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2015

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J. Reyes[1], M.E. McMechan[1] and F. Ferri[2]

[1]Geological Survey of Canada, 3303-33rd Street NW, Calgary, Alberta
[2]British Columbia Ministry of Natural Gas Development, 1810 Blanshard Street, Victoria, British Columbia

2015

doi:10.4095/297164

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation
Reyes, J., McMechan, M.E., and Ferri, F., 2015. Vitrinite reflectance data for selected samples from Devono-Mississippian and Lower Cretaceous shale cores in the Liard Basin area, northeast British Columbia; Geological Survey of Canada, Open File 7902, 1 .zip file. doi:10.4095/297164

Publications in this series have not been edited; they are released as submitted by the author.

Table of Contents

Introduction

Vitrinite reflectance (VR) determinations were made on selected samples from 5 cores of Lower Cretaceous Garbutt shale and 29 cores of Devono-Mississippian shale located in or adjacent to the Liard Basin area of British Columbia (Figure 1). The Cretaceous cores came from 5 different boreholes. The Devono-Mississippian cores came from 9 different boreholes that intersected several stratigraphic units including the Golata, Banff, Besa River, Exshaw, Kotcho, Muskwa, Otter Park and Evie formations (Table 1). Rock-Eval 6/TOC results were obtained for a more extensive suite of samples from these same Devono-Mississippian cores and these results are published in McMechan et al. (2015).

Vitrinite reflectance has been used widely to calibrate thermal history and time-temperature models for stratigraphic successions within sedimentary basins, particularly for evaluating coal rank and oil and gas generation (Potter, 1998; Bustin et al., 1983; ICCP, 1975). Since the rate of coalification reactions and percent reflectance in oil (%Ro) of huminite, vitrinite and bitumen increase with increasing temperature, these macerals provide an indirect geothermometer for evaluating the thermal conditions during sediment burial (Potter, 1998; Stasiuk, 1991; Tyson, 1987; Bustin et al., 1983; Powell and Snowdon, 1983).

Methodology

Whole rock core samples are prepared by crushing them into 1-5 mm particulates. The samples are mounted in a one inch mold using two parts epoxy, which are then ground on 240, 600, 800, 1000, 1200 grit silicon carbide papers in water and polished on pellon, silk and Lecloth cloth in 0.30 µm and 0.05µm alumina silica. The hardness and overall quality of the samples determines the grit papers and cloth combinations to get the best results. Random percent reflectance in oil (%Ro) are measured on huminite, vitrinite and primary bitumen macerals (n = 5 to 50). Humotelinite and telovitrinite are the preferred maceral subgroups for measuring vitrinite reflectance, wherever possible. In the absence of vitrinite maceral, vitrinite equivalent ($\%Ro_{equivalent}$) are calculated using the measured reflectance of primary bitumen ($\%Ro_{bitumen}$) and Jacob (1989) equation, which should always be used with caution. Random reflectance ($\%R_{random}$) measurements are carried out using a Leitz reflected light microscope with a 50X oil immersion objective and white (halogen; 546nm) and fluorescent (HBO 100W) light sources. The actual %Ro measurements are taken by the Leitz MPV II – COMBI photometer system attached to a pc-controller system for %Ro data collection which is mounted on top of the microscope. Reflectance is calibrated using Schott precision glass standards with 0.506, 1.025, and 1.817 %Ro refractive index. The oil used is halogen free/low fluorescence oil with a refractive index of ne = 1.518 at 23^{o}C. Sample preparation and standard calibration and maceral identification and classification are in accordance with standard procedures based on or modified from ASTM D7708–11, 2011; ISO 7404-2, 2009; ISO 7404-3, 2009; ISO 7404-5, 2009; ICCP, 1998; Potter, 1998; Mackowsky, 1983; Bustin et al., 1983; ICCP, 1975. The burial heating peak temperatures is estimated using Barker and Pawlewicz (1994) equation (Eq. 1).

Eq. 1. $T_{peak} = [\ln(\%Ro) + 1.68] / 0.0124$

Results

The measured VR (1.47%Ro to 3.70%Ro) of samples from Devono-Mississippian cores indicate that these strata are all within the dry gas window (Figure 2 and Figure 3, Tables 2-10) with estimated burial heating peak temperature (BHT_{peak}) of 169^{o}C to 242^{o}C based on Barker and Pawlewicz (1994) equation. Cores from the Evie, and Otter Park formations and most cores from the Besa River and Muskwa formations, have high VR, ranging from 2.15%Ro to 3.70%Ro with estimated BHT_{peak} of between 200^{o}C to 242^{o}C (Tables 7-10, Figures 2 and 3). Core samples from the Besa River and Muskwa formations taken from TRANSEURO ET AL BEAVER B-036-K (B-036-K/094-N-16) and LTS HZ POPLAR HILLS A-040-G (A-040-G/094-O-03) wells are showing much lower VR (1.47%Ro to 1.87%Ro, estimated BHT_{peak} of 163^{o}C to 188^{o}C) compared to the other wells (Figure 3, Table 4 and Table 6). The Exshaw and Kotcho formation core from the eastern edge of the basin have VR between 1.48%Ro and 1.78%Ro with an estimated BHT_{peak} ranging from 200^{o}C to 235^{o}C (Figure 3, Tables 4-5). The VR of the core sample from the Golata and Banff formations collected from TRANSEURO BEAVER D-064-K (D-064-K/094-N-16) well have VR ranging from 1.64%Ro to 2.68%Ro with estimated BHT_{peak} of 174 ^{o}C to 216^{o}C (Figure 3, Tables 2-3).

Most of the Lower Cretaceous Garbutt samples are within the early to late hydrocarbon generating window (0.60 to 1.0%Ro, estimated BHT_{peak} range 95^{o}C to 136^{o}C) with the exception of TSOO A-13-H (A-13-H/ 94-O-14) well samples, that are in the dry gas window (>1.30%Ro) (Figures 2 and 3, Tables 11-15). These suggest that the Garbutt Formation in this area was subjected to a much higher temperature (>163^{o}C) compared to the cores from further north in the Maxhamish Lake area (Figure 1).

Qualitative petrographic analyses of the dispersed organic matter (DOM), microfossils (siliceous and calcareous) and their microtextures in Devono-Mississippian and Lower Cretaceous core samples ranges from bright yellow fluorescing liptinite (alginite, sporinite, bituminite and solid bitumen) macerals to overmature, granular, spent amorphous kerogen at various concentration (See comments column in Appendix A1- A14). Most of the amorphous kerogens found in the Devono-Mississippian are derived from autochthonous unicellular prasinophyte alginite like *Tasmanites*. Conodont, chitinozoan, and siliceous radiolarian microfossils are observed in some core samples from Besa River/Muskwa, Muskwa and Otter Park formations collected from TRANSEURO ET AL BEAVER B-036-K (B-036-K/094-N-16), JOINT VENTURE NO. 1 C-010-E (C-010-E/094-N-07) and LTS HZ POPLAR HILLS A-040-G (A-040-G/094-O-03) (Appendix 4, 7 and 8). The occurrence of these organic microfossils are indicative of Type II/I kerogen deposited in deep marine paleodepositional environment and/or zone of upwelling (Reyes et al., 2013; Stasiuk and Fowler, 2004). Cores from the Evie and other cores from the Besa River and Muskwa formations (Appendix A5, A8-A9) are also Type II/I kerogen deposited in shallower paleodepositional environment compared to the well locations mentioned above. Core samples collected from the Mississipian Kotcho, Golata and Mattson formations contains reworked and allochthonous inertinite, vitrinite and liptinite macerals derived from early terrestrial plants (See comments column in Appendix A1 to A5), which suggest that these formations were deposited in shallow to intermediate marine paleodepositional environment and are characterized as Type II kerogen by source (Reyes et al., 2013; Stasiuk and Fowler, 2004).

The organic facies of Lower Cretaceous Garbutt Formation are mostly spent and partially spent amorphous kerogen with bright yellow to weak reddish fluorescing liptinite (alginite, bitumen, sporinite) inclusions. Thick coaly lenses derived from filamentous and/or algal mats, *Botryococcus* like colonial algae and terrestrial plant derived organic macerals are also observed in Garbutt Formation samples collected from AEC MAXHAMISH B-053-B (B-053-B/94-O-14) and STX MAXHAMISH B-006-C (B-006-C/094-O-11) well (Table A10). These organic facies are characterized as Type II kerogen by source that was deposited in shallow to intermediate marine paleodepositional environment (Figure 2).

The absence of terrestrial plant derived macerals, in itself, does not imply deep marine depositional environment. Other factors such as lithology (particle grain size), mineralogy, microfossils composition (calcareous or siliceous) and the age of the formation are also used as qualifiers in estimating relative paleobathymetry during the time of deposition. Likewise, paleobathymetry alone does not determine the temporal-vertical and lateral organic facies variation within the same strata. Tectonic events, oceanic paleothermocline, topography, sediment and nutrient loading during the time of deposition also play significant roles in determining organic richness and biodiversity (Reyes et al., 2013, Stasiuk and Fowler, 2004 and references therein).

