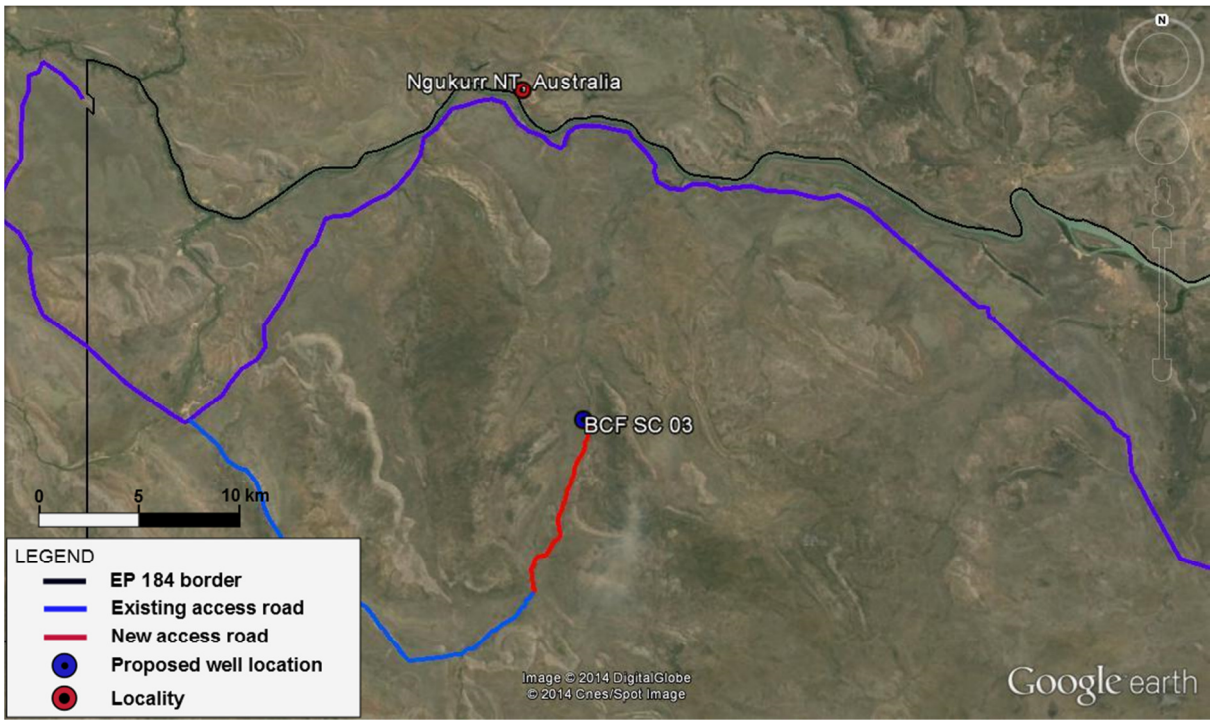

Figure 1: Location of well BFSC03 within EP184 and relative to the community of Ngukurr in the East Arnhem region of the Northern Territory.

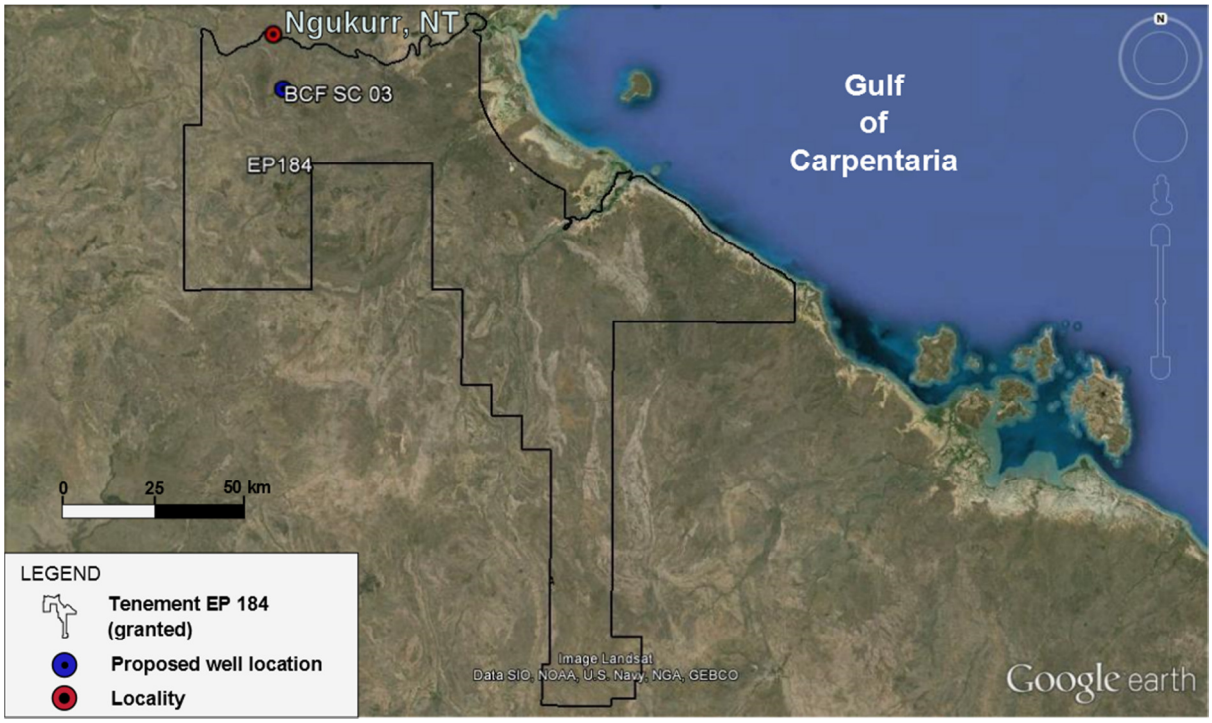

Figure 2: Location and access of Well BCFSC03 within EP184

To access the drill site coming from Darwin follow the Stuart Highway south for 424 km until the turnoff to Roper Bar is reached 5 km south of Mataranka. The single strip, sealed Roper Highway goes to Roper Bar a distance of 175 km. To access the drill site from Roper Bar head to the Roper Highway from the Roper Bar Motel. Turn left and left again after 1 km to access the Nathan River Rd. Head south and turn right after 42 km follow the Old Saint Vidgeon Station access road (named "military road" on topographic maps) for 10km. Once past the old station airstrip turn left onto the access track and follow for 7 km.

Summary

The exploration well BCF SC 03 was designed and positioned to penetrate and test the carbonaceous-pyritic shale of the Saint Vidgeon Formation in a near outcrop position. The site was selected for proximity to outcrop to reduce the depth of core required to obtain samples for geochemical characterisation and hydrocarbon source rock potential evaluation. The well design provided for open hole drilling to just below the zone of oxidation prognosed to be at ~50 m depth. The hole was to be HQ cored from 50m to total depth (TD). No gas or petroleum reservoir was encountered in the well due to the shallow depth of the core hole. The target formation was not encountered. No samples were taken from this well.

Introduction

Imperial Oil & Gas Ltd, as Tenement Holder and Operator, undertook to drill a vertical pilot and partly cored exploration hole within EP184 in the McArthur Basin of the Northern Territory, approximately 350 km southeast of Darwin and 250 km east of Katherine. This hole was planned as an exploration well targeting the Barney Creek Formation equivalent, the Saint Vidgeon Formation, within the Umbolooga Sub-group of the McArthur Group in the Urapunga fault zone.

The objective of the exploration program was to determine if the Saint Vidgeon Formation contained organic shales of suitable characteristic that could be a hydrocarbon source rock within deeper portions of the basin. And, to provide data on geological structures within the McArthur Group deposits.

In a first stage the shallow well BCFSC03 was drilled to 50.7m using an air percussion hammer. Chip samples were obtained and logged to record the lithology of the encountered rock formation(s). Post this depth the hole was then continuously cored using a HQ coring bit to a measured depth of ~120m.

The core obtained was photographed and lithologically logged however no samples were taken from the core as it did not penetrate any organic shales. On reaching total depth the hole was flushed clean using a high air flow and the hole filled with clean water then downhole geophyscially logged. On completion of the logging the hole was plugged with cement and abandoned in accordance with approvals provided by the Northern territory Department of Mines and Energy.

All operations and equipment used in the program complied with the API standards and Imperial Oil & Gas's Safety Management Systems.

Geology and previous exploration

Regional geology

The regional geology of the McArthur River Basin is well summarised by Jackson *et al.* (1987), Plumb and Roberts (1992), Plumb *et al.* (1990), Madigan and Rawlings (1994) and Pietsch *et al.* (1994).

The Middle Proterozoic McArthur Basin of Central Australia outcrops over an area of 200 000 km^2, in the Northern Territory, with a relatively unknown, but large, section which sub-crops below younger sequences.

The Northern McArthur Basin within EP184 is dominated by the Walker Trough and the Urapunga Fault Zone, a north-west trending, extensively faulted zone approximately 50 to 70 km wide.

Gentle warping and folding can be related to the faults. Fold axis generally trend North-North-West and locally east north east and North-West to West North West. It is estimated that during deposition of the McArthur Basin a number of subsidence events due to rifting associated with extension along pre-existing basement structures probably occurred.

The basin contains up to 12 km of relatively undeformed and un-metamorphosed sedimentary rocks comprising clastics, evaporites and carbonates. The stratigraphy is subdivided into four stratigraphic groups separated by regional unconformities. The four stratigraphic groups of the Middle Proterozoic are the Tawallah Group, McArthur Group, Nathan Group, and the Roper Group. An unnamed sequence of Neoproterozoic sediments accumulated over the Roper Group.

The main structural features reflecting the tectonic evolution of the McArthur Basin are; east-west trending basement ridges such as the Murthy and the Urapunga Ridges; northwest-trending strike-slip faults, such as the Calvert, Mallapunyah and Bulman Faults; and north-trending high angle older normal faults with later inversion, such as the Emu, Tawallah and Four Arches faults.

Differential subsidence of the Walker Trough probably started during deposition of the Lower McArthur Group and continued, to a lesser extent, during the deposition of the Nathan Group (Jackson, *et.al*., 1987). Thickening of the Roper Group, to 5 km on the Bauhinia Shelf, west of the Abner Range area reflects a shift of the basin depocenter during the deposition of the Roper Group.

The Tawallah Group is the lowermost of the four major sequences; it is up to 4 500 m thick and represents the economic or effective basement. The Tawallah Group consists mainly of sandstones with subordinate finer grained clastics, volcanics and rare carbonates.

