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Destructive Analysis Report

Geologic controls of black shale deposition in the Palaeo-Proterozoic of the McArthur Basin

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under the supervision of Professor Martin Kennedy

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1. Rationale

This report includes the following data: total organic carbon (TOC), total inorganic carbon (TIC), Rock-Eval pyrolysis data (S1, S2, HI, PI, T max, Calc. Ro), XRD and porosity (from grain-density techniques, BET N_2 absorption, SEM imaging) of cored cutting samples selected from ten wells intersecting carbonaceous shale units in the Proterozoic Southern McArthur Basin (NT, Australia).

The McArthur Basin has been investigated by the Australian Shale Carbon Sequestration Group of the University of Adelaide both for research purposes (PhD project) and pursuant an agreement between Adelaide Research & Innovation Pty Ltd and Imperial Oil & Gas Pty Ltd.

Samples were collected from wells BB5 (Bornman J.C., 1982a), McA5 (The Broken Hill Proprietary Co Ltd., 1983), MY4 (Bornman J.C., 1982b), LV09-001 (Reddicliffe T.H. and Rockett. G.M.I., 2010), GRNT-79-7 (Thomas G., 1981), GR10 (Dashlooty S.A., 1982) for studying the Barney Creek Formation, while from wells Broadmere 1 (Amoco Australia Petroleum Company, 1985), Scarborough 1 (Barberis C. and Ledlie. I.M. 1988), and Shea 1 (Hibbird S., 1991) for studying the Velkeri Formation. In addition, samples from well MANT-79-3 (Thomas G., 1981) were chosen to investigate the Lynott Formation. All samples were chosen to be representative of the differing sedimentological natures exhibited through core sections.

Samples were taken from the 1st to the 19th October 2012 at the Core Facilities & Technical Support, Department of Resources, Northern Territory Geological Survey, Darwin, Northern Territory.

2. Sample Preparation and Methodology

2.1 Organic geochemistry (TOC and SRA)

Sample TOC was calculated by subtracting the inorganic carbon content, determined using a modified version of the pressure calcimeter method of Sherrod *et al.* (2002), from the total carbon content, identified using a Carbon-Hydrogen-Nitrogen analyser (Perkin Elmer 2400 Series II CHNS/O).

Total petroleum hydrocarbon analyses (TPH) were conducted using a Source Rock Analyser (SRA TPH Workstation, Weatherford Laboratories Instruments Division); this is equivalent to the "Rock-Eval" analytical instrumentation. The sample is purged in helium prior to being raised into a desorption furnace at 300 °C for 3 minutes which releases the free hydrocarbon, or S1, fraction. The sample is then pyrolysed by heating at a 25 °C/minute ramp to 600 °C to generate the potential hydrocarbon, or S2, fraction. Detection of released hydrocarbons is conducted by flame ionization detection (FID) and quantification is conducted by calibration against a certified reference material of known S1 & S2 response. Based on the TPH data collected by SRA a sub-suite of samples (~3 per core) were identified for further characterization of the organic matter (OM) fractions by mass spectrometry. Both the S1 & S2 fractions of each sample were evolved by thermal and pyrolytic extraction respectively.

2.2 XRD

Mineralogy was determined from randomly orientated bulk powder samples, using X- ray diffraction (XRD; Bruker D8 Advance XRD with Cu source). Samples were scanned between 3.5° - 50°2θ using a 0.02° step size and 1s dwell time. Mineral phases were identified in the Diffrac.Eva software package using reference patterns from the Open Crystallography Database. Clay mineralogy was determined on orientated preparations of the <5μm fraction and prepared as per Moore and Reynolds (1997).

2.3 Porosity (grain-density technique, BET, SEM)

Porosity values were estimated: on 29 samples by means of particle and grain density techniques (Manger, 1963); on a 8-sample subset by means of nitrogen adsorption isotherms from BET measurements; and finally on a 3-sample subset by means of SEM backscatter imaging.
Nitrogen adsorption was used characterize mesopore (2-50 nm) size distribution. A Micromeritics gas adsorption rig at Adelaide Microscopy was used to measure nitrogen adsorption at cryogenic temperatures (77 K). Isotherms were constructed point-by-point by introducing known amounts of nitrogen. The Brunauer-Emmett-Teller (BET) method was used to derive surface

area from the isotherms. The Horvath and Kawazoe (HK) method was used to calculate pore size distributions from the isotherms.

Porosity was also calculated from scanning electron microscope (SEM) images. The samples were polished by ion milling, then imaged with an FEI Quanta 450 SEM at Adelaide Microscopy. Back-scattered electron images were used because they provide good mineral phase contrast. The SEM images were analysed with Fiji/ImageJ software. The images were thresholded to provide a binary image that segmented pores from all other phases. Porosity was then calculated from the thresholded image.

3. Results

Data are tabulated and illustrated in the following tables and figures:

Table 1 – TOC and SRA (Rock-Eval equivalent) data

Table 2 – XRD data

Table 3 – Porosity values estimated from particle and grain density techniques

Table 4 – Nitrogen absorption isotherms values (from BET measurements) for estimating %Micropore volumes.

Table 5 – Comparison between the porosity values estimated from particle and grain size density techniques and from SEM backscatter images.

Table 6 – Pore size distribution of samples.

