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Hydrocarbon Analysis by Thermal Desorption Gas Chromatography on Selected Alberta Strata (Viking, Westgate, Cardium, Wilrich, Exshaw)

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AER/AGS Special Report 107

Hydrocarbon Analysis by Thermal Desorption Gas Chromatography on Selected Alberta Strata (Viking, Westgate, Cardium, Wilrich, Exshaw)

J.G. Pawlowicz, S.D.A. Anderson* and D. Rokosh

* Corresponding author

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Alberta Geological Survey
4th Floor, Twin Atria Building
4999 – 98th Avenue
Edmonton, AB T6B 2X3 Canada

Tel: 780.638.4491
Fax: 780.422.1459
E-mail: AGS-Info@aer.ca
Website: ags.aer.ca

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Abstract

This report publishes a summary report from Trican Geological Solutions using thermal desorption gas chromatography to identify and quantify hydrocarbon compositions and to estimate specific and API gravities of six core samples from five well locations in Alberta. This report summarizes the methods and analytical results.

Hydrocarbon paraffins, aromatics and napthenes were detected and quantified. The analyzed samples are mainly dominated by C6-C40 straight chained alkane hydrocarbons, aromatic hydrocarbons, and napthenes. Using simulated distillation methods, initial and final boiling points were determined.

1 Introduction

In 2012, the Alberta Geological Survey (AGS) published a report that determined the quantity and spatial extent of shale- and siltstone-hosted hydrocarbons (oil, gas, and natural gas liquids) in the province (Rokosh et al., 2012). The AGS is releasing client reports and digital data to disseminate knowledge from the project. These data and reports can be accessed from the AGS website (http://ags.aer.ca).

This report disseminates results on thermal desorption analyses, performed by Trican Geological Solutions, of six core samples from various well locations and was carried out to identify and quantify hydrocarbon compositions and to estimate the specific and API gravities.

2 Sample Locations and Descriptions

Table 1 lists the samples and sites examined in the study.

Table 1. Samples collected for thermal desorption gas chromatography analysis.

AGS Sample ID	UWI	Formation	Sample Type	Sample Depth (m)
11221	100/16-23-058-24W4/00	Viking	Core	732.80
11222	100/16-23-058-24W4/00	Westgate	Core	736.40
13256	100/04-03-044-07W5/00	Cardium	Core	1820.53
13285	100/04-18-060-20W5/00	Cardium	Core	1611.55
13807	100/07-15-098-02W6/00	Wilrich	Core	666.00
13826	102/08-07-075-05W5/00	Exshaw	Core	1086.50

References

Rokosh, C.D., Lyster, S., Anderson, S.D.A., Beaton, A.P., Berhane, H., Brazzoni, T., Chen, D., Cheng, Y., Mack, T., Pana, C. and Pawlowicz, J.G. (2012): Summary of Alberta's shale- and siltstone-hosted hydrocarbon resource potential; Energy Resources Conservation Board, ERCB/AGS Open File Report 2012-06, 327 p., URL < http://ags.aer.ca/publications/OFR_2012_06.html > [March 2017].

Hydrocarbon Analyses

by Thermal Desorption-Gas Chromatography

AER

Various Wells

Alberta Energy Regulator

April 2014

TRICAN GEOLOGICAL SOLUTIONS LTD
621-37th Ave NE
Calgary, Alberta
T2E 2M1
(403) 250-5582
http://geologicalsolutions.trican.ca

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SAMPLE SUMMARY

Well Locations:	100/16-23-058-24W4/00 100/04-03-044-07W5/00 100/04-18-060-20W5/00 100/07-15-098-02W6/00 102/08-07-075-05W5/00
Formations:	Viking, Westgate, Cardium, Wilrich, Exshaw
# of Samples Analyzed:	6
Sample Type:	Core
Analyses Completed:	Thermal Desorption-Gas Chromatography

EXECUTIVE SUMMARY

Thermal desorption gas chromatography, or TD-GC, was used to analyze the thermal desorption of six core samples from various wells. Hydrocarbon paraffins, aromatics and napthenes were detected and quantified. The analyzed samples are mainly dominated by C6-C40 straight chained alkane hydrocarbons, aromatic hydrocarbons, and napthenes. Using simulated distillation methods, initial and final boiling points were determined

Analysis of these six samples yielded no obvious trends in hydrocarbon content, peak indicators, or simulated distillation results. Calculated API gravity ranged from 33.1°API to 42.6°API with an average of 38.7°API. Hydrocarbon rich zones ranged from C6-C27, with modal identified peaks ranging from C8 to C15 and an average of C12. Initial boiling points ranged from 58°C to 74°C, averaging at 64°C. Final boiling points ranged from 484°C to 523°C, with an average of 503°C.

