PETROFRONTIER (AUSTRALIA) PTY. LTD.

MACINTYRE-2H

WELL REPORT
PART 1 - GEOLOGY

EP 127
SOUTHERN GEORGINA BASIN
NORTHERN TERRITORY

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1	30/11/2012	First draft (v0)	G. Weste / R. Clark	GW/RAC
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THIS REVISION			
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Name	**Initial/Date**	**Name**	**Initial/Date**
G Weste		A Freeman	Dec 17, 2012
Submitted to:	Earl Scott		

CONTENTS

FIGURE 1. LOCATION PLAN

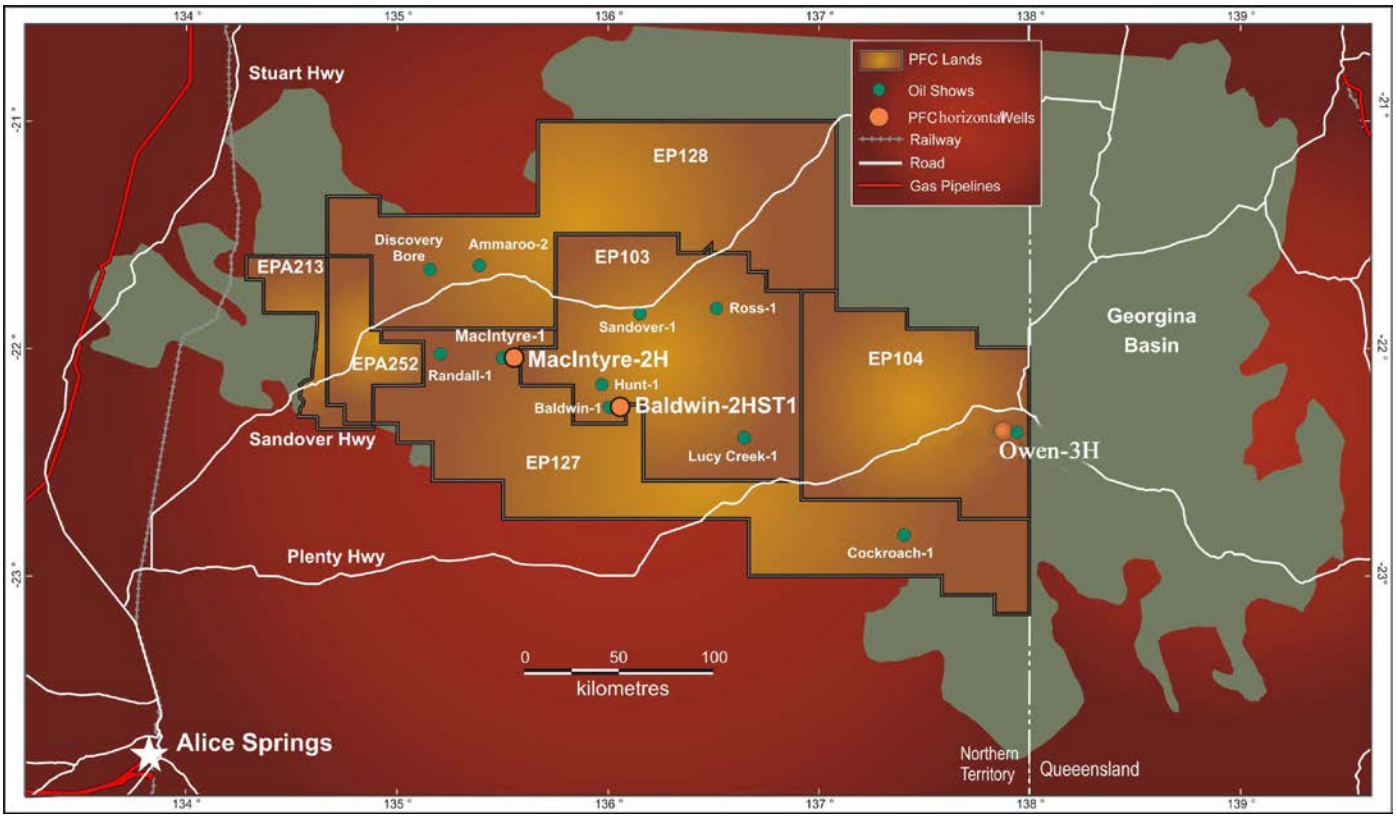

Table 1. WELL DATA CARD

WELL SUMMARY			
PetroFrontier	WELL NAME	MacIntyre-2H	
	PARENT HOLE	MacIntyre-2, TD: 929.6mRT, 470.1mSS	
	WELL CLASS	Exploration / appraisal	
LOCATION DETAILS			
BASIN	Southern Georgina Basin	NORTHING	7562669.48mN
LICENCE	EP 127	EASTING	555236.74mE
LOCATION	Northern Territory	ZONE	UTM 53S
SEISMIC SURVEY REF.		LATITUDE	22° 02' 23.33" S
SEISMIC REF.	286mS of SP 930, Line 89-104	LONGITUDE	135° 32' 06.99" E
ELEVATIONS	GL 380.7m, RT 385.8m (5.1m)	GRID	GDA'94
OPERATION DETAILS			
OPERATOR	PetroFrontier (Australia) Pty. Ltd	DRILLING RIG / CONTRACTOR	Ensign Rig 918
PRIMARY OBJECTIVE	Basal Arthur Creek Formation; 'Hot Shale'	SPUD DATE	06/06/2012 at 00:00 hrs
STRUCTURE	Stratigraphic layer	KICK-OFF DATE KICK-OFF DEPTH	08/06/2012 at 15:30 hrs 540mMDRT
DRILLER TD	1916.0mMDRT	TD DATE	23/06/2012 at 08:15 hrs
TVD	815.4mTVDRT, 429.6mTVDSS	RIG RELEASE	30/06/2012 AT 08:00 hrs
WELL TYPE	Horizontal	OPERATION DAYS	21

HOLE SUMMARY			
HOLE SIZE	**CASING SIZE**	**SHOE DEPTH**	**CASING TYPE**
12 ¼" (311mm) (Pilot)	9 5/8" (244mm)	72.3mMDRT	40#, K55, BTC
8 ½" (216mm) (Pilot)	7" (178mm)	502.4mMDRT	23#, K55, BTC
6 1/8" (178mm)	4 ½" (114mm) 1906.5-906.0mMD 4 ½" x 5 ½" cross-over 5 ½" (139mm) 904.6mMD - surface	1909.5mMDRT	13.5#, P-110 LT&C 17#,L80, TDFJ

FORMATION TOPS						
AGE	**FORMATION**	**MDRT (m)**	**TVDRT (m)**	**TVDSS (m)**	**TVT (m)**	**Diff. TVD (m)**
Late Cambrian	Hagen Member	560.5	560.2	174.4	25.1	0.2 H
Mid Cambrian	Upper Arthur Creek Formation	586.0	585.3	199.5	57.2	0.5 L
	Oolitic Reef	646.0	642.5	256.7	16.8	0.1 H
	Lower Arthur Creek Formation	664.6	659.3	273.5	121.3	0.6 L
	Basal Arthur Creek Formation; 'Hot Shale'	834.5	780.6	394.5	36.9	0.3 L
	Thorntonia Formation	1130.0	817.5	431.7	N/A	1.0 H
	Basal Arthur Creek Formation; 'Hot Shale' (re-entry)	1184.0	817.6	431.8	N/A	N/A

MWD-LWD BHA & LOGGING SUMMARY				
BHA #	**IN**	**OUT**	**MWD-LWD TOOLS RUN**	**REMARKS**
1	495	540	Neutron Porosity-Density-OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Failed to kick-off with RSS @100% due to soft cement
2	540	546	OnTrac MWD + Motor set at 2.12°	
3	546	989	OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Resistivity tool failure
4	989	1192	OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Resistivity tool failure
5	1192	1916	OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Resistivity tool failure
6	LWD/Reamer run at TD		LithoTrak: Neutron Porosity – Density - Caliper	Logged 830-973mMDRT Logged 1176-1900mMDRT

CORING	SIDEWALL CORES	FORMATION TESTS
No cores taken	No sidewall cores taken	No formation tests completed

1. SUMMARY

MacIntyre-2H is the second well in a PetroFrontier three well program designed to assess and test the Southern Georgina Basin Arthur Creek Formation as an unconventional hydrocarbon play. MacIntyre-2H was drilled as a horizontal sidetrack to pilot hole MacIntyre-2, which was drilled and suspended by PetroFrontier in 2011. A completions casing string was run and the well was suspended for subsequent fracture stimulation. MacIntyre-2H was drilled for fracture stimulation and the testing of the basal 'Hot Shale' interval of the Middle Cambrian Arthur Creek Formation in EP 127, Northern Territory. Drilling operations were carried out by PetroFrontier in June 2012. Drilling operations are covered by MacIntyre-2H Well Report, Part 2: Drilling.