Figure 1 – SEM backscatter images

Figure 2 – Cross-plots between porosity and TOC values and between porosity and Calc. Ro % values.

4. References

Amoco Australia Petroleum Company (1985). Broadmere 1 Well Completion Report. *Northern Territory Geological Survey*, Open File Petroleum Report PR_1985-0015.

Barberis C. and Ledlie. I.M. (1988). Scarborough 1 Well Completion Report. Pacific Oil & Gas Pty Ltd. *Northern Territory Geological Survey*, Open File Petroleum Report PR_989-0094.

Bornman J.C. (1982a). BB5 Well Completion Report. The Shell Company of Australia Ltd. Metal Division. Annual Report on EL-1782 Bing Bong Northern Territory. Report n. 08.1145. *Northern Territory Geological Survey*, Open File CR 1982-0249.

Bornman J.C. (1982b). MY4 Well Completion Report. The Shell Company of Australia Ltd. Metal Division. *Northern Territory Geological Survey*, Open File PR 1982-0020.

Hibbird S. (1991). Shea 1 Well Completion Report. Pacific Oil & Gas Pty Ltd. *Northern Territory Geological Survey*, Open File Petroleum Report PR_1991-0077.

Manger G.E., 1963. Porosity and Bulk Density of Sedimentary Rocks. Contributions to Geochemistry, United States Department of the Interior, *Geological Survey Bulletin* 1144-.

Dashlooty, S.A. (1982). GR10 Well Completion Report. *Northern Territory Geological Survey*, Open File Petroleum Report CR_1983-0048.

Moore D.M. & Reynolds R.C., 1997. X-ray Diffraction and the Identification and Analysis of Clay Minerals Second, *Oxford University Press*.

Reddicliffe T.H. and Rockett. G.M.I. (2010). Leviathan Anomaly, Drill-hole LV09-001. North Australian Diamonds Limited. Northern Territory Geological Survey, Open File Petroleum Report CR_2010-0260.

Sherrod L. *et al.*, 2002. Inorganic carbon analysis by modified pressure-calcimeter method. *Soil Science Society of America Journal*, 66(1), pp.299–305.

The Broken Hill Proprietary Co Ltd. (1983). McA5 Well Completion Report. *The Broken Hill Proprietary Co. Ltd*. *Northern Territory Geological Survey (NTGS)* Open File: CR 1983-0202.

Thomas, G. (1981). MANT79/3 and GR7 Wells Completion Report. *Kennecott Explorations (Australia) Ltd.* Northern Territory Geological Survey, Open File Petroleum Report CR_1981-0028.