INTRODUCTION

Thermal Desorption-Gas Chromatography Analysis

Thermal Desorption analyses of six core samples from various well locations was carried out to identify and quantify the hydrocarbon compositions and to estimate the specific and API gravities. This report summarizes the methods and analytical results.

Thermal desorption-gas chromatography is a method in which a powdered rock sample or an extracted liquid sample is heated to thermally desorb hydrocarbons within the sample. Volatilized hydrocarbons are cryogenically cooled and transferred to an Agilent HP-5 column where components are separated based on physical properties.

The detector used by the TD-GC is a flame ionization detector or FID. The FID operates by combusting a compound to give it a charge. The charged particles then contact the detector and transfer their charge. The FID records this change in charge as a peak which relates to concentrations based on calibrated standards.

The resulting chromatograms are analysed using Agilent ChemStation methods to identify and quantify the hydrocarbon concentrations. Hydrocarbon grouping is applied through the use of Agilent SimDis methods. Details of the analysis, sample preparation, methods and data plots are provided in Appendices A-C.

RESULTS AND INTERPRETATION: TD-GC

Hydrocarbon Compositions

The quantitative hydrocarbon concentrations are tabulated in Tables 1-3. A specific gravity of the fluid has been calculated using densities for the hydrocarbons analysed. The specific gravity has been re-calculated into API gravity. For each sample, please note the percentage of the peaks from the chromatograms that have been identified. Mole, mass and volume fraction plots are provided in Appendix B at the end of this report.

Hydrocarbon rich zones have been tabulated below in Table A. The hydrocarbon rich zone in the Viking Formation was identified in the range from C6-C16 with a modal peak of C13. Hydrocarbon rich zone of the Westgate Formation was identified in the C10-C23 range with a modal peak of C14. Hydrocarbon rich zones in the Cardium Formation were identified in the C6-C20 range with a modal peak of C15. In the Wilrich Formation the hydrocarbon rich zone ranged from C7-C16 with a modal peak of C8. From the Exshaw Formation the hydrocarbon rich zone ranged from C8-C27 with a modal peak of C9.

Simulated Distillation

Simulated distillation results are tabulated in Tables 4-5. Peak data from the chromatogram is collected and hydrocarbons are grouped by boiling point. Temperature and carbon number are then determined at a variety of percent yields ranging from 0.5% to 99.5%. Percent Yield plots are provided in Appendix C at the end of this report.

Initial boiling point (IBP, 0.5% yield), final boiling point (FBP, 99.5% yield) and related carbon numbers have been tabulated below in Table A. In the Viking Formation the initial boiling point was 58°C with a carbon number of C6, and the final boiling point was 523°C with a carbon number of C40. The Westgate Formation was determined to have an initial boiling point of 62°C with a carbon number of C6, and a final boiling point of 508°C with a carbon number of C38. In the Cardium Formation sample 13256 had an initial boiling point of 70°C and a carbon number of C6, with a final boiling point of 484°C and a carbon number of C34. In the Cardium Formation sample 13285 had an initial boiling point of 60°C with a carbon number of C6, and the final boiling point was 485°C with a carbon number of C34. The Wilrich Formation was determined to have an initial boiling point of 61°C with a carbon number of C6, and a final boiling point of 506°C with a carbon number of C38. In the Exshaw Formation the initial boiling point was 74°C with a carbon number of C6, and the final boiling point was 511°C with a carbon number of C38.

Chromatogram Quality

To determine the quality of results gathered, each chromatogram is assessed and given a quality indicator. The criteria assessed to determine chromatogram quality are abnormal baseline drift, peak response, and a consistent bell-curve shape to the peaks. Chromatograms which are assessed as “Best” and “Excellent” have little to no baseline drift, excellent peak response, and a very consistent bell-curve. “Good” and “Ok” chromatograms have moderate baseline drift, good peak response, and a somewhat consistent bell-curve. “Poor” and “No Good” chromatograms have significant baseline drift, poor peak response, and few hydrocarbons which can be identified. Hydrocarbon content present in the sample is the largest factor in resulting chromatogram quality, with higher hydrocarbon content usually equalling better chromatogram quality.

Table A - Summary of the hydrocarbon rich zones identified in six samples from various locations.