The primary objective, determined from interpretation of MacIntyre-2 data, was to construct a horizontal bore hole along an interpreted mechanically weak zone at the base of the 'Hot Shale' interval. The 'Hot Shale' is an informal unit at the base of the Arthur Creek Formation and is characterised by laterally continuous gamma ray "spikes" and abundant organic material. The drilling of MacIntyre-2H involved intercepting this horizon and then maintaining a horizontal trajectory within a 3 metre interval above the underlying Thorntonia Formation. This interval was identified as being organic rich and mechanically weaker and therefore suitable for fracture stimulation. The aim was to intersect 1000 metres of the 'Hot Shale' to provide a sufficient interval for stimulation and testing during a subsequent completions phase. The well objective was met.

The 'Hot Shale' interval was previously intercepted in the MacIntyre-2 pilot hole, in MacIntyre-1 and other historical bore holes within the area, indicating that it is extensive across much of the basin. The offset well for this project was the MacIntyre-1 vertical hole drilled by Pacific Oil and Gas in 1989. MacIntyre-1 was drilled and cored to test the thickness and qualities of reservoir and source rocks as conventional targets in the Red Heart Dolomite, Andagera Formation and Arthur Creek Formation. MacIntyre-1 was continuously wireline cored through the entire Arthur Creek section. Although gas and oil shows were detected, the well was plugged and abandoned as a dry hole.

To minimise any losses and seal off potential water bearing zones in the upper formations, MacIntyre-2 pilot hole was cased with the 9 ⅝" shoe set at 72.3mMDRT and the 7" shoe at 502.4mMDRT (reference to Ensign rig 918 RT height of 5.1m). MacIntyre-2H kicked-off into the Chabalowe Formation at 540mMDRT and reached TD at 1916mMDRT, within the Arthur Creek Formation 'Hot Shale'. In total, 1023.5m horizontal distance was drilled within the 'Hot Shale' unit. A 5 ½" casing string was run to 904.9mMDRT where a crossover to the 4 ½" completion string was set. The completion was run and set at 1909.5mMDRT. MacIntyre-2H was drilled using a rotary steerable system complete with LWD near-bit inclination, gamma ray and resistivity measurements. A neutron-porosity, density and caliper LWD run was conducted at TD.

MacIntyre-2 pilot hole formation tops were used for the MacIntyre-2H prognosis. Small scale variations up to 1.0m were seen during the build section of MacIntyre-2H. Correlation of gamma ray signatures between MacIntyre-1, MacIntyre-2 and MacIntyre-2H 'Hot Shale' units were excellent and provided distinct very thin marker horizons which could be traced along the wellbore. Structural analysis and correlation of these signatures found some lateral variation in the thickness and deformation within the 'Hot Shale'. Gas was recorded along the wellbore with up to 300 total gas units recorded within the lower part of the 'Hot Shale'.

2. GENERAL INFORMATION

Well Name:	MacIntyre-2H
Parent Well:	MacIntyre-2
Operator:	PetroFrontier (Australia) Pty. Ltd.
Well Type:	Horizontal exploration
Basin:	Southern Georgina Basin
Area:	Northern Territory, 1:100,000 map sheet - Arapunga
Tenement:	EP 127
Interests:	75% PetroFrontier (Australia) Pty Ltd, 25% Baraka Petroleum Ltd
Geographic cords (surface):	Lat 22° 02’ 23.33” S, Long 135° 32’ 06.99” E, GDA’94
UTM cords (surface):	7562669.48mN, 555236.74mE, Zone 53S
Elevations:	GL 380.7m, RT (5.1m) 385.8m
Seismic Surveys:	Pacific Oil & Gas 1989
Seismic Reference:	286m S of SP 930, Line 89-104
Structure:	Stratigraphic (non-conventional)
Primary Objective:	Basal Arthur Creek Formation; ‘Hot Shale’
Prognosed TD:	1973mMDRT (826.6mTVDRT, 440.8mTVDSS)
Actual TD:	1916mMDRT (815.4mTVDRT, 429.6mTVDSS)
Geographic cords (TD):	Lat 22° 02’ 28.720” S, Long 135° 32’ 49.119” E, GDA’94
UTM cords (TD):	7562449.38mN, 556443.73mE, Zone 53S
Well Status:	Pending completion
Drill Rig:	Ensign rig 918
OCR:	John Vander Heide / Graham Blue (Day), Damon Ross (Night)
Wellsite Geologists:	Annelise Freeman (Day), KJ Cooper (Night)
Drilling Contractor:	Ensign International Energy Services (Australia)
Directional Drilling:	Baker Inteq
MWD/LWD:	Baker Inteq
Mudlogging:	Geoservices
Cementing:	BJ Services
Mud Engineers:	AMC Oil and Gas
Site Construction:	R & M Dehne Pty Ltd
Earthmoving:	R & M Dehne Pty Ltd
Environmental:	Low Ecological Services P/L
Seismic Interpretation:	Ginkgo Resources

3. RATIONALE

PetroFrontier's primary target at the MacIntyre site is the Middle Cambrian Arthur Creek Formation basal 'Hot Shale' horizon which extends over a significant portion of the Southern Georgina Basin. The unit consists of a succession of thinly laminated dolomitic siltstones, dolostone and black anoxic claystones and siltstones, rich in organic material. MacIntyre-2H is the second horizontal well in a three well program to assess the 'Hot shale' as an unconventional hydrocarbon play.

Recognition of the hydrocarbon potential of the Southern Georgina Basin began with scattered reports of oil contamination in agricultural wells and natural gas fires at surface during the 1940's and 1950's. Initial exploration was sporadic. A few shallow, cored, stratigraphic holes were drilled and gravity and aeromagnetic surveys conducted. The only significant exploration prior to the present PetroFrontier work was carried out by Pacific Oil & Gas with seismic and drilling between 1988 and 1991. Their wireline core wells intersected significant hydrocarbon shows in very low porosity basal Arthur Creek dolomitic siltstones and claystones, and in the underlying Thorntonia Formation dolostones. Shows were generally oil in vugs and fractures, oil stains and core fluorescence. Pacific Oil and Gas considered the porosities and permeabilities of these rocks to be too low to be indicative of the presence of commercial conventional hydrocarbon reservoirs and ceased exploration of the basin.

Technological advances and successes in horizontal drilling and hydraulic fracturing techniques have enabled unconventional plays to be exploited, aiding the industries shifting focus into shale oil and gas plays which were previously unknown / inaccessible.

Additional seismic surveys in the Georgina Basin have been undertaken in recent years (2010/2011) by Texalta and PetroFrontier in order to provide a better understanding of the sub-surface and attempt to map the extent of the 'Hot Shale' unit. PetroFrontier used the seismic to map the horizons and structures within the Petrofrontier tenements, focusing on the Thorntonia Formation reflector. It was anticipated that a slight regional dip would be present over the MacIntyre area, with a syncline identified from seismic approximately 450m into the horizontal length of the well path.

4. HYDROCARBON SUMMARY

Although fluorescence was recorded in cores from nearby MacIntyre-1, none was detected in the cuttings from MacIntyre-2H. However, minor non-fluorescent oil staining and significant gas was continually recorded from kick-off to TD. Bituminous material was observed in cuttings.

A Background total gas of 0.8 units was recorded in the Hagen Member. Below the Hagen gas readings steadily increased, reaching a maximum of 3.5 units (C1-C5) in the Upper Arthur Creek and 6 units in the Lower Arthur Creek. Background total gas reached 100-150 units (C1-C5) at penetration of the 'Hot Shale' and then fluctuated between 50 and 300 units in the 'Hot Shale' along the horizontal well path.

Cuttings from the 'Hot Shale" contained significant bituminous matter and exuded a petroliferous odour. Minor non-fluorescing oil staining was observed, but no fluorescence.

5. STRATIGRAPHIC SUMMARY

A more detailed stratigraphic summary is provided in the MacIntyre-2 Well Suspension Report. The Georgina Basin spans some 330,000 square kilometres over the Northern Territory and into Queensland. The MacIntyre prospect is located in the Dulcie Syncline area of the Southern Georgina Basin. The surface location of the MacIntyre-2 parent well is 281m south of MacIntyre-1, located on the hanging wall of a gently dipping, small reverse thrust. Dip is to the south east as determined by post drilling seismic interpretation and analysis of formation tops.

During its history, the Southern Georgina Basin has undergone multiple deformation phases with notable extensional and compressional regimes, which have influenced deposition and structures within the basin. Presently it has a NW-SE trend and contains up to 3.7km of marine and non-marine sediments. Two major troughs are present on the south side of the basin; the Dulcie Syncline and the Toko Syncline. The MacIntyre prospect is situated within the Dulcie Syncline (see Figure 2 below).

