

AV Source and Reservoir Rock Attributes of Mesoproterozoic Shale, Beetaloo Basin, Northern Territory, Australia

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Search and Discovery Article #110130 (2010)

Posted June 14, 2010

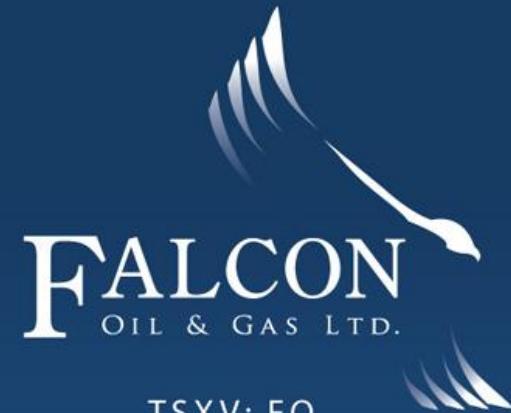
*Adapted from oral presentation at session, Genesis of Shale Gas--Physicochemical and Geochemical Constraints Affecting Methane Adsorption and Desorption, at AAPG Annual Convention, New Orleans, LA, April 11-14, 2010

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Abstract

Rock-eval data, petrophysical evaluations, and core descriptions from the Mesoproterozoic Kyalla and Velkerri Shales (1.4 Ga) in the Beetaloo Basin, Northern Territory, Australia, exhibit very favorable characteristics for the production of oil and gas. The Kyalla and Velkerri shales are composed of medium- gray to black, organic-rich, laminated shale, interbedded with thin siltstone and very fine-grained sandstone, deposited in shallow- to moderate-depth marine environments. In some parts of the Velkerri and Kyalla shales there are what appear to be vertical, trace fossil burrows. The cores are commonly oil-stained. Organic matter is composed of liquid-prone, types I and II kerogen. Maximum cumulative thickness of these liquid-prone shales is 1600 m. Total organic carbon (TOC) values range from 2 to 8 %. In particular, the middle Velkerri Shale (~300 m thick), the most organic-rich part of either shale interval, has an average TOC of 3.96 %. The calculated average original TOC in the middle Velkerri is 5.82 %. The present-day hydrocarbon index (HI) for the middle Velkerri is 281 mg HC/g TOC, and the calculated original HI is 425 mg HC/g TOC. Tmax data indicates that the Kyalla and Velkerri Shales range in thermal maturity from immature to over-mature. The top of thermally mature Kyalla and Velkerri occurs at a depth of about 350 m and the top of thermally over-mature Kyalla and Velkerri occurs at a depth of about 1500 m. Open hole logs indicate an increase in gamma ray and resistivity along with density and sonic porosity over intervals of elevated TOC. A linear relationship established between TOC and density porosity accounts for about 50% of the increase in porosity. The remaining porosity, with TOC subtracted, is interpreted to represent intergranular porosity which may store gas and/or oil and may provide a permeable path for commercial hydrocarbon production. An independent assessment of the recoverable gas resources from the Kyalla and Velkerri shales is 23 trillion cubic feet. An assessment of recoverable oil from the upper Kyalla Shale is 17.8 billion barrels.

We anticipate acquiring desorption and x-ray diffraction data as well as additional geochemical data from current drilling operations in the Beetaloo Basin.



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April 14, 2010



SOURCE AND RESERVOIR ROCK ATTRIBUTES OF MESOPROTEROZOIC SHALE, BEETALOO BASIN, NORTHERN TERRITORY, AUSTRALIA

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OUTLINE

LOCATION

BRIEF HISTORY

CORES

SHALE PROPERTIES

SHENANDOAH # 1A WELL

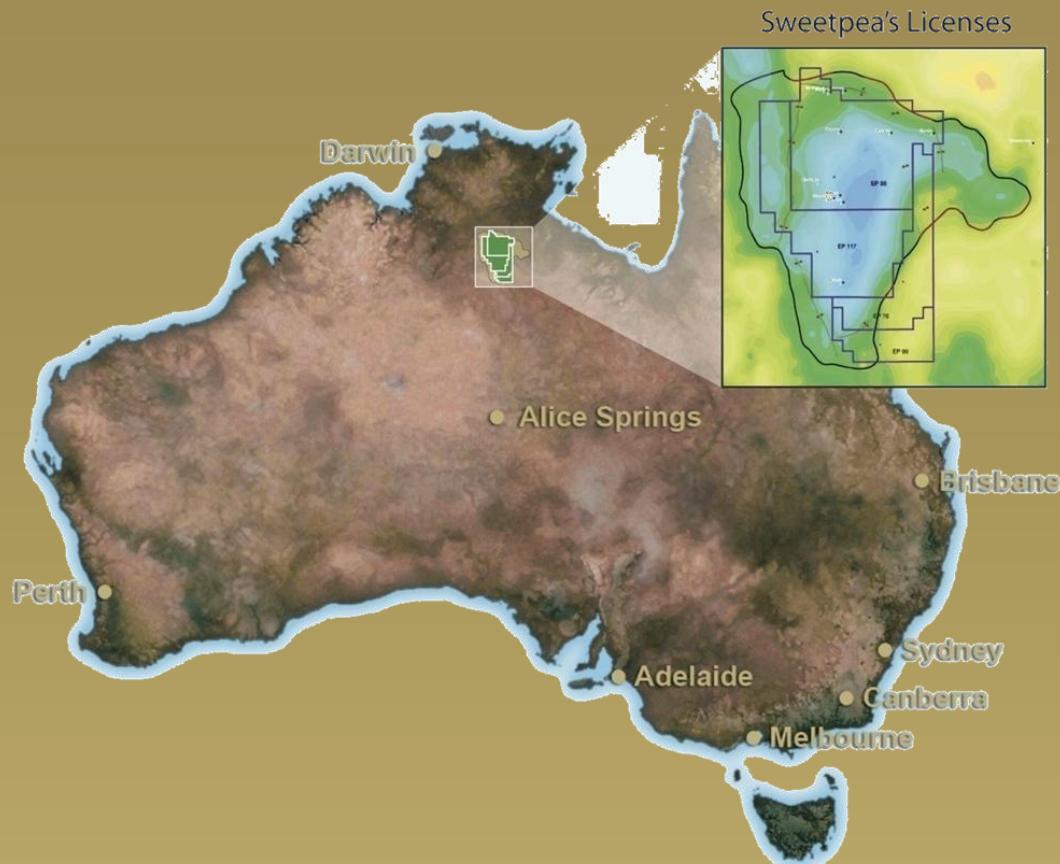
SHALE PROPERTIES

DESORPTION DATA

SUMMARY



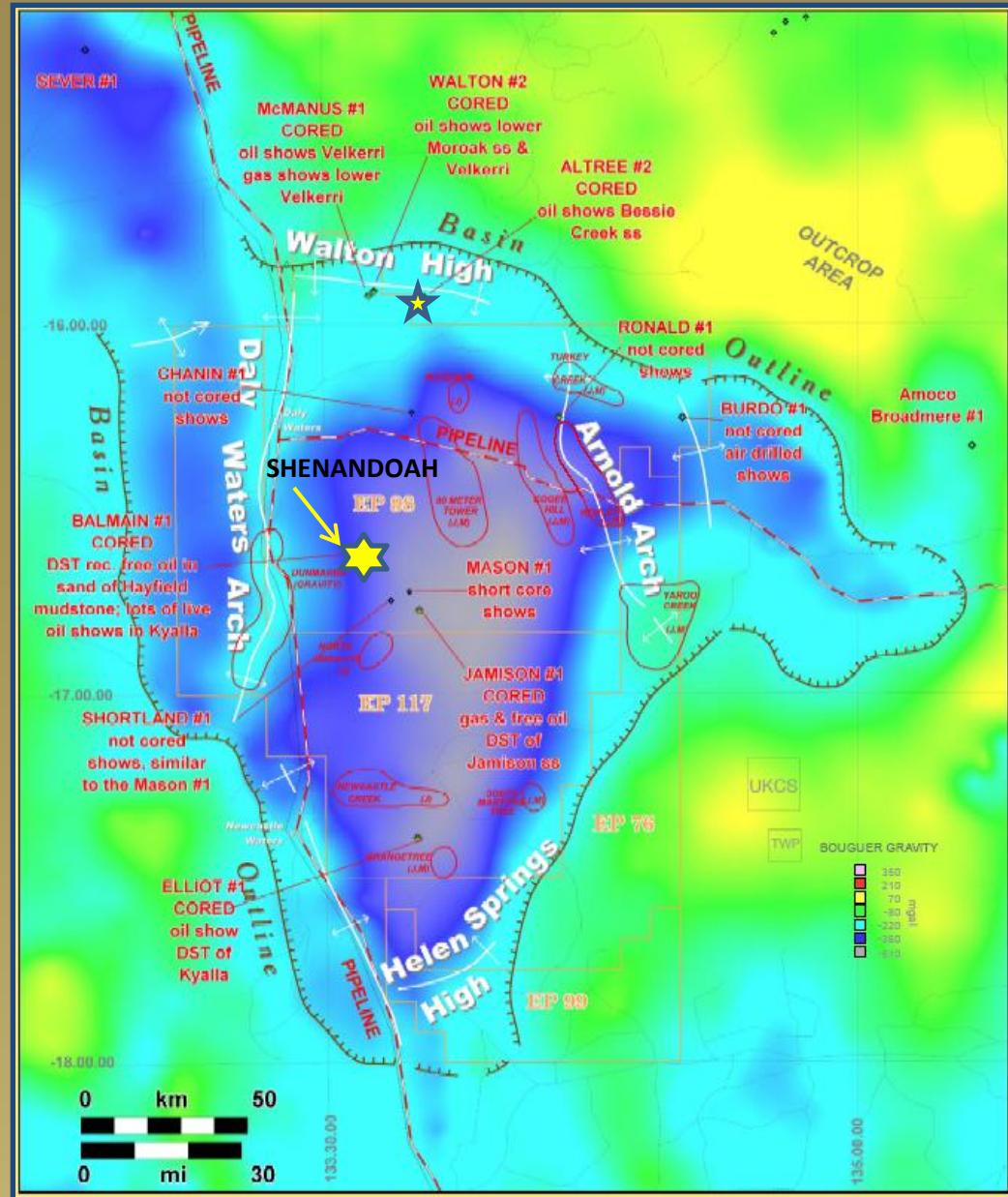
Beetaloo Basin, Australia





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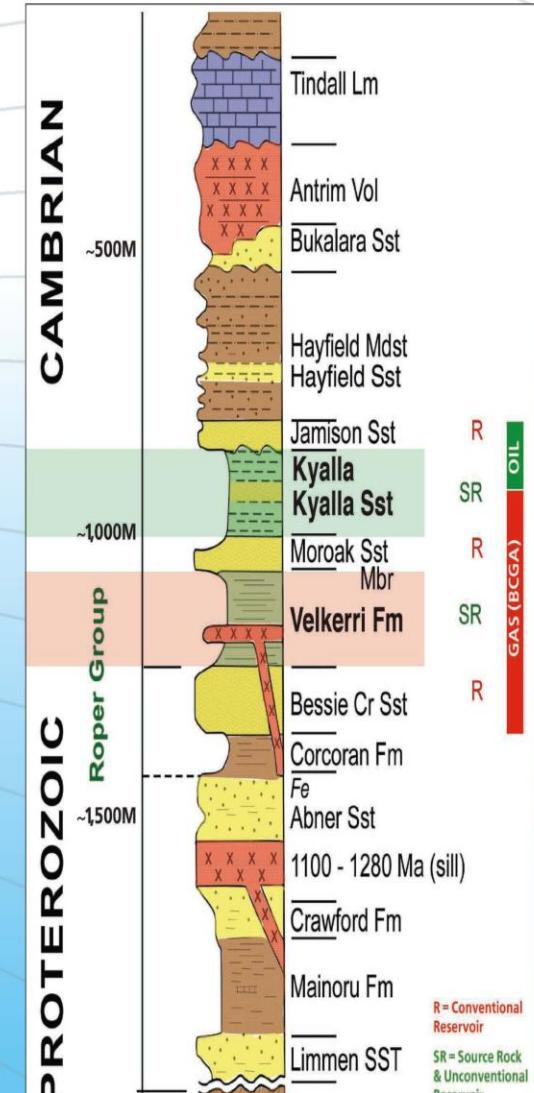
Two Thick Organic Rich Shales – Thick Self-Sourcing Reservoirs