The McArthur and Nathan Groups overlay the Tawallah Group; they have a combined thickness of between 3 000 and 5 500 m. They are mostly stromatolitic and evaporitic dolostones interbedded with lesser siltstones and shales.

The McArthur and Nathan Group sediments were deposited in a variety of environments including marginal marine, lagoonal, lacustrine and fluvial. The McArthur and Nathan Groups are potentially a source of the hydrocarbons encountered in wells.

The uppermost unit, the Roper Group varies between 2 500 and 4 000 m in thickness. The Roper Group thickens to the southwest. It consists of alternating quartz arenites, siltstones and shales. The Roper Group unconformably overlies the McArthur and the Nathan Groups.

The sedimentary sequences within the Roper Group have significant lateral extent, with more uniform facies when compared to the underlying successions, of the Tawallah, McArthur and Nathan Groups. The estimated age of the Roper Group is at least 1 430 Ma. An un-named succession of sandstones and shales of probable Neo-Proterozoic age, overlays the Roper Group, these have a maximum thickness in excess of 600 m.

Organically rich source rocks with the potential to generate both oil and gas are present in several intervals within thick shales of the McArthur Group such as the Barney Creek and Yalco Formations and Caranbirini Member of the Lynott Formation; and in the Upper Roper Group, in the Velkerri and Kyalla Formations.

Recognised reservoirs are developed at various levels within carbonates of the McArthur Group; these are potentially sealed by shales in Barney Creek and Lynott Formations or by thick evaporites at the base of the Balbirini Dolomite. Traditionally the Barney Creek Formation is considered the major source rock, but the Lynott and Yalgoo formations have also good generating potential and are currently in the oil window. Carbonate reservoirs in the McArthur Group are the major objectives in the Batten Trough area covered by EP184. Good vuggy porosities have been observed in the Coxco Dolomite, Reward Dolomite, and the Barney Creek Formation.

The proposed exploration targets four-way dip closed features and fault bounded anticlines. Structural plays, mostly anticline features, are the major targets for oil and gas exploration in the folded Batten Trough.

Trial field geology

No seismic exists in proximity to this location though historical acquired seismic exists to the south of this location. In 2013 a gravity survey was acquired by the Northern Territory Geological Survey (NTGS) over the southern McArthur Basin and released in 2014 (Dhu *et al* 2014). The survey covers an area of approximately 75 000 km^2 south of Roper.

The scope of the project was to better the understanding of the framework architecture of the McArthur Basin. A Bouguer anomaly map was produced, that confirms northwest-trending structures that are consistent with the strike of the major faults including the Mallapunyah and Calvert Hills Fault (southeast) and the Bulman Fault (north). These results are congruent with the findings in known seismic lines that indicate two 4 way closed structures present in the Ngukurr area lying also along a NW –SE direction. Gravity inversion was used for modelling the pre-sedimentation basin architecture of the greater McArthur Basin by L. Ailleres *et al* 2014. Preliminary results show a series of basement cover interfaces that are geologically consistent. The outcome is an estimate of depth to basement (Ailleres *et al* 2014).

2D Formation modelling undertaken of the region was undertaken using historical data available from the Northern territory geological Survey. This data was combined with additional information obtained through field outcrop mapping and the determination of dip and strike of outcrops and faults with cross section interpretation of the historical seismic.

The BCF SC 03 well is positioned to test the nearby Saint Vidgeon Formation outcrop at depth for geochemical characterisation and hydrocarbon source rock potential. Formation modelling is based on surface outcrop mapping and determination of dip and strike of outcrops and faults with cross section interpretation of the seismic.

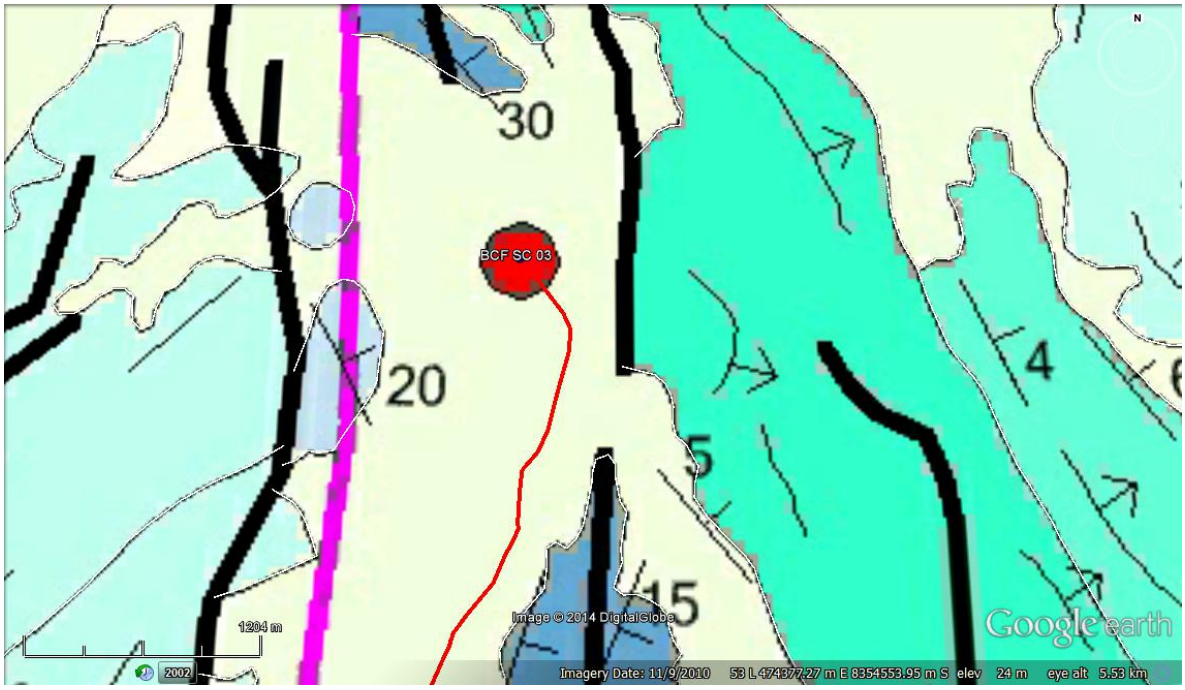

Figure 3: dip and strike of the formations with the drill site marked in red.

Previous exploration

A search of the NT Drill Holes data base for hydrocarbon and mineral holes has shown previous limited shallow drilling in close proximity to the proposed location by the Bureau of Mineral Resources, Pacific Oil & Gas and Rio Tinto.

The nearest existing wells found in the records are seven mineral wells drilled by Rio Tinto in 1997 (DD97WG01 and DD97WG02) and 1998 (DD98WG03- DD98WG07). The nearest existing petroleum well(s) are in the Urapunga area to the West of the proposed location, Urapunga 4 to 6. Also of significance are the petroleum wells, Alexander-1 and Scarborough-1 drilled to the south of BCF SC 03 in 1987 by Pacific Oil & Gas and encountered hydrocarbons in the Velkerri Formation, as well as Shea-1 to the West.

Nearest Wells

The diamond core hole DD97WG01 and DD97WG02 were drilled in 1997 by Rio Tinto at the Mt Birch prospect to explore for strata bound base metal mineralisation, within the Mid Proterozoic Vizard and Nathan Groups. The two wells lie only 130 m apart and 11 km north of the proposed drill location BCF SC 03.

The diamond core hole **DD97WG01** was drilled to 81.9 m. The well was collard in the Nagi Formation at 468808 mE and 836489 mS. The well was drilled at an inclination of -60^0 with an azimuth of 215^0. and went into the St Vidgeon around 23 m. The hole intersected a fault zone at 20 m within the upper St Vidgeon Formation dolomites and siltstones. Core loss and poor sample return were frequent. The rock was silicified from 76 m down hole.

The diamond core hole **DD97WG02** (COREDAT ID: 3422) was collared It was collared in the lower Nagi Formation of the Vizard Group, a quartz sandstone and conglomerate. The top of the water table was encountered at 49 m. No significant water influx was recorded in the Drill Hole Ledger (Report CR19980574_1998_GA). At 25.6 m the well went into the Saint Vidgeon Formation, the Barney Creek Formation equivalent in the Urapunga Fault Zone, where it terminated at a depth of 179.2 m MD after 14 days of drilling. The lithology of the

Nagi Formation is dominated by a medium grained, quartz and feldspar rich sandstone and quartz-lithic conglomerate. The main lithology of the Saint Vidgeon Formation are shale and sandstone. The dominant colour in the top part is light to dark grey and changes to varieties of pink at around 55 m. Weathering is reported throughout the entire well with minor sections described as fresh and/or silicified. Core loss occurred frequently.

Five diamond core holes (**DD98WG003 - 007**) were drilled by Rio Tinto in 1998 at Mountain Creek prospect, approx. 10 km south of BCF SC 03. All five wells were interpreted to lie entirely in the Knuckey Formation (Pnk) of the Nathan Group, but frequent intersection of pinkite (pink tuff layers) might indicate intersection of Saint Vidgeon or Nagi Formation instead.

Diamond hole **DD98WG003** consisted of 36 m of RC collar with a diamond core tail extending to 236.2 m. Drilling took 8 days, the top of the water table was intersected at 45 m

Diamond hole **DD98WG004** was drilled to 217.7 m. The base of weathering was at 33 m and primarily dark-grey carbonaceous carbonates of the Knuckey Formation was intersecting.

DD98WG005 was originally drilled with a 42 m RC pre-collar and diamond tail to 74.4 m, but very broken and faulted ground forced re-drilling of this hole about 2 m away with 118 m RC pre-collar and a diamond tail of 165.8 m. Strong fracturing and faulting forced the abandonment of the hole. Intersected weathered siltstone and shales.

DD98WG006 was a core extension of RC98WG006 to 219.2 m. The hole intersected fresh laminated dolomitic, carbonaceous siltstones and stromatolites, evaporitic, sandy and massive light grey dolomitic siltstone of the Knuckey Fm.

DD98WG007 had a 30 m RC pre-collar and a diamond core tail extending to 131.1 m depth the base of oxidation was encountered at 24 m and the entire section was interpreted as Knuckey Formation.

The Urapunga wells (1 - 6) were drilled by the Bureau of Mineral Resources to obtain fresh core material from the Roper Group to study stratigraphy, sedimentology and hydrocarbons (HC). Three shallow cores (1-3) were drilled in 1983 which supplement three fully cored holes drilled in 1985 (4-6).