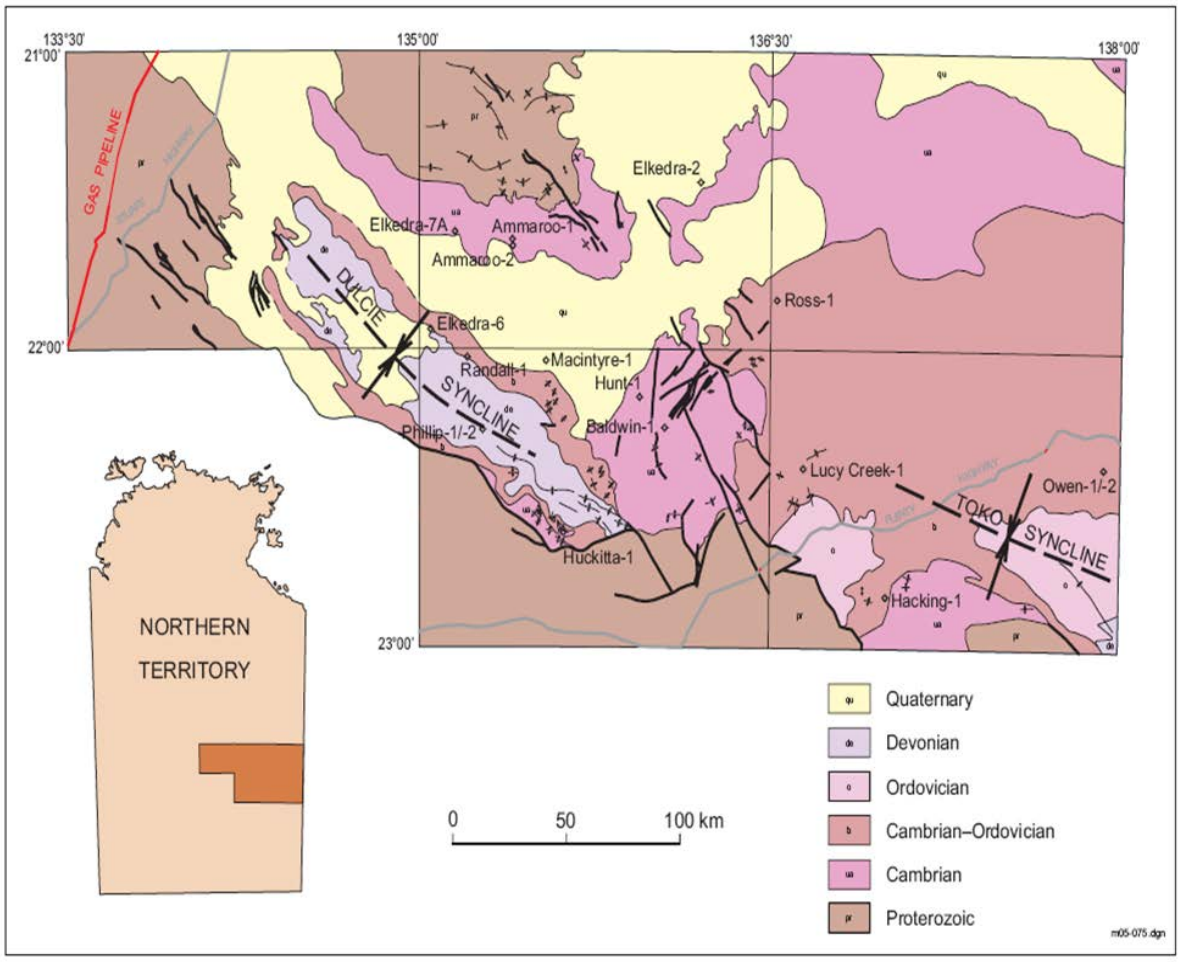

FIGURE 2. Regional surface geology of the southern Georgina Basin showing outcrop and major tectonic elements, and previous borehole positions (Volk et al, 2007)

Structural elements created during the Petermann Orogeny influenced the deposition of the early Cambrian Shadow Group. The middle Cambrian Narpa Group was then deposited during a basin-sagging extensional phase, which subsequently gave way to another compressional period during the onset of the Delamerian Orogeny. This saw the formation of carbonate ramps in the mid-upper Cambrian, as well as reversing of pre-existing faults. During this compressional phase and subsequent movements of the Alice Springs Orogeny, the reaction of the formations to tectonism differed in nature. Fully cemented carbonate rich formations were prone to brittle deformation whilst bedding slip movements were more likely to occur in argillaceous and siliciclastic formations. Figure 3 represents the Cambrian stratigraphy in the Southern Georgina Basin.

The Narpa Group Arthur Creek Formation basal 'Hot Shale' (informal unit) is an unconventional, stratigraphic target for hydrocarbons. The unit is present over a significant area of the Southern Georgina Basin, and can reach localised thicknesses of 40m (see Figure 4). Deformation has resulted in small-scale buckling and possible faulting of the thinly laminated beds.

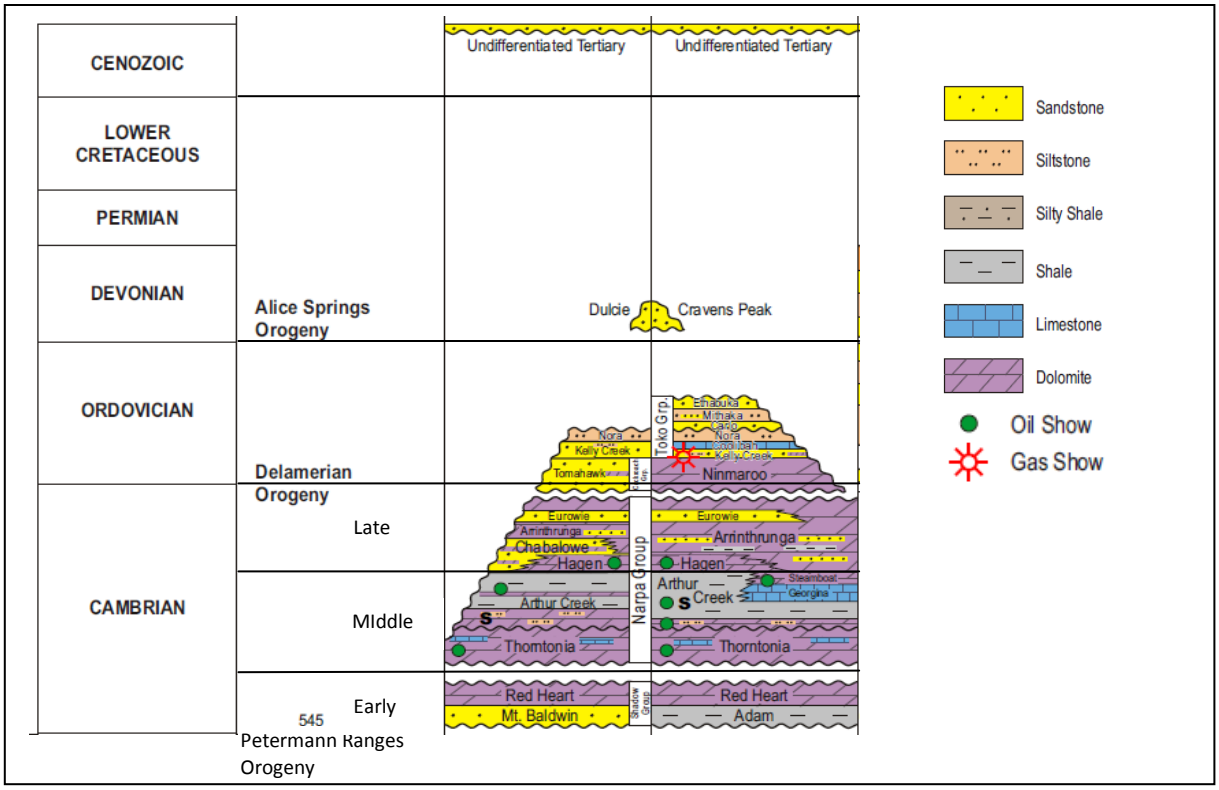

FIGURE 3. - Schematic regional stratigraphic table.