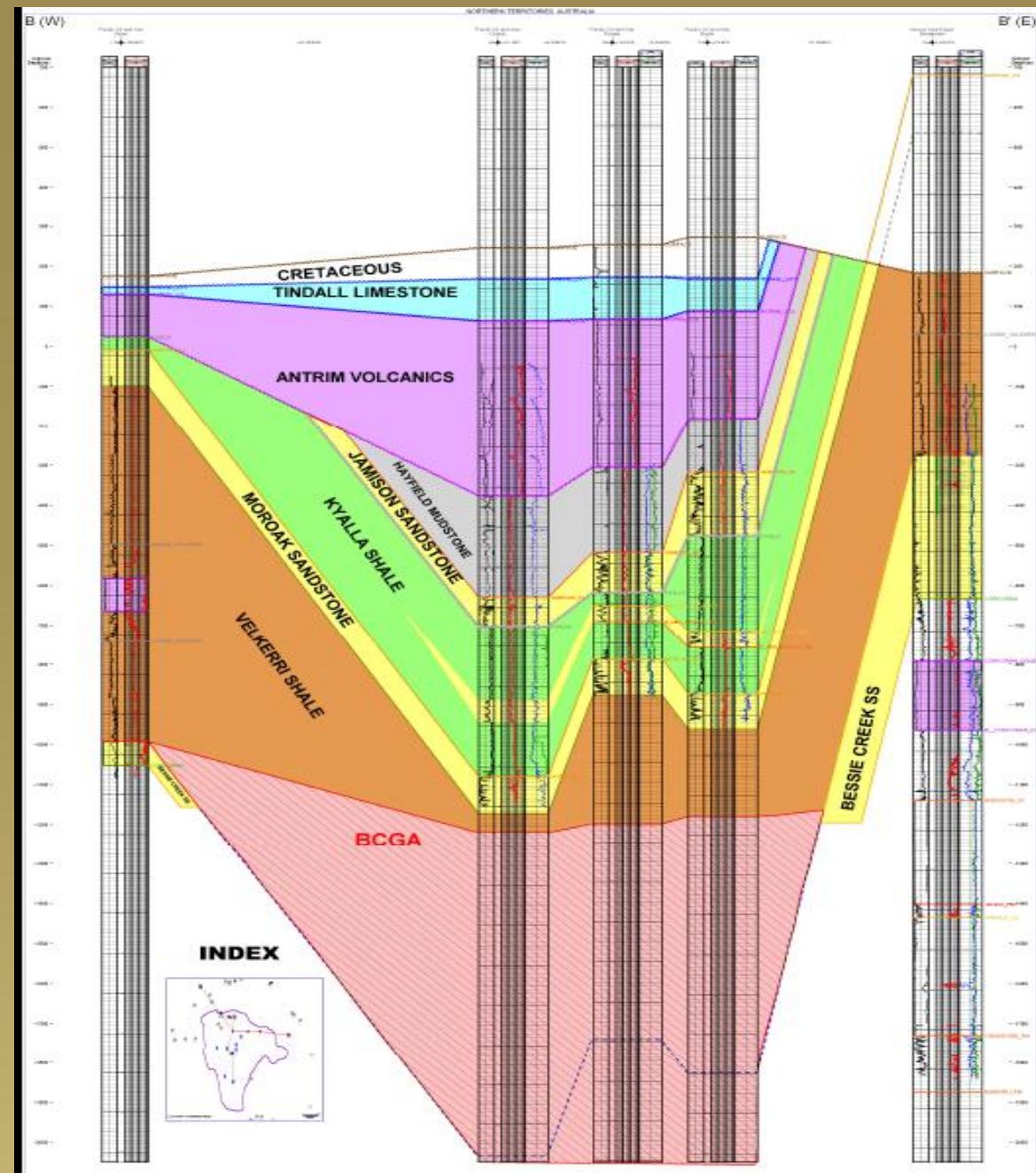
Kyalla Shale

- Up to 800 Meters Thick
- TOC 2-3%, Thin Intervals to 9%
- Oil-Prone & Currently in Oil Window
- Highly Fractured

Velkerri Shale

- Up to 800 Meters Thick
- TOC Up to 12%
- Mature for Oil & Gas
- Gas Shale in BCGA







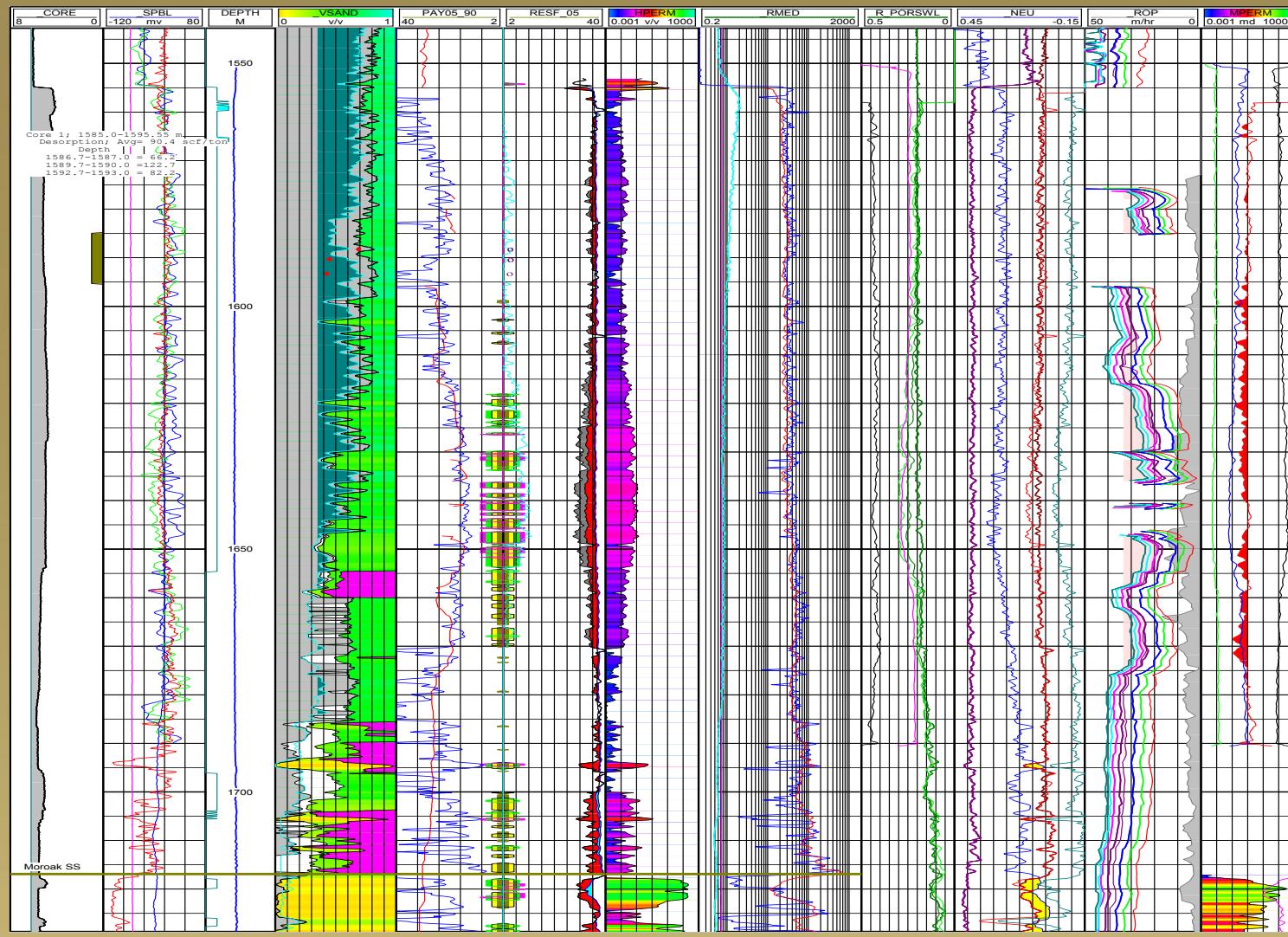
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Core Int.
1585-
1595 m