BMR Urapunga 4 was collard 63 km northwest of BCF SC 03 and went vertically to a TD of 532 m. Stratigraphy encountered in this well include McMinn Formation (0 - 41.2 m), Velkerri Formation (41.2 – 372.1 m), Bessie Creek Sandstone (372.1 - 397.6 m) and Corcoran Formation (397.6 – 532 m). The thick intersection of Velkerri Formation contains several extensive layers of organic rich shale. Live oil was encountered at 342.8 m and 346.0 – 347.5 m. Further evidence of a good HC source rock was found in the Moroak Sandstone Member of the McMinn Formation and Bessie Creek Sandstone where bitumen and oil stains in vuggy intervals point towards HC migration.

BMR Urapunga 5 (TD 604 m) is located 41 km northwest of BCF SC 03 and was collard in the Munyi Member. It intersected the Abner Sandstone and Crawford Formation and reached TD in the Mainoru Formation. No HC were encountered in this well.

BRM Urapunga 6 is located 28.5 km northwest of BCF SC 03 and was drilled to a total depth of 422.8 m through the Limmen Sandstone into the Mantungula Formation of the Lower Roper Group. The well was therefore stopped above our target formation. Neither of the two intersected formations show source rock potential or adequate porosity and permeability.

Scarborough-1 is a petroleum well drilled by Pacific Oil & Gas in 1987. The well is located 190 km east of Mataranka and 34 km southwest of BCF SC 03. It intersected five different formations being from top to TD: Kyalla Member (0 – 52 m), Moroak Sandstone Member (52 – 122 m), Velkerri Formation (122 – 621 m), Bessie Creek Sandstone (621 – 667 m) and Corcoran Formation (667 - 691.3 m (TD)). In total 499 m of Velkerri Formation were intersected. The Velkerri Formation was divided into three section: "upper" Velkerri from 122 - 295 m (thickness 173 m), "middle" Velkerri from 295 – 457 m (thickness 162 m) and "lower" Velkerri from 457 – 621 m (thickness 164 m). Different HC occurrences were reported in the Moroak Member, Velkerri Formation and Bessie Creek Sandstone. The Moroak Member showed bitumen blebs in vugs and oil and bitumen staining throughout. The Velkerri Formation showed occasional kerosene odour throughout the section, minor oil bleeds in association with carbonate veinlets as well as all colours of fluorescence between 270 – 470 m. The Bessie Creek Sandstone had bitumen pore-fillings throughout as well as rare yellow/green fluorescence and relict oil/water contact at 642.7 m.

Alexander-1 was drilled in 1987 by Pacific Oil & Gas to a TD of 689.6 m. The well lies 34 km south southeast of BCF SC 03. Sections intersected are almost identical to those drilled in Scarborough-1. Moroak sandstone Member 0- 62 m, Velkerri Formation 62 - 617 m (thickness 555 m), Bessie Creek Sandstone 617 – 661 m and Corcoran Formation 661 – 689.6 m (TD). The Velkerri Formation was divided into three section. The "upper" Velkerri extends from 62 - 280 m with a thickness of 218 m. The "middle" Velkerri was intersected from 280 – 446 m (thickness 166 m) and described as highly carbonaceous mudstone/shale with common Pyrite, occasional oil bleeds and olive black to black colouring. The "lower" Velkerri extends from 446 – 617 m (thickness 171 m) and is described as a partly glauconitic carbonaceous mudstone.

Shea-1 is a stratigraphic well that was drilled in 1991 by Pacific Oil & Gas and CSIRO in a joint research project. The well is located about 75 km east southeast of Mataranka and 110 km west southwest of BCF SC 03. The objective to the CSIRO was to determine in-situ rock properties of the "middle" Velkerri Formation. The well was spudded in the Proterozoic Bukalorkmi Member of the McMinn Formation, followed by a thicker than prognosed Kyalla Member. Moroak Sandstone Members and the McMinn Formation were also intersected before entering the "upper" Velkerri Formation at 284.89 m interbeds of mudstone and siltstone. The black, carbonaceous mudstone of the "middle" Velkerri Formation was intersected between 468.9 – 609 m. The hole was terminated at 616 m in the bluish grey claystones of the "lower" Velkerri Formation.

Water Bores

Most of the water bores in the area have been drilled around the townships of Ngukurr and Roper Bar to the north of BCF SC 03 and in proximity to the Roper River.

The closest water bore is **Tollgate Creek**, 14 km northwest of the proposed drill location at the southern bank of Roper River approximately 6 km south west of Ngukurr. It reached a total depth of 64.5 m. Water was encountered at 20 m (0.5 L/s), 35 m (1 L/s) and 56 m (2.5 L/s). Tollgate Creek is located 25 m off a side arm of the Roper River and at a height of 18 m GL, this equates to a TD below sea level of 46.5 m (Bore Report RN026364). The Bore Completion Report states a specific conductance of 610 µs/cm and 620 µs/cm in the airlift sample and pump test sample, respectively. The practical salinity can be inferred by using the specific conductance and equates to 0.296 psu and 0.301 psu.

2/82 Nullawan, 19.5 km northeast of the proposed location, is located on the far side of the Roper River. It was drilled in 1982 to a total depth of 73 m. Water struck at 24 m in form of

seepage and at 57 m with 0.189 L/s. Water analysis recorded iron levels and pH value out of the drinking water range (Bore Report RN021484). The specific conductance has been reported as 1710 µs/cm, which equates to a salinity of 0.86 psu.

A third water bore in proximity to the proposed well location is **Test No. 07** (475932.50 mE and 8369189.96mS), drilled in 1961, 14.5 km northeast of BCF SC 03. It is at an elevation of 10 m and approximately 300 m from the southern bank of the Roper River. Drilling stopped at 16.2 m as the rock was too hard to drill. The strata was described as hard and soft bands of porcellanite with odd pieces of quartzite and jasper (Bore Report RN002741). As no water zone was intersected there is no information on salinity at this location.

The close proximity of Tollgate Creek to the river and semi-permanent waterholes of Tollgate Creek, increases the chance of water influx which is not given at the location of BCF SC 03.

A review of this information and taking the distance of BCF SC 03 from the river into account, a significant flow from aquifers is not expected at drill site BCF SC 03.

Well History

BCF SC 03 was spudded on the 23rd July and drilled to a TD of 119.95m in 2 days. The hole was percussion-drilled down to 50.67 m on day one and HWT casing set at this point to permit coring. Cuttings from the open hole section were logged at 1 m intervals and representative samples of the formation encountered were taken and stored in calico bags. Additional subsamples were taken and retained in chip trays. Water was encountered at 6m. The water flow measured was 5.7L/s. No sample was taken for analysis as it was deemed to contain introduced fluids from the drilling process and would thus not be a true sample.

HQ coring commenced at this depth and continued to 81.21m on day one. Each run suffered significant core loss. This was probably due to the highly weathered nature of the formation and loss of integrity of the sandstones.

Day two of the drilling continued the HQ coring. This continued to the TD of 119.95 m. Core loss was significant in each run. On obtaining the approved TD the hole was flushed clean of cuttings and wireline geophysically logged for density, gamma, calliper, sonic and verticality. Drilling was conducted on a single shift daylight only basis. The time line is shown in figure 4 time depth curve.

On completion of logging the hole was set up for plug and abandon (PnA). On receipt of approval to PnA from the NT Dep't Mines and Energy the rig ran the cement plug on the 25th of July to the bottom of the HWT casing. The casing was then removed from the hole and the cement filled to surface. On the 26th the cement was topped up, the marker post set and the rig released. Site rehabilitation commenced once the rig had moved off the site. The schematic of the PnA well is shown in figure 5.

Despite being a petroleum exploration core hole due to the planned total depth the well was drilled using a mineral style under approvals given by the Northern Territory Dep't Mines and Energy.

