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# Destructive Analysis Report

TOC and Rock-Eval pyrolysis data for the Amadeus Basin,  
Northern Territory, Australia.

GEOSCIENCE AUSTRALIA

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# Acknowledgments

Access to the East Mereenie 1, Finke 1, Mt Winter 2A, Orange 1, Tent Hill 1 and Undandita 1A wells were provided to Geoscience Australia by NTGS. Max Heckenberg (NTGS) is thanked for assistance with access to the Core Library, Northern Territory Geological Survey, 16 Power Street, Alice Springs NT 0870.

## 1 Introduction

Ongoing collaborative research projects between the Onshore Energy Branch, Geoscience Australia and NTGS are designed to produce pre-competitive information to assist with the evaluation of the petroleum prospectivity of onshore Northern Territory basins.

This report contains the total organic carbon (TOC) content and Rock-Eval pyrolysis data of samples selected from six petroleum wells in the Amadeus Basin; East Mereenie 1, Finke 1, Mt Winter-2A, Orange 1, Tent Hill 1 and Undandita 1A. These samples were selected to complement previous work undertaken by Geoscience Australia and the NTGS. This work was carried out in the Isotope and Organic Geochemistry Laboratory at Geoscience Australia and was undertaken as part of Australian Source Rock Study Project.

Samples were taken between the 16<sup>th</sup> and 20<sup>th</sup> of March 2015 at the Core Facilities and Technical Support, Department of Resources, Northern Territory Geological Survey, Alice Springs. Table 1 lists the rocks analysed in this study. 55 samples were analysed from six petroleum wells. These samples covered nine formations ranging from the Cryogenian (Tonian) Johnnys Creek Formation through to the Lower Ordovician Stairway Sandstone (Table 1).

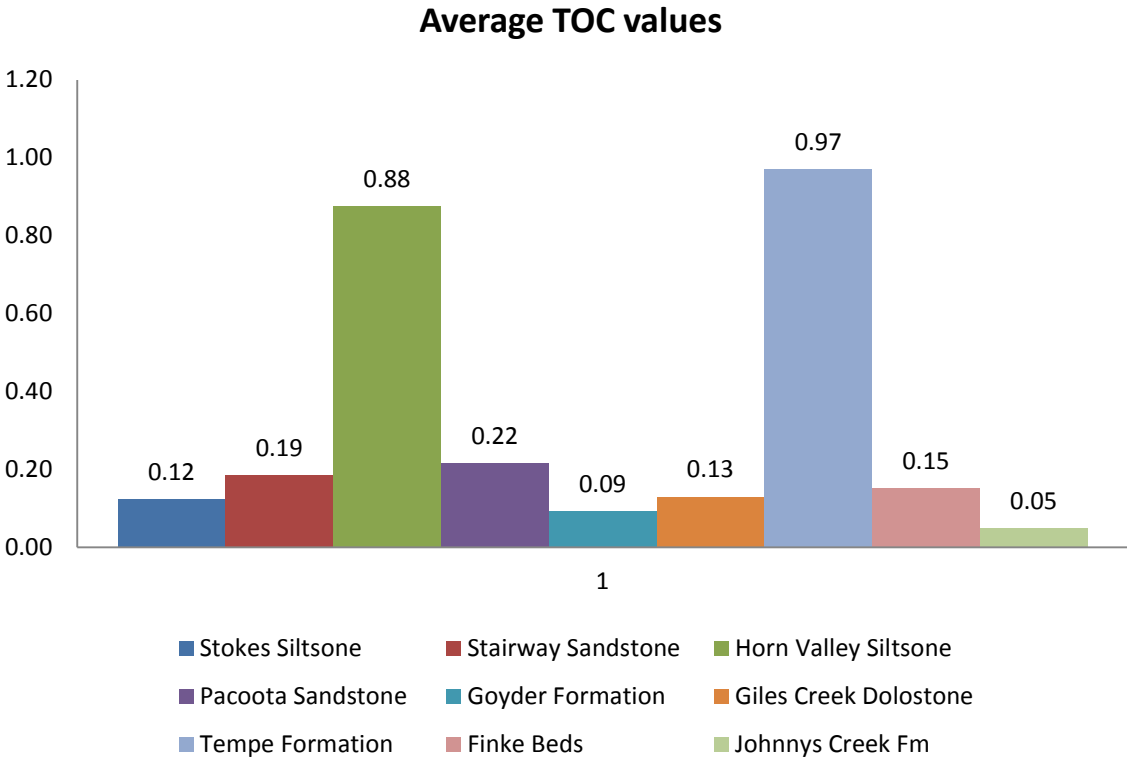
## 2 Experimental procedure: Rock-Eval pyrolysis