Summary/Conclusion

This open file releases vitrinite reflectance determinations obtained for samples from 30 cores of Devono-Mississippian or Lower Cretaceous shale in the Liard area of British Columbia. The core samples came from 13 different boreholes and 11 different formations. These VR data fill some of the gap in thermal maturity data for the Liard Basin. Devono-Mississippian formations are overmature and well within the dry gas window. VR results from the Lower Cretaceous Garbutt Formation suggest that it is thermally mature in the eastcentral part of the Liard Basin and overmature in the southeastern part (TSOO A-13-H (A-13-H/ 94-O-14) well). Qualitative petrographic analyses of Devono-Mississippian and Lower Cretaceous strata indicates they were deposited in shallow to deep marine paleodepositional environments and are characterized as Type II/I and II kerogen by source.

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Acknowledgments

We thank Dr. Dennis Jiang for his helpful review of this open file. Samples were made available for study by the BC Oil and Gas Commission. This study was funded by PERD (Program of Energy Research and Development) Natural Resources Canada.

Tables and Figures

Tables

Table 1. The list provides the well name, location, license number, core number and number of samples (in parenthesis) and unit formation.

Well Name	Location	License	Core No.	Unit
EOG MAXHAMISH D-012-L	D-012-L/094-O-15	WA21643	1, 4, 9	Muskwa
EOG MAXHAMISH D-012-L	D-012-L/094-O-15	WA21643	11	Otter Park
TSOO A-13-H	A-13-H/ 94-O-14	WA14517	1 (3)	Garbutt
AEC MAXHAMISH B-053-B	B-053-B/94-O-14	WA09950	1 (3)	Garbutt
EXXON MOBILE N PETITOT D-033-F	D-033-F/094-P-13	WA06468	1 (2)	Garbutt
STX MAXHAMISH B-006-C	B-006-C/094-O-11	WA18890	3 (5)	Garbutt
BP ENERGY GROUP DEER LAKE A-090-I	A-090-I/094-O-06	WA0531	1 (3)	Kotcho
LTS HZ POPLAR HILLS A-040-G	A-040-G/094-O-03	WA25913	1 (4)	Exshaw
LTS HZ POPLAR HILLS A-040-G	A-040-G/094-O-03	WA25913	1	Kotcho
LTS HZ POPLAR HILLS A-040-G	A-040-G/094-O-03	WA25913	2 (2)	Muskwa
TRANSEURO BEAVER B-019-K	B-019-K/094-N-16	WA02563	1 (4), 2 (2), 3	Besa River/ Evie
TRANSEURO BEAVER D-064-K	D-064-K/094-N-16	WA0325	1 (6)	Golata
TRANSEURO BEAVER D-064-K	D-064-K/094-N-16	WA0325	20 (2)	Banff
TRANSEURO BEAVER D-064-K	D-064-K/094-N-16	WA0325	21 (3)	Besa River/ Muskwa
TRANSEURO HZ BEAVER D-A064-K	D-A064-K/094-N-16	WA02547	6 (4)	Golata
TRANSEURO ET AL BEAVER B-036-K	B-036-K/094-N-16	WA21755	1-4, 6-7	Besa River
TRANSEURO ET AL BEAVER B-036-K	B-036-K/094-N-16	WA21755	8, 9	Mattson
IOE DUNEDIN D-075-E	D-075-E/094-N-08	WA01331	15 (5)	Besa River/ Golata?
IOE DUNEDIN D-075-E	D-075-E/094-N-08	WA01331	16 (2)	Besa River
IOE DUNEDIN D-075-E	D-075-E/094-N-08	WA01331	17 (4)	Besa River
JOINT VENTURE NO. 1 C-010-E	C-010-E/094-N-07	WA0038	11, 16	Kindle
JOINT VENTURE NO. 1 C-010-E	C-010-E/094-N-07	WA0038	35 (4)	Besa River/ Muskwa
HARVEST BAY B-017-H	B-017-H/094-I-09	WA13960	1	Garbutt

Table 2. Vitrinite reflectance data for Golata formation collected from TRANSEURO HZ BEAVER D-A064-K (WA2547) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	*Organic Type	$\%Ro_R$	SD	N
1	C-572064	WA2547	6	1914.7	Golata	657/13	2	1.64	0.09	9
2	C-572068	WA2547	6	1917.7	Golata	658/13	2	1.72	0.11	11
3	C-572078	WA2547	6	1920.8	Golata	659/13	2	1.69	0.07	13
4	C-572089	WA2547	6	1923.8	Golata	660/13	2	1.81	0.06	11

***Organic Type**
2 = Vitrinite
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values

Table 3. Vitrinite reflectance data for Golata and Besa River/Muskwa formations collected from TRANSEURO BEAVER D-064-K (WA325) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	$\%Ro_R$	SD	N
1	C-571599	WA325	1	2535.8	Golata	638/13	2	2.16	0.07	10
2	C-571594	WA325	1	2537.3	Golata	637/13	2	2.30	0.13	21
3	C-571589	WA325	1	2538.9	Golata	636/13	2	2.51	0.05	12
4	C-571579	WA325	1	2541.9	Golata	635/13	2	2.44	0.09	13
5	C-571569	WA325	1	2545.0	Golata	634/13	2	2.45	0.12	13
6	C-571559	WA325	1	2548.0	Golata	633/13	2	2.39	0.13	20
7	C-571602	WA325	20	2895.5	Banff	640/13	2	2.56	0.09	16
7	C-571600	WA325	20	2896.1	Banff	639/13	2	2.68	0.17	14
8	C-571627	WA325	21	3364.2	Besa River/ Muskwa	643/13	2	3.10	0.11	10
9	C-571615	WA325	21	3368.2	Besa River/ Muskwa	642/13	2	3.09	0.09	5
10	C-571603	WA325	21	3371.8	Besa River/ Muskwa	641/13	2	2.99	0.12	12

Table 4. Vitrinite reflectance data for Exhaw, Kotcho and Muskwa formations collected from LTS HZ POPLAR HILLS A-040-G (WA25913) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	$\%Ro_R$	SD	N
3	C-572148	WA25913	1	1224.4	Exshaw	680/13	2	1.48	0.03	6
4	C-572158	WA25913	1	1227.8	Exshaw	681/13	2	1.59	0.08	14
5	C-572165	WA25913	1	1233.9	Kotcho	682/13	2	1.63	0.06	9
6	C-572166	WA25913	2	2145.1	Muskwa	676/13	2	1.81	0.09	10
7	C-572168	WA25913	2	2145.75	Muskwa	677/13	2	1.77	0.12	2

Table 5. Vitrinite reflectance data for Kotcho formation collected from BP ENERGY GROUP DEER LAKE A-090-I (WA531) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	$\%Ro_R$	SD	N
1	C-572109	WA531	1	1658.6	Kotcho	665/13	2	1.78	0.01	2
2	C-572112	WA531	1	1661.6	Kotcho	666/13	2	1.75	0.11	7
3	C-572114	WA531	1	1663.6	Kotcho	667/13	2	1.69	0.09	6

Table 6. Vitrinite reflectance data for Mattson (lower) and Besa River formations collected from TRANSEURO ET AL BEAVER B-036-K (WA21755) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	$\%Ro_R$	SD	N
1	C-572115	WA21755	9	1835	Mattson - lower	675/13	2	1.45	0.09	12
2	C-572116	WA21755	8	1838.5	Mattson - lower	674/13	2	1.47	0.06	15
3	C-572117	WA21755	7	1856	Besa River	673/13	2	1.47	0.06	15
4	C-572118	WA21755	6	1882.7	Besa River	672/13	2	1.56	0.09	23
5	C-572119	WA21755	2	1969.2	Besa River	669/13	2	1.66	0.06	10
6	C-572120	WA21755	4	1995.7	Besa River	671/13	2	1.69	0.09	18
7	C-572121	WA21755	3	2000.7	Besa River	670/13	2	1.74	0.08	8
8	C-572122	WA21755	1	2114	Besa River	668/13	2	1.87	0.07	14

Table 7. Vitrinite reflectance data for Kindle, Kindle/Mattson and Besa River/Muskwa formations collected from JOINT VENTURE NO. 1 C-010-E (WA0038) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	$\%Ro_R$	SD	N
1	C-572207	WA0038	16	593.7	Kindle	693/13	2	2.81	0.15	19
2	C-572208	WA0038	11	631.4	Kindle/Mattson	694/13	2	2.81	0.15	16
3	C-572209	WA0038	35	1573.3	Besa River/ Muskwa	695/13	2	3.28	0.07	4
4	C-572218	WA0038	35	1576.0	Besa River/ Muskwa	696/13	2	3.19	0.22	18
5	C-572226	WA0038	35	1578.5	Besa River/ Muskwa	697/13	2	3.21	0.22	13
6	C-572234	WA0038	35	1580.9	Besa River/ Muskwa	698/13	2	3.16	0.20	11