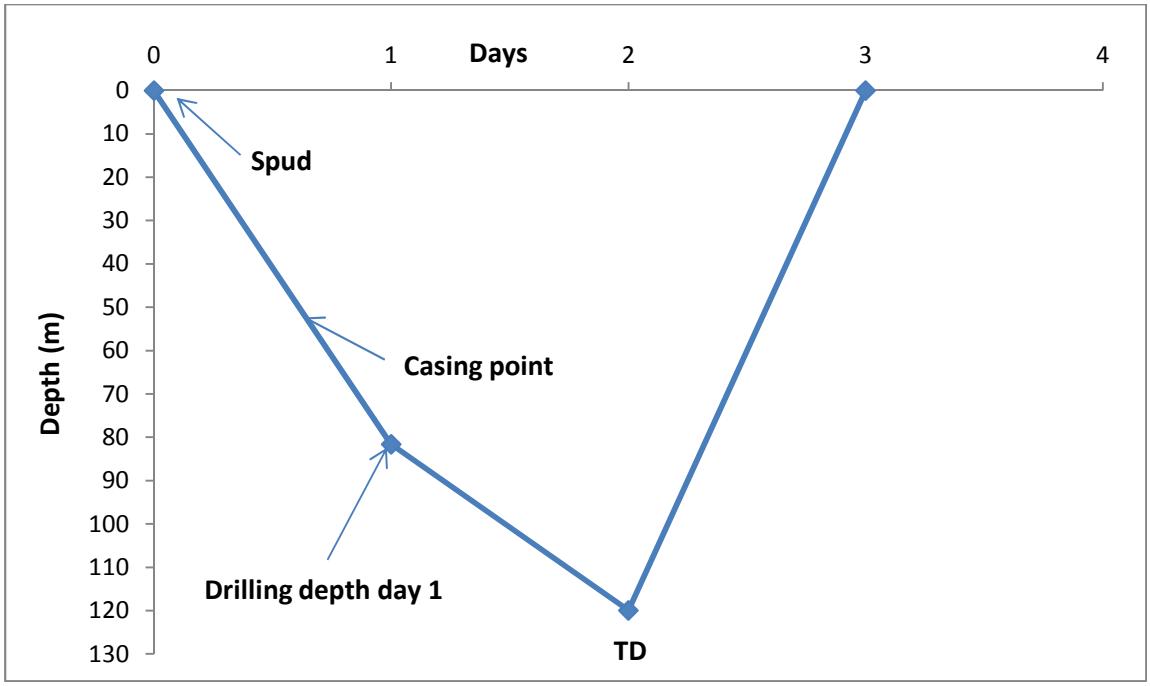

Figure 4: time depth curve

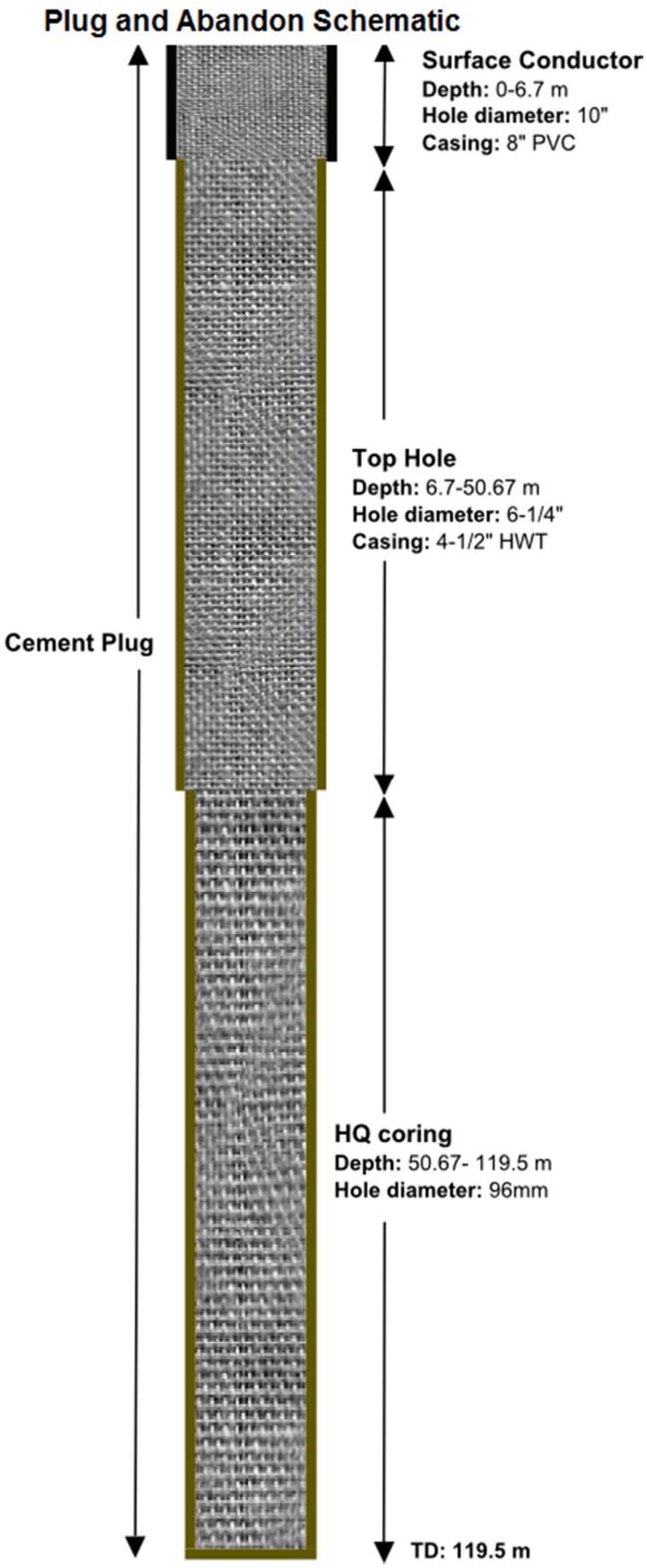

Figure 5: Schematic of the plug and abandoned well BSFSC03

Rig data

The Hydco 1200G drilling rig specifications:

- Heavy Duty Mast - 9 meter rod pull – 2 meter dump - UHMWPE Slides
- Main Pump - Kawasaki K3VL200
- Water pump - FMC John Bean L09-18HD-BCD
- Engine - Cummins QSC 8.3 Electronic 305hp engine, readouts and controls
- Certified Mast Wireline and Main Winch Ropes
- hydraulic side mount rod bin
- Hydco Hydraulic Make and Break drill pipe
- system 3 1/2 & 4 1/2 Rods, rod kicker & valving
- Fire Suppression System (Both Engines) from 1 tank
- Air Start Engines, Engine choking device, Spark arrestors
- Hydco Hydraulic Rod Loader including hydraulic rod bins and operator control arm
- 40K Drill Head Water Swivel & Adaptor Flange including hosing & Fitting
- CBM - 3 meter Zone including cabinet and signals to Panel
- Wood Group "Rig Saver" Certified air intake
- emergency shutdown (range 50 meters) CBM
- Rod Spinner Sandvik on sprung pivot arm
- Hydraulic Mast Position Lock

Feed

- Variable feed pressure control
- Pull Back 21,500KG (Variable)
- Pull Down 12,500KG (Variable)

Drive head

- 2 Speed Hollow Floating Spindle Drill head
- Variable speed hydraulic motor
- Pressure Lubricated - (Gears Hardened & Ground)
- Speed and torque variable

	240 bar
200 to 1500RPM	710 nm
50 to 1000 RPM	1,070 nm
10 to 250 RPM	4,280 nm
0 to 160 RPM	6,400 nm

Well information

Well location

Latitude and longitude in GDA94 values

0473 968 m E, 8355 030 m N

Map sheet name and graticular block number

1:250K Map Sheet Name:	Urapunga-Roper River Special
1:100K Map Sheet Name:	Urapunga
5 Minute Graticular Block Number:	SD53 2482
1 Minute Graticular Block Number:	L

Seismic line location and shot point number

N/A

The elevation of the ground and kelly bushing

GL: 29 m
KB: 0.89 m

If the well is a side track – the name of the parent well

N/A

Names of MWD and LWD tools used

N/A

List of all well evaluation logs including measurement while drilling logs, pressure detection logs and mud logs

lithology log

List of log runs for wireline logging and velocity surveys

Table 1: Wireline logging runs.

Log run	From [m]	To [m]	Comment
1	119.5	0.00	Dummy
2	119.4	0.00	Density, Caliper
3	118	82	FWS
4	119.4	0.00	Deviation, GR, FTC
5	0.00	0.00	Res IP

Drilling Fluids

Average loaded-hole fluid properties were: Density ρ: 8.4 ppg Viscosity: 33 sec/qt.

Cementing Operation

	Conductor Casing	Surface Casing	Core Hole
Hole Size [inches]	10	5 – ¾	99mm
Casing Size [in]	8	4 ½ (retrieved)	N/A
Setting depth [m]	6.7	56.7	119.5
Est. BHT [^{0}C]	N/A	N/A	33.5
Cement type	Grout	Grout	Grout
Yield (ppg)	14	14	14
Mix water type	Surface water	Surface water	Surface water
Excess [%]	25	25	25

Bit Record

Bit record	Hole Section	Bit Size [“]	Hole size [“]	Make	Depth in [m]	Depth out [m]	Meters drilled in this hole	WOB [lbs]	Rod spin [rpm]
1	Conductor	6 ¼	6 ¼	Halo	0	6.7	6.7	2000	45
2	Top Hole	5 ¾	5 ¾	Halo	6.7	56.7	50.0	3000	45
3	Coring section	99 mm	63mm	HWL	56.7	119.5	62.8	5000	700

The purpose of the well

The exploration well BCF SC 03 was designed and positioned to penetrate and test the carbonaceous-pyritic shale of the nearby Saint Vidgeon Formation outcrop at depth for geochemical characterisation and hydrocarbon source rock potential just below the zone of oxidation prognosed to be at ~50 m depth. The objective was to collect fresh samples from the St Vidgeon Formation, for geochemical analysis. It was not expected that any reservoir will be encountered due to the shallow depth of the core hole.

Well outcomes

The hole was drilled to 119.95 m. On completion of drilling the hole was geophysically wireline logged and then plugged and abandoned. No St Vidgeon formation was encountered in the hole. Samples of chip were retained for lithology typing of the formation(s) encountered. The hole did not meet the objective set for it.

Raw pressure time listings for any formation fluid sample tests and production tests

N/A

Important Dates

Spud date:	23-07-2014
Date of reaching total depth:	24-07-2014
Rig release date:	26-07-2014

Depth reference

Ground level.

Measured depth of the well

Drillers depth:	119.95 m
Loggers depth:	119.5 m

True vertical depth of the well

119.5

If applicable, the depth of perforation in the petroleum reservoir

N/A

If the well is deviated or horizontal

The surveyed path of the well

6 degree deviation from vertical

The co-ordinates of the bottom of the well bore

N/A

If applicable the coordinates and true vertical depth of the intersection of the well with the reservoir horizon