Table 1 - TOC and SRA data									
Sample ID	**Depth (m)**	**TIC (wt %)**	**TOC (wt %)**	**S1**	**S2**	**T Max (°C)**	**Calc. Ro**	**HI**	**PI**
BB5-42	215.6	2.3	2.6	0.28	0.47	445	0.85	18	0.37
BB5-40	218.5	0.1	1.5	0.05	0.13	438	0.73	9	0.28
BB5-37	223.6	5.0	1.3	0.12	0.27	447	0.89	20	0.31
BB5-35	228.4	5.1	0.9	-	-	-	-	-	-
BB5-33	234.5	4.0	1.3	-	-	-	-	-	-
BB5-30	245.7	1.6	0.7	0.06	0.14	431	0.59	21	0.30
BB5-28	251.6	5.3	0.9	-	-	-	-	-	-
BB5-27	255.5	3.4	0.9	-	-	-	-	-	-
BB5-24	262.5	3.7	0.7	0.08	0.10	444	0.83	13	0.44
BB5-22	273.0	2.5	0.9	-	-	-	-	-	-
BB5-19	283.7	2.2	1.3	0.11	0.16	439	0.74	13	0.41
BB5-17	292.2	3.0	1.3	-	-	-	-	-	-
BB5-14	302.4	0.7	1.3	0.15	0.30	434	0.65	24	0.33
BB5-12	308.4	1.4	3.8	0.36	0.92	448	0.90	24	0.28
BB5-11	311.4	1.5	3.7	0.22	0.91	448	0.91	25	0.19
BB5-9	316.9	0.8	1.5	-	-	-	-	-	-
BB5-7	325.9	0.8	1.1	-	-	-	-	-	-
BB5-6	332.6	0.5	1.1	0.13	0.24	441	0.78	23	0.35
BB5-4	337.7	0.2	0.5	-	-	-	-	-	-
BB5-2	343.7	0.0	0.2	-	-	-	-	-	-
McA5-52	68.0	1.3	2.8	0.53	1.83	463	1.18	66	0.22
McA5-49	83.4	0.5	3.2	0.36	1.36	455	1.04	43	0.21
McA5-46	101.7	1.8	1.8	0.17	0.57	441	0.79	32	0.23
McA5-44	109.0	2.0	1.6	-	-	-	-	-	-
McA5-40	136.0	2.9	2.0	0.28	0.65	426	0.51	32	0.30
McA5-36	172.0	1.2	0.5	0.03	0.08	427	0.52	16	0.27
McA5-34	183.4	2.9	0.9	-	-	-	-	-	-
McA5-32	207.8	2.8	0.8	0.05	0.08	444	0.83	10	0.38
McA5-29	235.3	2.7	1.1	-	-	-	-	-	-
McA5-27	247.4	1.3	1.1	0.39	0.63	404	0.11	60	0.38
McA5-23	276.2	2.4	0.4	-	-	-	-	-	-
McA5-58	293.2	0.5	0.2	0.01	0.04	441	0.78	17	0.20
McA5-20	293.5	1.9	1.6	-	-	-	-	-	-
McA5-60	298.0	1.9	1.3	0.20	0.35	456	1.04	28	0.36
McA5-17	314.0	1.0	6.3	0.73	2.61	462	1.15	41	0.22
McA5-16	321.2	1.5	4.1	0.42	1.08	450	0.94	26	0.28
McA5-15	327.9	1.3	1.6	0.27	0.45	436	0.69	28	0.38
McA5-14	336.3	1.6	1.2	0.21	0.35	436	0.68	29	0.38
McA5-13	344.8	1.1	1.0	0.24	0.36	443	0.82	34	0.40
McA5-12	354.6	0.5	1.4	0.32	0.33	445	0.85	23	0.49
McA5-9	368.3	1.6	0.4	-	-	-	-	-	-
McA5-4	386.4	1.5	0.5	0.01	0.02	445	0.85	4	0.33
McA5-56	390.0	0.3	0.1	-	-	-	-	-	-
MY4-10	22.7	1.2	1.6	0.10	0.84	443	0.82	52	0.11
MY4-9	26.8	1.1	1.9	-	-	-	-	-	-
MY4-8	26.9	4.6	0.9	0.19	1.13	433	0.63	126	0.14
MY4-7	33.0	4.0	1.3	0.14	1.00	440	0.76	79	0.12
MY4-6	43.9	2.0	2.9	0.27	2.82	443	0.81	98	0.09
MY4-5	55.5	7.6	1.9	0.31	2.84	425	0.49	151	0.10
MY4-4	58.9	3.0	3.2	0.28	3.03	442	0.79	94	0.08
MY4-3	69.8	2.9	1.0	0.10	0.43	440	0.77	44	0.19
MY4-2	76.8	1.8	1.2	-	-	-	-	-	-
MY4-1	85.0	2.6	2.6	0.11	1.49	444	0.82	57	0.07
LV09-47	397.7	3.5	0.5	0.03	0.09	423	0.46	17	0.25
LV09-45	403.5	6.5	0.9	0.12	2.44	430	0.57	273	0.05
LV09-42	414.7	0.8	2.5	1.36	10.49	424	0.48	427	0.11
LV09-40	423.0	0.4	2.6	-	-	-	-	-	-
LV09-38	427.3	2.1	2.0	0.82	8.06	434	0.65	409	0.09
LV09-36	430.0	2.5	1.4	-	-	-	-	-	-
LV09-34	435.4	1.2	1.6	0.72	4.34	432	0.61	272	0.14
LV09-32	440.7	2.1	1.2	0.98	5.40	424	0.48	445	0.15
LV09-31	443.2	0.2	3.5	2.38	17.03	433	0.64	492	0.12
LV09-30	446.3	1.9	2.1	0.96	8.08	435	0.67	380	0.11
LV09-11	448.4	0.9	1.6	0.60	5.15	429	0.57	323	0.10
LV09-28	455.6	0.4	1.1	0.43	3.26	432	0.61	291	0.12
LV09-10	459.3	0.2	3.2	1.55	13.79	434	0.65	434	0.10
LV09-27	466.5	1.6	2.1	0.44	5.09	424	0.47	243	0.08
LV09-9	474.2	1.1	2.4	-	-	-	-	-	-
LV09-8	478.3	0.3	2.6	-	-	-	-	-	-
LV09-5	480.0	0.8	2.8	-	-	-	-	-	-
LV09-24	480.4	0.8	2.8	1.65	10.64	425	0.48	374	0.13
LV09-7	485.9	0.1	2.5	1.45	8.99	428	0.54	354	0.14
LV09-22	496.6	0.9	2.6	1.41	8.91	437	0.70	339	0.14
LV09-6	498.5	0.1	3.3	1.21	9.64	432	0.61	295	0.11
LV09-20	501.7	0.3	1.5	0.53	3.58	432	0.61	240	0.13
LV09-3	502.3	0.2	1.1	0.19	1.10	438	0.72	98	0.15
LV09-19	506.0	2.0	1.9	1.13	7.57	435	0.66	403	0.13
LV09-2	509.6	0.3	6.4	3.06	32.42	440	0.77	507	0.09