Table 8. Vitrinite reflectance data for Muskwa and Otter formations collected from EOG MAXHAMISH D-012-L (WA21643) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	$\%Ro_R$	SD	N
1	C-572235	WA21643	1	2956.15	Muskwa	699/13	2	3.34	0.13	8
2	C-572238	WA21643	4	2966.5	Muskwa	700/13	2	3.40	0.00	1
3	C-572243	WA21643	9	2971.1	Muskwa	701/13	2	3.19	0.03	2
4	C-572247	WA21643	11	2978.7	Otter Park	702/13	2	3.18	0.09	6

Table 9. Vitrinite reflectance data for Besa River/Golata? and Besa River formations collected from IOE DUNEDIN D-075-E (WA1331) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-571628	WA1331	15	3688.8	Besa River/ Golata?	644/13	2	2.49	0.12	4
2	C-571638	WA1331	15	3691.9	Besa River/ Golata?	645/13	2	2.15	0.00	1
3	C-571649	WA1331	15	3695.2	Besa River/ Golata?	646/13	2	2.30	0.10	6
4	C-571660	WA1331	15	3698.6	Besa River/ Golata?	647/13	2	2.24	0.20	13
5	C-571672	WA1331	15	3702.2	Besa River/ Golata?	648/13	2	2.38	0.01	2
6	C-571673	WA1331	16	3773.2	Besa River	649/13	2	2.88	0.09	7
7	C-571679	WA1331	16	3775.0	Besa River	650/13	2	2.58	0.11	15
8	C-571680	WA1331	17	3889.7	Besa River	651/13	2	2.97	0.14	17
9	C-571685	WA1331	17	3891.5	Besa River	652/13	2	2.91	0.07	4
10	C-571692	WA1331	17	3893.3	Besa River	653/13	2	3.07	0.11	19
11	C-571701	WA1331	17	3895.5	Besa River	654/13	2	3.05	0.13	6

Table 10. Vitrinite reflectance data for Besa River/Evie and Besa River formations collected from TRANSEURO BEAVER B-019-K (WA02563) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-572181	WA02563	1	3777.8	Besa River/Evie	686/13	2	2.75	0.17	9
2	C-572184	WA02563	1	3778.7	Besa River/Evie	687/13	2	2.74	0.10	12
3	C-572188	WA02563	1	3779.9	Besa River/Evie	688/13	2	3.05	0.21	13
4	C-572192	WA02563	1	3781.2	Besa River/Evie	689/13	2	3.22	0.20	17
5	C-572193	WA02563	2	3781.5	Besa River/Evie	690/13	2	3.10	0.00	1
6	C-572200	WA02563	2	3783.6	Besa River/Evie	691/13	2	3.10	0.21	14
7	C-572206	WA02563	3	3785.4	Besa River/Evie	692/13	2	3.70	0.00	1

Table 11. Vitrinite reflectance data for Garbutt formation collected from AEC MAXHAMISH B-053-B (WA9950) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-572090	WA9950	1	1260.0	Garbutt	661/13	2	0.65	0.07	27
2	C-572096	WA9950	1	1266.0	Garbutt	662/13	2	0.68	0.07	27
3	C-572101	WA9950	1	1272.0	Garbutt	663/13	2	0.72	0.07	26

Table 12. Vitrinite reflectance data for Garbutt formation collected from HARVEST BAY B-017-H (WA13960) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-591340	WA13960	1	339.7	Garbutt	462/14	2	0.77	0.07	12

Table 13. Vitrinite reflectance data for Garbutt formation collected from EXXON MOBILE N PETITOT D-033-F (WA06468) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-591347	WA06468	1	298.0	Garbutt	460/14	2	0.79	0.06	17
2	C-591348	WA06468	1	309.0	Garbutt	461/14	2	0.81	0.10	19

Table 14. Vitrinite reflectance data for Garbutt formation collected from STX MAXHAMISH B-006-C (WA18890) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-571537	WA18890	3	1476	Garbutt	628/13	2	0.79	0.03	8
2	C-571538	WA18890	3	1476.6	Garbutt	629/13	2	0.82	0.07	18
3	C-571544	WA18890	3	1481.4	Garbutt	630/13	2	0.93	0.05	14
4	C-571551	WA18890	3	1487.7	Garbutt	631/13	2	0.91	0.03	11
5	C-571558	WA18890	3	1494	Garbutt	632/13	2	0.92	0.07	11

Table 15. Vitrinite reflectance data for Garbutt formation collected from TSOO A-13-H (WA14517) well.

No.	Catalog No.	License No.	Core No.	Depth (m)	Formation	Peller No.	Organic Type	%Ro_R	SD	N
1	C-572169	WA14517	1	1403.2	Garbutt	683/13	2	1.41	0.06	22
2	C-572174	WA14517	1	1408	Garbutt	684/13	2	1.50	0.09	13
3	C-572180	WA14517	1	1414.2	Garbutt	685/13	2	1.46	0.09	6

Figures

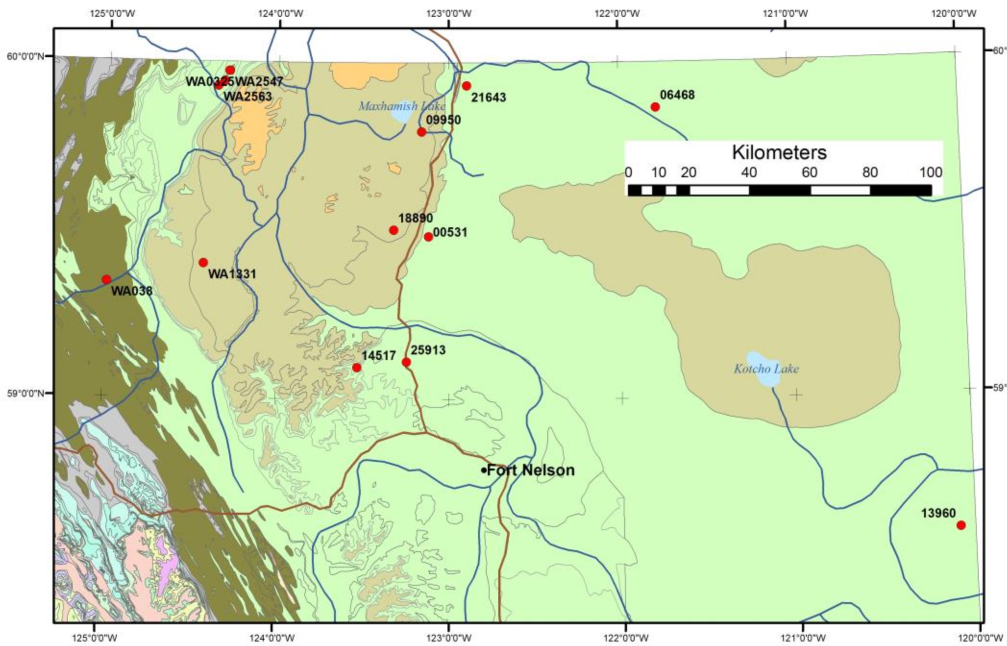

Figure 1. Map of the study area showing the locations of the wells in the Liard Basin northeast British Columbia.