N/A

List of cores, cuttings and samples taken and their depths and intervals

Core none

Cuttings 0 -50m in 1 m intervals

Samples none

Sampling

N/A

Geology data

Well stratigraphy

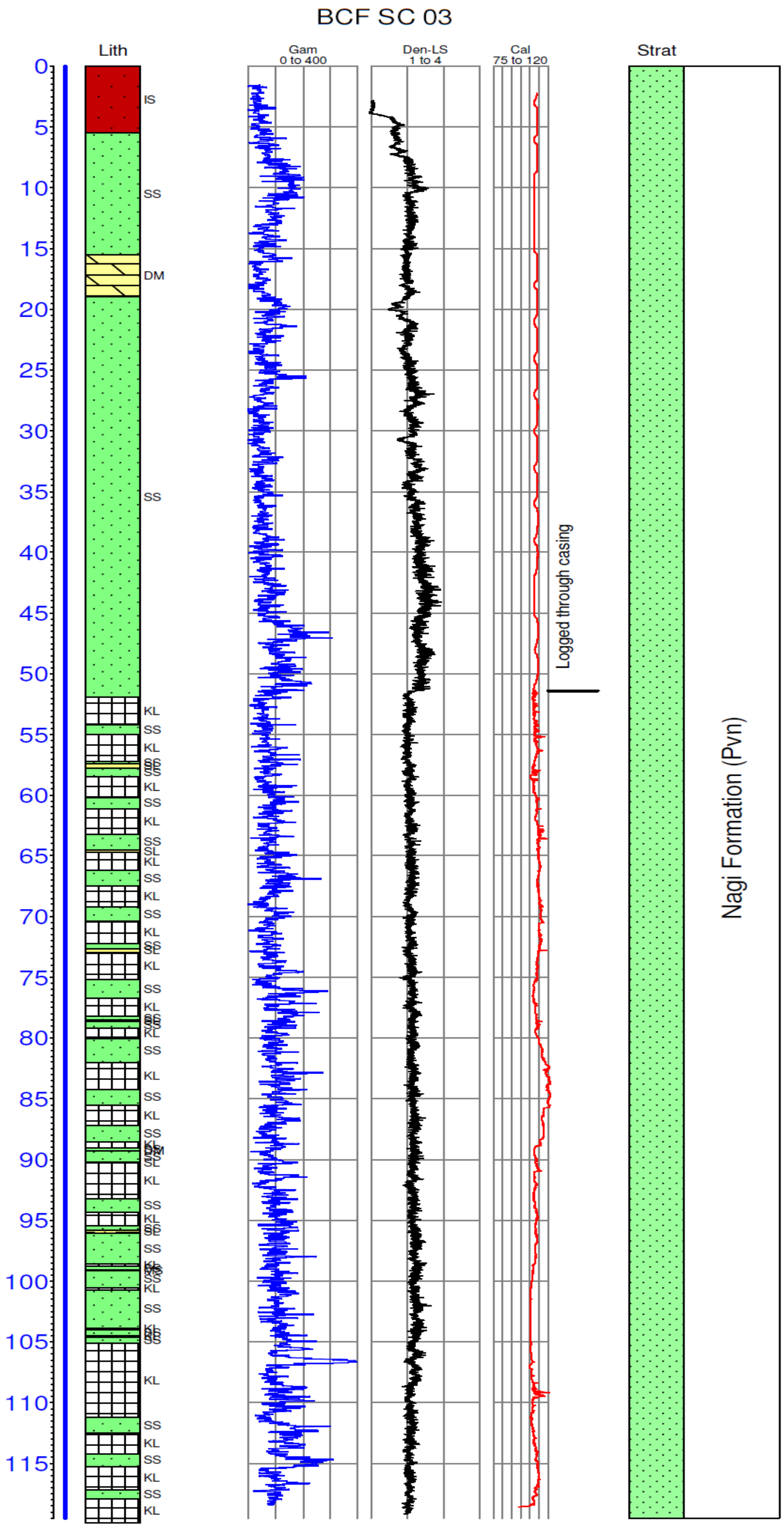

Figure 6: Well stratigraphy with Gamma, calliper and density shown. Formations are interpreted from available lithology and geophysical data.

Geology setting

Formation modelling for BCF SC 03 was based on surface outcrop maps and determination of dip and strike information from outcrops and faults utilizing the NTGS published 250k geology maps. The well was proposed to be collared into Nagi Formation then penetrate into the upper portion of the St Vidgeon formation at approximately 50m drill depth.

The basin here is part of the structural entity of the Urapunga Fault Zone (UFZ), comprising Vizard Group overlain by Nathan Group, and bounded by thrust faults. The drill location outcrop is located between two thrust faults and was predicted to have uplifted older units relative to the surrounding formations. Dips in the thrust fault zone are shown to be 20° to the SW on the 250k geology. Due to the shallow nature of the well, uncertainties about the formation boundaries, dips and faults, and its unique location between two thrust faults, there was a high risk that the Saint Vidgeon Formation might be lower, higher or not even present in this location.

The intersected formation in BCF SC 03 was dominated by highly weathered sandstone with minor interbedded dolomites at the top of the unit and minor siltstones and mudstones with increasing depth. Between 0 – 50 m the rock chips were mainly comprised of cream to brown highly weathered sandstones with a surface 6m of highly weathered lateritic iron stained sandstone. A single shallow aquifer was encountered at 6m sitting below the ironstone band. Water flow was measured at approximately 5.7L/s.

Below the 50m depth sandstone continued to dominate the formation. The sandstone was highly weathered and lacked cohesive structure. As a consequence the drilling suffered considerable core loss from each run. Only minor occasional bands of siltstone and mudstone were encountered in the drilling through to the planned total depth of 120m.

Hydrocarbon indications

No Hydrocarbons were encountered in BCF SC 03.

Conclusion

The hole spudded into the Nagi formation and did not drill deep enough to penetrate into the target St Vidgeon Formation.

This hole did not meet its objective.

Appendix:

Daily drilling reports

IMPERIAL OIL & GAS

Level 7, 151 Macquary St
Sydney NSW 2000, Australia

DAILY DRILLING REPORT

Satphone Drillstralis: 0147 141 886
Satphone IOG: 0420 369 871
Geo: 040 6693 779

WELL	BCF SC 03	Permit	EP184	
Report number	1	Rig	Hydco1200G	
Report for	23/07/2014	Spud Date	23/07/2014	
Date report submitted	24/07/2014	Prognosed TD	100 m ± 20	
Weather	sunny	RT - GL	0.88 m	
Days from Spud	0	GL - Elevation	29 m	
HSE	No Incidents, Accidents or Spills.			

Drilling

Last casing set @ [m]	N/A	Size [inch]	N/A
Starting depth (6 am) [m]	0		
Finishing depth (6 pm) [m]	81.21		
Days progress [m]	81.21		
Summary of operations carried out	Mobilisation to site, drill top hole to 50.67 m and HQ core to 81.21 m.		

Operations Break Down

Time	Duration [h:min]	Depth [m]	Operation
6:00	0:10	0	Prestart meeting
6:10	0:20	0	Wait on transort to site
6:30	2:00	0	Mobelisation to site
8:30	1:00	0	Set uo rig
9:30	1:00	6.7	Drill 10"conductor section to 6.7m, set 8" PVC
10:30	1:30	50.67	Drill 6-1/4" hole to 50.67m
12:00	0:30	50.67	Change from Hammer to coring tools
12:30	0:30	50.67	Set HWT casing to 50.67m
13:00	0:20	50.67	Change over waterswivel
13:20	0:40	50.67	Wash in HQ
14:00	3:50	81.21	Drill HQ from 50.67-81.21m
17:50	0:30	81.21	Travel back to camp

Summary of the Next 24hrs	Core to TD. Log well and cement to surface.

Formation Description

Lithology description	Depth from [m]	Depth to [m]	Background gas (Units)	Gas peak [ppm]	Formation name
Dull red to yellow highly weathered Iron Stone	0	6	N/A	N/A	
Red to cream coloured baned highly weathered sandstone with mudstone sections. High core loss	6	81.21	N/A	N/A	

Estimated daily and cumulative well costs

Yesterday	$	-
Daily Costs	$	16,700.00
Cumulated	$	16,700.00

Surveys

Date	Depth [m]	Deviation [°]

Pre-job safety meeting record

Date	Place	# of ppl
23/07/2014	Roper Bar	15

Personell on drillsite

Drill crew - DRILLSTRALIS	3
Logger - ACS	0
Geologist	1
Cultural monitor	2

IMPERIAL OIL & GAS

Level 7, 151 Macquary St
Sydney NSW 2000, Australia

DAILY DRILLING REPORT

Satphone Drillstralis: 0147 141 886
Satphone IOG: 0420 369 871
Geo: 040 6693 779

WELL	BCF SC 03	**Permit**	EP184	
Report number	2	**Rig**	Hydco1200G	
Report for	24/07/2014	**Spud Date**	23/07/2014	
Date report submitted	25/07/2014	**Prognosed TD**	100 m ± 20	
Weather	sunny	**RT - GL**	0.88 m	
Days from Spud	1	**GL - Elevation**	29 m	

HSE	No Incidents, Accidents or Spills.

Drilling

Last casing set @ [m]	50.67	**Size [inch]**	4-1/2 HWT
Starting depth (6 am) [m]	81.21		
Finishing depth (6 pm) [m]	119.95		
Days progress [m]	38.74		
Summary of operations carried out	HQ core from 81.21 m to TD at 119.95 m. Run density, gamma and deviation logs.		

Operations Break Down

Time	Duration [h:min]	Depth [m]	Operation
6:00	0:10	81.21	Prestart meeting
6:10	3:10	81.21	Wait on fog to clear for safe trip with the chopper to drillsite
9:20	0:10	81.21	Prestart
9:30	6:00	119.95	HQ core to 119.95 m
15:30	0:30	119.95	Trip out HQ
16:00	1:30	119.95	Wireline logging. Loggers TD: 119.5 m
17:30	0:30	119.95	Travel back to camp

Summary of the Next 24hrs	Finish logging, cement to surface, install signage

Formation Description

Lithology description	Depth from [m]	Depth to [m]	Background gas (Units)	Gas peak [ppm]	Formation name
Red to cream coloured banded highly weathered sandstone with mudstone sections. High core loss	81.21	119.95	N/A	N/A	

Estimated daily and cumulative well costs

Yesterday	$	16,700.00
Daily Costs	$	20,500.00
Cumulated	$	37,200.00

Surveys

Date	Depth [m]	Deviation [°]
24/07/2014	119.95	6.00

Pre-job safety meeting record

Date	Place	# of ppl
24/07/2014	Roper Bar	16

Personell on drillsite

Drill crew - DRILLSTRALIS	3
Logger - ACS	1
Geologist	1
Cultural monitor	2

IMPERIAL OIL & GAS

Level 7, 151 Macquary St
Sydney NSW 2000, Australia

DAILY DRILLING REPORT

Satphone Drillstralis: 0147 141 886
Satphone IOG: 0420 369 871
Geo: 040 6693 779

WELL	BCF SC 03	**Permit**	EP184	
Report number	3	**Rig**	Hydco1200G	
Report for	25/07/2014	**Spud Date**	23/07/2014	
Date report submitted	26/07/2014	**Prognosed TD**	100 m ± 20	
Weather	sunny	**RT - GL**	0.88 m	
Days from Spud	2	**GL - Elevation**	29 m	
HSE	No Incidents, Accidents or Spills.			

Drilling

Last casing set @ [m]	50.67	**Size [inch]**	4-1/2 HWT
Starting depth (6 am) [m]	119.95		
Finishing depth (6 pm) [m]	119.95		
Days progress [m]	0		
Summary of operations carried out	Run soniclogs, cement hole.		