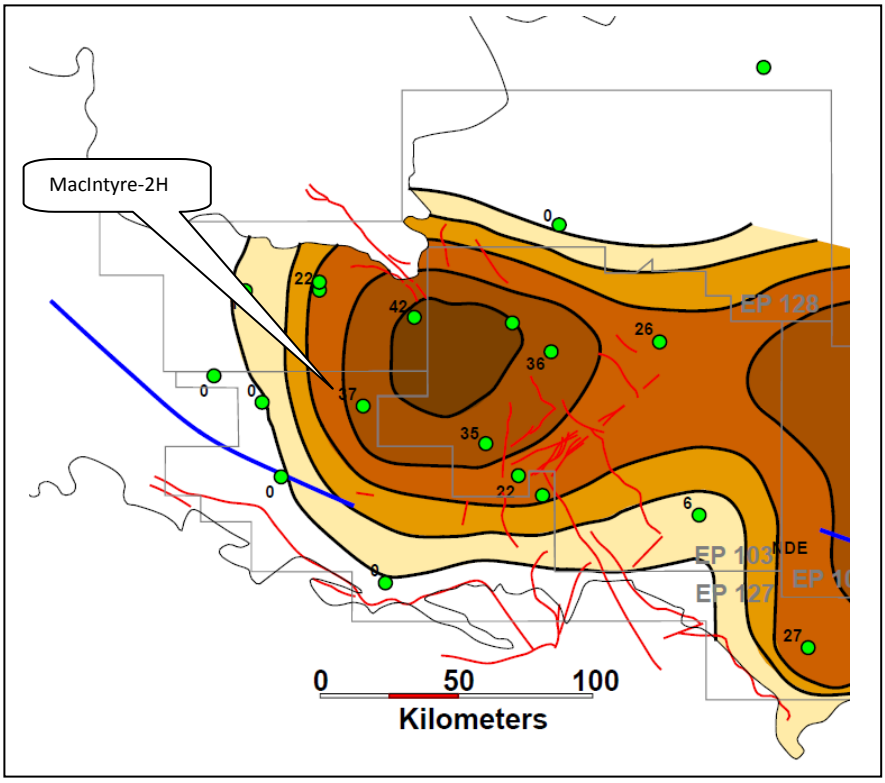

FIGURE 4. Arthur Creek Basal 'Hot Shale' Unit Isopach Map (PetroFrontier).

6. PROSPECT DESCRIPTION

6.1 General

A more detailed description of the prospect is provided in the MacIntyre-2 Well Suspension Report. The MacIntyre-2H prospect is located in the Dulcie Creek Syncline portion of the Southern Georgina Basin. It is an unconventional hydrocarbon play targeting the Arthur Creek Formation basal 'Hot Shale' which has the potential to be source, reservoir and seal for oil and gas production via fracture stimulation. PetroFrontier's pilot hole, MacIntyre-2, confirmed target and optimum depth for the horizontal MacIntyre-2H. The 'Hot Shale' reached a thickness of 38.2m (TVT) in the MacIntyre-2 pilot hole.

6.2 Reservoir

The Arthur Creek Formation 'Hot Shale' is a potential unconventional hydrocarbon resource (source, reservoir and seal). Matrix porosities and permeabilities are low, too low for these rocks to be considered conventional reservoirs. Petrophysical analysis of MacIntyre-1 core samples determined helium porosities ranging from 0.3% (797.06m) to 6.2% (803.07m). Permeability ranged from <0.001 mD to 0.16 mD (803.79m). Reservoir enhancement of micropermeability by fracture stimulation is a requisite for hydrocarbon production. In MacIntyre-2H a 1023.5m horizontal interval was drilled within the 'Hot Shale' reservoir.

6.3 Source

The organic rich 'Hot Shale' also acts as the source rock. Analyses of samples from various wells provide a range in TOC from 0.11 to 14.2%. Evidence of maturation is provided by the oil shows reported in MacIntyre-1 and Tmax of 467 deg °C (gas window) for that well.

6.4 Structure and seismic interpretation

The 'Hot Shale' is not identified as a mappable seismic reflector. However, the Thorntonia Formation, which in most areas directly underlies the 'Hot Shale', does have a near-top reflector which is mappable. The well is located on a gently dipping small reverse thrust hanging wall. It was anticipated that a slight regional south east dip would be present over the MacIntyre area, with a syncline identified from seismic approximately 450m into the horizontal length of the well path.

Figure 5 displays the post MacIntyre-2, pre MacIntyre-2H Top Thorntonia Formation TWT structure map annotated with the MacIntyre-2 and MacIntyre-1 well locations and well paths. Figure 6 is a plot of the MacIntyre-2H well path projected onto the seismic section. Figure 8 is the post MacIntyre-2H structure map (see below).