Shenandoah 1 – L Kyalla

CPI



Jamison #1 Core—1640M

Lower Kyalla Shale



TOC 2.14%
Tmax 461° C.
4.1%- Ø
0.14 Kmd

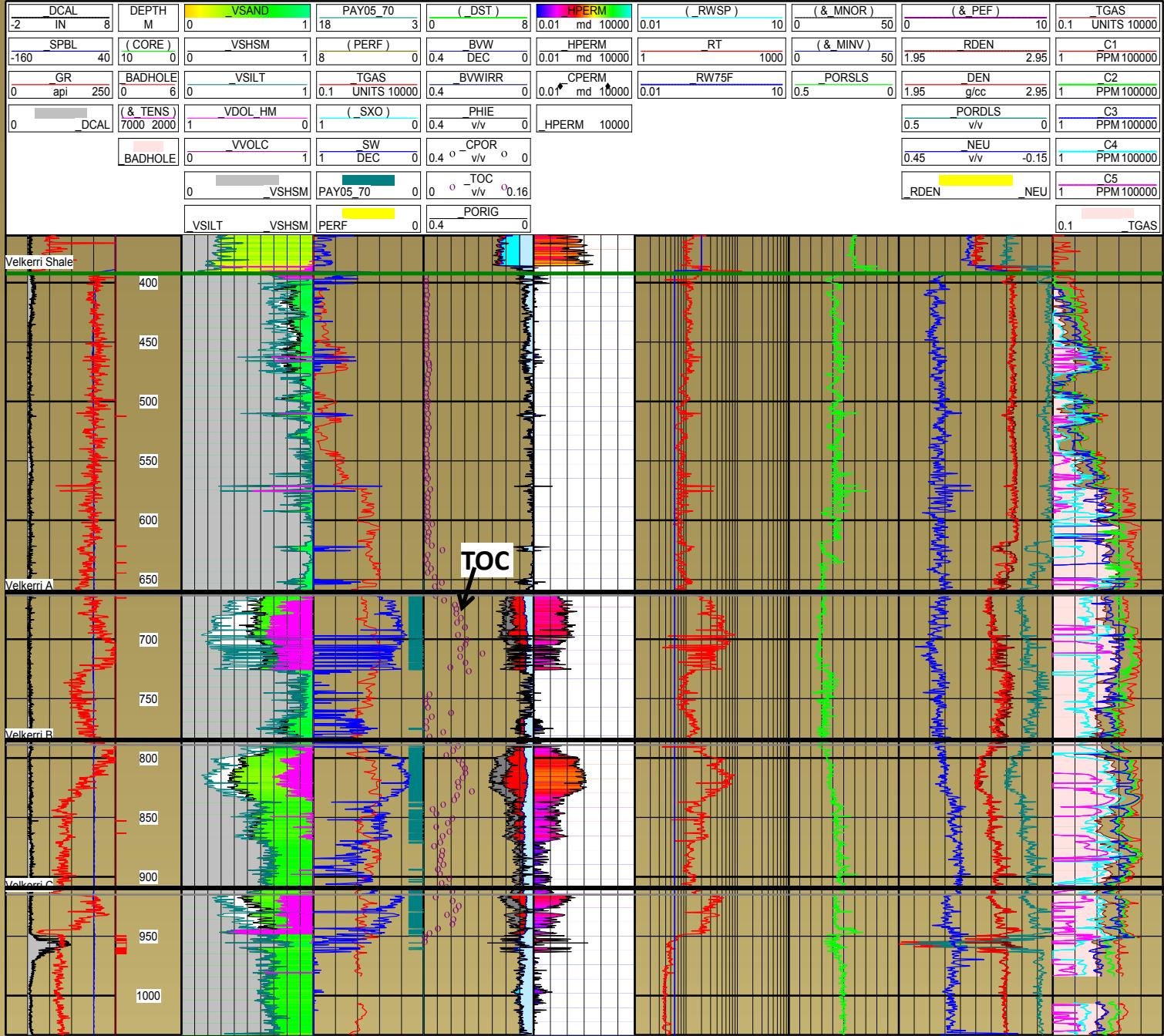


ALTREE 2 WELL

Velkerri A

Velkerri B

Velkerri C

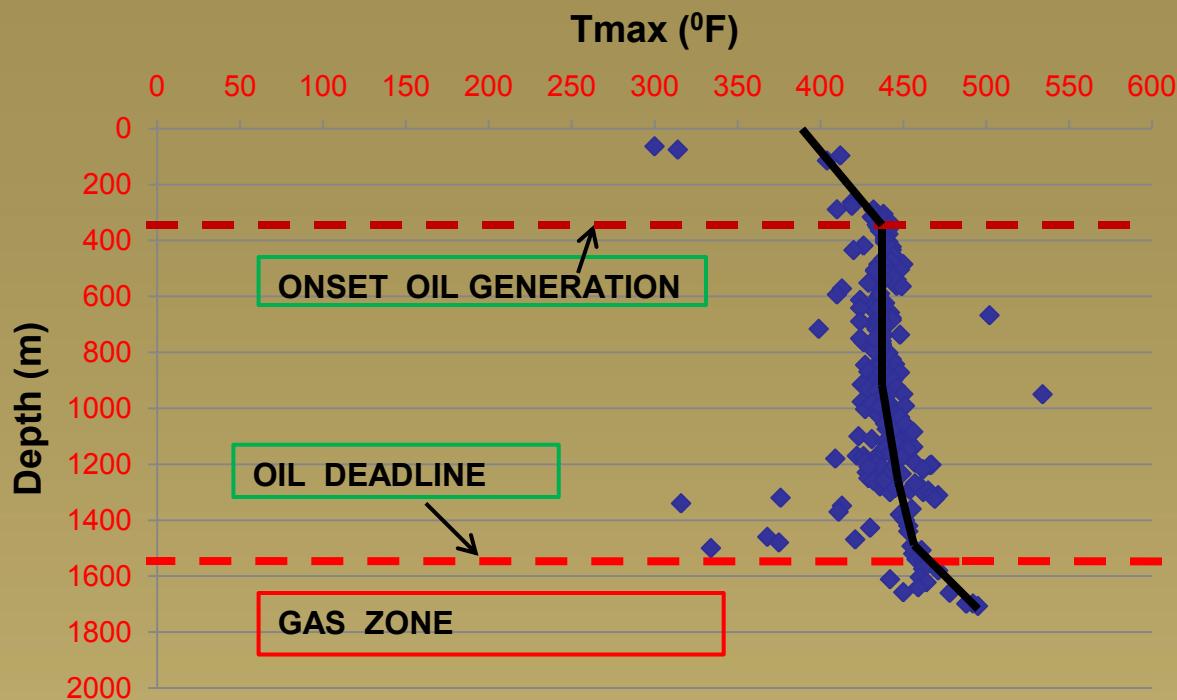






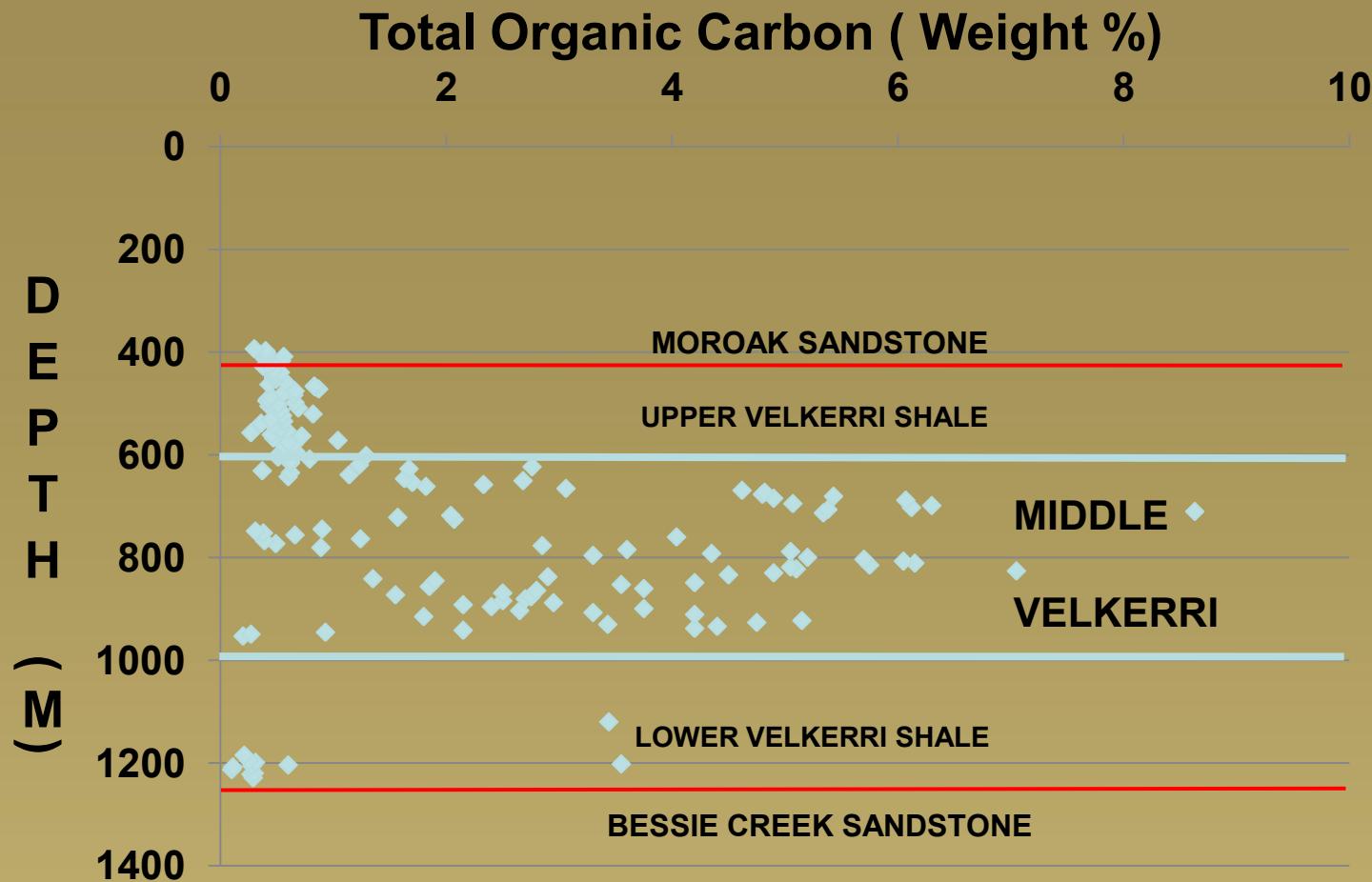
Beetaloo-- Tmax vs. Depth

9 wells
n=256



DEPTH vs. TOC – VELKERRI SHALE

Altree 2 Well





SHENANDOAH #1A

**Drilled to 2714 m (8902 ft)
Penetrated Lower-Velkerri
Two Cores Recovered Kyalla & Velkerri
Desorption Data**



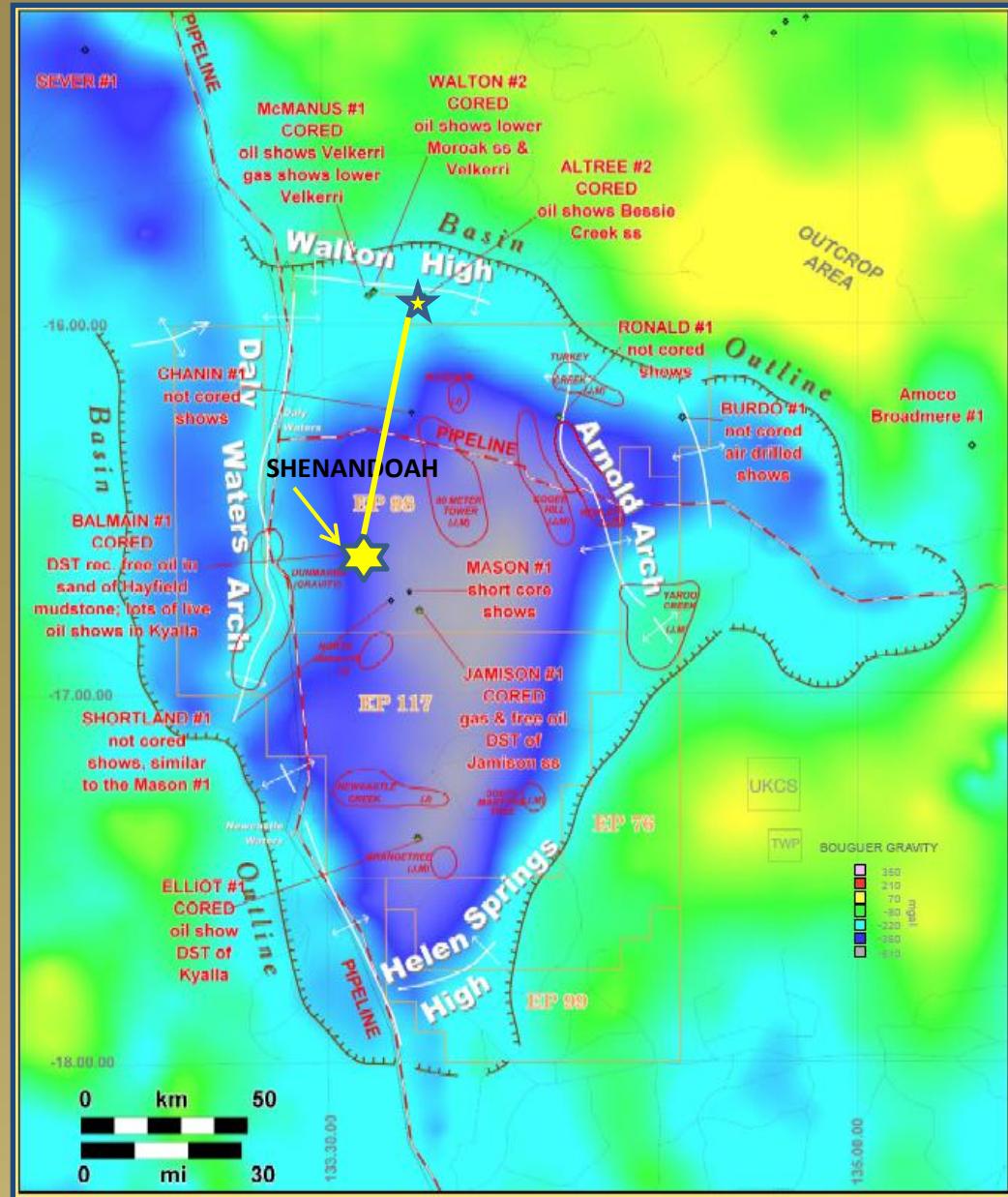
Shenandoah #1 (2007) Central Beetaloo Basin