Operations Break Down

Time	Duration [h:min]	Depth [m]	Operation
6:00	0:10	119.95	Prestart meeting
6:10	0:20	119.95	Wait on daylighy for chopper
6:30	8:30	119.95	Wireline logging. Loggers TD: 119.5 m
15:00	0:20	119.95	Run in hole and flush
15:20	0:40	119.95	Cement hole to bottom of HWT
16:00	1:40	119.95	Free casing and flush
17:40	0:20	119.95	Cement to surface
18:00	0:20	119.95	Travel back to camp

Summary of the Next 24hrs	Top up cement, install signage, rig move

Formation Description

Lithology description	Depth from [m]	Depth to [m]	Background gas (Units)	Gas peak [ppm]	Formation name

Estimated daily and cumulative well costs

Yesterday	$	20,500.00
Daily Costs	$	21,500.00
Cumulated	$	58,700.00

Surveys

Date	Depth [m]	Deviation [°]
24/07/2014	119.95	6.00

Pre-job safety meeting record

Date	Place	# of ppl
25/07/2014	Roper Bar	16

Personell on drillsite

Drill crew - DRILLSTRALIS	3
Logger - ACS	1
Geologist	2
Cultural monitor	2

IMPERIAL OIL & GAS

DAILY DRILLING REPORT

Level 7, 151 Macquary St
Sydney NSW 2000, Australia

Satphone Drillstralis: 0147 141 886
Satphone IOG: 0420 369 871
Geo: 040 6693 779

WELL	BCF SC 03	**Permit**	EP184	
Report number	4	**Rig**	Hydco1200G	
Report for	26/07/2014	**Spud Date**	23/07/2014	
Date report submitted	27/07/2014	**Prognosed TD**	100 m ± 20	
Weather	sunny	**RT - GL**	0.88 m	
Days from Spud	3	**GL - Elevation**	29 m	
HSE	No Incidents, Accidents or Spills.			

Drilling

Last casing set @ [m]	50.67	**Size [inch]**	4-1/2 HWT
Starting depth (6 am) [m]	119.95		
Finishing depth (6 pm) [m]	119.95		
Days progress [m]	0		
Summary of operations carried out	Rig move. Top up cement. Set marker post.		

Operations Break Down

Time	Duration [h:min]	Depth [m]	Operation
6:00	0:10	119.95	Prestart meeting
6:10	1:50	119.95	Waiting on fog to lift. Travel to site.
8:00	2:00	119.95	Rig down an top up cement
10:00	4:00	119.95	Move to next site BCF SC 02
14:00	3:30	119.95	Breakdown, busted suspension air bag
17:30	0:30	119.95	Return to camp

Summary of the Next 24hrs	Complete rig move to BCF SC 02. Drill top 6m and set conductor. Chip drill to casng depth. Set HWT casing. Set up for coring.

Formation Description

Lithology description	Depth from [m]	Depth to [m]	Background gas (Units)	Gas peak [ppm]	Formation name

Estimated daily and cumulative well costs

Yesterday	$	58,700.00
Daily Costs	$	16,500.00
Cumulated	$	75,200.00

Surveys

Date	Depth [m]	Deviation [°]
24/07/2014	119.95	6.00

Pre-job safety meeting record

Date	Place	# of ppl
26/07/2014	Roper Bar	16

Personell on drillsite

Drill crew - DRILLSTRALIS	3
Logger - ACS	2
Geologist	2
Cultural monitor	2

Lithology Log

Lithology Coding Sheet

Sheet 1 of 6

Project	Site	Hole number	Grid East	Grid Northing	Section (e.g. 56J)
184	St Vidgeon	BCFSC03	473968	8355080	53K

Total Depth	Date start	Date end	Drill Rig	Driller	Logged by Pers.	Core Size	Drill Type	Hole Size	Case Type	Casing depth	V-notch sample depth	V-Notch sum
119.45	23-7-14	24-7-14	HYDCO	TS	CE	83	DD	96	HWT	50.67		

Sample Number	Fm	Start Depth	Base Depth	Lith.	Lith. %	Shade Hue Colour	Gr. Size	Qualifier	Mech State	Hard	Bedding	Basal Features	Weathering	Bedding Dip	Bedding Tect	Tectonic Type	Tectonic Freq	Tectonic Dip	Fossil / Minerals Abund	Fossil / Minerals Type	Fossil / Minerals Assoc	Index Ref
		0	1	IS		Dull red brown						HW										
		1	2	IS		orange to cream																
		2	5.5	IS		Cream to white																
		5.5	6																			
moist		6	7			CR → White		ET IS fragments dark red														
		7	8			CR																
		9	11	ST		CR → Orange																
		11	14.5	ST		Dull orange																
		14.5	19.5	ST		W/ DM fragments																
		15.5	17.5	DM		CR																
		17.5	19	DM		Light G																
		19	21.5	ST		CR		ET DM fragments														
		21.5	22.5	ST		BR light		" "														
		22.5	26.5	ST		LGR → BR		" "														
		26.5	31.5	ST		OR		W/ DM FR														
		31.5	34.5	ST		BR light		" "														
		34.5	36.5	ST		DM FR		CR → Light Red														
		36.5	40	ST		CR																
		40	49	ST		CR																

Start of Coring

Note: 0 → 6.76 m 10"
6.76 → 50 m 6-1/4"

Hit water @ ~ 6m Flow rate: 5-7 L/s !

Lithology Coding Sheet

Sheet 2 of 6

Project	Site	Hole number	Grid: East	Section (e.g. 56J): Northing	Section
184	St. Vidgeon	BCFSC03	473968	8355030	53

Total Depth	Date start	Date end	Drill Rig	Driller	Logged by / Pers	Core Size	Drill Type	Hole Size	Case Type	Casing depth	V-notch sample depth	V-Notch mm
119.95	23-7-2014	26-7-2014	Hydro 1200	TS	C.E	63	DD	96	HWT	50.67		

Sample Number	Fm	Start Depth	Base Depth	Lith.	Lith. %	Shade Hue Colour	Gr. Size	Qualifier	Mech State	Hard	Bedd-ing	Band Features	Weathering	Bedding Dip	Bedding Text	Tectonic Type	Tectonic Fms	Tectonic Dip	Fossil / Minerals Mineral	Fossil / Minerals Type	Fossil / Minerals Assoc	Sedim Ref
Run 1		50.67	51.21	Cored		0.54 m		Rec	0.56m					PU	0.02m							
				SS		PRD	MF	Wet	YB				E									
Run 2		51.21	51.91	Cored			3m	Rec	0.7m			CL		2.3m								
		51.21	51.91	SS		PRD							E									
		51.91	54.21	KL																		
Run 3		54.21	54.98	Cored			3m	Rec	0.77m			CL		2.23m								
		54.21	54.98	SS		PRD ->	YB						E									
		54.98	57.21	KL																		
Run 4		57.21	58.51	Cored			3m	Rec	1.3m					CL 1.7m								
		57.21	57.4	SS		PRD							E									
		57.4	57.75	SL		YB							E									
		57.75	58.51	SS		YB							E									
		58.51	60.21	KL																		
Run 5		60.21	61.11	Cored			3m	Rec 0.9m														
		60.21	61.11	SS		RD																
		61.11	63.21	KL																		

Lithology Coding Sheet

ver.01

Sheet 3 of 6

Project	Site	Hole number	Grid East	Section (e.g. 56J) Northing	Section
184	St Vidgeon	BCFSC003	473968	8355030	653

Total Depth	Date start	Date end	Drill Rig	Driller	Logged by / Pers.	Core Size	Drill Type	Hole Size	Case Type	Casing depth	V-notch sample depth	V-Notch mm
119.45	23-7-2014	24-7-2014	HYDROPOO	TS	CE	63	RD	93	HWT	50.67		

Sample Number	Fm	Start Depth	Base Depth	Lith.	Lith. %	Shade Hue Colour	Gr. Size	Qualifier	Mech State	Hard	Bedd-ing	Basal Features	Weathering	Bedding Dip	Bedding Text	Tectonic Type	Tectonic Frac	Tectonic Dip	Fossil / Minerals Abund	Fossil / Minerals Type	Fossil / Minerals Assoc	Sedim Ref
Run 6		63.21	64.72		Cored		3m	Rec: 1.49						CL 1.51m								
		63.21	64.52	SS		RD							E									
		64.52	64.72	SL		RD							E									
		64.72	66.21	KL																		
Run 7		66.21	67.46		Cored		3m	Rec. 1.25m						CL 1.75m								
		66.21	67.46	SS		RD → YR							H									
		67.46	69.21	KL																		
Run 8		69.21	70.40		Cored:		3m	Rec: 1.19				CL		1.81m								
		69.21	69.40	SS		RD → YR		x bedding					H									
		69.4	69.80	SS		RD → CR							H									
		69.8	70.10	SS		KK							H									
		70.1	70.40	SS		RD → CR							H									
		70.4	72.21	KL																		
Run 9		72.21	72.96		Cored:		3m	Rec: 0.75m						CL: 2.25m								
		72.21	72.50	SS		YW							H									
		72.50	72.63	SS		DRD							H									
		72.63	72.77	SB		VR							H									
		72.77	72.96	SL		KK							H									
		72.96	75.21	KL																		

Lithology Coding Sheet

Sheet 4 of 6

ver.01

Project	Site	Hole number	Grid Est	Section (e.g. 5kJ) Northing	Section
184	St. Kilgeran	BCFSC03	473968	8235030	53

Total Depth	Date start	Date end	Drill Rig	Driller	Logged by Prin.	Core Size	Drill Type	Hole Size	Case Type	Casing depth	V-notch sample depth	V-Notch int.
119.95	23-7-2014	26-7-2014	HYDROND	TS	CE	63	DD	96	NWT	50.67		

Sample Number	Fm	Start Depth	Base Depth	Lith.	Lith. %	Shade Hue Colour	Gr. Size	Qualifier	Mech State	Hard	Bedding	Basal Features	Weathering	Bedding Dip	Bedding Text	Tectonic Type	Tectonic Prac	Tectonic Dip	Fossil / Minerals Abund	Fossil / Minerals Type	Fossil / Minerals Assoc	Rodrec Rel
Run 10		75.21	76.71	Cored: 3m Rec: 1.5m										CL: 1.5m								
		75.21	76.71	SS		RD → WH							SI									
		76.71	79.21	KL																		
Run 11		78.21	79.21	Cored: 1.8m Rec 1.0m										CL: 0.8m								
		78.21	78.51	SS		XB → RD							SI									
		78.51	78.64	SL		WR							SI									
		78.64	79.21	SS		YB							SI									
		79.21	80.01	KL																		
Run 12		80.01	81.24	Cored 1.2m Rec: 1.23m										RL: 0.03m								
		80.01	81.24	SS		PRD							M									
Run 13		81.21	82.02	Cored: 3m Rec: 0.81m										CL: 2.01m								
		81.21	82.02	SS		PRD							M									
		82.02	84.21	KL																		
Run 14		84.21	85.52	Cored 3m Rec: 1.31										CL: 1.69m								
		84.21	84.96	SS		PRD → CR bands				S			M	30°	B		F 10-60°					
		84.96	85.52	SS		PRD							SI									
		85.52	87.21	KL																		