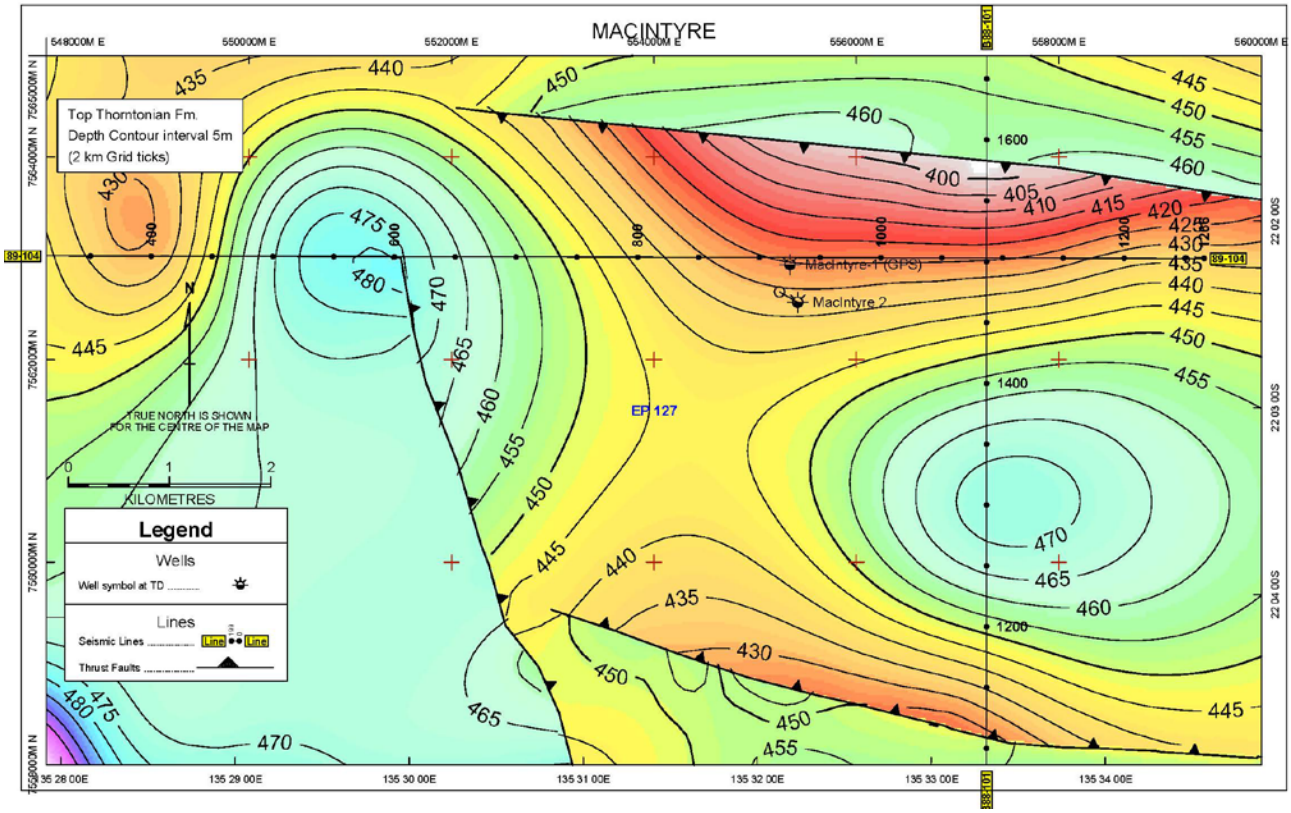

FIGURE 5. Top Thorntonia Formation TWT structure map pre MacIntyre-2H

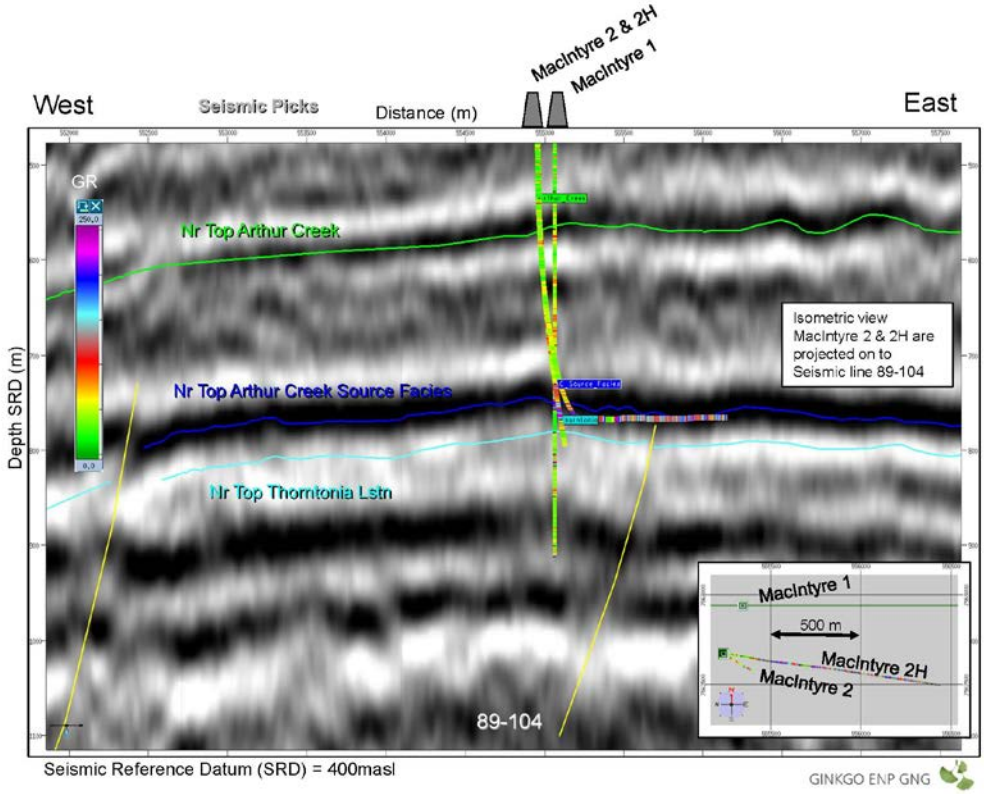

FIGURE 6. MacIntyre-2H projected onto seismic section

Geological well path monitoring and geosteering whilst drilling the horizontal section utilised LWD Azimuthal "Up" and "Down" gamma ray data. Plotting of the well LWD spatial coordinates with the azimuthal gamma ray data and well gas data identified very minor folding of the 'Hot Shale' along the well path. This is interpreted as being a more ductile response to compressional deformation by the 'Hot Shale' siltstones compared with the more brittle underlying Thorntonia Formation dolostones which appear to have fractured. On the seismic data, interpreted minor reverse faults in the Thorntonia appear to terminate at, or close to, the contact with the overlying 'Hot Shale'. Figure 7 is an interpreted plot of the actual well path and shows an small unprognosed antithetic backthrust intersected by the well. The identification of this fault resulted in a significant revision of the seismic structure map (Figure 8).

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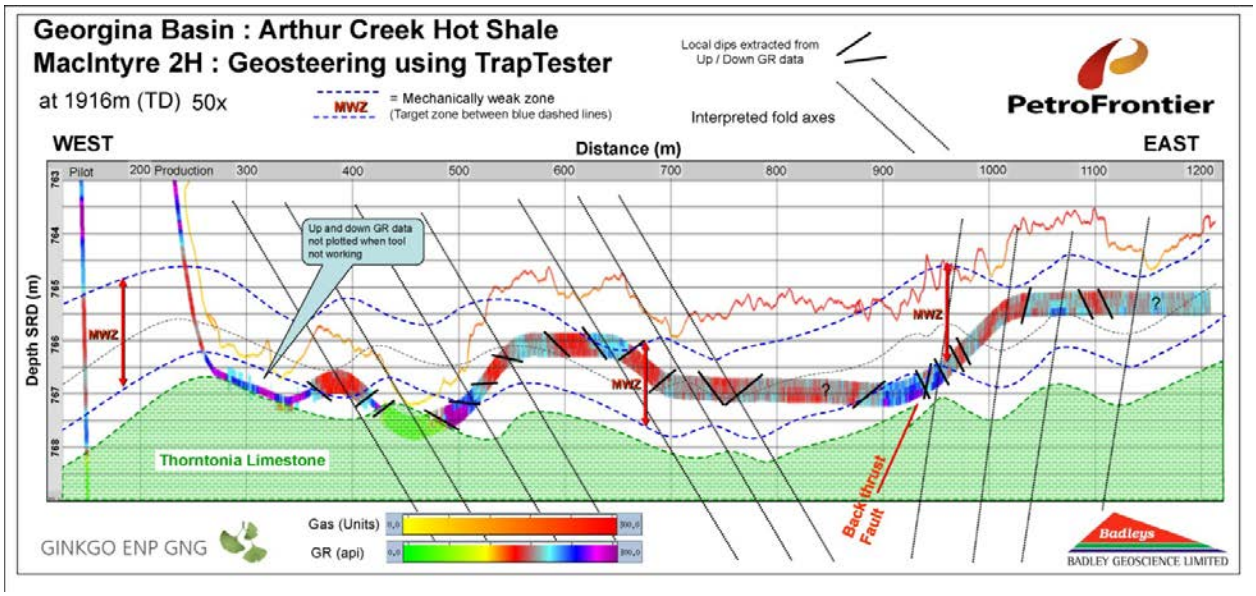

FIGURE 7. Plot of the well path with structural interpretation (dips determined by interpretation of azimuthal gamma ray components).

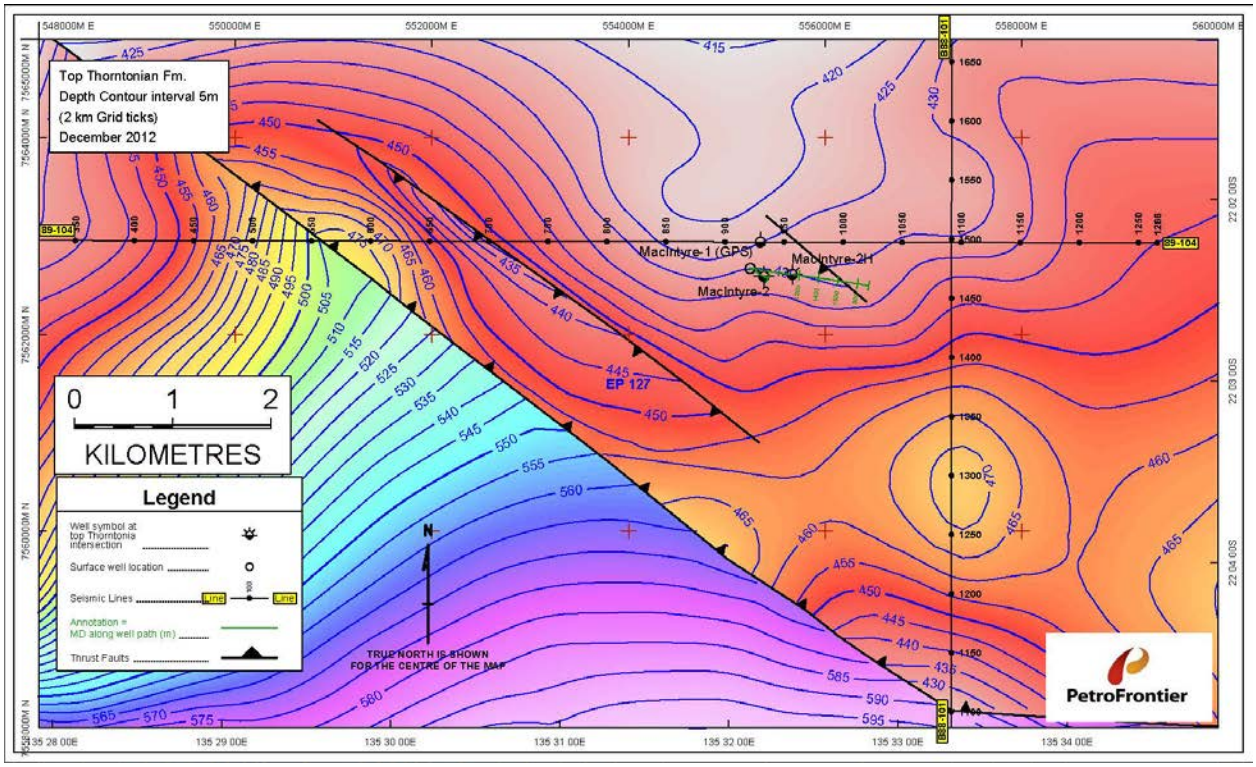

FIGURE 8. Top Thorntonia Formation TWT structure map post MacIntyre-2H.

7. STRATIGRAPHY

Formation tops were picked based on the MacIntyre-2 pilot hole drilling results. Formation tops intercepted during the build up to horizontal were very close to the prognosis. A difference of 1m (TVD) was found at the top of the Thorntonia Formation and was intercepted due to local variation.

TABLE 2. Formation Tops

	GL: 380.7m RT: 385.8m (5.1m)	Prognosed Depths			Actual Depths			Diff. to prog. TVD (m)	TVT (m)	Picks Based On
Age	**Formation Name**	**MD (m)**	**TVDRT (m)**	**TVDSS (m)**	**MD (m)**	**TVDRT (m)**	**TVDSS (m)**			
Late Cambrian	**NARPA GROUP**									
	Chabalowe Fm Hagen Member	560.5	560.4	(174.6)	560.5	560.2	(174.4)	0.2 H	-	LWD Gamma
Mid-Cambrian	Upper Arthur Creek Fm.	585.3	584.8	(199.0)	586.0	585.3	(199.5)	0.5 L	57.2	LWD Gamma
	--Oolitic Reef	646.1	642.6	(256.8)	646.0	642.5	(256.7)	0.1 H	16.8	LWD Gamma
	Lower Arthur Creek Fm.	663.9	658.7	(272.9)	664.6	659.3	(273.5)	0.6 L	121.3	LWD Gamma
	--Basal 'Hot Shale'	835.2	780.3	(394.5)	834.5	780.6	(394.8)	0.3 L	36.9	LWD Gamma
	Thorntonia Fm.	1017.8	818.5	(432.7)	1130.0	817.5	(431.7)	1.0 H	-	LWD Gamma
	--Re-entry of Basal 'Hot Shale'	N/A	N/A	N/A	1184.0	817.6	(431.8)	N/A	-	LWD Gamma

8. WELL EVALUATION

8.1 General

MacIntyre-2H was drilled to provide a horizontal wellbore suitable for the fracture stimulation of the 'Hot Shale'. The well will be fracture stimulated through a number of intervals along the horizontal well path followed by a testing program aimed at recovering significant volumes of hydrocarbons.