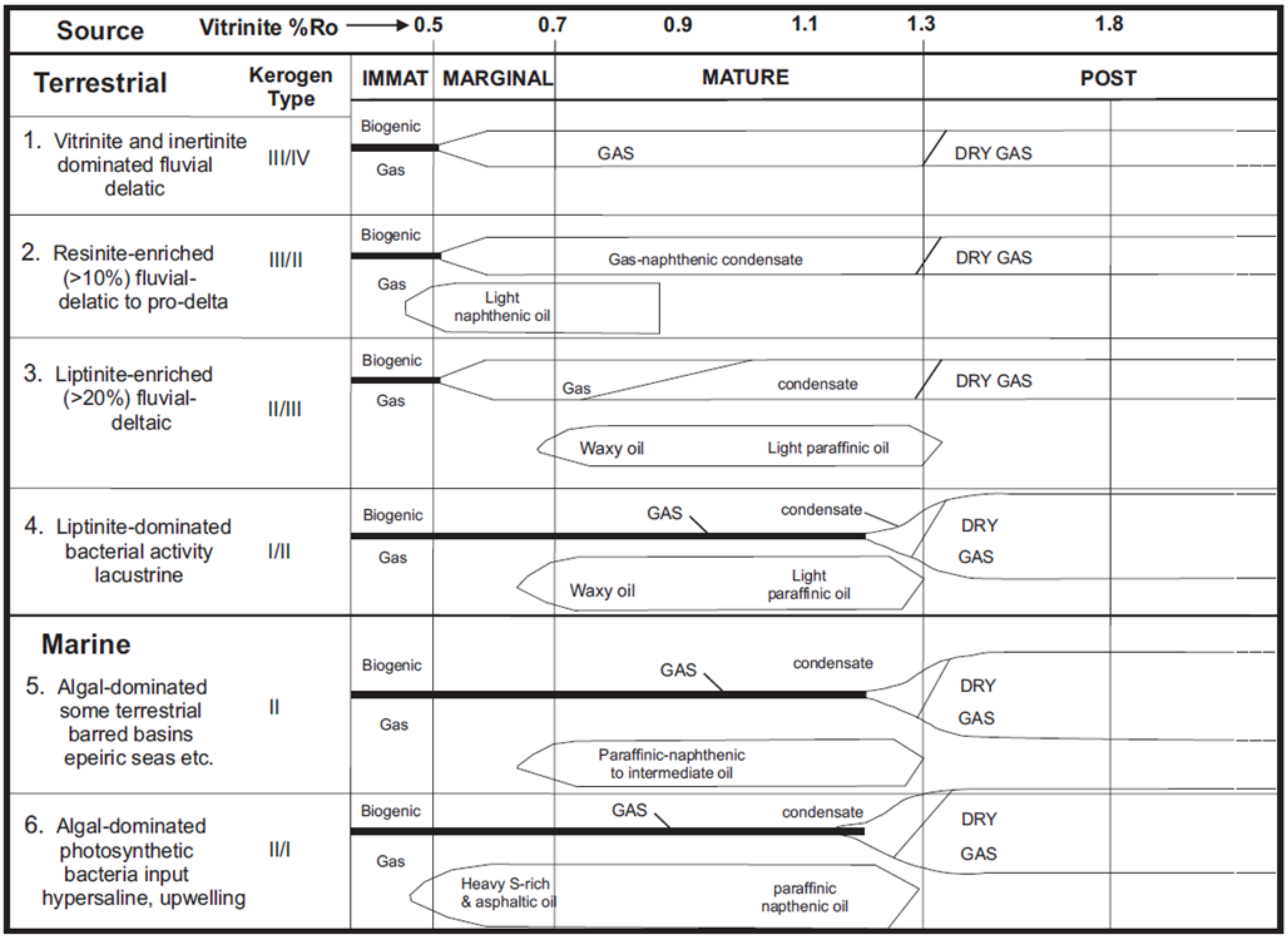

Figure 2. Hydrocarbon generation model using vitrinite reflectance (%Ro) values used to determine form of hydrocarbon generated depending on the kerogen type and source rock paleodepositional environment . (Modified from Potter, 1998 and Stasiuk, 1991). See also Powell and Snowdon, 1983).

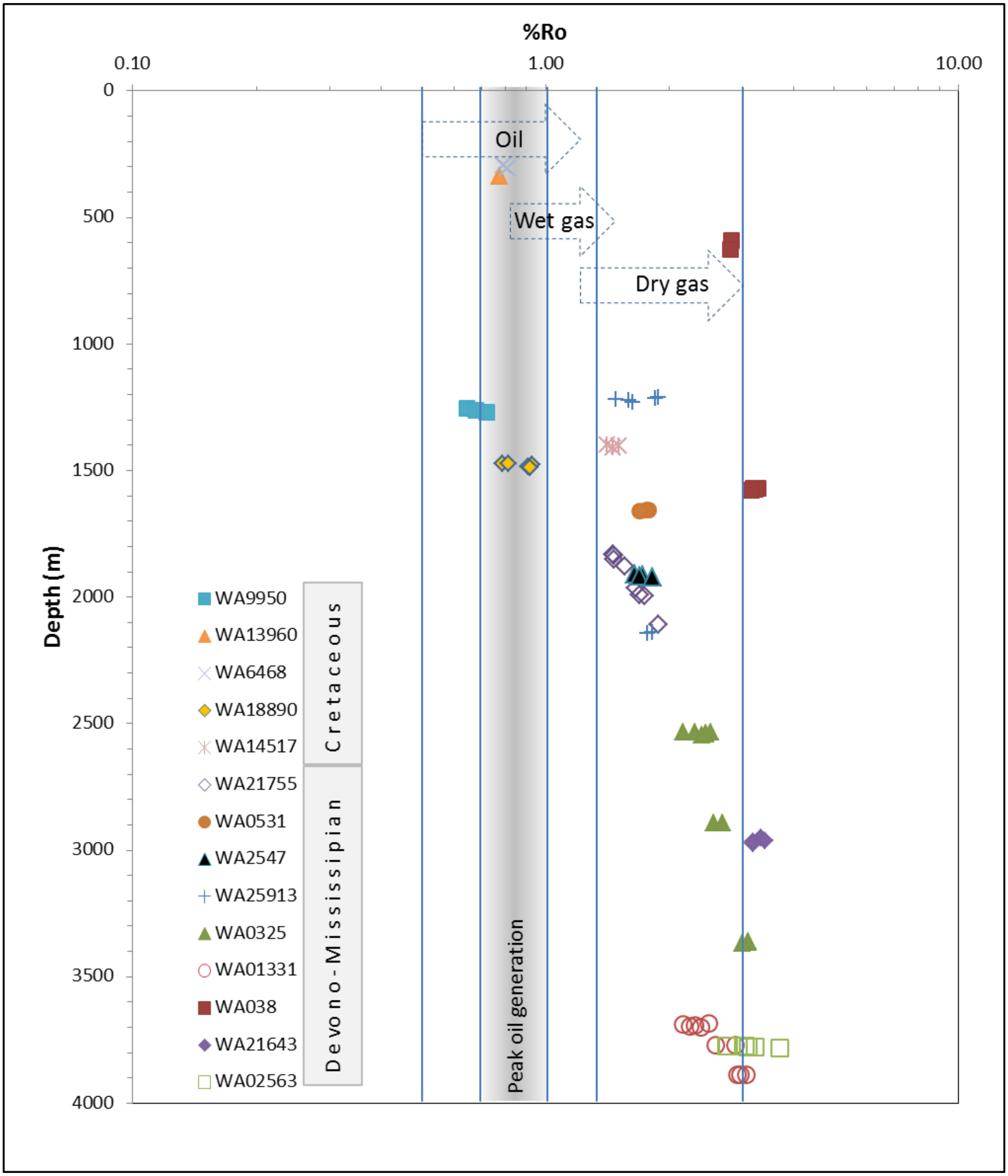

Figure 3. Vitrinite reflectance (%Ro) versus depth (m) profile of selected core samples of Devono-Mississippian and Lower Cretaceous shale from Liard Basin British Columbia overlain on the estimated maturation pathways for oil, wet gas and dry gas generation based measured %Ro and observed kerogen types.

Appendix

Open_File_1902 Appendix 1 to 14 contains detailed vitrinite reflectance data including qualitative assessment of each sample.

A1- Complete vitrinite reflectance data for Golata formation collected from TRANSEURO HZ BEAVER D-A064-K (WA2547) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE*	$\%Ro_R$	SD	N	COMMENTS
1	C-572064	WA2547	6	1914.7	Golata	657/13	2	1.64	0.09	9	Light brown silty shale with minor amount of mostly amorphous kerogen with trace amount of overmature alginite derived vitrinite and pyrobitumen (observed mostly between interagranular pores of siltstone microlithotype) macerals. Micrinite and pyrite are also observed in the matrix.
							4	1.89	0.04	9	
							4	2.09	0.04	10	
							2.2	1.43	0.00	2	
							40	2.31	0.06	7	
							40	2.51	0.08	4	
2	C-572068	WA2547	6	1917.7	Golata	658/13	2	1.72	0.11	11	Light brown shaley siltstone with rare amount of OG consisting mostly amorphous kerogen with trace amount of overmature alginite derived vitrinite and pyrobitumen (observed mostly between interagranular pores of siltstone microlithotype) macerals. Micrinite and pyrite are also observed in the matrix.
							4	2.22	0.17	17	
							2.2	1.42	0.06	4	granular
							2.2	2.73	0.10	2	reworked
							40	3.15	0.07	3	
3	C-572078	WA2547	6	1920.8	Golata	659/13	2	1.69	0.07	13	Light brown silty shale with rare amount of mostly amorphous kerogen with trace amount of overmature alginite derived vitrinite and pyrobitumen macerals. Micrinite and pyrite are also observed in the matrix. Diagenetic calcite are also observed.
							4	1.97	0.10	28	
							4	2.33	0.08	9	
							2.2	1.37	0.10	10	granular
4	C-572089	WA2547	6	1923.8	Golata	660/13	2	1.81	0.06	11	Light brown shale with rare amount of mostly amorphous kerogen with trace amount of overmature alginite derived vitrinite and pyrobitumen macerals. Micrinite and pyrite are also observed in the matrix.
							4	2.07	0.06	21	
							2.2	1.60	0.04	9	
							2.2	2.29	0.03	3	
							2.2	2.79	0.05	4	reworked
							2.2	2.44	0.32	2	

