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1. INTRODUCTION

Pangaea Resources Pty Ltd carried out core sampling at the Northern Territory Geological Survey's core facility library in Alice Springs in May, 2010. The aim of the sampling was to expand previous work to identify potential source rocks in the Amadeus and Georgina Basins.

Nine wells were sampled in total; four from the Amadeus Basin and five from the Georgina Basin as listed in Table 1 and shown in Figure 1. Wells were chosen to achieve a lateral and vertical distribution of samples across different formations. Sample selection was biased towards picking dark, visibly organic-rich looking shales. Sampling from the Amadeus wells avoided the younger Ordovician and Devonian rocks, which already have a wealth of data available.

Well	Basin
Baldwin 1	Georgina
Phillip 2	Georgina
Huckitta 1	Georgina
Randall 1	Georgina
Hacking 1	Georgina
Highway Anticline 1	Amadeus
Erldunda 1	Amadeus
Mt Winter 1	Amadeus
Murphy 1	Amadeus

Table 1: List of wells sampled with corresponding basins.

A subset of the samples collected was sent to CoreLabs in Kuala Lumpur for rock eval analysis. The results are presented below.

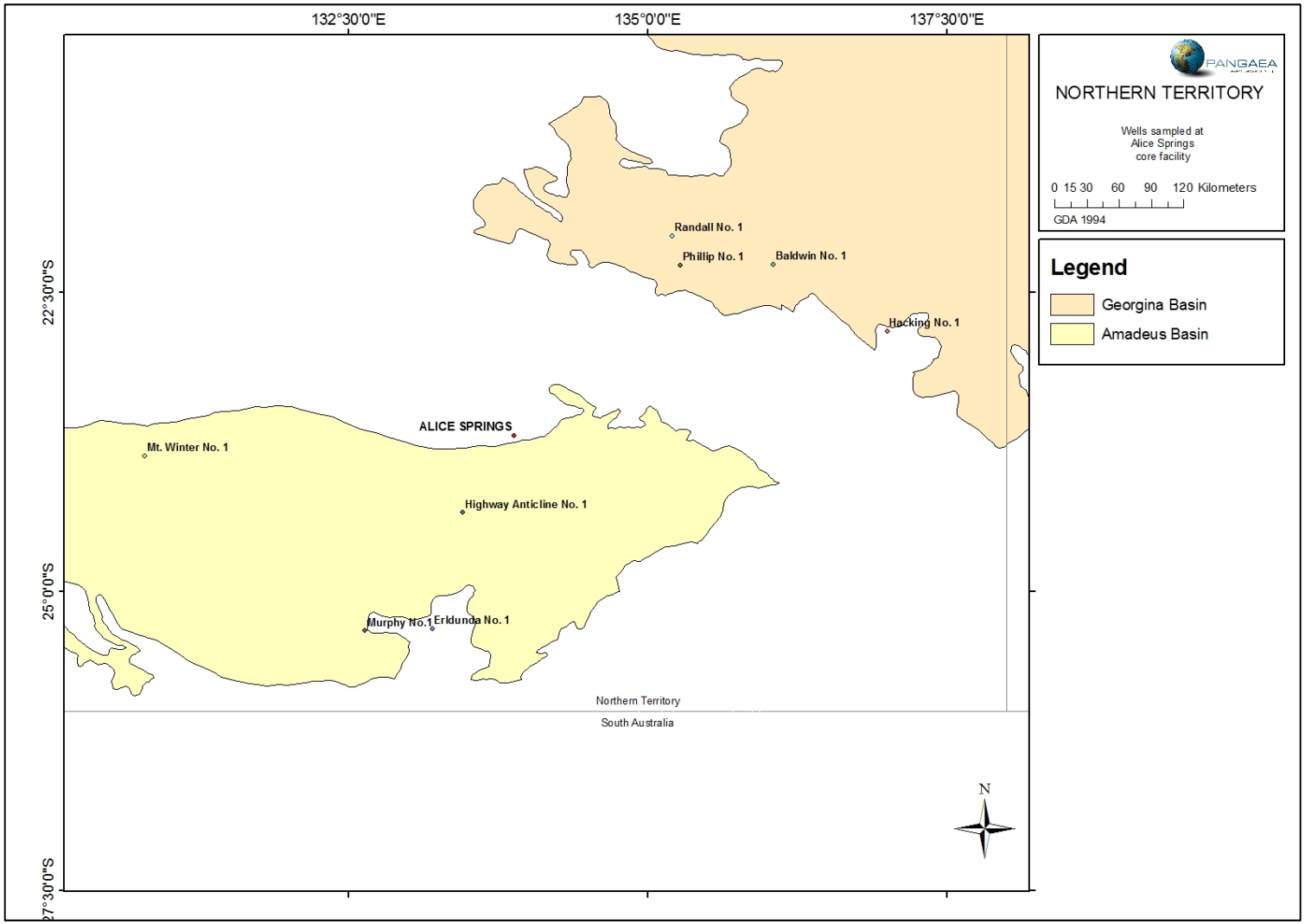

Figure 1 - Map showing the location of wells sampled.

2. RESULTS

Thirty-six samples were sent to CoreLabs for analysis. Refer to Table 2 for all results.

2.1 Total organic carbon (TOC) content

2.1.1 Georgina Basin

The twenty-six samples analysed from the Georgina Basin yielded TOC contents between 13.75% and 0.08%, with an average of 2.97%. Twenty samples were analysed from the Cambrian Arthur Creek Formation. The maximum and minimum TOC content from this formation was 13.75% and 0.08% respectively, with an average of 3.35%.