LV09-15	512.9	6.3	0.2	0.21	1.58	430	0.58	717	0.12
LV09-1	515.5	0.6	3.0	1.36	11.21	435	0.67	370	0.11
LV09-13	517.5	4.5	0.9	0.45	3.55	433	0.64	412	0.11
GR7-1	53.4	3.3	2.0	0.20	5.82	433	0.64	295	0.03
GR7-3	92.3	0.1	1.8	0.13	1.47	430	0.57	81	0.08
GR7-6	162.5	4.1	1.3	-	-	-	-	-	-
GR7-8	195.0	4.4	1.8	0.49	5.49	436	0.70	298	0.08
GR7-9	205.5	0.9	1.2	-	-	-	-	-	-
GR7-10	255.5	2.3	3.3	0.84	13.00	436	0.68	389	0.06
GR7-11	275.0	2.3	1.8	0.49	7.84	436	0.69	427	0.06
GR7-12	297.5	1.9	1.5	0.24	3.25	436	0.68	217	0.07
GR7-15	329.0	3.5	0.1	0.04	0.34	429	0.57	299	0.11
GR7-17	352.0	2.2	1.1	-	-	-	-	-	-
GR7-19	386.0	2.9	0.9	0.14	1.51	436	0.68	160	0.08
GR7-21	422.0	2.3	1.0	0.11	0.89	433	0.64	90	0.11
GR7-23	466.0	3.8	0.7	0.07	0.60	434	0.65	84	0.10
GR7-26	495.5	2.3	1.3	-	-	-	-	-	-
GR7-30	558.4	2.3	1.9	0.40	2.80	439	0.75	150	0.13
GR7-33	601.0	2.7	1.5	-	-	-	-	-	-
GR7-37	636.0	2.5	1.6	-	-	-	-	-	-
GR7-40	692.5	1.9	1.6	0.38	1.92	441	0.77	123	0.17
GR7-42	722.0	0.4	0.4	-	-	-	-	-	-
GR7-45	770.0	1.0	1.7	0.50	2.79	444	0.83	160	0.15
GR7-47	803.2	1.2	1.5	-	-	-	-	-	-
GR7-51	847.0	2.1	1.3	-	-	-	-	-	-
GR7-53	880.4	0.3	0.7	-	-	-	-	-	-
GR7-55	901.3	0.4	0.8	-	-	-	-	-	-
GR10-129	22.1	3.7	1.9	0.39	10.77	432	0.61	557	0.03
GR10-126	35.4	1.6	2.7	0.31	10.07	433	0.63	373	0.03
GR10-123	48.7	1.2	2.5	0.37	11.60	432	0.61	472	0.03
GR10-117	65.5	1.0	2.0	0.22	6.65	432	0.61	338	0.03
GR10-114	77.2	0.4	2.3	0.35	7.94	431	0.60	345	0.04
GR10-106	105.8	4.9	2.0	0.51	6.64	434	0.64	340	0.07
GR10-101	125.1	3.9	4.3	0.88	17.13	436	0.69	401	0.05
GR10-95	152.2	1.0	1.8	0.21	4.85	419	0.39	270	0.04
GR10-90	175.8	3.8	0.8	-	-	-	-	-	-
GR10-83	213.9	2.2	1.0	-	-	-	-	-	-
GR10-80	232.7	2.9	1.4	-	-	-	-	-	-
GR10-76	264.8	2.9	1.4	0.17	2.48	435	0.66	177	0.06
GR10-74	285.0	3.3	1.1	0.21	2.98	437	0.71	279	0.07
GR10-71	305.0	2.5	1.2	0.18	2.28	437	0.70	185	0.07
GR10-67	326.5	4.2	0.1	0.05	0.41	427	0.52	315	0.11
GR10-63	348.4	2.7	1.0	0.07	0.90	439	0.74	86	0.07
GR10-56	375.9	2.8	0.7	0.08	0.93	434	0.65	142	0.08
GR10-50	407.0	1.8	1.2	0.19	1.44	436	0.69	118	0.12
GR10-46	440.3	3.0	1.1	0.12	0.89	437	0.71	83	0.12
GR10-42	472.7	4.1	0.9	0.12	0.84	439	0.75	89	0.13
GR10-37	505.9	2.8	1.1	-	-	-	-	-	-
GR10-31	522.2	1.4	1.4	0.35	1.87	442	0.79	135	0.16
GR10-29	568.0	0.7	1.7	0.29	1.98	443	0.81	117	0.13
GR10-27	582.5	1.9	1.2	-	-	-	-	-	-
GR10-18	616.5	0.7	1.2	-	-	-	-	-	-
GR10-13	638.7	1.0	1.0	-	-	-	-	-	-
GR10-6	677.7	3.3	0.4	-	-	-	-	-	-
GR10-1	703.8	5.1	0.3	-	-	-	-	-	-
MANT-1	12.9	1.4	1.4	-	-	-	-	-	-
MANT-2	33.5	3.0	1.7	0.06	0.06	444	0.83	4	0.50
MANT-3	50.0	2.4	0.8	-	-	-	-	-	-
MANT-4	71.3	3.9	1.6	0.04	0.09	458	1.08	6	0.31
MANT-5	82.6	1.9	0.7	-	-	-	-	-	-
MANT-6	100.0	-	-	-	-	-	-	-	-
MANT-7	129.7	2.7	0.8	-	-	-	-	-	-
MANT-8	144.2	4.5	0.4	-	-	-	-	-	-
MANT-9	156.5	0.7	1.1	0.04	0.06	470	1.30	6	0.40
MANT-10	161.7	5.5	0.5	0.03	0.02	440	0.76	4	0.60
BROAD1-72	112.3	6.4	0.0	0.03	0.09	435	0.68	252	0.25
BROAD1-68	124.3	0.4	2.4	0.44	4.21	423	0.45	178	0.09
BROAD1-65	133.3	0.0	2.8	0.87	7.64	432	0.62	273	0.10
BROAD1-64	136.3	0.3	2.9	0.66	8.91	435	0.66	307	0.07
BROAD1-62	142.3	0.2	4.8	0.77	12.29	434	0.65	257	0.06
BROAD1-60	148.3	0.3	3.9	0.40	5.32	425	0.49	136	0.07
BROAD1-58	154.3	0.1	3.8	0.39	5.45	430	0.57	145	0.07
BROAD1-56	160.3	0.3	2.5	0.24	2.01	432	0.62	80	0.11
BROAD1-54	166.3	0.4	1.1	0.18	1.15	435	0.66	102	0.14
BROAD1-50	178.3	0.1	0.8	-	-	-	-	-	-
BROAD1-47	187.3	0.1	0.2	-	-	-	-	-	-
BROAD1-43	199.3	0.0	0.2	-	-	-	-	-	-
BRAOD1-39	211.3	0.1	0.1	-	-	-	-	-	-
BROAD1-35	223.3	0.1	0.1	-	-	-	-	-	-
BROAD1-31	235.3	0.0	0.1	-	-	-	-	-	-
BROAD1-27	247.3	0.0	0.1	-	-	-	-	-	-