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A2. Complete vitrinite reflectance data for Golata and Besa River/Muskwa formations collected from TRANSEURO BEAVER D-064-K (WA325) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro$_R$	SD	N	COMMENTS
1	C-571599	WA325	1	2535.8	Golata	638/13	2	2.16	0.07	10	Brown organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen. Calcareous microfossil, diagenetic calcite cement.
							21	2.77	0.09	19	
							21	2.47	0.08	12	
							2.2	1.91	0.07	2	granular
							40	3.11	0.11	7	
							40	3.71	0.05	2	
2	C-571594	WA325	1	2537.3	Golata	637/13	2	2.30	0.13	21	Dark brown organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen. Calcareous microfossil, diagenetic calcite cement.
							21	2.71	0.15	18	
							2.2	1.80	0.14	7	
							40	3.26	0.12	4	
3	C-571589	WA325	1	2538.9	Golata	636/13	2	2.51	0.05	12	Dark brown organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen. Calcareous microfossil, diagenetic calcite cement.
							21	2.86	0.11	22	
							2.2	2.15	0.05	4	
							2.2	1.94	0.06	4	granular
							40	3.42	0.10	9	
4	C-571579	WA325	1	2541.9	Golata	635/13	2	2.44	0.09	13	Dark brown organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen. Calcareous microfossil, diagenetic calcite cement.
							21	2.70	0.07	12	
							2.2	2.10	0.10	13	
							2.2	1.69	0.04	2	
							21	3.00	0.04	9	
							40	3.27	0.07	4	
5	C-571569	WA325	1	2545.0	Golata	634/13	2	2.45	0.12	13	Dark brown organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen.
							21	2.84	0.10	7	
							2.2	2.06	0.07	4	
							21	3.19	0.07	4	
							40	3.89	0.00	1	
6	C-571559	WA325	1	2548.0	Golata	633/13	2	2.39	0.13	20	Dark brown organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen.
							21	2.93	0.15	13	
							2.2	2.12	0.01	3	
							2.2	1.88	0.14	5	
							40	3.40	0.00	1	
7	C-571602	WA325	20	2895.5	Banff	640/13	2	2.56	0.09	16	Light brown organically lean silty shale matrix traces of mainly unicellular alginite.
							2.21	2.90	0.09	18	
							2.2	2.05	0.12	8	
							21	3.42	0.10	9	
7	C-571600	WA325	20	2896.1	Banff	639/13	2	2.68	0.17	14	Organically lean shale with rare amount of mostly dark amorphous kerogen lenses, overmature small amorphinite lenses, unicellular alginite derive vitrinite (colotelinite) macerals and isotropic pyrobitumen. Calcareous microfossil, diagenetic calcite cement.
							4	3.16	0.11	11	
							2.2	2.02	0.07	4	
							40	3.70	0.09	7	
8	C-571627	WA325	21	3364.2	Besa River/ Muskwa	643/13	2	3.10	0.11	10	Black shale matrix with mostly dark granular spent amorphous kerogen with trace amount of alginite derived vitrinite and pyrobitumen macerals and trace amount of frambiodal pyrite.
							21	3.62	0.12	7	

							2.2	2.49	0.12	4	granular
							21	4.03	0.05	9	
							40	4.37	0.05	2	
9	C-571615	WA325	21	3368.2	Besa River/ Muskwa	642/13	2	3.09	0.09	5	Black shale matrix with mostly dark granular spent amorphous kerogen with trace amount of alginite derived vitrinite and pyrobitumen macerals and trace amount of frambiodal pyrite.
							21	3.43	0.02	2	
							2.2	2.32	0.07	6	granular
							2.2	2.69	0.07	3	granular
							2.2	1.84	0.00	1	granular
10	C-571603	WA325	21	3371.8	Besa River/ Muskwa	641/13	2	2.99	0.12	12	The host rock consist of diagenitic calcite cement rich black siltstone with dark spent amorphous kerogen and clay observed between intergranular pores. Black shale matrix with mostly dark granular spent amorphous kerogen with trace amount of alginite derived vitrinite and pyrobitumen macerals and trace amount of frambiodal pyrite.
							2.2	3.41	0.12	6	
							2.2	2.60	0.12	6	granular
							2.2	2.24	0.04	3	
							21	3.90	0.05	3	

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3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A3. Complete vitrinite reflectance data for Exhaw, Kotcho and Muskwa formations collected from LTS HZ POPLAR HILLS A-040-G (WA25913) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro_R	SD	N	COMMENTS
1	C-572123	WA25913	1	1216.5	Exshaw	678/13	3	1.56	0.05	3	Brown silty shale with rare amount of measurable vitrinite and bitumen macerals. Presence of framboidal pyrite.
							2.2	2.20	0.09	9	
							2.2	2.66	0.12	8	
							40	2.98	0.01	2	
							40	3.44	0.08	3	
2	C-572135	WA25913	1	1220.5	Exshaw	679/13	3	1.54	0.08	2	Pyrite rich carbonate matrix with mostly spent amorphous kerogen displace by micrinite and framboidal pyrite minerals. High amount of conodont like microfossils and other calcareous microfossils.
							2.2	1.25	0.06	2	granular
							2.21	2.45	0.14	8	
							40	3.20	0.03	2	
							40	3.57	0.12	3	
3	C-572148	WA25913	1	1224.4	Exshaw	680/13	2	1.48	0.03	6	Dark brown organic rich shale matrix showing mostly brown amorphous kerogen and rare zooclast derived inertinite macerals. Possible secondary oil migration due to two phase bitumen thermal maturity. Minor amount of fish bones, possibly conodont.
							4	1.81	0.12	10	
							2.2	2.22	0.07	8	
							2.21	2.59	0.19	4	
							40	3.14	0.08	4	
4	C-572158	WA25913	1	1227.8	Exshaw	681/13	2	1.59	0.08	14	Dark brown organic and framboidal rich silty shale matrix showing mostly brown amorphous kerogen and zooclast derived inertinite macerals. Possible secondary oil migration due to two phase bitumen thermal maturity. Minor amount of fish bones, possibly conodont.
							4	1.88	0.06	15	
							2.2	1.28	0.05	5	
							4	2.14	0.06	10	
							2.2	2.67	0.00	1	
5	C-572165	WA25913	1	1233.9	Kotcho	682/13	2	1.63	0.06	9	Organically lean silty shale with rare amount of mostly inertinite maceral and trace amount of unicellular alginite derived vitrinite maceral and corpogelinite maceral.
							4	1.80	0.04	5	
							4	2.14	0.07	7	
							2.2	1.15	0.21	5	
							2.2	2.47	0.14	6	
6	C-572166	WA25913	2	2145.1	Muskwa	676/13	2	1.81	0.09	10	Organically lean siltstone trace amount of measurable vitrinite and bitumen macerals and dark shale matrix showing mostly thin amorphinite lenses and amorphous kerogen. Trace amount of alginite derived vitrinite and pyrobitumen macerals. Conodont.
							21	2.24	0.04	9	
							21	2.08	0.04	9	granular
							2.2	2.49	0.11	15	
							2.2	2.96	0.00	1	
7	C-572168	WA25913	2	2145.75	Muskwa	677/13	2	1.77	0.12	2	dark shale matrix showing mostly thin amorphinite lenses and amorphous kerogen. Trace amount of alginite derived vitrinite and pyrobitumen macerals. Conodont.
							21	2.36	0.10	13	
							21	2.13	0.05	4	
							2.2	2.80	0.19	18	
							40	3.79	0.13	5	

KEY FOR ORGANIC TYPE

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3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A4. Complete citrinite reflectance data for Kotcho formation collected from BP ENERGY GROUP DEER LAKE A-090-I (WA531) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	$\%Ro_R$	SD	N	COMMENTS
1	C-572109	WA531	1	1658.6	Kotcho	665/13	2	1.78	0.01	2	Cream colored oragnically lean silty shale with trace amount of inertinitic kerogen lenses and alginite derived vitrinite and pyrobitumen macerals and brown long thin amorphous kerogen lenses.
							4	2.16	0.00	1	
							2.4	1.45	0.00	1	
							2.2	2.55	0.09	4	
							2.2	2.88	0.02	2	
2	C-572112	WA531	1	1661.6	Kotcho	666/13	2	1.75	0.11	7	Cream colored oragnically lean silty shale with trace amount of inertinitic kerogen lenses and alginite derived vitrinite and pyrobitumen macerals.
							4	2.06	0.02	5	
							4	2.35	0.10	4	
							2.2	1.27	0.05	3	
3	C-572114	WA531	1	1663.6	Kotcho	667/13		1.69	0.09	6	Cream colored oragnically lean silty shale with trace amount of inertinitic kerogen lenses and alginite derived vitrinite and pyrobitumen macerals and brown long thin amorphous kerogen lenses.
							4	2.01	0.05	4	
							2.2	2.33	0.05	3	
							2.2	1.44	0.04	2	
							2.2	2.72	0.13	3	