8.2 Geosteering

Onsite geological evaluation carefully monitored the well path to ensure that it remained within the 3 metre target window. The 3 metre target zone contained minor folding requiring careful interpretation of the LWD azimuthal gamma ray data and drill cuttings. LWD data was downloaded at connections and interpreted on-site and off-site by direct comparison with McIntyre-2 gamma ray log data. Regular minor adjustments to the well path were required. The well path did penetrate the very top of the Thorntonia Formation dolostone between 1130 and 1184 metres MD (see Figure 7). This provided a "Top Thorntonia" depth of 817.5 mTVD.

8.3 Gas and cuttings

Gas was continuously monitored by the mud log unit. Cuttings were described in detail and subjected to show evaluation by the wellsite geologists. From 538mMDRT, prior to kick-off being established, 100% C1 gas was continually recorded with small total gas peaks, less than 1 unit, detected at 540m, 546m and 554mMDRT. Organic/bituminous material was described as fill within stylolites from 548m and noted in dolostones below this depth. Gas readings increased from 563mMDRT, in the Hagen Member, where a background concentration of roughly 0.8 units was recorded at this depth. Gas reading peaks were attributed to connection gas. Gas readings steadily increased once the Arthur Creek Formation was penetrated, reaching a maximum of 3.5 units (C1-C5) over a silty limestone interval from 614m-626mMDRT. Background levels dropped back to 1 unit coinciding with increased dolostone in samples. Below 640mMDRT gas levels again increased, reaching 6 units by 665mMDRT where the Lower Arthur Creek Formation was intercepted.

A steady rise in the gas levels was recorded with increasing depth of the well. Below 810mMDRT crushing and acid effervescence of drill cuttings produced an oily film (non fluorescent) and rare oily bubbles. An increase in the amount of bituminous matter was also described over the transition into the 'Hot Shale' unit and samples had a slight petroliferous odour. A petroliferous odour was also present at the shale shakers and continued throughout drilling in the 'Hot Shale'. Background total gas reached 100-150 units (C1-C5) at penetration of the 'Hot Shale' at 834.5mMDRT. Through the 'Hot Shale' total gas fluctuated between 50 and 300 units along the well path, with the majority of readings showing values in the 100's. Between 930m and 1030m cutting were described as a bituminous claystone and bituminous siltstone, containing disseminated black organic matter. Total gas dropped to 8-20 units when dolostone was intercepted at 1030-1035mMDRT. Gas levels dropped again to around 20 units when the Thorntonia Formation was briefly entered between 1130m and 1186mMDRT (see Figure 7). Total Gas units returned to the 100's as drilling continued through the Lower 'Hot Shale' consisting of bituminous silts and claystones. Only a few minor variations in gas levels and lithology were seen along the remainder of the wellbore. Connections were made

approximately every 10m and some associated gas elevations were recorded. No fluorescence or cut was observed in the samples.

8.4 Wellsite Geology

Two wellsite geologists were present to monitor the well 24 hours per day during open-hole drilling operations. In addition to normal well site duties the geologists assisted with geosteering by monitoring the azimuthal gamma ray data and drill cuttings lithologies.

8.5 Mudlogging

Mudlogging services were provided and cutting sample collection was done from kick-off to TD. Equipment used for monitoring of the wellbore included sensors for recording depth, total and chromatographic gas, fluorescence, mud-pit levels, WOB, RPM, SPP, torque and ROP. A record of the well may be found in the mud log and drill log accompanying this report. Samples were taken at 5m intervals from 560 – 580mMD, 10m intervals from 580m – 640mMD, 5m intervals from 640m – 795mMD and 3m intervals from 795m – TD at 1916mMD.

8.6 LWD logs

The quality of the LWD induction resistivity tool data was insufficient to enable any meaningful petrophysical analysis. The azimuthal gamma ray data enabled accurate geosteering of the well path and the LWD survey data provided. Table 3 below shows the logging runs recorded at MacIntyre-2H.

TABLE 3. LWD Logging Runs

MWD-LWD BHA & LOGGING SUMMARY				
BHA #	**IN**	**OUT**	**MWD-LWD TOOLS RUN**	**REMARKS**
1	495	540	Neutron Porosity-Density-OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Failed to kick-off with RSS @100% due to soft cement
2	540	546	OnTrac MWD + Motor set at 2.12°	
3	546	989	OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Resistivity tool failure
4	989	1192	OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Resistivity tool failure
5	1192	1916	OnTrac MWD-Resistivity-GR-Annular Pressure-Near bit inclination + AutoTrak rotary steerable system	Resistivity tool failure
6	LWD/Reamer run at TD		LithoTrak: Neutron Porosity – Density - Caliper	Logged 830-973mMDRT Logged 1176-1900mMDRT

8.7 Petrophysical Evaluation

To date there has been no petrophysical analysis of MacIntyre-2H, mainly because of the poor induction log response.

9. CONTRIBUTION TO EXPLORATION

The principal contribution provided by drilling of MacIntyre-2H was to provide a suitable horizontal bore-hole suitable for fracture stimulation of the base of the 'Hot Shale'. Geosteering of the wellpath showed that the pre-drilling interpretation that the 'Hot Shale' is undeformed is not correct. In fact small scale folds were intersected associated with an antithetic backthrust.

10. FORMATION LITHOLOGIES

10.1 Chabalowe Formation

540.0 - 560.5mMD

Dolomitic sandstone and interbedded sandy siltstone.

DOLOMITIC SANDSTONE: pale yellowish white to light brown and pale reddish brown, hard, very fine clear subround quartz grains, silty in part, minor disseminated lithic grains, grades to SANDY SILTSTONE: light brown, hard, common to abundant rounded quartz, slightly to very argillaceous, dolomite cement, no visible porosity.

10.2 Chabalowe Formation Hagen Member

560.5 - 586.2mMD

Thickness: 26.0mTVD

Description

Dolostone with interbedded dolomitic siltstone

DOLOSTONE: cream to very pale grey, locally mottled reddish brown, hard, mudstone texture, grades to DOLOMITIC SILTSTONE: light to medium grey, hard, minor very fine quartz and dark lithic grains, very minor scattered coarse oolite shadows, oolitic wackestone/packstone laminae. No visible porosity.

10.3 Upper Arthur Creek Formation

586.0-646.0mMD

Thickness: 57.2mTVT

Dolostone with minor dolomitic siltstone interbeds, overlying limestone with minor interbeds, overlying dolomitic siltstone/marlstone and minor dolomitic sandstone.

Interval descriptions

586.0-610.0mMD: SILTY DOLOSTONE: light-medium grey, light brown, hard, minor oolite shadows, minor anhydrite, organic fragments, trace pyrite, microcrystalline, very fine crystalline in part, no visible porosity.

610.0-632.0mMD: LIMESTONE with minor DOLOSTONE. LIMESTONE: light greyish brown to medium brown, hard, mudstone texture, argillaceous in part, grades to CALCAREOUS MARLSTONE: very pale grey to yellowish white, hard, dolomitic and silty in part, no visible porosity. SILTY DOLOSTONE: light greyish brown where clean, medium brown, dark brown with increasing argillaceous matter, in part moderately-very argillaceous, grades to DOLOMITIC MARLSTONE: dark brown to greyish brown, hard, platy, no visible porosity.

632.0-646.0mMD: DOLOSTONE with LIMESTONE and minor SANDSTONE. DOLOSTONE: medium-dark brown and grey-brown, micro to very-fine crystalline, mudstone texture, moderately to very argillaceous. LIMESTONE: predominantly light grey-brown to medium brown, minor off-white to cream, hard, mudstone texture, moderately to very argillaceous,

grades to CALCAREOUS MARLSTONE: greyish brown, hard, platy, dolomitic in part, silty, no visible porosity. SANDSTONE: off-white to light grayish brown, very fine grained quartz, well sorted, rounded, moderately well consolidated, abundant dolomitic cement, no visible porosity, grades to very SILTY DOLOSTONE as above.

10.4 Oolitic Reef

646.0-664.6mMD
Thickness: 16.8mTVT
Oolitic dolostone with traces of claystone and chert.