BROAD1-23	259.3	0.0	0.2	-	-	-	-	-	-
BROAD1-19	271.3	0.0	0.1	-	-	-	-	-	-
BROAD1-15	283.4	0.1	0.1	-	-	-	-	-	-
BROAD1-11	295.6	0.2	0.2	-	-	-	-	-	-
BROAD1-8	310.8	0.4	0.6	-	-	-	-	-	-
BROAD1-5	323.1	0.2	0.2	-	-	-	-	-	-
BROAD1-1	335.2	0.1	2.5	0.28	3.78	451	0.96	153	0.07
SCAR1-1	127.0	0.0	0.7	0.10	0.60	441	0.78	80	0.14
SCAR1-5	166.4	0.0	0.6	0.06	0.20	432	0.61	31	0.23
SCAR1-7	187.0	0.0	0.6	0.06	0.14	426	0.52	22	0.30
SCAR1-10	193.6	0.0	0.7	0.07	0.27	430	0.58	40	0.21
SCAR1-12	213.4	0.0	1.7	0.48	1.90	430	0.59	109	0.20
SCAR1-14	230.8	0.0	2.3	0.73	3.03	431	0.60	131	0.19
SCAR1-16	248.4	0.0	0.8	0.25	0.56	449	0.92	64	0.31
SCAR1-20	287.5	0.0	2.5	1.15	2.35	437	0.71	91	0.33
SCAR1-26	317.0	0.0	1.4	0.05	0.17	425	0.49	12	0.23
SCAR1-28	332.0	0.0	2.3	0.49	1.83	429	0.56	77	0.21
SCAR1-32	366.0	0.0	2.6	1.17	3.30	436	0.69	125	0.26
SCAR1-36	401.8	0.0	1.2	0.24	0.57	448	0.90	46	0.30
SCAR1-40	439.4	0.0	3.5	1.22	2.98	442	0.80	85	0.29
SCAR1-44	454.4	0.2	0.1	-	-	-	-	-	-
SCAR1-46	472.0	0.0	0.1	-	-	-	-	-	-
SCAR1-50	510.6	0.0	0.3	-	-	-	-	-	-
SCAR1-53	523.4	0.0	0.2	-	-	-	-	-	-
SCAR1-56	537.5	0.0	0.1	-	-	-	-	-	-
SCAR1-61	559.5	0.0	0.1	-	-	-	-	-	-
SCAR1-66	581.1	0.0	0.2	-	-	-	-	-	-
SCAR1-70	601.0	0.0	1.7	-	-	-	-	-	-
SCAR1-75	620.4	0.0	0.0	-	-	-	-	-	-
SHEA1-110	283.7	0.1	0.4	-	-	-	-	-	-
SHEA1-106	296.7	0.1	0.4	-	-	-	-	-	-
SHEA1-101	317.9	0.0	0.4	-	-	-	-	-	-
SHEA1-96	334.0	0.1	0.4	-	-	-	-	-	-
SHEA1-92	352.4	0.1	0.5	-	-	-	-	-	-
SHEA1-89	369.0	0.1	0.9	-	-	-	-	-	-
SHEA1-84	385.5	0.0	0.5	-	-	-	-	-	-
SHEA1-80	400.6	0.1	0.6	-	-	-	-	-	-
SHEA1-75	419.6	0.2	2.8	1.07	6.18	440	0.76	223	0.15
SHEA1-70	443.0	0.3	0.2	-	-	-	-	-	
SHEA1-64	470.4	0.1	3.0	1.96	7.03	438	0.73	232	0.22
SHEA1-59	484.5	0.1	7.9	3.30	21.51	437	0.71	273	0.13
SHEA1-57	493.0	0.0	3.8	2.01	7.60	433	0.64	200	0.21
SHEA1-54	502.6	0.1	5.8	2.23	11.73	435	0.68	202	0.16
SHEA1-50	515.5	0.1	5.3	2.75	14.73	441	0.77	277	0.16
SHEA1-41	535.0	0.1	3.7	1.48	4.37	441	0.77	118	0.25
SHEA1-36	552.4	0.1	2.8	2.06	4.52	434	0.65	159	0.31
SHEA1-34	559.4	0.0	2.7	1.91	4.92	440	0.76	180	0.28
SHEA1-32	567.0	0.1	2.3	2.71	4.64	438	0.72	203	0.37
SHEA1-29	574.1	0.1	2.8	2.81	7.58	422	0.44	273	0.27
SHEA1-26	582.8	0.2	3.3	3.28	5.95	431	0.59	180	0.36
SHEA1-9	596.9	0.1	2.6	0.99	2.00	434	0.65	78	0.33
SHEA1-1	613.7	0.1	0.1	-	-	-	-	-	-