Lithology Coding Sheet

Sheet 5 of 6

Project	Site	Hole number	Grid East	Grid Northing	Section
184	ST Vidgeon	BCFSC03	473968	8355030	53

Total Depth	Date start	Date end	Drill Rig	Driller	Logged by Pers.	Core Size	Drill Type	Hole Size	Case Type	Casing depth	V-notch sample depth	V-Notch run
119.95	23-7-2014	24-7-2014	HYDRO1200	TS	CE	G35	[illegible]	96	HWT	50.67		

Sample Number	Fm	Start Depth	Base Depth	Lith	Lith %	Shade Hue Colour	Gr. Size	Qualifier	Mech State	Hard	Bedding	Bed Features	Weathering	Bedding Dip	Bedding Text	Tectonic Type	Tectonic Frac	Tectonic Dip	Fossil / Minerals Abund	Fossil / Minerals Type	Fossil / Minerals Assoc	Sedim Rel
Run 15		87.21	88.53	CORED: 1.84m				REC: 1.32m						CL: 0.52m								
		87.21	87.67	SS		KU -> ?D																
		87.67	88.21	SS		DRD		et SL interbeds														
		88.21	88.53	SS		PRD																
		88.53	89.05	KL																		
Run 16		89.05	91.01	CORED: 4.16m				REC: 1.96m								CL: 2.2						
		89.05	89.26	SS																		
		89.26	89.28	DM																		
		89.28	90.22	SS													F	80				
		90.22	90.23	SL																		
		90.23	91.01	SS		PRD																
		91.01	93.21	KL																		
Run 17		93.21	94.31	CORED: 2.24m				REC: 1.1m								CL: 1.14m						
		93.21	94.31	SS		PRD		AB MS BU WH														
		94.31	95.45	KL																		
Run 18		95.45	98.58	CORED: 3.21m				REC: 2.3m								CL: 0.08m						
		95.45	95.84	SS					S				M									
		95.84	96.03	SL					S				M									
		96.03	98.58	SS				AB SL BU	S				M									
		98.58	99.76	KL																		

Lithology Coding Sheet

Sheet 6 of 6

Project	Site	Hole number	Grid: East	Section (e.g. 563): Northing	Section
184	St Vincent	BCF-SC03	473968	8355030	53K

Total Depth	Date start	Date end	Drill Rig	Driller	Logged by / Pres.	Core Size	Drill Type	Hole Size	Case Type	Casing depth	V-notch sample depth	V-Notch rate
119.95	23-7-16	24-7-16	HYDCO	TS	CE	HQ	DD	96	HWT	50.67		

Sample Number	Fm	Start Depth	Base Depth	Lith.	Lith. %	Shade Hue Colour	Gr. Size	Qualifier	Mech State	Hard	Bedding	Basal Features	Weathering	Bedding: Dip	Bedding: Text	Tectonic: Type	Tectonic: Frac	Tectonic: Dip	Fossil / Minerals: Abund	Fossil / Minerals: Type	Fossil / Minerals: Amor	Strat. Ref
Run 19		98.76	100.73	CORE				1.97 REC:														
		98.76	99.09	SS																		
			99.11	MS																		
			99.42	1cm	MS			wt DM clasts			99.76	MS										
			100.24	1cm	bed			wt DM +/-														
			100.73	5cm	MS			bed														
Run 20	100.73 →		104.01 →					Cored 3.28 Rec: 3.12m														
				SS				R→CR-KK-W wt MS beds														
Run 21	104.01 →		104.62	SS				CR														
Run 22	104.62 →		111.21 →					Cored 6.59 Rec: 0.45m														
		104.62	104.76	CR	SS																	
			105.07	R	SS			wt DM fractures														
Run 23	111.21 →		114.21	Cored 3m Rec. 1.72m																		
								DRL→ KK Sandstone wt MS interbeds														
Run 24	114.21 →		117.21	Cored 3m Rec. 1.01m																		
				SS				CR-KK-R wt MS beds							1-30°							
Run 25	117.21 →		119.93	Cored 2.72m Rec: 0.70																		
				SS	C	R		KK														

EOH

Lithology dictionary

Code	Lithology
AI	Acid Intrusive
AL	Alluvium
AN	Andesite
AV	Acid Volcanic
BI	Basic Intrusive
BO	Boulders
BR	Breccia
BS	Basalt
BU	Basement Undifferentiated
BV	Basic Vocanic
CA	Carbonaceous
CC	Calcite
CB	Carbonate
CE	Calcrete
CG	Conglomerate
CH	Chert
CK	Chalk
CL	Clay
CO	Coal
CS	Claystone
CV	Colluvium
DE	Diatomaceous Earth
DI	Diamictite
DM	Dolomite
DO	Dolerite
FB	Fault Breccia
FC	Fireclay
FI	Fill
FK	Ferricrete
FW	Fossil Wood
GB	Gabbro
GD	Granodiorite
GN	Gneiss
GR	Granite
GV	Gravel
IG	Igneous Rock, undifferentiated
II	Intermediate Intrusive
IN	Intrusive Rock, undifferentiated
IS	Ironstone
IV	Intermediate Volcanic
KA	Kaolinite
KK	Cone in Cone Carbonate
KL	Core Loss
LA	Laterite
LG	Lignite
LI	Limonite
LO	Loam
LS	Limestone
M1	Conglomerate (>65% matrix)
M2	Conglomerate (35-65% matrix)
M3	Conglomerate (<35% matrix)
MD	Mud
MM	Metamorphic Rock, undifferentiated
MS	Mudstone
MY	Mylonite
NL	Not Logged
NR	No Recovery
OS	Oil Shale
OW	Old Workings
PC	Pellet Claystone
PE	Peat
PH	Phyllite
PY	Pyrite
QT	Quary Tuffaceous
QZ	Quartz
RH	Rhyolite
SA	Sand
SC	Silcrete
SD	Siderite
SH	Shale
SI	Silt
SL	Slate
SO	Soil
SS	Sandstone
ST	Siltstone
SU	Sedimentary Rock, undifferentiated
SZ	Schist
TA	Talc
TF	Tuff
TI	Tillite
TN	Tonstein
TS	Tar Sand
TT	Tuffite
VB	Volcanic Breccia
VD	Void
VR	Volcanic Rock, undifferentiated
XC	Carbonaceous Claystone
XH	Carbonaceous Shale
XM	Carbonaceous Mudstone
XS	Carbonaceous Sandstone
XT	Carbonaceous Siltstone
ZC	Coaly Claystone
ZH	Coaly Shale
ZM	Coaly Mudstone
ZS	Coaly Sandstone
ZT	Coaly Siltstone

Code	Shade
A	light to medium
B	medium to dark
C	light to dark
D	dark
E	medium
L	light
M	mottled
N	banded
S	speckled
V	variegated

Code	Hue
B	brownish
C	creamy
E	greenish
F	buff
G	greyish
K	blackish
L	bluish
O	orangey
P	pinkish
R	reddish
U	purplish
W	whitish
X	off-whitish
Y	yellowish

Code	Colour
B	brown
C	cream
E	green
F	buff
G	grey
K	black
L	blue
M	multi-coloured
O	orange
P	pink
R	red
U	purple
W	white
X	off-white
Y	yellow

Code	Grain size
CS	clay sized
CX	coarse to very coarse grained
FC	fine to coarse grained
FF	fine grained
FM	fine to medium grained
FU	fusainous
FX	fine to very coarse grained
GG	granular
GO	granular to cobbly
GP	granular to pebbly
GU	granular to bouldery
GV	gravelly
MC	medium to coarse grained
MM	medium grained
MS	mud sized
MX	medium to very coarse grained
OO	cobbly
OU	cobbly to bouldery
PO	pebbly to cobbly
PP	pebbly
PB	pebbly to bouldery
S1	very fine grained (VV)
S2	fine grained (FF)
S3	fine to medium grained (FM)
S4	medium grained (MM)
S5	coarse to very coarse grained (CX)
S6	interbedded, fine and coarse
S7	medium to coarse grained (MC)
S8	coarse grained (CC)
S9	very coarse grained (XX)
SS	sand sized
SY	stony
TS	silt sized
UU	bouldery
VC	very fine to coarse grained
VF	very fine to fine grained
VM	very fine to medium grain
VV	very fine grained
VX	very fine to very coarse grained
WE	weathered
XX	very coarse grained

Code	Lithology Qualifier
AN	anthracite
CA	Carbonaceous
CC	Calcite
CG	coarse grained
CI	cindered
CL	clayey
CT	cannel (torbanite, bog)
CU	undifferentiated
HA	heat affected
IF	inferior
IO	iron Oxide
IS	iron stained/iron stone

Code	Lithology Qualifier
PU	puggy
SA	sandy
SI	silty
SP	sapropelic

Code	Adjective
AB	abundant (30-60%)
AC	acidic
AK	arkosic
AL	altered
AM	sub arenitic
AR	arenitic
AS	as
AT	alternating
BC	basic
BE	bentonitic
BL	blebs
BN	bands
BR	bright
BS	basaltic
BU	near base of unit
CA	Carbonaceous
CB	carbonate
CC	calcite
CD	concoidal
CG	conglomeratic
CI	concretions
CL	clayey
CM	common (15-30%)
CO	coaly
CR	chloritic
CS	claystone
CT	clasts
DA	decreasing in abundance
DD	dull
DE	detrital
DM	dolomitic
DO	dominant (>60%)
DS	disseminated
ET	and
FE	ferruginous
FF	finer
FO	fossiliferous
FR	fragments
FS	feldspathic
FT	fault gauge
FU	fusainous
FN	No idea
GC	glauconitic
GG	granules
GN	grains
GP	graphitic
HA	heat affected
HI	highly
HR	hard
HY	shelly
IA	increasing in abundance
IB	interbanded
IS	iron stained
IL	illitic
IM	intermediate
IN	intrusive
IP	in part
IR	irregular
KA	kaolinitic
LA	lateritic
LC	clear
LI	limonitic
LM	laminae
LN	lenses
LO	loamy
LR	large
LT	lithic
LU	lustrous
LY	layers
MD	muddy
MG	manganiferous
MI	micaceous
MM	metamorphosed
MN	minor (1-15%)
MO	moderately
MR	marly
MS	mudstone
MU	near middle of unit
MX	matrix
ND	nodules
OF	of
ON	on
OO	cobbles
OP	opaque
OX	oxidised
PA	partings
PB	pebbles
PE	peaty
PH	phases
PO	pods
PP	phosphatic