TOC content and hydrocarbon potential were measured using a Rock-Eval 6 Turbo™ (Vinci Technologies, France). Approximately 60 mg of powdered whole rock (shale and carbonate lithologies) samples were loaded into pre-combusted crucibles (600°C; 9 hours) which were loaded into the carousel and heated under inert nitrogen in both the pyrolysis (to obtain S1, S2, Tmax and S3 peaks) and oxidation (to obtain the S4 peak) ovens. The pyrolysis oven was first held at 300°C for 5 minutes and then ramped at 25°C per minute to 650°C. The oxidation oven was held at 400°C for 3 minutes, and then ramped at 20°C per minute to 850°C and held isothermal at 850°C for 5 minutes. The flame ionisation detector (FID) was calibrated by running IFP standard '160000'. The infra-red (IR) analyser was calibrated against a standard gas with a known concentration of CO<sub>2</sub> and CO. Analysis

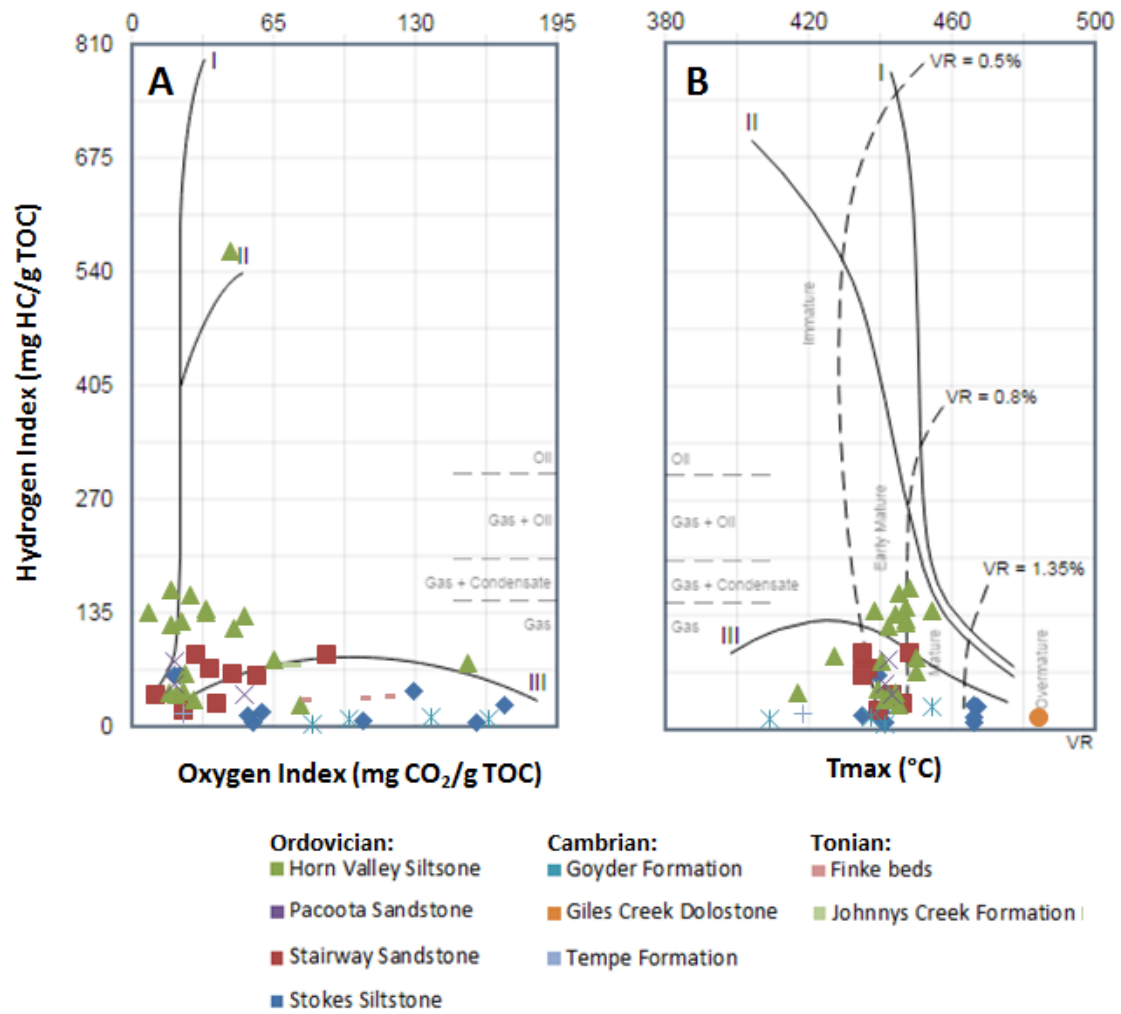
blanks were run with the sample batch and the blank data was automatically subtracted from all analyses. The results were processed with Optkin 3.0.0 software where peak heights (S1, S2 [Tmax], S3, S4) and geochemical indices including, for example; Total Organic Carbon (TOC) content, Oxygen Index (OI), Hydrogen Index (HI) and Production Index (PI) are automatically calculated. Definitions and calculations of Rock-Eval pyrolysis parameters are provided in Table 2.