Hydrocarbon Analysis Summary Table for ERCB, Various Wells																		
					Paraffins					Peak Indicators		Simulated Distillation						
Sample	UWI	Formation	Sample Type	Sample Depth (m)	% Light Condensate	% Heavy Condensate	% Napthenes	% Aromatics	% Biomarkers	Range >2%	Peak	Initial Boiling Point (°C)	Carbon Number	Final Boiling Point (°C)	Carbon Number	Calculated Specific Gravity	Calculated API gravity	Chromatogram Quality
11221	100/16-23-058-24W4/00	Viking	Core	732.80	35.86	47.45	4.58	10.90	1.21	C6-C16	C13	58	C6	523	C40	0.813	42.6	Poor
11222	100/16-23-058-24W4/00	Westgate	Core	736.40	15.98	67.18	2.19	5.55	9.10	C10-C23	C14	62	C6	508	C38	0.838	37.4	Poor
13256	100/04-03-044-07W5/00	Cardium	Core	1820.53	15.39	77.28	0.75	2.65	3.95	C11-C16	C14	70	C6	484	C34	0.831	38.7	Good
13285	100/04-18-060-20W5/00	Cardium	Core	1611.55	18.80	52.64	5.72	15.78	7.05	C6-C20	C15	60	C6	485	C34	0.827	39.6	Ok
13807	100/07-15-098-02W6/00	Wilrich	Core	666.00	22.56	32.01	5.48	36.80	3.16	C7-C16	C8	61	C6	506	C38	0.822	40.6	Poor
13826	102/08-07-075-05W5/00	Exshaw	Core	1086.50	13.93	61.28	0.78	15.45	8.60	C8-C27	C9	74	C6	511	C38	0.860	33.1	Ok

** Light Condensates consist of nC6 through nC12*
** Heavy Condensates consist of nC13 through nC40*
** Naphthenes consist of Cyclopentane, Methylcyclopentane, Cyclohexane, Methylcyclohexane*
** Aromatics consist of Benzenes, Toluene, Ethylbenzene, Xylenes*
** Biomarkers consist of Pristane & Phytane*

Table 1 - Thermal desorption of samples 11221 and 11222 analyzed and quantified using thermal desorption-gas chromatography.

ERCB Various Wells	11221	732.80 m		
	Normalized Area %	Mol Fraction	Mass Fraction	Volume Fraction
Cyclopentane	0.66	0.02	0.01	0.0070
C6	0.91	0.02	0.01	0.0110
Methylcyclopentane	1	0.02	0.01	0.0100
Benzene	0.26	0.01	0.00	0.0020
Cyclohexane	2.75	0.05	0.03	0.0270
C7	0.14	0.00	0.00	0.0020
Methylcyclohexane	0.17	0.00	0.00	0.0020
Toluene	0.6	0.01	0.01	0.0050
C8	2.44	0.03	0.02	0.0270
Ethylbenzene	1.27	0.02	0.01	0.0110
m,p-Xylene	4.17	0.06	0.04	0.0370
o-Xylene	2	0.03	0.02	0.0170
C9	2.22	0.03	0.02	0.0240
Trimethylbenzene	2.6	0.04	0.03	0.0230
C10	4.21	0.05	0.04	0.0440
C11	10.38	0.11	0.10	0.1070
C12	15.56	0.15	0.16	0.1590
C13	18.42	0.16	0.18	0.1860
C14	11.38	0.09	0.11	0.1150
C15	5.28	0.04	0.05	0.0530
C16	2.51	0.02	0.03	0.0250
C17	1.18	0.01	0.01	0.0120
Pristane	0.83	0.01	0.01	0.0080
C18	0.39	0.00	0.00	0.0040
Phytane	0.38	0.00	0.00	0.0040
C19	0.25	0.00	0.00	0.0020
C20	0.63	0.00	0.01	0.0060
C21	0.53	0.00	0.01	0.0050
C22	2.33	0.01	0.02	0.0220
C23	0.23	0.00	0.00	0.0020
C24	0.25	0.00	0.00	0.0020
C25	0.25	0.00	0.00	0.0020
C26	0.35	0.00	0.00	0.0030
C27	0	0.00	0.00	0.0000
C28	3.18	0.01	0.03	0.0300
C29	0	0.00	0.00	0.0000
C30	0	0.00	0.00	0.0000
C31	0.04	0.00	0.00	0.0000
C32	0	0.00	0.00	0.0000
C33	0	0.00	0.00	0.0000
C34	0.25	0.00	0.00	0.0030
C35	0	0.00	0.00	0.0000
C36	0	0.00	0.00	0.0000
C37	0	0.00	0.00	0.0000
C38	0	0.00	0.00	0.0000
C39	0	0.00	0.00	0.0000
C40	0	0.00	0.00	0.0000