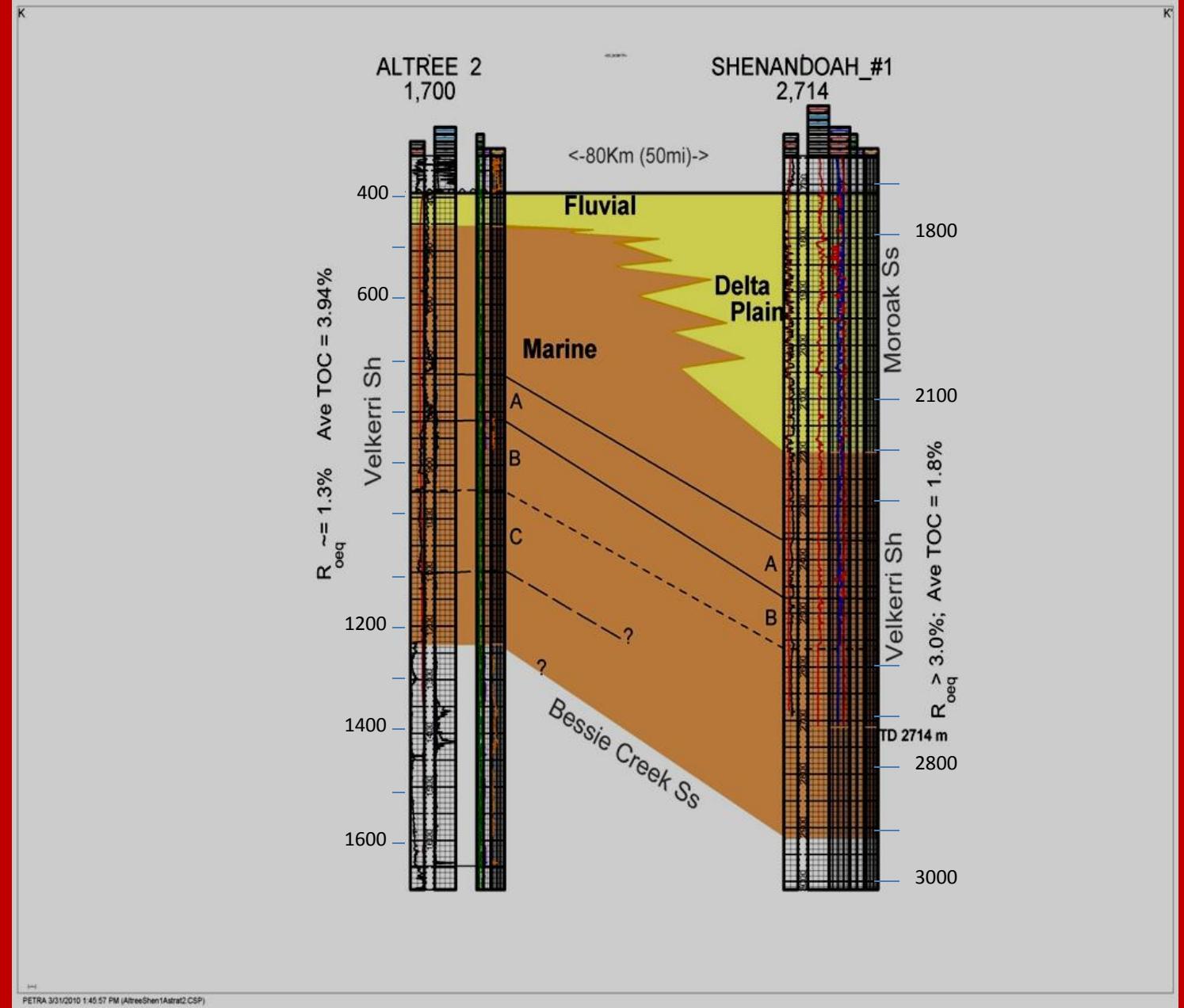




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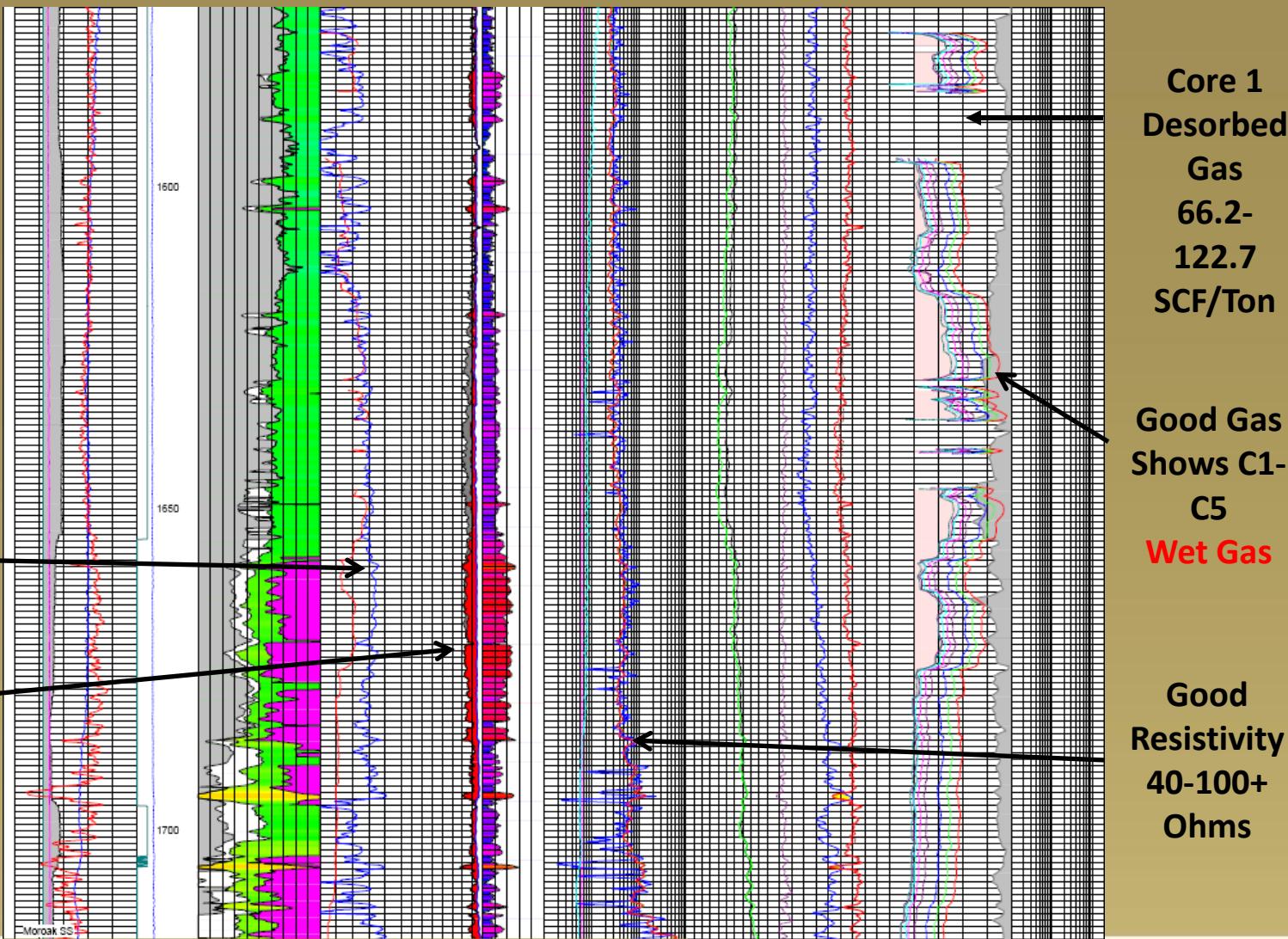








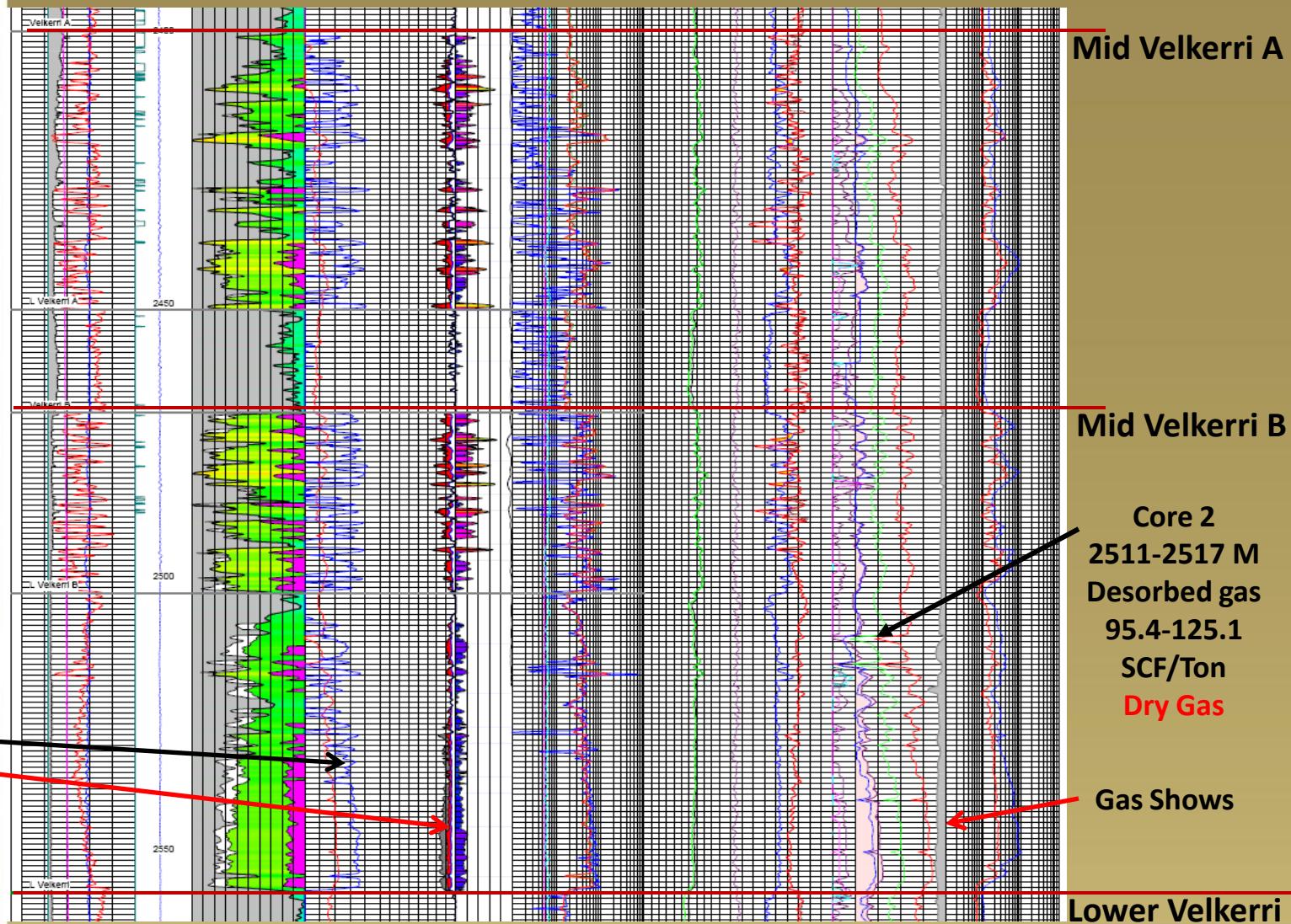
Lower Kyalla Gas Shale (1500-1718M) Gas Shows to 1000 Units (11% C1-C5)