Only one sample each was analysed for the Late Cambrian Chabalowe and Elyuah Formation, which gave TOC contents of 0.22% and 0.23% respectively. Two samples were analysed from the Neoproterozoic Mopunga Formation in Baldwin 1, producing TOC contents between 1.76% and 2.37%. Two samples were also analysed from the Early Cambrian Mt Baldwin Formation, yielding TOC contents of 0.35% and 5.18%.

2.1.2 Amadeus Basin

Ten samples analysed from the Amadeus Basins returned TOC contents between 3.75% and 0.03%, with an average 1.33%. The Areyonga Formation from Erldunda 1 gave the highest TOC content, whereas the Pertaoorta Group in Murphy 1 gave the lowest.

2.2 Rock eval pyrolysis

2.2.1 Georgina Basin

T_{max} ranges from 301°C to 538°C, with an average of 405°C. Results are problematic where the oil production index (OPI) is >0.1 and T_{max} is low because the rock is apparently not mature enough to return an OPI this high. The pyrograms for these samples should be reviewed to ensure that the correct S_2 peak has been picked.

2.2.2 Amadeus Basin

T_{max} ranges from 301°C to 341°C, with an average of 316.8°C. These results are also considered to be inconsistent as the OPI is high but T_{max} is low. Again, reviewing the pyrograms will ensure that the correct S_2 peak has been picked.

S_1 = Free Hydrocarbons | S_2 = Pyrolysable Hydrocarbons | S_3 = Organic CO_2

Oil Production Index = Transformation Ratio = $S_1/(S_1+S_2)$ | Tmax = Temperature of Maximum S_2 | Oxygen Index = $(S_3/TOC) \times 100$

* Pyrolysis by Rock Eval II; TOC content by Leco Analyzer | Hydrogen Index = $(S_2/TOC) \times 100$