Table 2 – XRD data qualitative analysis

Core	Sample number – (Depth; m)	Quartz	Feldspar	Dolomite	Calcite	Mica	Illite	Pyrite	Gypsum	Apatite	Mixed-layer Illite/Smectite	Kaolinite	Chlorite
BB5	2 - (343.7)	X	X	X		X	X						X
BB5	6 - (332.6)	X	X	X		X	X	X					X
BB5	42 - (215.6)	X	X	X		X	X	X	X				X
McA5	16 - (321.2)	X	X	X		X	X	X	X	X			X
McA5	52 - (68.0)	X	X	X		X	X	X	X	X			X
McA5	58 - (293.2)	X	X			X	X	X			X		X
GR7	42 - (722.0)	X	X	X		X	X	X					X
GR7	10 - (255.5)	X	X	X	X	X	X	X	X				X
GR10	106 - (105.8)	X	X	X		X	X	X	X				X
GR10	6 - (677.7)	X	X	X	X	X	X			X			X
LV09	31 - (443.2)	X	X	X		X	X	X	X				
LV09	47 - (397.7)	X	X	X		X	X	X	X				
LV09	10 - (459.3)	X	X	X		X	X	X	X				
MY4	6 - (43.9)	X	X	X		X	X	X	X				X
MY4	4 - (58.9)		X	X		X	X	X	X				X

Bulk mineralogy of the selected samples from the Barney Creek Formation

Core	Sample number – (Depth; m)	Quartz	Feldspar	Dolomite	Calcite	Mica	Illite	Pyrite	Gypsum	Apatite	Mixed-layer Illite/Smectite	Kaolinite	Chlorite
SHEA1	54 - (166.3)	X				X	X	X	X	X	X		X
SHEA1	64 - (136.3)	X	X	trace		X	X	X	X	X	X		X
SCAR1	46 - (472.0)	X	X	trace		X	X				X	X (high)	X
SCAR1	40 - (439.4)	X	X			X	X	X	X	X	X		X
SCAR1	16 - (248.4)	X	X			X	X	X			X		X
Broad	62 - (142.3)	X		trace		X	X	X	X	X	X		X
Broad	68 - (124.3)	X		X		X	X	X	X	X	X		X
Broad	1 - (335.2)	X				X	X	X			X		X

Bulk mineralogy of the selected samples from the Velkerri Formation

Core	Sample number – (Depth; m)	Quartz	Feldspar	Dolomite	Calcite	Mica	Illite	Pyrite	Gypsum	Apatite	Mixed-layer Illite/Smectite	Kaolinite	Chlorite
MANT	3 - (50.0)	X	X	X		X	X	X	X				
MANT	4 - (71.3)	X	X	X		X	X	X	trace	X			X
MANT	5 - (82.6)	X	X	X		X	X	X					X

Bulk mineralogy of the selected samples from the Lynott Formation

Sample	Porosity	Depth (m)
LV09-47	6.86%	397.65
LV09-45	4.38%	403.50
LV09-42	6.27%	423.00
LV09-36	2.41%	430.00
LV09-31	2.98%	443.20
LVO9-10	1.88%	459.25
LVO9-8	5.64%	478.25
LVO9-7	2.22%	485.85
LVO9-6	2.58%	498.45
LVO9-1	0.19%	515.45
GR7-1	2.93%	53.40
GR7-6	0.11%	162.50
GR7-9	0.94%	205.50
GR7-10	2.62%	255.50
GR7-17	2.53%	352.00
GR7-26	2.47%	495.50
GR7-30	0.27%	558.35
GR7-40	1.20%	692.50
GR7-45	1.83%	770.00
GR7-51	0.16%	847.00
MCA5-52	3.28%	68.00
MCA5-49	3.81%	83.40
MCA5-40	0.53%	136.00
MCA5-34	1.45%	183.40
MCA5-20	1.35%	293.50
MCA5-16	0.76%	321.20
MCA5-12	0.50%	354.60
MCA5-4	2.65%	386.40
MCA5-56	0.40%	390.00

Table 3 – Porosity values estimated from particle and grain density techniques for the three cores intersecting the Barney Creek Formation (McA5, LV09, and GR7). Values range from 0.11 to 6.86 %, with the highest values found on well LV09.

Sample	Adsorption N2 Total Volume (cc/g)	t-plot Micropore volume (cc/g)	%Micropore Volume
LV09_42	0.00370	0.000000	0.00%
LV09_31	0.00630	0.000343	5.45%
LV09_10	0.01130	0.000000	0.00%
McA5_16	0.00720	0.000106	1.47%
McA5_49	0.00725	0.000000	0.00%
McA5_52	0.00730	0.000160	2.20%
GR7_1	0.02011	0.002072	10.30%
GR7_10	0.01290	0.000843	6.53%

Table 4 – Nitrogen absorption isotherms values (from BET measurements) for estimating %Micropore volumes of eight selected samples from cores LV09, McA5 and GR7.