Mid Velkerri Shale CPI Log

A & B Gas Shows to 174 Units (C1-C3)





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Beetaloo Shale Properties Shenadoah 1A Well

Sample	Depth (ft)	TOC (%)	Thermal Maturity (Ro eq)	Desorbed Gas (scf/ton)
Kyalla-1	5263.5	1.13		66.2
Kyalla -2	5216.15	1.22	1.76	122.7 Ave.= 90.4
Kyalla-3	5225.1	1.1		82.2
Velkerri-1	8286.3	1.05		98.0
Velkerri-2	8245.0	2.34	>3.0	125.1 Ave. = 106.1
Velkerri-3	8251.56	2.08		95.4

LANGMUIR STORAGE CAPACITY

Sample	Depth (ft)	Storage Capacity (scf/ton)
Kyalla	5217.74	10.78
Kyalla	5226.66	10.40
Velkerri	8240.95	49.83
Velkerri	8247.47	78.17



DESORBED GAS COMPOSITION

Sample	Depth (ft)	C1	C2	C3+	O2	N2	CO2	H2
Kyalla	5,216.0	82.27	9.81	6.27	0.0	0.0	0.0	0.0
Kyalla	5,225.9	98.98	0.0	0.0	0.0	0.0	1.02	0.0
Velkerri	8,249.6	92.09	3.65	0.18	0.0	0.0	4.08	0.0
Velkerri	8,253.1	93.75	2.31	0.38	0.0	0.0	3.56	0.0

VELKERRI – Crushed CORE ANALYSIS vs. LOG ANALYSIS Log Analysis Model (2511-2517 m)

Velkerri Core; 2511 - 2517 m

Crushed Core Analysis (Average)

Dry Helium Porosity = 4%
Water Saturation = 76%
Bulk Volume Water = 3%
Gas Filled Porosity = 1%
Dry Grain Density = 2.696 g/cc

Current Log Analysis (Average)

_PORIG = 4.6%
_BVW = 2.5%
_BVHC = 2.1%
Grain Density= 2.71 g/cc

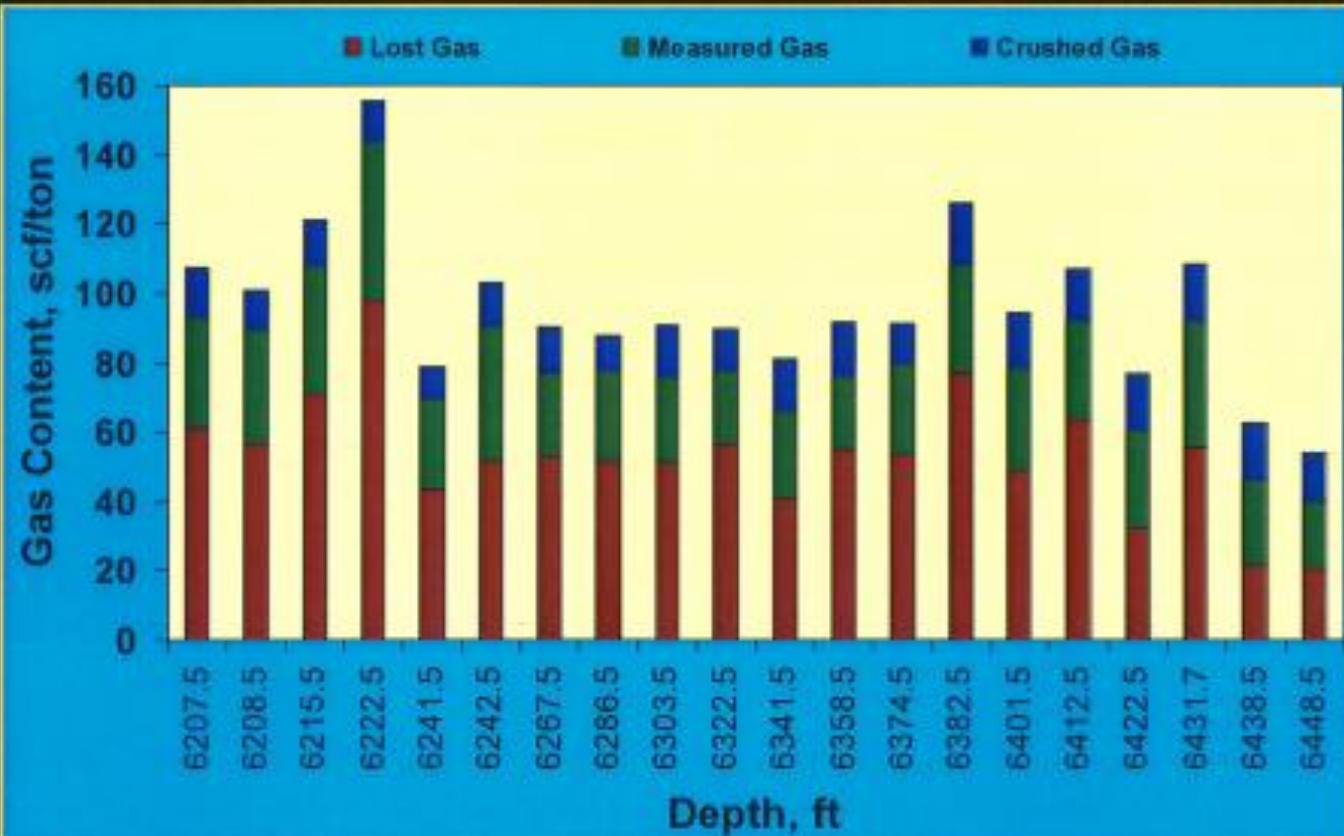
Velkerri Sweet Spot; 2546 - 2557 m

No Core Data

_PORIG = 5.6%
_BVW = 2.7%
_BVHC = 2.9%
Grain Density=2.71 g/cc

Desorption Data Show Adsorbed Gas Content(90.4 scf/ton L.Kyalla; 106.1 scf/ton-- Velkerri B) is favorable to U.S. Shales