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A5. Complete vitrinite reflectance data for Mattson (lower) and Besa River formations collected from TRANSEURO ET AL BEAVER B-036-K (WA21755) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro_R	SD	N	COMMENTS
1	C-572115	WA21755	9	1835	Mattson - lower	675/13	2	1.45	0.09	12	Micrinite and framboidal pyrite rich dark brown silty shale showing mostly brown amorphous kerogen with trace amount of small bitumen and alginite derived lenses inclusions.
							4	1.79	0.09	8	
							2.2	2.10	0.11	3	
							2.2	0.99	0.14	6	
							2.2	2.57	0.10	3	phosphatic
2	C-572116	WA21755	8	1838.5	Mattson - lower	674/13	2	1.47	0.06	15	Dark brown organic and framboidal rich silty shale matrix showing mostly brown amorphous kerogen and zooclast derived inertinite macerals. Minor amount of alginite derived vitrinite macerals and isotropic solid bitumen. Traces of diagenetic calcite and replacive dolomite are also observed.
							4	1.68	0.06	12	
							4	1.88	0.04	10	
							2.2	1.29	0.04	5	granular polish
							2.2	2.19	0.09	6	
3	C-572117	WA21755	7	1856	Besa River	673/13	2	1.47	0.06	15	Dark brown shale matrix showing mostly brown amorphous kerogen and zooclast derived inertinite macerals. Minor amount of alginite derived vitrinite macerals and isotropic solid bitumen.
							4	1.69	0.07	15	
							4	1.92	0.04	7	
							2.2	2.16	0.08	2	
4	C-572118	WA21755	6	1882.7	Besa River	672/13	2	1.56	0.09	23	Dark brown shale matrix showing mostly brown amorphous kerogen and zooclast derived inertinite macerals. Minor amount of alginite derived vitrinite macerals and isotropic solid bitumen. Traces of diagenetic calcite and replacive dolomite are also observed.
							4	1.92	0.06	11	
							2.2	1.35	0.06	10	granular
5	C-572119	WA21755	2	1969.2	Besa River	669/13	2	1.66	0.06	10	Light brown silty shale with rare amount of mostly amorphous kerogen and inertinite with trace amount of overmature alginite derived vitrinite and pyrobitumen macerals. Micrinite and pyrite are also observed in the clay rich microlaminite.
							4	1.93	0.06	18	
							4	2.19	0.09	12	
							2.2	2.50	0.03	4	
							2.2	2.93	0.00	1	
6	C-572120	WA21755	4	1995.7	Besa River	671/13	2	1.69	0.09	18	Dark brown shale and silty shale microlithotypes showing mostly brown amorphous kerogen and zooclast derived inertinite macerals. Minor amount of alginite derived vitrinite macerals and isotropic solid bitumen.
							4	1.98	0.11	11	
							4	2.38	0.14	6	
							2.2	1.39	0.09	11	granular
7	C-572121	WA21755	3	2000.7	Besa River	670/13	2	1.74	0.08	8	Light brown silty shale with rare amount of mostly amorphous kerogen and inertinite with trace amount of overmature alginite derived vitrinite and pyrobitumen macerals. Micrinite and pyrite are also observed in the clay rich microlaminite.
							4	1.99	0.09	19	
							4	2.31	0.07	4	
							2.2	1.44	0.04	2	granular
							2.2	2.78	0.00	1	
8	C-572122	WA21755	1	2114	Besa River	668/13	2	1.87	0.07	14	Light brown silty shale with rare amount of mostly amorphous kerogen and inertinite with trace amount of overmature alginite derived vitrinite and pyrobitumen macerals. Micrinite and pyrite are also observed in the clay rich microlaminite.
							21	2.20	0.10	16	
							2.2	1.58	0.09	12	granular
							2.2	2.65	0.00	1	

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A6. Complete vitrinite reflectance data for Kindle, Kindle/Mattson and Besa River/Muskwa formations collected f including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	$\%Ro_R$	SD	N
1	C-572207	WA038	16	593.7	Kindle	693/13	2	2.81	0.15	19
							21	3.61	0.11	8
							21	3.19	0.07	10
							2	2.26	0.12	4
2	C-572208	WA038	11	631.4	Kindle/Mattson	694/13	2	2.81	0.15	16
							21	3.44	0.14	8
							2	2.33	0.13	7
							21	3.92	0.00	1
3	C-572209	WA038	35	1573.3	Besa River/ Muskwa	695/13	2	3.28	0.07	4
							21	4.33	0.12	13
							21	3.82	0.15	23
							2	2.83	0.12	3
							40	4.72	0.09	5
4	C-572218	WA038	35	1576.0	Besa River/ Muskwa	696/13	2	3.19	0.22	18
							21	3.86	0.14	16
							21	4.31	0.09	4
							2	2.62	0.07	2
							40	4.72	0.00	1
5	C-572226	WA038	35	1578.5	Besa River/ Muskwa	697/13	2	3.21	0.22	13
							21	3.90	0.18	18
							2	2.50	0.17	6
							40	4.62	0.09	8
6	C-572234	WA038	35	1580.9	Besa River/ Muskwa	698/13	2	3.16	0.20	11
							21	4.20	0.09	4
							21	3.74	0.13	6
							2	2.57	0.16	2
							40	4.67	0.08	4

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the rework

from JOINT VENTURE NO. 1 C-010-E (WA0038) well

COMMENTS
Organic rich calcareous siltstone reservoir rock matrix showing mostly granular secondary migrated pyrobitumen with rare alginite derived vitrinite maceral inclusion. High percentage of calcareous microfossil. Morphology suggest possible oxidation.
poorly polish
Black shale showing mostly dark, long microlaminate of spent amorphous kerogen derived from lamalginite with rare amount of small thin lenses of unicellular alginite derive overmature vitrinite maceral and pyrobitumen lenses. Traces of granular hebamorphinite macerals.
poorly polish
poorly polish
Black shale showing mostly spent amorphous kerogen rare amount of thin long lenses of alginite derive overmature vitrinite maceral and pyrobitumen lenses. Presence of diagenitic calcite minerals with isotropic pyrobitumen inclusion. Trace of radiolaria and conodont microfossils.
poorly polish
corpogillinite
Black shale showing mostly spent amorphous kerogen rare amount of thin long lenses of alginite derive overmature vitrinite maceral and pyrobitumen lenses. Presence of diagenitic calcite minerals with isotropic pyrobitumen inclusion. Trace of radiolaria, conodont and chitinozoan microfossils.
poorly polish
Black shale showing mostly spent amorphous kerogen rare amount of thin long lenses of alginite derive overmature vitrinite maceral and pyrobitumen lenses. Trace of radiolaria, conodont and chitinozoan microfossils.
poorly polish
Black shale showing mostly spent amorphous kerogen with rare amount of small overmature amorphinite lenses, unicellular alginite derived vitrinite maceral and pyrobitumen lenses. Presence of diagenitic calcite minerals with isotropic pyrobitumen inclusion. Trace of conodont microfossils.
poorly polish

ed maceral, they are not quantitative.

A7. Complete vitrinite reflectance data for Muskwa and Otter formations collected from EOG MAXHAMISH D-012-L (WA21643) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro_R	SD	N	COMMENTS
1	C-572235	WA21643	1	2956.15	Muskwa	699/13	2	3.34	0.13	8	Dark silty shale showing minor amount of mostly interconnected network of spent amorphous and small amorphinite kerogen, and minor amount of granular pyrobitumen observed between intergranular pores. Morphology suggest possible weathering and brittleness. Scolecodont or conodont microfossils are also observed.
							21	3.77	0.06	4	
							21	2.69	0.13	17	granular and brittle
							21	2.26	0.08	2	granular and brittle
							40	4.35	0.24	5	
2	C-572238	WA21643	4	2966.5	Muskwa	700/13	2	3.40	0.00	1	Dark shale showing minor amount of mostly interconnected network of spent amorphous and small amorphinite kerogen. Minor amount of granular pyrobitumen observed between intergranular pores. Morphology suggest possible weathering and brittleness. Scolecodont or conodont microfossils are also observed.
							21	2.70	0.10	11	granular and brittle
							21	2.34	0.06	10	granular and brittle
3	C-572243	WA21643	9	2971.1	Muskwa	701/13	2	3.19	0.03	2	Dark shale showing minor amount of mostly interconnected network of spent amorphous and small amorphinite kerogen. Minor amount of granular pyrobitumen observed between intergranular pores. Morphology suggest possible weathering and brittleness. Scolecodont or conodont microfossils are also observed.
							21	2.59	0.16	22	granular and brittle
							21	2.17	0.06	6	granular and brittle
							2.2	3.93	0.12	2	
4	C-572247	WA21643	11	2978.7	Otter Park	702/13	2	3.18	0.09	6	Dark brown shale showing minor amount of mostly thin interconnected network of spent amorphous kerogen with small amorphinite inclusions and trace amount of granular and isotropic pyrobitumen macerals. Morphology suggest possible weathering and brittleness. Scolecodont or conodont microfossils are also observed.
							21	2.74	0.11	10	granular and brittle
							21	2.26	0.08	3	granular and brittle
							2.2	3.63	0.00	1	
							40	4.08	0.00	1	