Well	Depth (m)	Lithology	Sample type	Formation	TOC (wt.%)	mg/gm rock			Tmax (°C)	Oil Productio	Potential Yield	Hydrogen Index	Oxygen Index
						S_1	S_2	S_3					
Hacking 1	1062.60	brnsh gy Sh	Core	Arthur Creek Formation	5.07	0.53	0.82	0.14	403	0.39	1.35	16	3
Hacking 1	1141.60	brnsh blk Sh	Core	Arthur Creek Formation	3.32	0.39	0.51	0.16	448	0.43	0.90	15	5
Hacking 1	1188.80	brnsh blk Sh	Core	Arthur Creek Formation	1.34	-	-	-	-	-	-	-	-
Hacking 1	1199.70	brnsh blk Sh	Core	Arthur Creek Formation	3.00	-	-	-	-	-	-	-	-
Hacking 1	1171.20	brnsh blk Sh	Core	Arthur Creek Formation	0.90	-	-	-	-	-	-	-	-
Hacking 1	1208.10	brnsh blk Sh	Core	Arthur Creek Formation	5.52	0.57	1.29	0.15	455	0.31	1.86	23	3
Baldwin 1	520.20	med lt gy Sh	Core	Arthur Creek Formation	4.64	0.04	0.08	0.17	301	0.33	0.12	2	4
Baldwin 1	601.20	brnsh blk Sh	Core	Arthur Creek Formation	0.14	-	-	-	-	-	-	-	-
Baldwin 1	661.95	brnsh gy Ls	Core	Arthur Creek Formation	0.08	-	-	-	-	-	-	-	-
Baldwin 1	868.40	brnsh blk Sh	Core	Arthur Creek Formation	1.94	-	-	-	-	-	-	-	-
Baldwin 1	878.50	brnsh blk Sh	Core	Arthur Creek Formation	3.28	-	-	-	-	-	-	-	-
Baldwin 1	882.00	brnsh blk Sh	Core	Arthur Creek Formation	7.47	-	-	-	-	-	-	-	-
Baldwin 1	884.50	brnsh blk Sh	Core	Arthur Creek Formation	5.82	-	-	-	-	-	-	-	-
Baldwin 1	887.20	dk gy Sh	Core	Arthur Creek Formation	13.25	-	-	-	-	-	-	-	-
Baldwin 1	889.20	brnsh blk Sh	Core	Arthur Creek Formation	4.08	0.26	0.50	0.18	538	0.34	0.76	12	4
Baldwin 1	900.80	brnsh gy Ls	Core	Arthur Creek Formation	0.09	-	-	-	-	-	-	-	-
Baldwin 1	970.00	gysh rd Sh	Core	Mt Baldwin Formation	5.18	0.03	0.07	0.18	336	0.30	0.10	1	3
Baldwin 1	1043.00	med dk gy Sh	Core	Mopunga Formation	2.37	0.03	0.07	0.11	370	0.30	0.10	3	5
Baldwin 1	1075.35	med dk gy Sh	Core	Mopunga Formation	1.76	0.04	0.18	0.09	500	0.18	0.22	10	5
Huckitta 1	457.18	med dk gy Sh	Cuttings	Arthur Creek Formation	1.30	0.17	0.39	0.26	364	0.30	0.56	30	20
Huckitta 1	627.86	brnsh gy Ls	Cuttings	Arthur Creek Formation	0.11	-	-	-	-	-	-	-	-
Huckitta 1	816.82	med dk gy Sh	Cuttings	Mt Baldwin Formation	0.35	0.08	0.10	0.18	344	0.44	0.18	29	51
Huckitta 1	984.46	med gy Sh	Cuttings	Elyuah Formation	0.23	0.06	0.09	0.22	354	0.40	0.15	39	95
Randall 1	234.41	brnsh gy Sh	Core	Chabalowe	0.22	0.08	0.13	0.14	447	0.38	0.21	58	63
Randall 1	280.52	brnsh gy Ls	Core	Arthur Creek Formation	0.34	0.11	0.38	0.19	444	0.22	0.49	111	55
Phillip 2	419.38	med dk gy Sh	Cuttings	Arthur Creek Formation	5.42	0.02	0.08	0.13	369	0.20	0.10	1	2
Murphy 1	870.00	gysh rd Sh	Cuttings	Pertaoorta Group	0.03	-	-	-	-	-	-	-	-
Murphy 1	1056.00	brnsh blk Sh	Cuttings	Inindia Beds	1.94	0.56	0.57	0.32	303	0.50	1.13	29	16
Murphy 1	1782.00	brnsh blk Sh	Cuttings	Gillen Member	0.13	-	-	-	-	-	-	-	-
Highway Anticline 1	771.11	gysh brn Sh	Cuttings	Hugh River Shale	0.88	0.27	0.47	0.30	302	0.36	0.74	53	34
Erldunda 1	414.51	med dk gy Sh	Cuttings	Cleland Sandstone	0.12	-	-	-	-	-	-	-	-
Erldunda 1	1121.61	dk gy Sh	Cuttings	Pertatataka Formation	2.58	0.07	0.14	0.29	301	0.33	0.21	5	11
Erldunda 1	1270.95	dk gy Sh	Cuttings	Areyonga Formation	3.75	-	-	-	-	-	-	-	-
Erldunda 1	1362.39	brnsh gy Sh	Cuttings	Bitter Springs Formation	0.20	-	-	-	-	-	-	-	-
Mt Winter 1	1337.10	med dk gy Sh	Core	Tempe Formation	2.47	0.01	0.03	0.11	341	0.25	0.04	1	4
Mt Winter 1	1337.81	med dk gy Sh	Core	Tempe Formation	1.22	0.05	0.06	0.15	337	0.45	0.11	5	12