### 3 Results

The results of the Rock-Eval pyrolysis are presented in Table 1 and Figures 1 and 2. Figure 1 depicts the average TOC content for each sedimentary unit analysed in this study and Figure 2 plots pseudo van Krevelen diagrams of kerogen classification (HI vs OI) and hydrocarbon generation (HI vs Tmax).

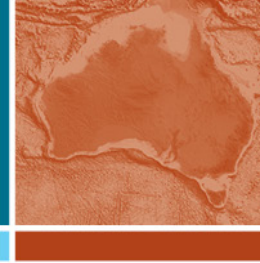


**Figure 1.** Average TOC values for Amadeus Basin samples analysed in this study.



**Figure 2.** Pseudo van Krevelin diagrams plotting **A-** Hydrogen Index versus oxygen Index, and **B-** Hydrogen Index versus Tmax temperature for recognition of genetic type and maturity for rock units with TOC values  $\geq 1\%$  in the Amadeus Basin.





**Table 1.** Rock-Eval 6 pyrolysis data for samples analysed in this study measured using a Rock-Eval 6 Turbo™

Well	Top (mKB)	Base (mKB)	Formation	Generated values				Derived values		
				S1 (mg HC/ g rock)	S2 (mg HC/ g rock)	S3 (mg HC/ g rock)	Tmax (°C)	HI (mg HC/ g TOC)	OI (mg HC/ g TOC)	TOC (wt %)
East Mereenie 1	823.72	823.80	Stairway Sandstone	0.03	0.20	0.10	435	68	34	0.30
East Mereenie 1	962.00	962.10	Stairway Sandstone	0.01	0.11	0.11	447	86	88	0.12
East Mereenie 1	1021.08	1036.32	Horn Valley Siltstone	0.03	0.19	1.22	416	39	248	0.49
East Mereenie 1	1036.32	1051.56	Horn Valley Siltstone	0.13	0.40	0.81	439	75	153	0.53
East Mereenie 1	1051.56	1066.80	Horn Valley Siltstone	0.12	0.41	1.36	426	82	271	0.50
East Mereenie 1	1053.44	1053.45	Horn Valley Siltstone	0.54	1.08	0.40	443	132	49	0.82
East Mereenie 1	1055.83	1055.90	Horn Valley Siltstone	0.74	1.77	0.39	446	140	31	1.26
East Mereenie 1	1056.77	1056.80	Horn Valley Siltstone	1.05	2.51	0.38	444	156	24	1.60
East Mereenie 1	1057.78	1057.80	Horn Valley Siltstone	0.52	1.10	0.41	441	117	44	0.94
East Mereenie 1	1058.42	1058.50	Horn Valley Siltstone	0.25	8.12	0.62	354	569	43	1.43
East Mereenie 1	1066.80	1082.04	Horn Valley Siltstone	0.08	0.45	1.46	313	72	232	0.63
Finke 1	263.27	263.4	Finke beds	0.02	0.06	0.19	349	33	104	0.18
Finke 1	264.2	264.26	Finke beds	0.01	0.04	0.12	332	35	116	0.11
Finke 1	265.2	265.25	Finke beds	0.02	0.07	0.18	329	31	77	0.23
Finke 1	271.2	271.24	Finke beds	0.01	0.03	0.24	313	30	258	0.09
Finke 1	303.58	303.62	Johnnys Creek Fm	0.02	0.03	0.03	298	72	72	0.05
Mount Winter 2A	102.1	102.15	Stairway Sandstone	0.00	0.12	0.08	434	63	44	0.19
Mount Winter 2A	110.25	110.3	Stairway Sandstone	0.00	0.10	0.10	434	60	56	0.17