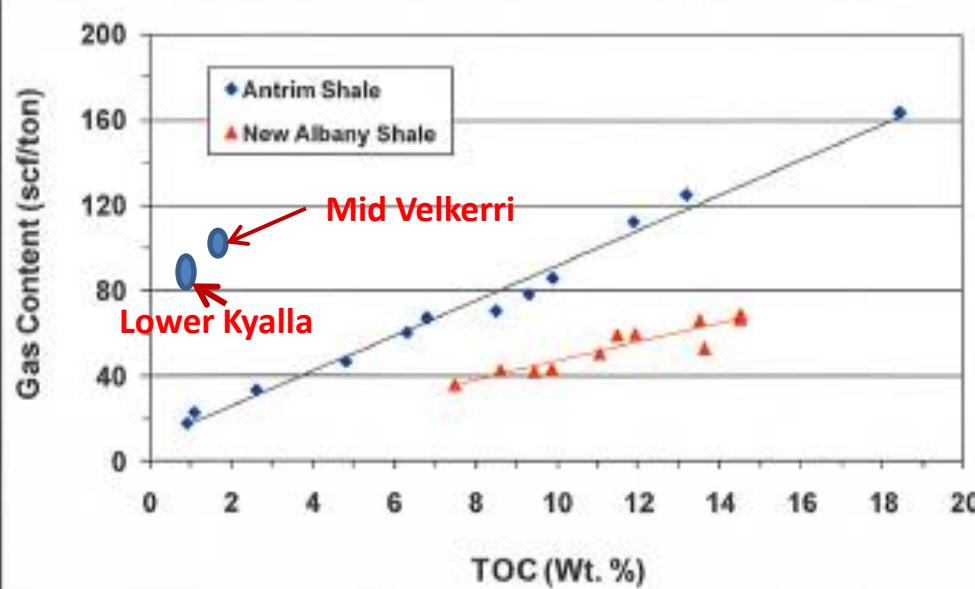
Canister Gas



Kyalla & Velkerri Shales

Good Gas Content Compared to U.S. Devonian Gas Shales

Relationship of Absorb Gas and TOC



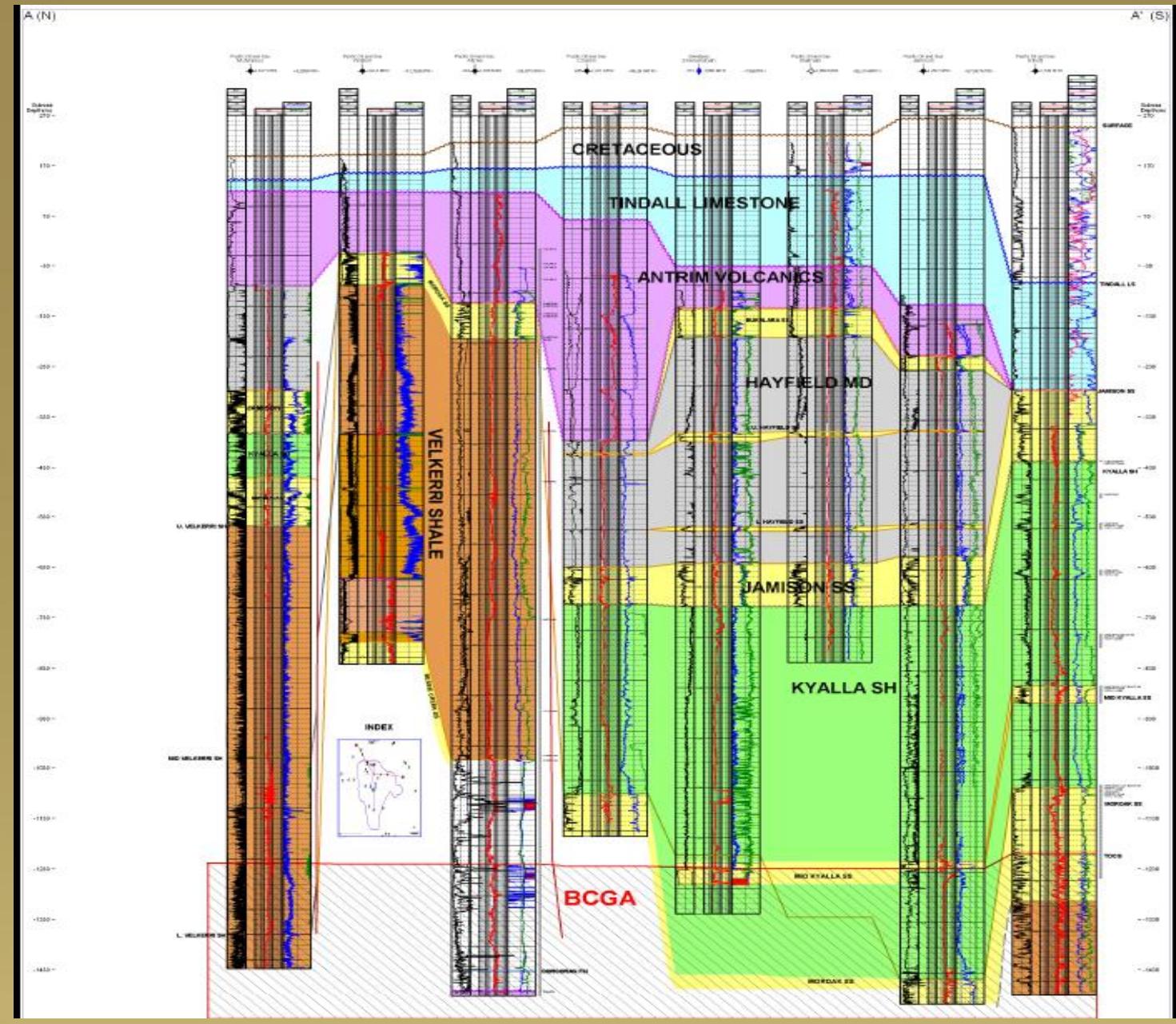


CONCLUSIONS

- Shales are 1.4 Billion years old
- Shales are organic-rich (up to 12% TOC with an ave. TOC in the Mid. Velkerri of 3.96%).
- Shales are as thick as 1600 m (5,250 ft).
- Shales range from thermally immature to over-mature and contain liquid-prone kerogen
- Huge potential for both oil and gas.
- Shallow drilling depths

CONCLUSIONS (Cont.)

- Core-derived gas desorption values range from 66.2 to 122.7 scf in the lower Kyalla and 95.4 to 125.1 scf in the Middle Velkerri.
- Desorption values in the Kyalla and Velkerri sweet spots are likely to be much higher than in the core-derived intervals.





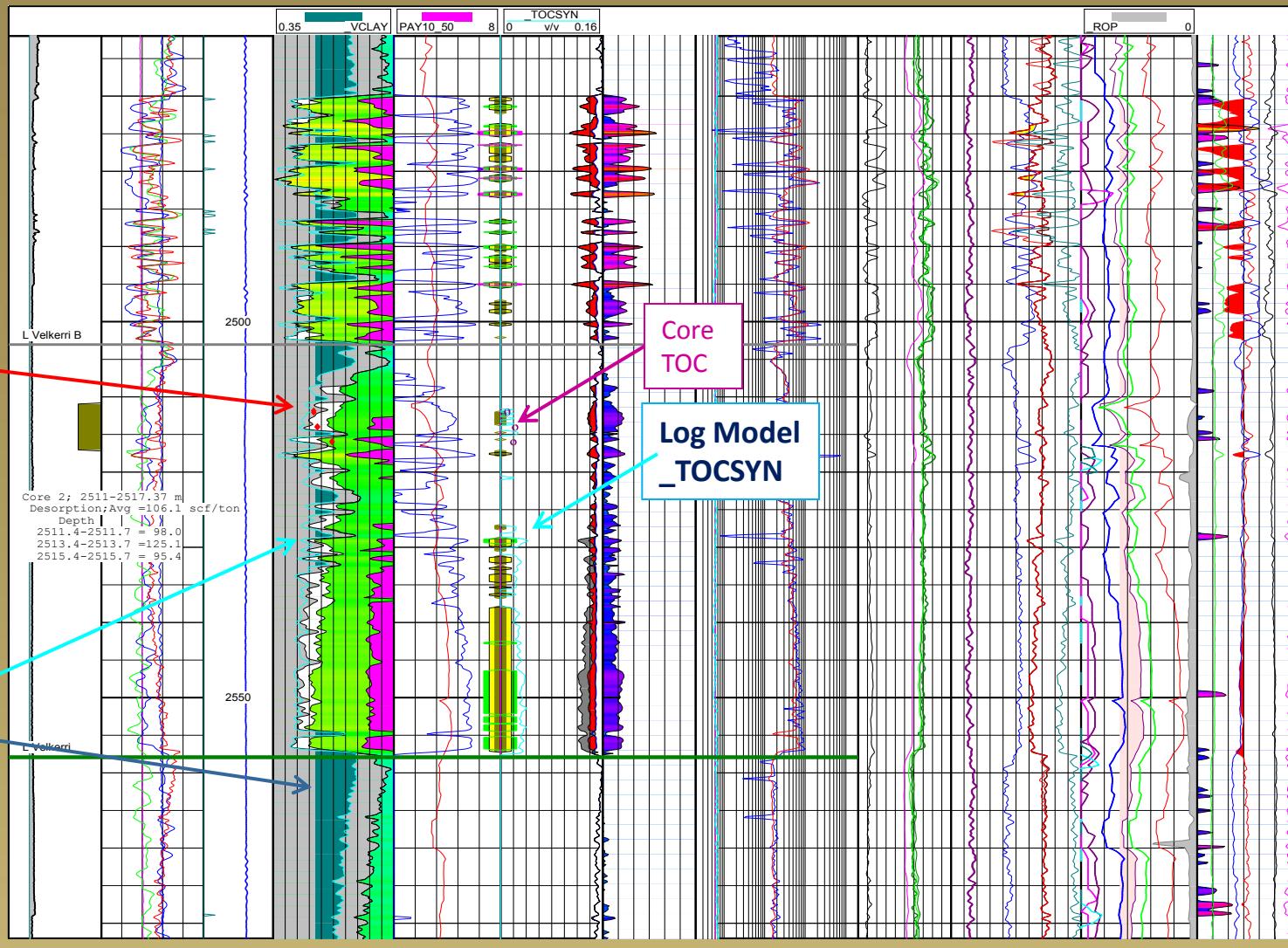
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Core
TOTCLAY

Log Model
_VCLAY
Shaded > 0.35

Shenandoah 1 - Velkerri

Core Analysis vs. Petrophysical Model



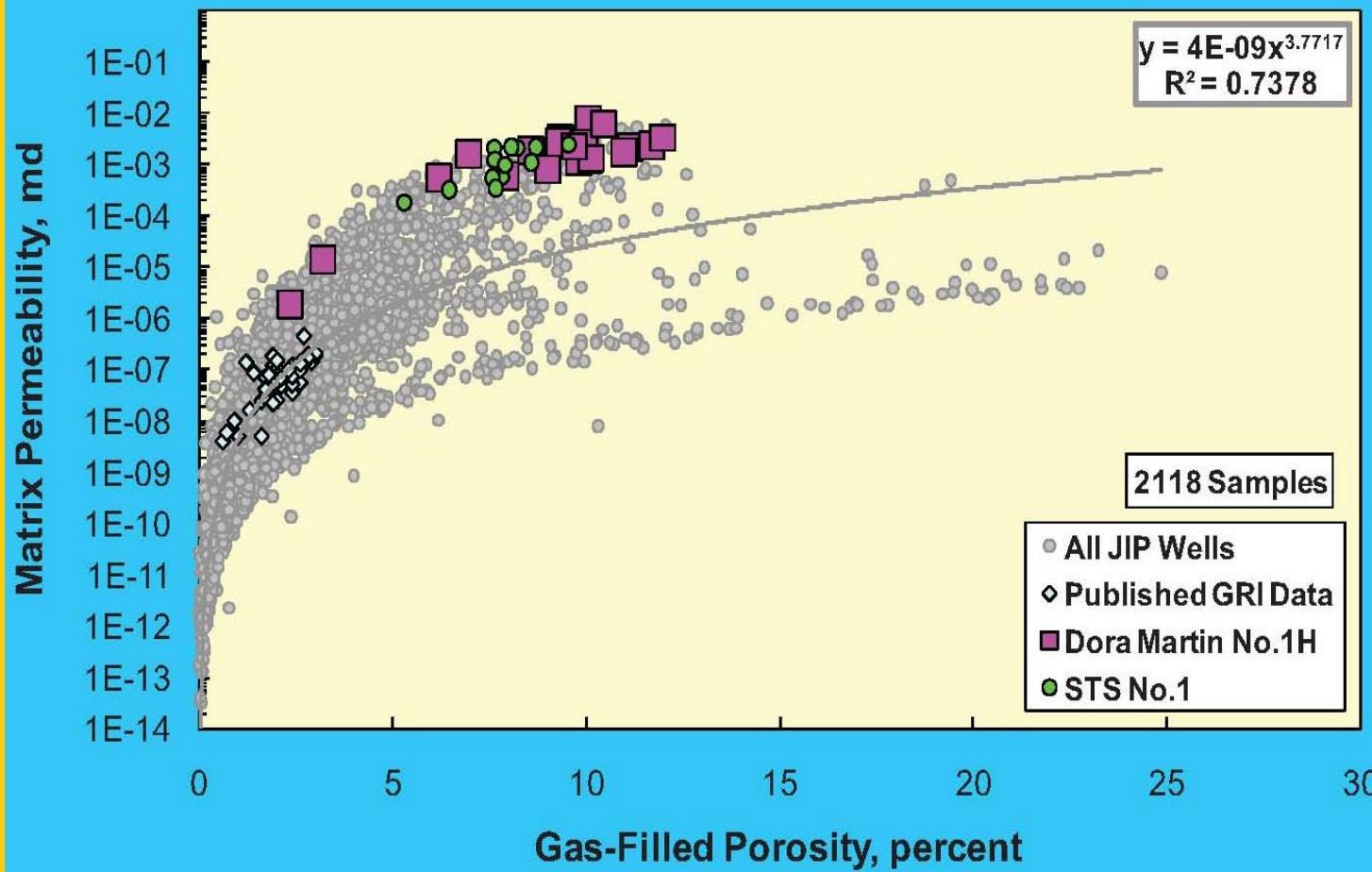


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Shenandoah 1- Weatherford Core Analysis

BASIC ROCK PROPERTIES (GRI Method)