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A8. Complete vitrinite reflectance data for Besa River/Golata? and Besa River formations collected from IOE DUN

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro$_R$	SD	N
1	C-571628	WA1331	15	3688.8	Besa River/ Golata?	644/13	2	2.49	0.12	4
							21	3.10	0.11	10
							2.21	3.59	0.11	6
							2.21	3.94	0.07	5
							40	4.31	0.28	10
2	C-571638	WA1331	15	3691.9	Besa River/ Golata?	645/13	2	2.15	0.00	1
							21	2.80	0.17	7
							2.1	3.61	0.20	7
							40	4.45	0.30	5
3	C-571649	WA1331	15	3695.2	Besa River/ Golata?	646/13	2	2.30	0.10	6
							21	2.93	0.08	6
							2.2	1.92	0.01	2
							2.21	3.64	0.24	9
							40	4.45	0.00	1
4	C-571660	WA1331	15	3698.6	Besa River/ Golata?	647/13	2	2.24	0.20	13
							21	2.99	0.18	7
							2.2	1.67	0.02	2
							21	3.72	0.16	11
							40	4.48	0.08	2
5	C-571672	WA1331	15	3702.2	Besa River/ Golata?	648/13	2	2.38	0.01	2
							21	2.96	0.19	13
							2.21	3.55	0.17	17
							40	4.32	0.21	14
6	C-571673	WA1331	16	3773.2	Besa River	649/13	2	2.88	0.09	7
							2.2	2.31	0.13	3
							21	3.33	0.06	4
							2.21	3.90	0.18	15
							40	4.49	0.21	8
7	C-571679	WA1331	16	3775.0	Besa River	650/13	2	2.58	0.11	15
							2.2	2.17	0.07	8
							21	3.10	0.11	5
							2.21	3.62	0.17	4
							40	4.26	0.08	3
8	C-571680	WA1331	17	3889.7	Besa River	651/13	2	2.97	0.14	17
							2.2	2.34	0.11	5
							21	3.64	0.15	12
							40	4.59	0.26	7
9	C-571685	WA1331	17	3891.5	Besa River	652/13	2	2.91	0.07	4
							21	3.54	0.19	9
							2.2	2.34	0.16	4
							40	4.40	0.14	8

10	C-571692	WA1331	17	3893.3	Besa River	653/13	2	3.07	0.11	19
							21	3.67	0.23	25
							2.2	2.41	0.22	9
							40	4.07	0.08	7
11	C-571701	WA1331	17	3895.5	Besa River	654/13	2	3.05	0.13	6
							21	3.51	0.05	7
							2.2	2.65	0.03	2
							21	3.96	0.14	8
							40	4.66	0.13	7

KEY FOR ORGANIC TYPE

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2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworke

NEDIN D-075-E (WA1331) well including qualittative analysis.

COMMENTS
Black siltstone matrix with mostly dark brown spent amorphous kerogen with trace amount of pyrobitumen, vitrinite and inertinite maceral inclusions. All observed between intergranular pores.
Black siltstone matrix with mostly dark brown spent amorphous kerogen with trace amount of pyrobitumen, vitrinite and inertinite maceral inclusions. All observed between intergranular pores.
granular
Black organically rich shale/siltstone matrix showing mostly interconnected network of dark amorphous kerogen and overmature amorphinite lesnes between intergranular pores. Rare amount of granular thin lenses of alginite derived vitrinite and pyrobitumen macerals inclusions. Conodont microfossil are also observed. High percentage of granular phosphatic organic matrix. possible in-situ oxidation.
granular
Black organically rich shale/siltstone matrix showing mostly interconnected network of dark amorphous kerogen and overmature amorphinite lesnes between intergranular pores. Rare amount of granular thin lenses of alginite derived vitrinite and pyrobitumen macerals inclusions. High percentage of granular phosphatic organic matrix. possible in-situ oxidation.
Black organically rich shale/siltstone matrix showing mostly interconnected network of dark amorphous kerogen and overmature amorphinite lesnes between intergranular pores. Rare amount of granular thin lenses of alginite derived vitrinite and pyrobitumen macerals inclusions. High percentage of granular phosphatic organic matrix. possible in-situ oxidation.
granular
Black shale matrix with mostly dark granular spent amorphous kerogen with trace amount of alginite derived vitrinite and pyrobitumen macerals and trace amount of frambiodal pyrite.
granular
Black organically rich silty shale matrix showing mostly interconnected network of dark amorphous kerogen and overmature amorphinite lesnes. Rare amount of granular thin lenses of alginite derived vitrinite and pyrobitumen macerals inclusions. High percentage of granular phosphatic organic matrix. possible in-situ oxidation.
granular
Black organic rich shale matrix showing some amorphous kerogen with overmature amorphinite lesnes. Minor amount of alginite derived vitrinite and pyrobitumen macerals inclusions. Framboidal pyrite and micrinite lenese are also observed in the matrix.
Black organic rich shale matrix showing mostly amorphous kerogen with overmature amorphinite lesnes and minor amount of framboidal pyrite. High amount of amount of alginite derived vitrinite macerals and pyrobitumen macerals inclusions. Framboidal pyrite and micrinite lenese are also observed in the matrix.

Black organic rich shale matrix showing mostly amorphous kerogen with overmature amorphinite lesnes and minor amount of framboidal pyrite. Minor amount of amount of alginite derived vitrinite macerals and pyrobitumen macerals inclusions. Framboidal pyrite and micrinite lenese are also observed in the matrix.
Black shale matrix showing mostly amorphous kerogen with overmature amorphinite lesnes and minor amount of alginite derived vitrinite macerals and rare pyrobitumen inclusions. Framboidal pyrite and micrinite lenese are also observed in the matrix.

d maceral, they are not quantitative.

A9. Complete vitrinite reflectance data for Besa River/Evie and Besa River formations collected from TRANSI qualitative anlysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro$_R$	SD	N
1	C-572181	WA02563	1	3777.8	Besa River/Evie	686/13	2	2.75	0.17	9
							21	3.57	0.26	14
							2.2	2.21	0.14	4
2	C-572184	WA02563	1	3778.7	Besa River/Evie	687/13	2	2.74	0.10	12
							21	3.32	0.18	19
							2.2	2.24	0.00	1
							21	3.87	0.11	4
							21	4.64	0.00	1
3	C-572188	WA02563	1	3779.9	Besa River/Evie	688/13	2	3.05	0.21	13
							21	3.85	0.15	10
							40	4.35	0.23	3
4	C-572192	WA02563	1	3781.2	Besa River/Evie	689/13	2	3.22	0.20	17
							21	3.86	0.07	7
							21	3.04	0.93	8
							40	4.98	0.00	1
5	C-572193	WA02563	2	3781.5	Besa River/Evie	690/13	2	3.10	0.00	1
							21	3.60	0.00	1
6	C-572200	WA02563	2	3783.6	Besa River/Evie	691/13	2	3.10	0.21	14
							21	3.79	0.17	10
							2.2	2.32	0.05	2
							40	4.23	0.02	6
7	C-572206	WA02563	3	3785.4	Besa River/Evie	692/13	2	3.70	0.00	1
							21	3.70	0.00	1
							21	4.10	0.00	1

KEY FOR ORGANIC TYPE

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3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the rew

EURO BEAVER B-019-K (WA02563) well including

COMMENTS
Orgnic rich dark shale showing mostly interconnected thin network of spent amorphoues kerogen.
granular
Black shale matrix with mostly dark granular spent amorphous kerogen with trace amount of alginite derived vitrinite and pyrobitumen macerals and trace amount of frambiodal pyrite. The host rock consist of diagenitic calcite cement rich black siltstone with dark spent amorphous kerogen and clay observed between intergranular pores.
small amorphinite
Dark brown shale matrix showing mostly small amorphinite lenses with trace amount of alginite derived overmature vitrinite and pyrobitumen macerals. Minor amount of framboidal pyrite.
Dark brown shale matrix showing mostly small amorphinite lenses with trace amount of alginite derived overmature vitrinite and pyrobitumen macerals. Trace amount of framboidal pyrite.
Dark brown shale matrix showing mostly small amorphinite lenses with trace amount of alginite derived overmature vitrinite and pyrobitumen macerals. Trace amount of framboidal pyrite.
Dark brown shale matrix showing mostly small amorphinite lenses with trace amount of alginite derived overmature vitrinite and pyrobitumen macerals. Trace amount of framboidal pyrite.
Black organic and framboidal pyrite rich shale showing mostly interconnected network of spent amorphous kerogen major amount of thin long lenses of alginite derive vitrinite maceral and pyrobitumen lenses.

vorked maceral, they are not quantitative.