Interval description

646.0-664.6mMD: OOLITIC DOLOSTONE with traces of CLAYSTONE and CHERT. OOLITIC DOLOSTONE: white to pale yellow-brown, light grey-brown, hard, dense, platy, wackestone to packstone texture, grainstone stringers, micro-very fine crystalline lime mud matrix, scattered to common medium-coarse spherical oolite shadows, scattered crystalline anhedral-subhedral and minor euhedral DOLOSTONE inclusions, trace crystalline anhydrite inclusions, trace micro pyrite, trace black bitumen filled slightly crenulated stylolites, trace chert laminae, no visible matrix porosity. CLAYSTONE: black, moderately hard, platy, silty, dolomitic.

10.5 Lower Arthur Creek Formation

664.6-834.5mMD
Thickness: 121.3mTVT
Interbedded dolostone and limestone grading to interbedded limestone and siltstone.

Interval description

664.6-698.0mMD: Interbedded DOLOSTONE and LIMESTONE. DOLOSTONE: light to medium greyish brown, hard, micro-crystalline to very-fine crystalline dolomite, scattered to numerous oolite shadows, trace white dolomite crystalline inclusions, fracture infill and possible fracture porosity, no visible matrix porosity. LIMESTONE: light grey-brown, occasionally off-white, minor medium brown, hard, argillaceous content increasing with depth, moderately dolomitic, mudstone texture, no visible matrix porosity.
698.0-710.0mMD: LIMESTONE with interbedded DOLOSTONE. LIMESTONE: light to medium grey, pale yellow-brown in part, hard, slightly to very argillaceous mudstone with rare oolites, no visible matrix porosity. DOLOSTONE: light-medium grey, very-fine crystalline, argillaceous, no visible matrix porosity.
710.0-726.0mMD: Interbedded LIMESTONE and SILTSTONE. SILTY LIMESTONE: white to pale grey and light-medium grey, mudstone texture, moderately-very silty, moderately hard, no visible matrix porosity. CALCAREOUS SILTSTONE: light to dark grey, moderately hard, argillaceous, moderately to very calcareous, sub-blocky to platy.
726.0-780.0mMD: Interbedded SILTSTONE and LIMESTONE. ARGILLACEOUS SILTSTONE: grey brown to dark brown, grading to brownish black with increasing dark argillaceous/organic matter, minor light grey mottled with dark grey argillaceous clasts, very calcareous, no visible porosity. CALCAREOUS SILTSTONE: light greyish brown, hard, minor clear quartz with light brown clay, moderately to very calcareous, grading in part to very silty limestone. SILTSTONE: medium to dark brown grading to brownish black with increasing dark argillaceous/organic matter, slightly to very calcareous, no visible porosity. LIMESTONE: mottled white to medium greyish brown, slightly argillaceous and silty,

bioturbated appearance, mudstone to wackestone texture, trace oolites, trace anhydrite crystalline inclusions and healed veins, no visible matrix porosity.
780.0-834.5mMD: Interbedded SILTSTONE and LIMESTONE. CALCAREOUS SILTSTONE: pale grey to white, locally mottled with darker argillaceous/organic matter, hard, grades to very fine grained SILTY SANDSTONE: clear well sorted rounded quartz grains with minor light brown hydrocarbon staining, abundant very pale brown clay, calcareous cement, grades to SILTY LIMESTONE: light to medium brown and greyish brown, hard, no visible porosity. ARGILLACEOUS SILTSTONE: medium greyish brown grading to brownish black with increasing argillaceous/organic matter, mottled light grey in part, moderately hard, moderately to very argillaceous, moderately to very calcareous, trace micro-pyrite crystals, sub-blocky. SILTY LIMESTONE: very pale grey, mudstone texture with bioturbated appearance, very silty, grading in part to CALCAREOUS SILTSTONE, no visible porosity.

10.6 Arthur Creek Formation 'Hot Shale'

Top: 834.5mMD
834.5-1130.0mMD
interbedded siltstone and claystone with minor limestone and sandstone.

Log character

The 'Hot Shale' is so named because of the presence of very high gamma ray 'spikes'. The top of this is marked by an increase in API to 120 units. Below 880mMD the gamma curve continues to increase, coinciding with the presence of an organic siltstone lithology. Two distinctive gamma ray peaks of ~350 and 330 API are present at 923.5m and 932mMD respectively. These correspond to predominantly siltstone lithology. The lower contact with the Thorntonia Formation is marked by a sharp decrease in gamma ray values.

Interval description

834.5-865.0mMD: SILTSTONE. SILTSTONE: medium grey to olive black, very calcareous, minor to abundant disseminated dark organic matter, moderately to very argillaceous, occasionally grades to CLAYSTONE: dark grey, moderately hard, sub-blocky to platy, very silty.
865.0-910.0mMD: BITUMINOUS SILTSTONE, thin LIMESTONE beds. BITUMINOUS SILTSTONE: dark brown-greyish brown, common brownish black, hard, clear quartz silt grains stained brown with (?)relict hydrocarbons, locally sub-vitreous, very argillaceous, abundant bituminous matter, and dark organic matter, grades to SILTSTONE: brownish black, moderately hard, moderately calcareous, sub-blocky to predominantly platy. BITUMINOUS SILTSTONE: brownish black to black, sub-vitreous lustre, abundant disseminated black organic matter, abundant silt, commonly grades to ARGILLACEOUS SILTSTONE: dark grey, sub-blocky to platy, locally slightly fissile; LIMESTONE: light grey, argillaceous, silty and sandy, abundant organic matter, no visible porosity.
910.0-945.0mMD: BITUMINOUS SHALE with minor SILTSTONE. BITUMINOUS SHALE: grey-black, moderately hard, sub-vitreous lustre, abundant disseminated black organic matter, common to abundant silt, calcareous, grades to ARGILLACEOUS SILTSTONE: as above, rare white calcite and dolomite veins, typically 0.1 v- 0.25mm thick, in part planar, in part crenulated, rare fracture surfaces lined with subhedral very-fine dolomite crystals: SANDSTONE: white, mottled in part with black argillaceous/bituminous matter, hard, clear very fine quartz grains, well rounded, well sorted, rounded grains, abundant calcite cement, minor fine to medium claystone clasts, occasionally grades to SANDY LIMESTONE: no visible porosity.

945.0-960.0mMD: BITUMINOUS SHALE: dark grey to greyish black, micro-micaceous, abundant disseminated organic matter, moderately silty, occasionally grades to ARGILLACEOUS SILTSTONE: dark grey, moderately calcareous, moderately hard, platy to slightly fissile.
960.0-1023.0mMD: BITUMINOUS SILTSTONE . BITUMINOUS SILTSTONE: dark brown to dark greyish brown, minor grey locally brown-black, moderately hard, argillaceous, micro-micaceous, abundant disseminated bituminous matter, slightly resinous lustre, common disseminated clear very fine quartz sand with light brown (?)relict hydrocarbon staining, trace micro-pyrite crystals, petroliferous odour, grades to slightly to moderately calcareous, micro-micaceous platy to subfissile.
1023.0-1041.0mMD: BITUMINOUS SILTSTONE with minor SILTSTONE and DOLOSTONE. BITUMINOUS SILTSTONE: medium greyish brown, hard, argillaceous, abundant disseminated dark organic matter, trace micro mica flakes, trace pyrite micro crystals, commonly grades to SILTSTONE: greyish brown, hard, slightly-moderately calcareous, faint petroliferous odour; DOLOSTONE: wackestone/packstone, white, light to medium brown, medium to coarse (?)oolite shadows with very fine crystalline matrix, bitumen filled hairline fracture zones, traces micro-crystalline matrix pyrite and pyrite coating of oolites and pyrite replacement of bitumen staining in matrix, trace parallel grey dolomite laminations, tightly crystalline mosaic, no visible porosity.
1041.0-1130.0mMD: ARGILLACEOUS SILTSTONE with interbedded SILTSTONE. ARGILLACEOUS SILTSTONE: dark grey-brown, abundant clay, abundant disseminated dark organic matter, in part grading to SILTSTONE: as above, faint petroliferous odour.

10.7 Thorntonia Formation

Top: 1130.0mMD
1130.0-1184.0mMD
Dolostone with minor siltstone and claystone.

Log character

The Arthur Creek Formation ‘Hot Shale’ and Thorntonia Formation contact is abrupt on the gamma ray curve. API values drop to a low of ~30 units which remains consistent to 1173mMD. As drilling increases through the section, gamma values increase to 150 units. The contact between the Thorntonia Formation and overlying Formation during re-entry into the base of the ‘Hot Shale’ section appears gradational. However this is drawn out due to lateral drilling and the variance in hole angle. Entry into the Thorntonia Formation was at 88.9° where as re-entry to the ‘Hot Shale’ was shallower at 90.4°. A vertical profile would likely show a sharp and distinct contact, as observed in MacIntyre-2 logs.