Table 2 – Rock eval pyrolysis and TOC content results.

3. Interpretation

3.1 Georgina Basin

The Arthur Creek Formation is considered to be the most prolific source rock in the Georgina Basin (Ambrose, 2006). Published TOC contents range up to 14.2%, although there is a suggestion that this sample was contaminated with free oil (Dunster et al., 2007). This may also be the case the for high TOC sample collected from Baldwin 1, which gave off petroliferous odour when the core was cut during sampling. The Mt Baldwin and Mopunga Formations also both have TOC >1%, suggesting their potential as source rocks.

Rock eval pyrolysis indicates that although the rock may have had generative capacity, any hydrocarbons generated have migrated away. For example, the potential yield (S_1+S_2) is <2 mg/g for all samples analysed. However, the pyrograms need to be reviewed to ensure that the correct S_2 peak has been picked.

3.2 Amadeus Basin

TOC data from the Amadeus Basin are not as high as the results from the Georgina. However, the best source rock in the basin was not sampled during this project. Intervals in the Areyonga Formation, the Inindia Beds and the Tempe Formation show potential as generative source rocks with TOC >1% (Merrill, 1991). Of interest is the Tempe Formation, which is reported to have low TOC content (<0.12%), except in well Undandita 1A (Marshall, 2005). These new results have yielded TOC contents up to 2.47% in Mt Winter 1. Also of note is the sample collected from the Areyonga Formation from Erldunda 1 that yielded a TOC of 3.75%. Similarly, this exceeds values currently available in the literature (Marshall, 2005). This new data will expand the zones of TOC enrichment as shown in Figures 22 and 36 of Marshall, 2005.

Although TOC data suggests that some of the intervals sampled have potential as source rocks, rock eval pyrolysis points to hydrocarbon migration. However, the pyrograms need to be reviewed to ensure that the correct S_2 peak has been picked. T_{max} is very low for all samples despite over mature vitrinite reflectance equivalent values from the sampled intervals (Marshall, 2005).

4. Conclusions

Sampling was carried out on core and cuttings from selected wells in the Amadeus and Georgina Basins to expand on data already available in the literature. The aim of the work was to understand more about source rocks in the Proterozoic and Cambrian formations.

TOC data collected indicates that the Arthur Creek, Mopunga, Mt Baldwin, Areyonga, Inindia, Pertatataka and Tempe Formations have potential as source rocks per the recommendations of Tissot and Welte, 1984 (Merrill, 1991) with TOC content >1.0%.

Rock eval pyrolysis results are considered problematic based on consistently low T_{max} values in formations known to be over mature. Reviewing the pyrograms is necessary to validate selection of the S_2 peak.

5. References

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