A10. Complete vitrinite reflectance data for Garbutt formation collected from AEC MAXHAMISH B-053-B (WA9950) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro_R	SD	N	COMMENTS
1	C-572090	WA9950	1	1260.0	Garbutt	661/13	2	0.65	0.07	27	Light brown organic rich shale with minor amount framboidal pyrite. Major amount of bright yellow to yellow orange fluorescing alginite maceral including some Botryococcus sp.. Some thick long coaly lenses derived from lamalginite. Tasmanites and Leiosphaeridia are also observed.
							4	0.36	0.06	3	
							2.2	0.90	0.05	12	
							2.2	1.13	0.07	8	
2	C-572096	WA9950	1	1266.0	Garbutt	662/13	2	0.68	0.07	27	Light brown organic rich shale and siltstone with diagenetic carbonate matrix showing minor amount framboidal pyrite. Major amount of bright yellow to yellow orange fluorescing alginite maceral including some Botryococcus sp??. Some thick long coaly lenses derived from lamalginite. Tasmanites and Leiosphaeridia are also observed.
							4	0.38	0.00	2	
							2	0.86	0.03	7	gelinite
							2.2	1.00	0.00	2	
							2.2	1.62	0.00	1	
3	C-572101	WA9950	1	1272.0	Garbutt	663/13	2	0.72	0.07	26	Light brown organic rich silty shale matrix showing minor amount framboidal pyrite. Major amount of bright yellow to orange fluorescing alginite maceral. Some thick long coaly lenses derived from lamalginite. Tasmanites and Leiosphaeridia are also observed.
							4	0.45	0.00	2	
							2.2	0.95	0.06	8	
							2.2	1.20	0.04	3	

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A11. Complete vitrinite reflectance data for Garbutt formation collected from HARVEST BAY B-017-H (WA13

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro_R	SD	N
1	C-591340	WA13960	1	339.7	Garbutt	462/14	2	0.77	0.07	12
							4	0.59	0.06	21
							4	0.32	0.03	8
							2.2	0.96	0.04	3

KEY FOR ORGANIC TYPE

2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the rewo

960) well including qualitative analysis.

COMMENTS
Organic rich silty shale consisting mostly of spent and partially spent grey and brown amorphous kerogen with minor amount of framboidal pyrite. High percentage of yellow to reddish brown fluorescing alginite macerals orange to brown fluorescing soluble organics (soluble solid bitumen). Rare amount of vitrinite and reworked inertinite macerals. Traces of dissolve organics are also observed in pore spaces. Possible suppression.
Soluble organic/ weak yellow to reddish fluorescing solid bitumen

rked maceral, they are not quantitative.

A12. Complete vitrinite reflectance data for Garbutt formation collected from EXXON MOBILE N PETITOT D-033-F (WA06468) well .

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	$\%Ro_R$	SD	N	COMMENTS
1	C-591347	WA6468	1	298.0	Garbutt	460/14	2	0.79	0.06	17	Organic rich shale showing mostly weak yellow to reddish brown fluorescing alginite and solid bitumen macerals.
							4	0.61	0.04	15	0.78
							4	0.47		1	
							2.2	1.37		1	
2	C-591348	WA6468	1	309.0	Garbutt	461/14	2	0.81	0.10	19	Organic rich shale with minor amount of framboidal pyrite. DOM consist mostly weak yellow to reddish brown fluorescing alginite and solid bitumen macerals. Possible suppression.
							4	0.56	0.04	25	0.74
							4	0.33	0.03	4	
							2.2	1.08	0.02	4	
							2.2	1.48	0.09	2	

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2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.

A13. Complete vitrinite reflectance data for Garbutt formation collected from STX MAXHAMISH B-006-C (WA1

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro_R	SD	N
1	C-571537	WA18890	3	1476	Garbutt	628/13	2	0.79	0.03	8
							4	0.63	0.08	26
							4	0.38	0.04	7
							2.2	0.98	0.05	2
							2.2	1.40	0.17	3
2	C-571538	WA18890	3	1476.6	Garbutt	629/13	2	0.82	0.07	18
							4	0.66	0.04	21
							4	0.37	0.08	3
							2.2	1.08	0.06	8
							2.2	1.39	0.00	1
3	C-571544	WA18890	3	1481.4	Garbutt	630/13	2	0.93	0.05	14
							4	0.71	0.07	21
							2	1.05	0.03	11
							2.2	1.24	0.06	7
							2.2	1.80	0.00	1
4	C-571551	WA18890	3	1487.7	Garbutt	631/13	2	0.91	0.03	11
							2	0.79	0.04	15
							4	0.64	0.04	10
							2	1.01	0.02	6
							2.2	1.20	0.05	3
5	C-571558	WA18890	3	1494	Garbutt	632/13	2	0.92	0.07	11
							4	0.78	0.02	13
							4	0.64	0.06	9
							2	1.16	0.06	5
							2.2	1.50	0.00	1

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3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the rework

l8890) well including qualitative analysis.

COMMENTS
Pale creamy brown silty shale matrix minor amount of mostly marine derived liptinite maceral (mainly unicellular alginite) in shaley matrix, Rare sporinite and and inertinite maceral observed in siltstone matrix. Minor amount of framboidal pyrite inclusion observed proximal to amorphous kerogen.
Organic and micrinite rich dark brown shale with minor amount of yellow to orange fluorescing alginite macerals. Large granular isotropic solid bitumen lenses and vitrinite derived from lamalginite. Minor to major amount micrinite and framboidal pyrite.
Organic and framboidal pyirite rich, dark brown shale with major amount of of mostly long thin lenses of lamalginite and alginite derived amorphoius kerogen. Rare amount of yellow orange to reddish fluorescing alginite macerals. Large granular isotropic solid bitumen lenses and vitrinite derived from lamalginite. Major amount micrinite and framboidal pyrite.
Organic and framboidal pyirite rich, dark brown shale with major amount of of mostly long thin lenses of lamalginite and alginite derived amorphoius kerogen. Rare amount of yellow orange to reddish fluorescing alginite macerals. Large granular isotropic solid bitumen lenses and vitrinite derived from unicellular to lamalginite. Major amount micrinite and framboidal pyrite. Traces of HCFI in carbonate minerals.
gelinite
Organic and framboidal pyirite rich, dark brown shale with major amount of of mostly long thin lenses of lamalginite and alginite derived amorphoius kerogen. Rare amount of yellow orange to reddish fluorescing alginite macerals. Large granular isotropic solid bitumen lenses and vitrinite derived from unicellular to lamalginite. Major amount micrinite and framboidal pyrite. Traces of HCFI in carbonate minerals.
gelinite

ed maceral, they are not quantitative.

A14. Complete vitrinite reflectance data for Garbutt formation collected from TSOO A-13-H (WA14517) well including qualitative analysis.

NO.	C #	Name	Core No.	DEPTH (m)	FORMATION	PEL #	ORG_TYPE	%Ro$_R$	SD	N	COMMENTS
1	C-572169	WA14517	1	1403.2	Garbutt	683/13	2	1.41	0.06	22	Dark brown organic rich silty shale matrix showing mostly brown amorphous kerogen and zooclast derived inertinite macerals. Possible secondary oil migration due to two phase bitumen thermal maturity. Possible post uplift.
							4	1.67	0.08	21	
							4	1.22	0.03	13	possible secondary migration of bitumen
							4	1.01	0.06	6	possible secondary migration of bitumen
							2.40	2.04	0.16	9	
2	C-572174	WA14517	1	1408	Garbutt	684/13	2	1.50	0.09	13	Brown calcareous shale showing traces amount of amorphous kerogen. Rare amount of vitrinite macerals and migrated bitumen inclusions observed in calcite filled pores. Trace amount mica like minerals, possibly biotite?
							4	1.80	0.07	6	
							4	1.23	0.09	8	possible secondary migration of bitumen
							2.40	2.00	0.08	7	
							2.40	2.44	0.15	5	
3	C-572180	WA14517	1	1414.2	Garbutt	685/13	2	1.46	0.09	6	Brown calcareous shale showing traces amount of amorphous kerogen. Rare amount of vitrinite macerals and migrated bitumen inlusions observed in calcite filled pores. High amount mica like minerals, possibly biotite?
							4	1.78	0.10	4	
							4	1.10	0.08	37	possible secondary migration of bitumen
							4	0.88	0.04	4	possible secondary migration of bitumen

KEY FOR ORGANIC TYPE
2 = Vitrinite
2.1,2.2,2.3 = refers to as reworked populations
3 = vitrinite equivalent (04) = 0.618 x %Ro(bitumen) + 0.40 values (Jacob, 1989).
4 = bitumen
21= pyrobitumen
22 = granular pyrobitumen
40 = inertinite
NOTE; Not all allochthonous maceral VR are measured, those measured are for reference only to determine the %Ro of the reworked maceral, they are not quantitative.