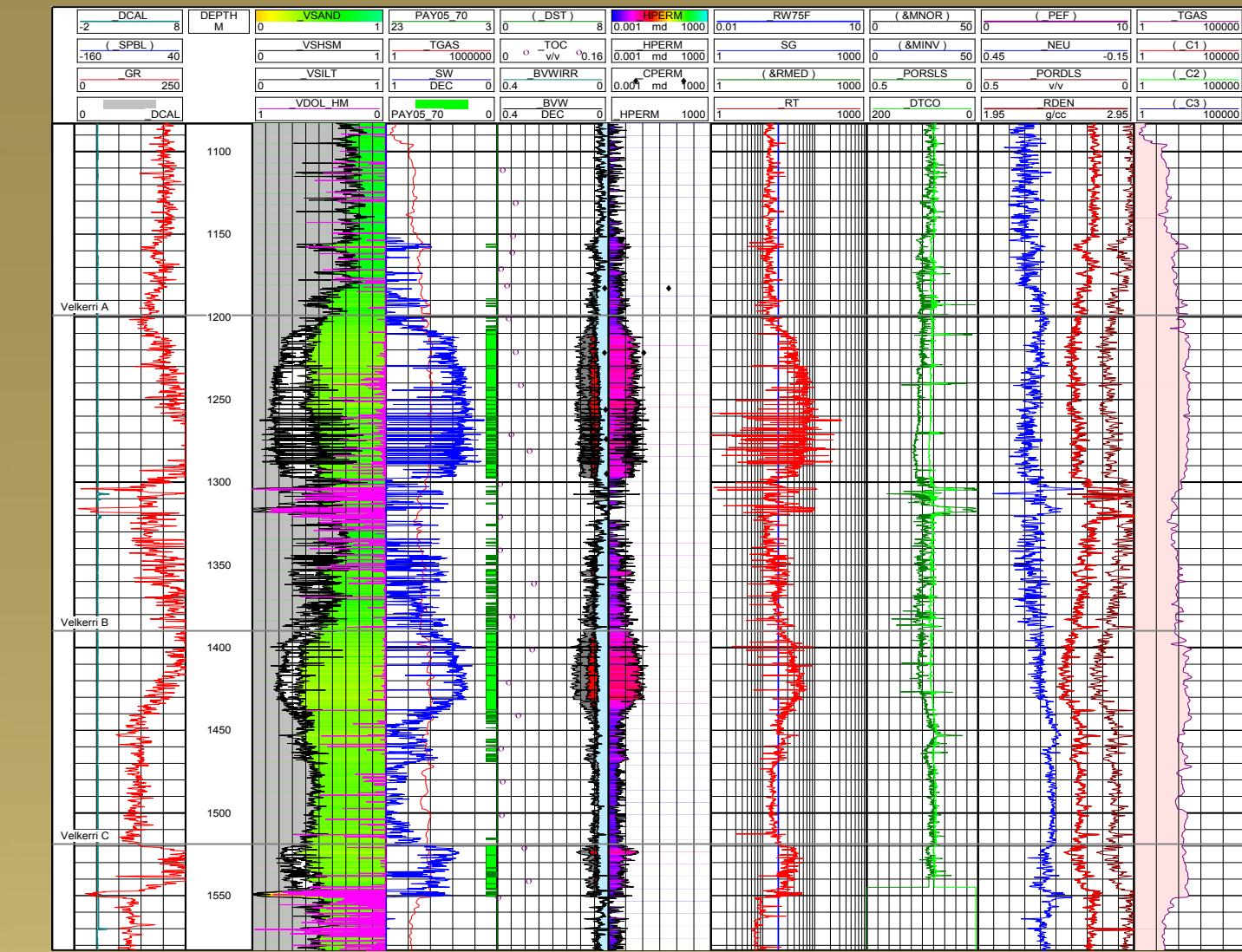


GAS COMPOSITION

Sample ID	Depth	C1	C2	C3	iC4	nC4	iC5	nC5	C6	C7	O2	N2	CO2	H2	Total
	feet	mol/f													
44589-2	5,218.0	0.8227	0.0881	0.0329	0.0122	0.0113	0.0063	0.0000	0.0000	0.0000	0.0000	0.0000	0.0168	0.0000	1.0000
44589-3	5,225.9	0.8898	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0102	0.0000	1.0000
44589-5	8,248.6	0.9209	0.0365	0.0014	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0408	0.0000	1.0000
44589-6	8,253.1	0.8375	0.0231	0.0029	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0358	0.0000	1.0000



Middle Velkerri Shale Petrophysics—Altree 2





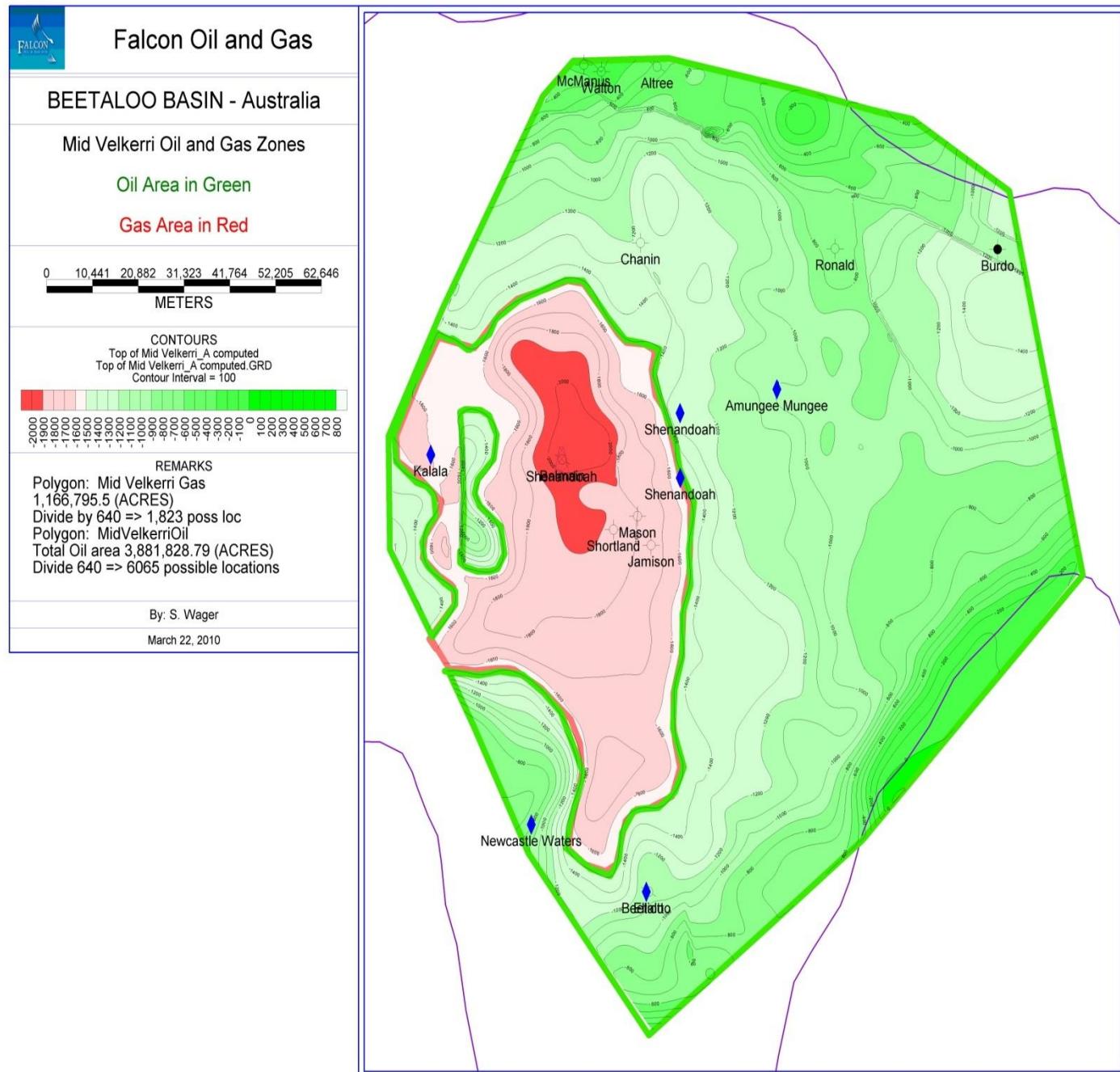
Initial Gas Composition for Kyalla and Velkerri-Shenandoah 1A

	Sample ID	Depth	C1	C2	C3+	O2	N2	CO2	H2	Total
		feet	mol%							
Kyalla	44569-2	5,216.0	0.8227	0.0981	0.0627	0.0000	0.0000	0.0166	0.0000	1.0000
Velkerri	44569-3	5,225.9	0.9898	0.0000	0.0000	0.0000	0.0000	0.0102	0.0000	1.0000
	44569-5	8,246.6	0.9209	0.0365	0.0018	0.0000	0.0000	0.0408	0.0000	1.0000
	44569-6	8,253.1	0.9375	0.0231	0.0038	0.0000	0.0000	0.0356	0.0000	1.0000



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Kyalla and Velkerri Shale Desorbed Gas Content

Shenandoah #1A

Sample ID	Top Depth	Bottom Depth	Air-Dry Weight	Lost Gas Time	Lost Gas Fraction	Measured Gas Fraction	Crushed Gas Fraction	Lost Gas Content	Measured Gas Content	Crushed Gas Content	Total Gas Content
	feet	feet	g	hours	%	%	%	scf/ton	scf/ton	scf/ton	scf/ton
Lower Kyalla Shale											
44569-1	5,205.71	5,206.69	6,167.0	10.86	36.88	40.04	23.08	24.4	26.5	15.3	66.2
44569-2	5,215.55	5,216.54	6,103.0	11.06	32.07	25.65	42.28	39.4	31.5	51.9	122.7
44569-3	5,225.39	5,226.38	6,208.0	11.23	32.04	37.36	30.60	26.3	30.7	25.1	82.2
Average	5,215.55	5,216.54	6,159.3	11.05	33.66	34.35	31.99	30.0	29.6	30.8	90.4
Velkerri B Shale											
44569-4	8,239.50	8,240.49	4,486.0	12.85	40.92	40.70	18.38	40.1	39.9	18.0	98.0
44569-5	8,246.06	8,247.05	4,716.0	12.97	53.36	30.45	16.19	66.7	38.1	20.2	125.1
44569-6	8,252.62	8,253.61	4,526.0	13.09	25.46	13.16	61.39	24.3	12.6	58.6	95.4
Average	8,246.06	8,247.05	4,576.0	12.97	39.91	28.10	31.99	43.7	30.2	32.3	106.1



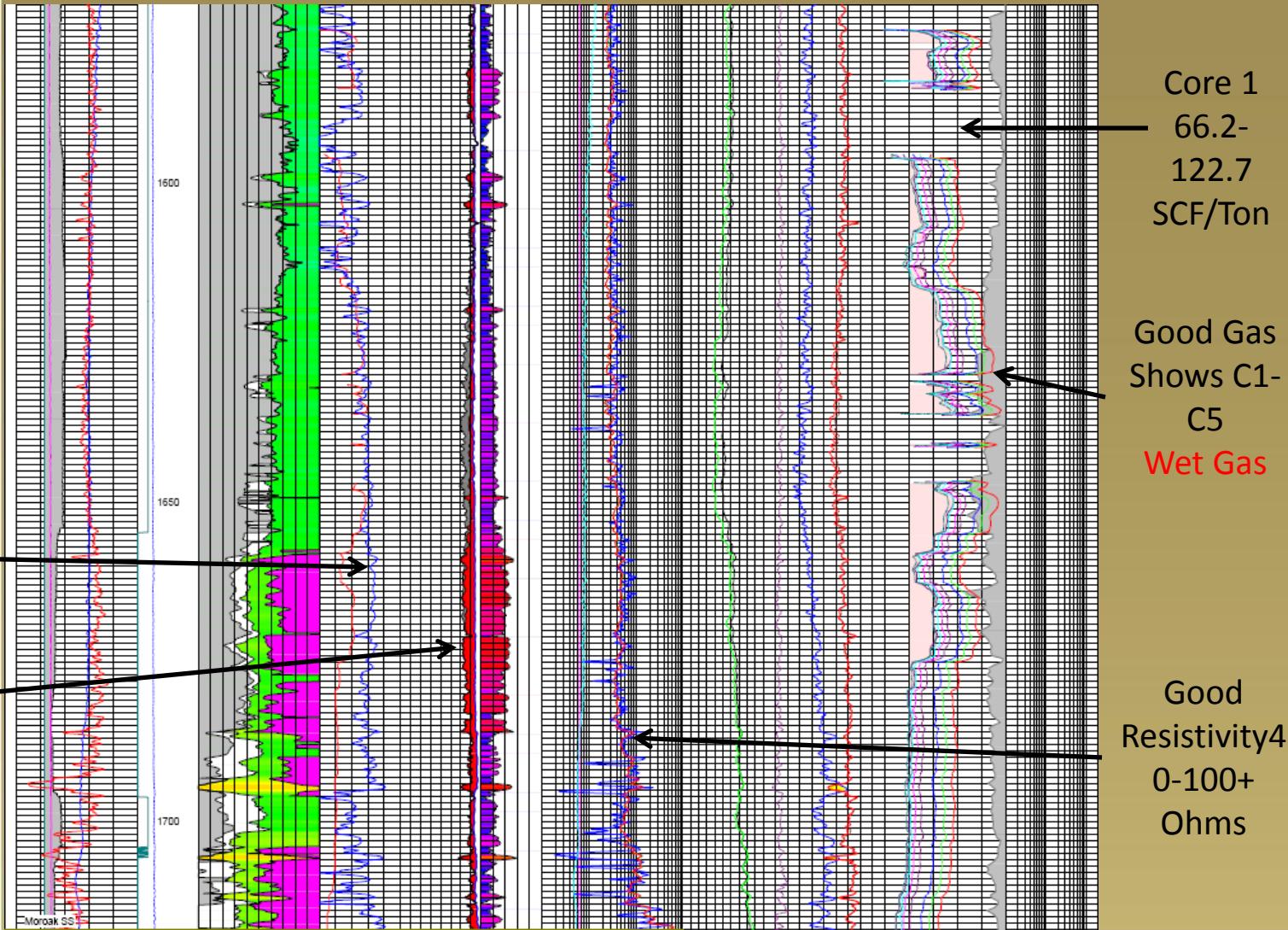
Beetaloo Basin Oil Resource Potential In Billion Barrels