Sample	Porosity - Image 40μm	Porosity - Grain Density	%TOC
LV09_42	6.27%	6.27%	2.46
GR7_10	2.62%	2.62%	3.34
McA5_52	3.28%	3.28%	2.78

Table 5 – Comparison between the porosity values estimated from particle and grain size density techniques and from SEM backscatter images on three control samples at 40-micrometre scale. Values appear surprisingly identical.

Macropore		Mesopore		Micropore		**Total Porosity**
PSD%	Porosity	PSD%	Porosity	PSD%	Porosity	
1%	0.07%	99%	4.69%	0%	0.00%	**4.75%**
11%	0.06%	39%	0.23%	50%	0.29%	**0.59%**
3%	0.02%	46%	0.28%	52%	0.31%	**0.61%**

Table 6 – Pore size distribution of samples LV09-42, GR7-10 and McA5-52 (from top to bottom) estimated by combining SEM backscatter images with nitrogen adsorption isotherms from BET measurements.

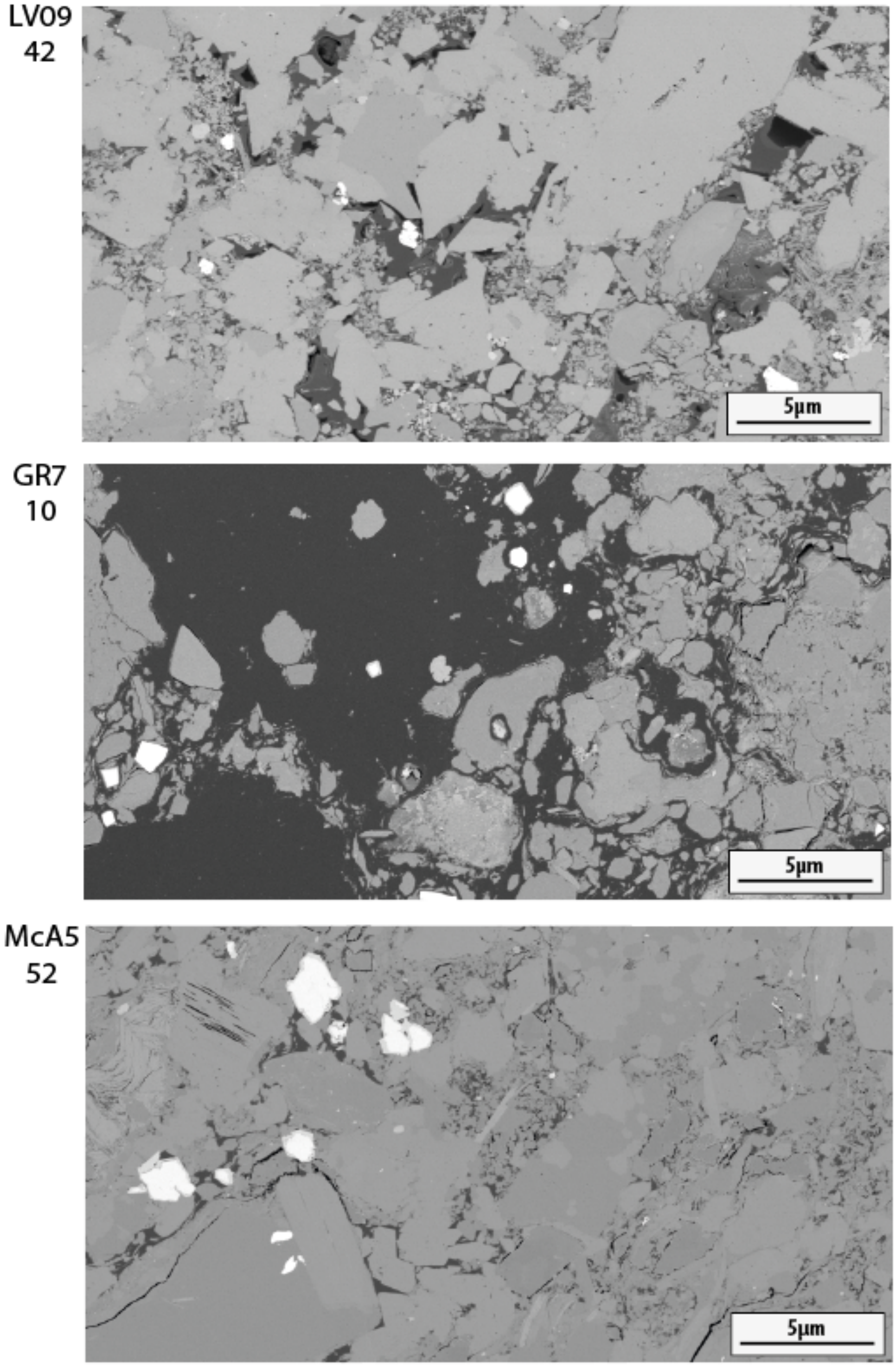
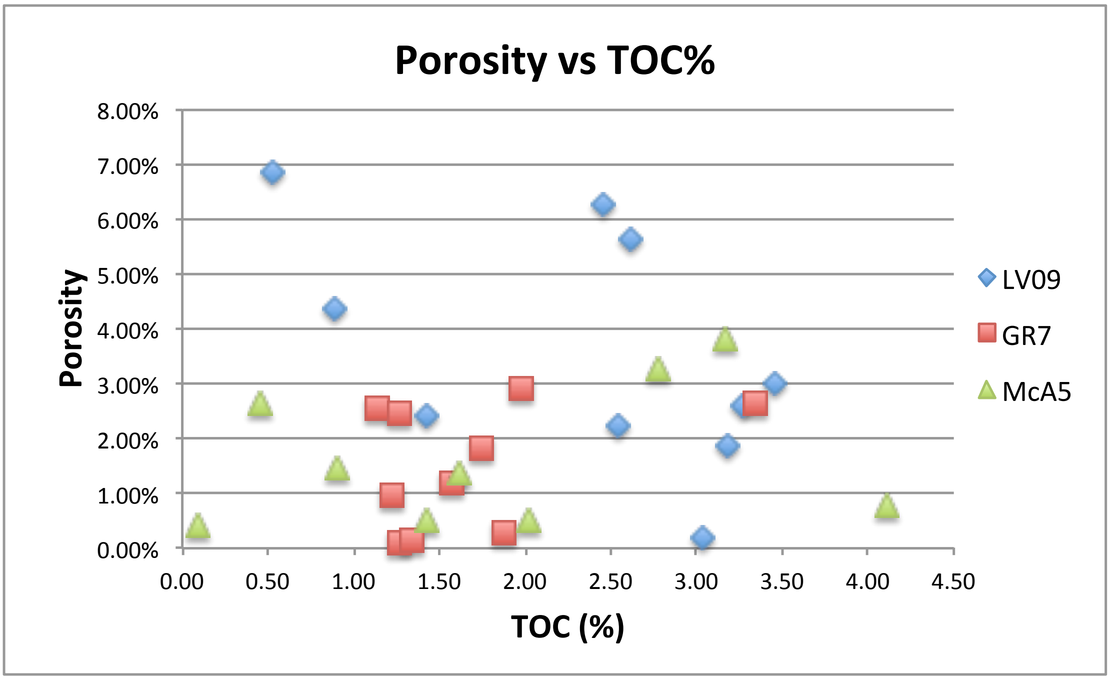