Interval description

1130.0-1133.0mMD: DOLOSTONE: very pale yellowish brown matrix with light to medium brown dolomitised bioclastic debris, very hard, clear to translucent silicified oolites and fine to medium grain rounded bioclastic grains, grades from wackestone to packstone, microcrystalline matrix, in part matrix dolomite has been replaced with crypto-crystalline silica, grading locally to fossiliferous chert, rare micro pyrite crystalline inclusions in the matrix, no visible porosity.
1133.0-1170.0mMD: DOLOSTONE: pale yellowish brown to pale olive brown, mottled white where crypto-crystalline silica has replaced dolomite matrix, very hard, grades to silicified fossiliferous wackestone/packstone/grainstone, fine to coarse bioclastic debris, oolites and bioclastic grains in finely crystalline matrix, no visible porosity.

1170.0-1186.0mMD: DOLOSTONE with SILTSTONE and minor SHALE: DOLOSTONE: light grey and translucent, white-very pale yellow-brown, very hard, floating bioclastic grains and debris, typically spicule-like fragments, rounded fine bioclastic grains, fine-medium grain (?) oolites, grades from mudstone to wackestone with packstone or stringers, finely crystalline matrix, locally siliceous, no visible matrix porosity, numerous loose dolomite crystals and crystalline fragments, trace fractures, crystalline pyrite inclusions, occasional euhedral dolomite crystal coated surfaces, bitumen stained fracture surfaces, occasional euhedral anhydrite prisms, oil stained hairline fractures, traces black bitumen particles plugging micro vughs. SILTSTONE: dark grey-brown to brown-black, very argillaceous, grades to silty claystone, earthy lustre, locally resinous, disseminated organic matter, slightly dolomitic, sub-blocky to platy.

10.8 Arthur Creek Formation 'Hot Shale' (re-entry)

Base: 1184.0mMD

1184.0-1916.0mMD

Interbedded SILTSTONE and SHALE.

Log character

As discussed in section above, the lower boundary between the 'Hot Shale' and underlying Thorntonia Formation is sharp. This last part of the well shows gamma ray values consistently high averaging 160 API units, increasing to approximately 200 units attributed to drilling through different beds within the 'Hot Shale' unit.

Interval description

1184.0-1192.0mMD: SILTSTONE and SHALE: SILTSTONE: medium to dark greyish brown and brownish black, hard, earthy lustre, clear quartz grains, very argillaceous, grades to SHALE: dark greyish brown to brownish black, very silty, patchy dark organic matter, minor calcite cement, in part slightly to moderately dolomitic, sub blocky.

1192.0-1296.0mMD: SILTSTONE, SHALE, BITUMINOUS SHALE: SILTSTONE: dark greyish brown to brownish black, earthy lustre, clear silt-sized quartz grains, very argillaceous, micro-micaceous, minor dolomite cement, sub-fissile, quartz commonly bitumen stained, calcite veins commonly with micro-crystalline pyrite, rare 'micro-breccia-like' fragments with calcite and pyrite, grades to SHALE: dark grey, very silty, calcite and dolomite cements, sub-blocky to platy, very faint petroliferous odour. BITUMINOUS SHALE: dark grey to black, resinous lustre, abundant disseminated bituminous organic matter, trace micro-mica, moderately to very silty.

1269.0-1360.0mMDRT: Interbedded BITUMINOUS SHALE and BITUMINOUS SILTSTONE: BITUMINOUS SHALE: very dark greyish brown to very dark grey and brownish black, resinous lustre, abundant disseminated bituminous matter, slightly to very silty, commonly grades to very argillaceous BITUMINOUS SILTSTONE: very dark greyish brown, very argillaceous, scattered micro-mica, rare pyrite micro-crystals, moderately calcareous, moderately hard, platy, locally slightly fissile, trace fractures healed by white planar calcite veins and vein fragments.

1360.0-1460.0mMD: Interbedded BITUMINOUS SHALE and SILTSTONE: BITUMINOUS SHALE: dark brown to dark greyish brown, locally brownish black, earthy lustre, very silty, abundant disseminated bituminous matter, micro-micaceous, grades to very ARGILLACEOUS SILTSTONE: dark greyish brown, moderately hard, very argillaceous, moderately calcareous, platy, minor silt-sized dark lithic/argillite particles, trace fractures with calcite veins, no visible

porosity. ARGILLACEOUS SILTSTONE: medium-predominantly dark brown to grey-brown, earthy lustre, clear silt-sized quartz with abundant clay.

1460.0-1503.0mMD: Interbedded BITUMINOUS SHALEE and SILTSTONE: BITUMINOUS SHALE: dark greyish brown to brownish black, resinous lustre in part, abundant disseminated bituminous matter, earthy in part, trace micro-mica flakes, slightly to very silty, grades to SILTSTONE: dark greyish brown, very argillaceous, slightly to moderately calcareous, sub-blocky to platy, no visible porosity, faint petroliferous odour.

1506.0-1572.0mMD: SILTSTONE with interbedded SHALE: SILTSTONE: medium to dark brown to greyish brown, earthy lustre, very argillaceous, silt-sized quartz grains and trace dark argillitic and lithic grains, slightly-moderately calcareous, grades to SHALE: dark grey-brown to locally brown-black, earthy lustre, locally resinous lustre, very silty, common disseminated bituminous matter, slightly-moderately calcareous, soft to very firm, locally slightly hard, sub-blocky, rare calcite veins, rare pyritised surfaces, no visible porosity, very faint petroliferous odour.

1572.0-1692.0mMD: Interbedded BITUMINOUS SHALE and SILTSTONE: BITUMINOUS SHALE: dark greyish brown to brownish black, resinous to locally sub-vitreous lustre, moderately-very silty, disseminated black bituminous matter, trace micro-mica flakes, grades to SILTSTONE, medium to dark brown to dark greyish brown, very argillaceous, slightly-moderately calcareous, common patchy bituminous matter, sub-blocky to platy, no visible porosity, faint petroliferous odour, rare fracturing, rare calcite vein fragments and healed veins, rare pyrite.

1692.0-1719.0mMD: Interbedded BITUMINOUS SHALE and SILTSTONE: BITUMINOUS SHALE: dark greyish brown, slightly to very silty, scattered black shale partings, slightly-moderately calcareous, sub-blocky, no visible porosity, very faint petroliferous odour, .commonly grades to SILTSTONE: dark brown to grey-brown, locally mottled dark grey to black, hard, platy, in part slightly fissile, very argillaceous, common patchy bituminous matter, slightly calcareous, rare silt-sized floating very fine dark argillite & lithic grains, flakes and fragments, rare pyritised surfaces, rare crystalline calcite inclusions, no visible porosity, faint petroliferous odour.

1719.0-1731.0mMD: SILTSTONE with minor SHALE. SILTSTONE: dark grey-brown to dark brown, locally mottled dark grey to black, very argillaceous, common patchy bituminous matter, clear silt-size quartz grains, rare floating very fine well rounded quartz, commonly stained light to medium brown with bituminous matter, minor silt-sized argillite and/or lithic grains, grades to SHALE: dark grey-brown to brownish black, very silty, common disseminated bituminous matter, scattered black shale partings, slightly to moderately calcareous, sub-blocky to platy, no visible porosity, faint petroliferous odour, no fluorescence.

1731.0-1770.0mMD: SHALE with interbedded SILTSTONE. SHALE: dark brown to dark greyish brown, earthy lustre, very silty, minor dull resinous lustre over patchy black mottles of locally increased bitumen content, scattered black shale partings, commonly grades to SILTSTONE: dark grey-brown to dark brown, locally mottled dark grey to black, moderately to very silty, common patchy bituminous matter, slightly calcareous, slightly dolomitic, moderately hard, brittle, sub-blocky to platy, scattered pyritised surfaces, patchy micro-crystalline pyrite 'smears', no visible porosity, faint petroliferous odour.

1770.0-1800.0mMD: Interbedded BITUMINOUS SHALE and SILTSTONE. BITUMINOUS SHALE: dark grey to black, moderately hard, ,resinous to sub-vitreous lustre, common disseminated bituminous matter, slightly to very silty, commonly grades to SILTSTONE:

dark brown to greyish brown, very argillaceous, slightly calcareous, slightly dolomitic, moderately fissile, no visible porosity.

1800.0-1916.0mMD: Interbedded SILTSTONE, SHALE and BITUMINOUS SHALE. SILTSTONE: medium dark brown to grey-brown, moderately hard, earthy lustre, very argillaceous, slightly calcareous and dolomitic, moderately fissile, trace very fine calcite crystalline inclusions, and rare pyrite crystal coated surface, no visible porosity, very faint petroliferous odour. commonly grades to SHALE: dark grey. Moderately hard, very silty, slightly-moderately calcareous and dolomitic, sub-blocky to platy, trace fractures, trace calcite crystalline inclusions and healed vein fragments, trace pyritised surfaces no visible porosity, very faint petroliferous odour. BITUMINOUS SHALE: dark grey to black, resinous to sub-vitreous lustre, abundant disseminated bituminous matter, slightly to moderately silty.