Reservoir	Unrisked Undiscovered Oil-In-Place (Bstb)			Unrisked Prospective (Recoverable) Oil Resources (Bstb)		
	Low	Best	High	Low	Best	High
Hayfield	0.049	0.088	0.148	0.005	0.010	0.018
Jamison	8.220	11.920	16.402	0.800	1.337	2.153
Conventional Subtotal	8.269	12.008	16.550	0.805	1.347	2.171
Upper Kyalla Shale Oil	127.4	180.9	256.0	11.3	17.8	27.4
Shale Oil Subtotal	127.4	180.9	256.0	11.3	17.8	27.4
Total Oil Resource Within The Beetaloo Basin	135.67	192.91	272.55	12.11	19.15	29.57

Lower Kyalla Gas Shale (1500-1718M) Gas Shows to 1000Units (11% C1-C5)

$S_w \sim 40\%$

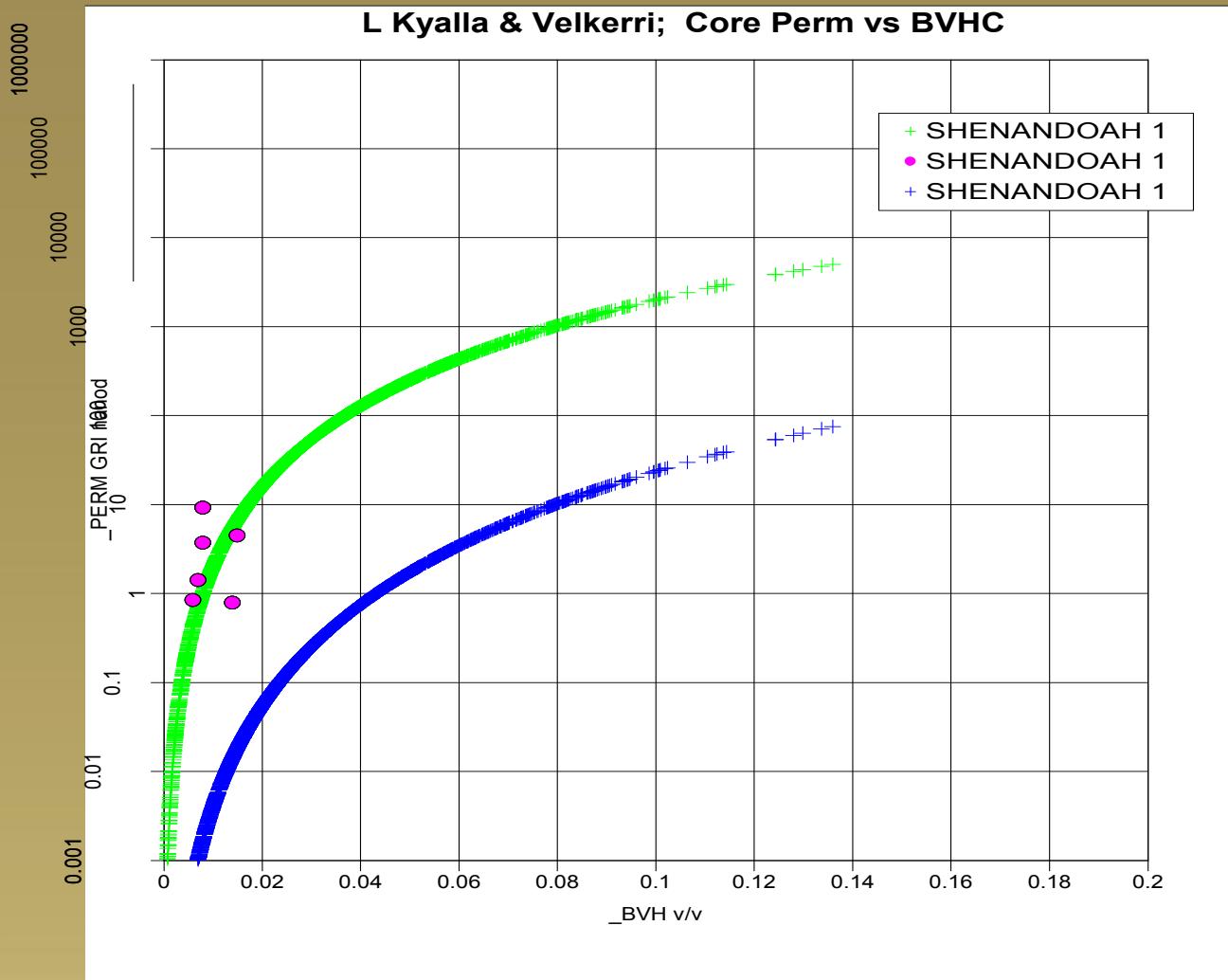
5-10%
Porosity
Gas





Shenandoah 1; L Kyalla & Velkerri

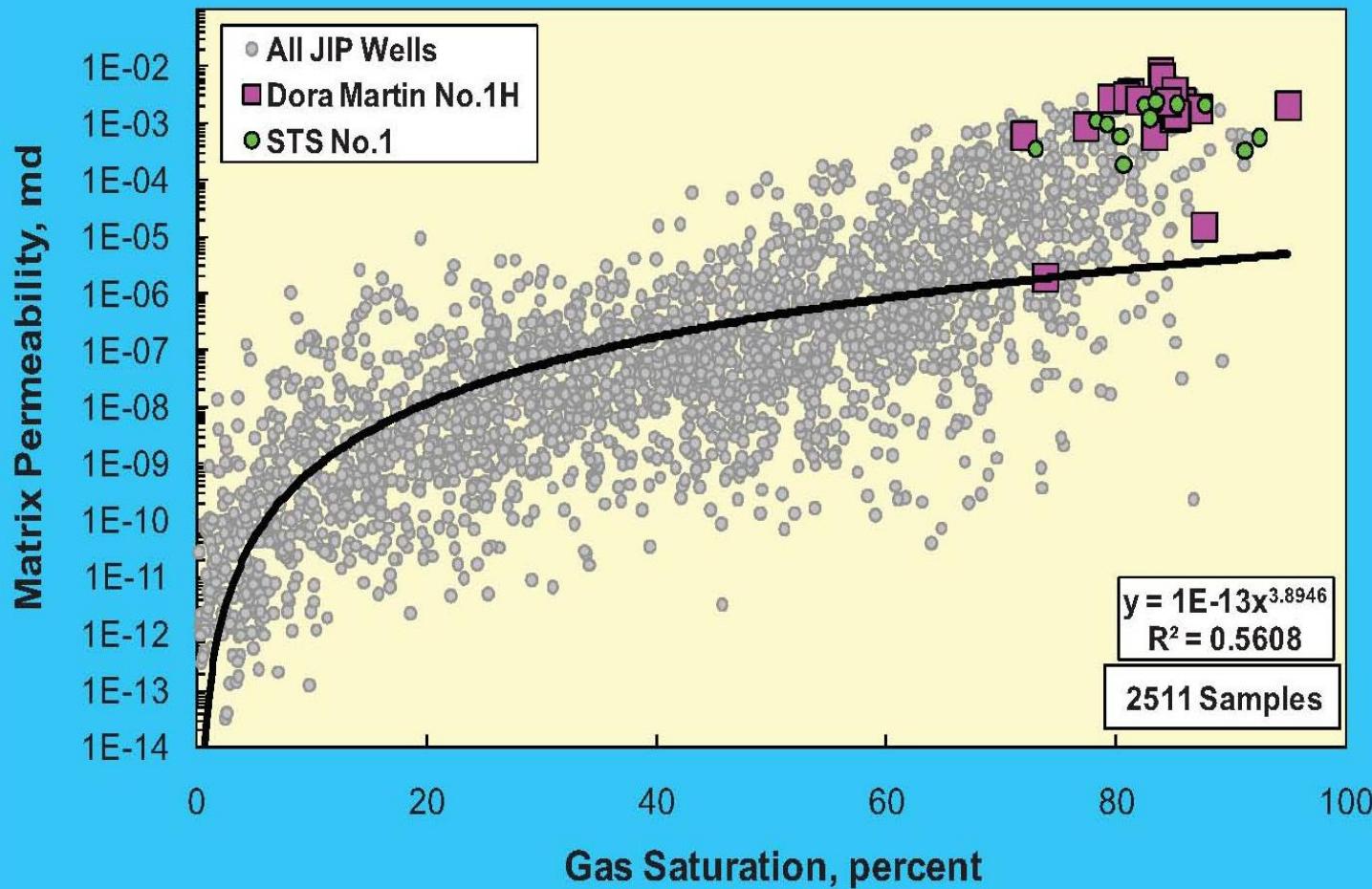
GRI Permeability / Porosity vs. Log Model





Shenandoah 1- Weatherford Core Analysis

BASIC ROCK PROPERTIES (GRI Saturation)





Shenandoah 1

Reservoir Summation – Porosity (PHIE) > 0.05

	Depth (m)	Net Pay (m)	PHIE	SW	TOC	PORIG	HPERM (md)
U Kyalla	943-1016	51	0.075	0.50	0.024	0.051	0.025
L Kyalla	1570-1670	88	0.075	0.46	0.022	0.053	0.027
Velkerri SS A & B	2405-2503	37	0.071	0.37	—	0.071	0.063
L Velkerri B	2514-2557	28	0.072	0.36	0.03	0.042	0.008



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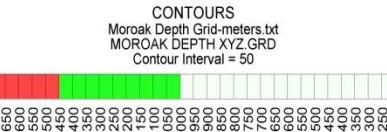
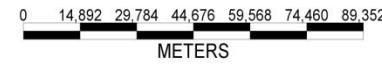
Falcon Oil and Gas

BEETALOO BASIN - Australia

Top of Moroak Contour Map

Red: L. Kyalla Gas Zone

Green: L. Kyalla Oil Zone



By: S. Wager

March 4, 2010