Well	Top (mKB)	Base (mKB)	Formation	Generated values				Derived values		
				S1 (mg HC/ g rock)	S2 (mg HC/ g rock)	S3 (mg HC/ g rock)	Tmax (°C)	HI (mg HC/ g TOC)	OI (mg HC/ g TOC)	TOC (wt %)
Mount Winter 2A	122.04	122.06	Stairway Sandstone	0.01	0.28	0.09	434	86	27	0.33
Orange 1	1231.7	1231.76	Goyder Formation	0.00	0.00	0.12	440	2	81	0.15
Orange 1	1234.41	1234.42	Goyder Formation	0.00	0.01	0.17	408	7	163	0.10
Orange 1	1236	1236.27	Goyder Formation	0.00	0.01	0.11	453	23	214	0.05
Orange 1	1237.08	1237.11	Goyder Formation	0.00	0.00	0.06	318	7	98	0.06
Orange 1	1244.1	1244.13	Goyder Formation	0.00	0.01	0.14	436	9	136	0.10
Orange 1	2155.48	2155.27	Giles Creek Dolostone	0.01	0.01	0.39	483	9	289	0.13
Tent Hill 1	878.14	878.18	Stokes Siltstone	0.00	0.01	0.15	466	23	494	0.03
Tent Hill 1	881.75	881.8	Stokes Siltstone	0.00	0.01	0.06	465	25	170	0.04
Tent Hill 1	883.95	884	Stokes Siltstone	0.00	0.00	0.05	465	4	157	0.03
Tent Hill 1	886.9	887	Stokes Siltstone	0.00	0.00	0.04	440	3	53	0.07
Tent Hill 1	886.3	886.32	Stokes Siltstone	0.00	0.00	0.08	465	9	226	0.04
Tent Hill 1	887.58	887.6	Stokes Siltstone	0.00	0.01	0.05	439	16	57	0.08
Tent Hill 1	890.12	890.2	Stokes Siltstone	0.00	0.03	0.13	434	12	51	0.25
Tent Hill 1	892.3	892.36	Stokes Siltstone	0.00	0.00	0.06	439	5	104	0.05
Tent Hill 1	895.66	895.68	Stokes Siltstone	0.00	0.19	0.06	438	60	19	0.31
Tent Hill 1	898.4	898.2	Stokes Siltstone	0.00	0.01	0.05	519	42	128	0.04
Tent Hill 1	900.15	900.18	Stokes Siltstone	0.01	0.26	0.07	435	60	17	0.43
Tent Hill 1	1006.28	1006.3	Stairway Sandstone	0.01	0.06	0.01	442	36	9	0.15
Tent Hill 1	1009.85	1009.9	Stairway Sandstone	0.00	0.02	0.03	445	26	37	0.09
Tent Hill 1	1011.88	1011.89	Stairway Sandstone	0.00	0.03	0.03	438	19	22	0.13