Code	Adjective (2)
PT	pellets
PY	pyritic
QT	query tuffaceous
QZ	quartzose
RA	rare (<1%)
RS	resinous
SA	sandy
SC	siliceous
SD	sideritic
SF	silicified
SG	stringers
SH	shaly
SI	silty
SM	smectitic
SO	soft
SS	sandstone
ST	siltstone
SX	sooty
SY	stony
TF	tuffaceous
TG	strongly
TH	thin
TI	tillitic
TK	thick
TL	translucent
TN	tonsteinous
TO	throughout
TR	traces
TT	tends to
TU	near top of unit
TY	slightly
VE	very
VI	vitrainous
VO	volcanic
WI	with
WP	wisps
XC	coarser
XU	near top and base of unit
XX	carbonaceous

Code	Mechanical State
BK	blocky
BL	brittle
BR	brecciated
CE	cleated
DW	disintegrates on wetting
EX	expanding clay
FB	friable
FG	flaggy
FI	fissured
FL	flaky
FR	fractured
FS	fissile
HP	high plasticity
HS	high slaking
IN	indurated
IP	intermediate plasticity
LP	low plasticity
LS	low slaking
MF	micro faulted
MS	medium slaking
NC	non-cleated
NP	non plastic
NS	non slaking
PO	powdery
PU	puggy
SF	subfissile
SH	sheared
SK	slickensided
SL	slabby
ST	sticky

Code	Interrelationship
BN	with bands of
BO	with boulders of
CM	with cement of
CT	with clasts of
CU	coarsening up to
DS	disseminated with
FR	with fragments of
FU	fining up to
GG	with granules of
IB	interbedded with
IC	intercalated with
IL	interlaminated with
IM	intermixed with
IR	irregularly interbedded with
LN	with lenses of
MX	with matrix of
ND	with nodules of
OO	with cobbles of
PB	with pebbles of
PO	with pods of
WP	with wisps of

Code	Est. Strength/hardness
Unconsolidated Cohesive	
C1	very soft
C2	soft
C3	firm
C4	stiff
C5	very stiff
C6	hard
Rock	
R1	extremely low strength rock
R2	very low strength rock
R3	low strength rock
R4	medium strength rock
R5	high strength rock
R6	very high strength rock
R7	extremely high strength rock
F	friable
S	Soft
M	Moderate hardness
VH	Very hard
UH	Ultra hard
Unconsolidated Cohesionless	
S1	very loose
S2	loose
S3	medium dense
S4	dense
S5	very dense

Code	Bedding
CB	thickly bedded (600-3000mm)
IR	irregular spaced bedding
LL	thinly laminated (<6mm)
LM	thickly laminated (6-20mm)
MA	massive/absent bedding
MB	medium bedded (200-600mm)
TB	thinly bedded (60-200mm)
UB	very thinly bedded (20-60mm)
VB	very thickly bedded (>2m)

Code	Texture
AG	amygdaloidal
AM	amorphous
AP	aphanitic
CH	cherty
CI	concretionary
CK	chalky
CS	clast supported
EA	earthy
EQ	equigranular
FB	fibrous
FL	flow banded
GG	granular
GS	glassy
GT	gritty
MS	matrix supported
ND	nodular
OO	oolitic
PL	platey
PR	porphyritic
PS	pisolitic
PT	pelletal
SO	soapy
SZ	schistose
VS	vesicular
VT	vitreous
VU	vuggy
WX	waxy
XL	crystalline

Code	Basal Contact
B	basal contact open or readily parts
D	basal contact deformed
ER	erosional basal contact
F	faulted at basal contact
GR	gradational basal contact
I	sharp and irregular basal contact
J	jointed at basal contact
O	oblique basal contact
SO	sharp and oblique basal contact
SP	sharp and planar basal contact
R	fractured at basal contact
S	sheared at basal contact
U	sharp and undulose basal contact

Code	Weathering
D	distinctly weathered
E	extremely weathered
F	fresh
H	highly weathered
M	moderately weathered
R	residual soil
S	slightly weathered
W	weathered
EW	extremely weathered

Code	Bedding
CB	current bedding
CR	climbing ripples
CT	contorted bedding
CU	coarsening upwards
CV	convoluted bedding
DB	disturbed bedding

Code	Bedding
DC	dessication cracks
DE	soft sediment deformation
DF	diffuse bedding
FL	flasar bedding
FS	flame structures
FU	fining upwards
FX	fine cross bedding
GB	graded bedding
LB	lenticular bedding
ML	medium scale cross laminations (200mm-2000mm)
MP	medium permeability (10mD-10000mD)
PL	planar bedding
RI	ripple bedding
RX	trough cross bedding
TX	tabular cross bedding
XB	cross bedding

Code	Defect Spacing
EW	extremely wide (>2m)
MN	moderately narrow (20-60mm)
MW	moderately wide (60-200mm)
NA	narrow (6-20mm)
VN	very narrow (<6mm)
VW	very wide (600-2000mm)
WI	wide (200-600mm)

Code	Tectonics
BP	bedding plane
BZ	broken zone
CF	contraction fracture
CL	clay band
DB	drilling induced break
DS	discing
DY	dyke
DZ	drilling induced broken zone
FO	foliation
FR	fracture (undifferentiated)
F	fault
J	joint
SH	shear zone
S	sill
SZ	softened zone (non-tectonic)
VN	vein

Code	Surface Roughness
K	slickensided
P	polished
R	rough
S	smooth

Code	Core State
B	broken core
C	crushed core
F	fragmented core
K	cuttings
O	overdrilled core
S	solid core
V	very broken core

Code	Sedimentary Features
AF	angular fragments
AG	angular grains
AP	angular pebbles
BO	boudinage
BF	subrounded fragments
BG	subrounded grains
BP	subrounded pebbles
BS	bimodal sorting
BT	bioturbated
BU	near base of unit
BW	burrowing
CF	compaction feature
CI	colloidal iron deposit
DG	bladed grains
DY	sedimentary dyke
GF	subangular fragments
GG	subangular grains
GP	subangular pebbles
HP	high permeability (>10000mD)
HX	high angle cross bedding (>30°)
IC	intraformational cracks
IM	imbricate clasts
IP	in part
IR	impermeable (<0.1mD)
LC	load cast
LG	prolate grains
LL	large scale cross laminations (>2m)
LP	low permeability (0.1mD-10mD)
LX	low angle cross bedding (<10°)
MC	mud casts/cracks
MS	moderately sorted
MU	near middle of unit
MX	medium angle cross bedding (10°-30°)
PB	penny bands
PC	bounce marks/prod casts
PD	poorly developed bedding
PE	permeable
PG	pebble lag
PO	porous
PS	poorly sorted
RB	rootlet beds

Code	Sedimentary Features
RF	rounded fragments
RG	rounded grains
RM	ripple marks
RP	rounded pebbles
RU	rip-up clasts
RW	reworked
SC	shrinkage cracks
SF	scour and fill
SL	small scale cross laminations (<200mm)
SP	slumping
ST	stylolites
TG	tabular grains
TO	throughout
TU	near top of unit
VF	very angular fragments
VG	very angular grains
VP	very angular pebbles
VV	varving
WB	wavy bedding
WD	well developed bedding
WE	water escape structures
WF	well rounded fragments
WG	well rounded grains
WL	wavy laminations
WP	well rounded pebbles
WS	well sorted
XU	near top and base of unit
YC	syneresis cracks
YS	polymodal sorting

Code	Mineral fossil abundance
A	abundant (30-60%)
C	common (15-30%)
D	secondary
E	accessory
M	minor (1-15%)
N	dominant (>60%)
R	rare (<1%)

Code	Minerals and Fossils
AN	ankerite
AP	apatite
BA	bauxite
BI	bivalves
BR	brachiopods
BT	biotite
BZ	bryozoans
CC	calcite
CB	carbonate
CE	chalcopyrite
CD	chalcedony
CH	chert
CL	clay
CP	coprolites
CH	chlorite
DI	dickite
DM	dolomite
EP	epidote
FB	charcoal
FM	foraminifera
FO	fossils
FR	faecal remains
FS	feldspar
FW	fossil wood
GA	galena
GC	glauconite
GO	goethite
GP	graphite
GR	garnet
GT	gastropods
GY	gypsum
HE	haematite
HM	heavy minerals
HY	shells
IL	illite
IM	ilmenite
IO	iron oxide
IS	ironstone
KA	kaolinite
LI	limonite
MC	marcasite
MF	marine fossils
MG	manganese
MI	mica
ML	montmorillinite
MT	magnetite
MV	muscovite
OL	olivine
OM	opaque minerals
OP	common opal
OR	orthoclase
PE	pelycepods
PF	plant fragments
PG	plagioclase
PI	plant impressions
PP	phosphates
PY	pyrite
QZ	quartz

Code	Minerals and Fossils
RA	resin aggregates
RC	carbonaceous root traces
RS	resin
RO	rootlets
RT	root traces
SD	siderite
SI	silica
SU	sulphides
SR	sediment filled root traces
TA	talc
UN	unidentified mineral
XR	carbonaceous remains
VV	volcanite
WF	woody fragments
ZE	zeolite

Code	Mineral Habit
AG	in amygdules
AM	amorphous
BL	in blebs
BN	bands
BP	on bedding planes
CB	concentrated at base
CC	coarse grains
CE	in cleat
CI	concretions
CM	cement
CN	concentrated at top
CT	clasts
CV	in cavities
DE	detrital
DS	disseminated
FB	fibrous
FD	infilling fault discontinuities
FF	fine grains
FL	radial filaments
FP	on fracture planes
FR	fragments
GD	glendonites
GN	grains
IB	infilling of burrows
IC	intercalations
IV	infilling vesicles
JN	on joints
KK	cone in cone structure
LM	laminae
LN	lenses
MF	microflakes
MX	matrix
ND	nodules
OO	oolites
PB	pebbles
PH	phenocrysts
PO	in pods
PT	pellets
RE	replacement
RF	replacing fossils
RH	rhombs
RS	resinous
SN	staining
TR	traces
VN	in veins
VS	in vesicles
VU	in vughs
WX	wisps
XL	crystals

Code	Gas
H	high gas present (10-15m³/t)
L	low gas present (1-5m³/t)
M	moderate gas present (5-10m³/t)
N	H_2S not detected
P	H_2S present
T	trace (<1m³/t)
V	very high gas present (>15m³/t)