Figure 1 – SEM backscatter images of the three samples LV09-42, GR7-10 and McA5-52 at 5-micrometre scale.



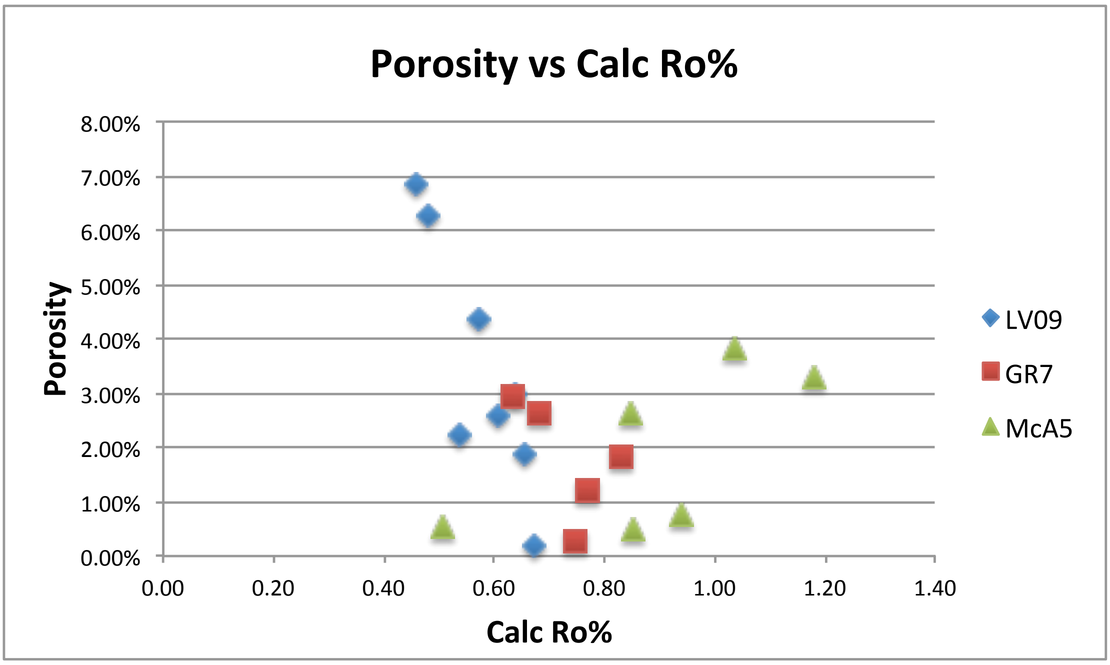


Figure 2 – Cross-plots between porosity and TOC values (above) and between porosity and Calc. Ro % values (below). The two plots show that while no correlation is found between porosity and TOC values, an inverse relationship between porosity and thermal maturity (Calc. Ro % values) appear to subsist in cores GR7 and LV09.