Well	Top (mKB)	Base (mKB)	Formation	Generated values				Derived values		
				S1 (mg HC/ g rock)	S2 (mg HC/ g rock)	S3 (mg HC/ g rock)	Tmax (°C)	HI (mg HC/ g TOC)	OI (mg HC/ g TOC)	TOC (wt %)
Tent Hill 1	1018.5	1018.53	Horn Valley Siltstone	0.00	0.04	0.03	440	31	26	0.13
Tent Hill 1	1020.23	1020.28	Horn Valley Siltstone	0.01	0.04	0.02	441	36	18	0.12
Tent Hill 1	1028.1	1028.15	Horn Valley Siltstone	0.01	0.06	0.02	443	39	14	0.15
Tent Hill 1	1030.57	1030.65	Horn Valley Siltstone	0.01	0.09	0.04	438	42	21	0.21
Tent Hill 1	1143.41	1143.43	Horn Valley Siltstone	0.09	0.27	0.09	449	63	22	0.44
Tent Hill 1	1145.9	1146	Horn Valley Siltstone	1.74	4.82	0.19	453	136	5	3.55
Tent Hill 1	1147.07	1147.1	Horn Valley Siltstone	0.75	1.83	0.22	446	121	15	1.52
Tent Hill 1	1153.32	1153.34	Horn Valley Siltstone	0.34	0.93	0.15	446	125	20	0.74
Tent Hill 1	1157.34	1157.37	Horn Valley Siltstone	1.24	3.02	0.29	447	163	15	1.86
Tent Hill 1	1167.42	1167.45	Horn Valley Siltstone	0.33	1.15	0.26	437	136	31	0.85
Tent Hill 1	1169.7	1169.75	Horn Valley Siltstone	0.14	0.32	0.26	449	79	63	0.41
Tent Hill 1	1179.3	1179.35	Horn Valley Siltstone	0.02	0.05	0.16	444	24	75	0.21
Tent Hill 1	1198	1198.02	Pacoota Sandstone	0.01	0.04	0.06	442	36	49	0.12
Tent Hill 1	1208.15	1208.2	Pacoota Sandstone	0.03	0.13	0.05	440	49	17	0.27
Tent Hill 1	1212.9	1212.95	Pacoota Sandstone	0.04	0.20	0.04	441	77	17	0.26
Undandita 1A	285.3	285.4	Tempe Formation	0.01	0.14	0.21	417	14	21	0.97





**Table 2.** Definitions of Rock-Eval pyrolysis parameters

Parameter	Name (units)	Definition
S1	mg extractable hydrocarbons (HCs) / g rock	Measure of the amount of free hydrocarbons (HCs) present in the rock. The free HCs are those thermally desorbed at 300°C for 3 mins.
S2	mg HCs (kerogen pyrolysate) / g rock	Measure of HCs formed by cracking of kerogen, resins and asphaltenes. The pyrolysate is measured from 300°C to 650°C at 25°C/min
S3	mg CO <sub>2</sub> (organic) / g rock	Measure of CO <sub>2</sub> generated from oxygenated functional groups in kerogen. The CO <sub>2</sub> is collected from 300°C to 390°C at 25°C/min
Tmax	Maximum height of the S2 peak in the temperature program (°C)	The temperature corresponding to the maximum rate of HC generation from the cracking of kerogen (S2)
TOC	Total Organic Carbon (wt %)	Measure of the rock's organic richness. TOC = PC (pyrolysable carbon, wt %) + RC (Residual carbon, wt %)
PC	Pyrolysable carbon (wt %)	The amount of TOC represented by S1 and S2. PC = 0.83 * (S1 + S2)
RC (S4)	mg C / g rock	Measure of the residual carbon (RC) in a rock. Also termed S4.
PI	Production Index	The extent to which kerogen has been transformed into oil and gas. PI = [S1 / (S1 + S2)]
HI	Hydrogen Index [mg hydrocarbons (S2) /g TOC]	Amount of HCs released on pyrolysis (S2) normalised to TOC. HI = 100 * S2 / TOC
OI	Oxygen Index [mg CO <sub>2</sub> (S3) /g TOC]	Amount of carbon dioxide released on pyrolysis (S3) normalised to TOC. OI = 100 * S3 / TOC
MINC	Mineral Carbon (wt %)	The amount of carbon (C) contained in mineral phases e.g. carbonates. Also termed total inorganic carbon (TIC)