% Identified Peaks	13.24
Specific Gravity	0.813
API Gravity	42.6

11222	736.40 m		
Normalized Area %	Mol Fraction	Mass Fraction	Volume Fraction
0.62	0.02	0.01	0.0060
0.46	0.01	0.01	0.0050
0.59	0.01	0.01	0.0060
0.13	0.00	0.00	0.0010
0.86	0.02	0.01	0.0090
0.48	0.01	0.01	0.0050
0.12	0.00	0.00	0.0010
0.72	0.02	0.01	0.0060
1.46	0.03	0.02	0.0160
0.47	0.01	0.01	0.0040
1.52	0.03	0.02	0.0140
0.72	0.01	0.01	0.0060
1.25	0.02	0.01	0.0130
1.99	0.03	0.02	0.0180
2.27	0.03	0.02	0.0240
3.66	0.05	0.04	0.0380
6.4	0.08	0.06	0.0660
6.25	0.07	0.06	0.0640
7.15	0.07	0.07	0.0730
6.43	0.06	0.06	0.0650
6.54	0.06	0.07	0.0660
5.77	0.05	0.06	0.0570
5.22	0.04	0.05	0.0520
7.28	0.06	0.07	0.0730
3.88	0.03	0.04	0.0380
6.23	0.05	0.06	0.0610
6.16	0.04	0.06	0.0600
5.12	0.04	0.05	0.0500
4.63	0.03	0.05	0.0450
2.63	0.02	0.03	0.0260
1.47	0.01	0.02	0.0140
0.79	0.01	0.01	0.0080
0.42	0.00	0.00	0.0040
0.17	0.00	0.00	0.0020
0.06	0.00	0.00	0.0010
0.04	0.00	0.00	0.0000
0.02	0.00	0.00	0.0000
0.02	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000
0	0.00	0.00	0.0000

14.26
0.838
37.4

Table 2 - Thermal desorption of samples 13256 and 13285 analyzed and quantified using thermal desorption-gas chromatography.

ERCB Various Wells	13256	1820.53 m			13285	1611.55 m		
	Normalized Area %	Mol Fraction	Mass Fraction	Volume Fraction	Normalized Area %	Mol Fraction	Mass Fraction	Volume Fraction
Cyclopentane	0.18	0.01	0.00	0.0020	0.28	0.01	0.00	0.0030
C6	0.15	0.00	0.00	0.0020	0.63	0.01	0.01	0.0070
Methylcyclopentane	0.17	0.00	0.00	0.0020	0.68	0.01	0.01	0.0070
Benzene	0.02	0.00	0.00	0.0000	0.21	0.00	0.00	0.0020
Cyclohexane	0.38	0.01	0.00	0.0040	4.27	0.08	0.04	0.0430
C7	0.19	0.00	0.00	0.0020	0.17	0.00	0.00	0.0020
Methylcyclohexane	0.02	0.00	0.00	0.0000	0.49	0.01	0.01	0.0050
Toluene	0.37	0.01	0.00	0.0030	1.02	0.02	0.01	0.0090
C8	0.55	0.01	0.01	0.0060	3.15	0.05	0.03	0.0350
Ethylbenzene	0.35	0.01	0.00	0.0030	1.71	0.03	0.02	0.0150
m,p-Xylene	0.75	0.01	0.01	0.0070	6.31	0.10	0.06	0.0570
o-Xylene	0.37	0.01	0.00	0.0030	2.9	0.05	0.03	0.0260
C9	0.68	0.01	0.01	0.0070	2.15	0.03	0.02	0.0230
Trimethylbenzene	0.79	0.01	0.01	0.0070	3.63	0.05	0.04	0.0320
C10	1.51	0.02	0.02	0.0160	2.76	0.03	0.03	0.0300
C11	3.61	0.05	0.04	0.0370	4.11	0.04	0.04	0.0430
C12	8.7	0.10	0.09	0.0890	5.83	0.06	0.06	0.0600
C13	16.39	0.17	0.16	0.1660	6.3	0.06	0.06	0.0650
C14	21.67	0.21	0.22	0.2180	9.43	0.08	0.09	0.0960
C15	18.73	0.17	0.19	0.1860	10.42	0.08	0.10	0.1050
C16	10.45	0.09	0.11	0.1040	7.01	0.05	0.07	0.0710
C17	4.8	0.04	0.05	0.0470	4.51	0.03	0.05	0.0450
Pristane	2.92	0.02	0.03	0.0290	5.2	0.03	0.05	0.0520
C18	2.01	0.02	0.02	0.0200	4.66	0.03	0.05	0.0470
Phytane	1.03	0.01	0.01	0.0100	1.85	0.01	0.02	0.0180
C19	0.99	0.01	0.01	0.0100	1.97	0.01	0.02	0.0190
C20	0.7	0.01	0.01	0.0070	2.21	0.01	0.02	0.0220
C21	0.51	0.00	0.01	0.0050	1.98	0.01	0.02	0.0190
C22	0.33	0.00	0.00	0.0030	1.39	0.01	0.01	0.0140
C23	0.18	0.00	0.00	0.0020	1.08	0.01	0.01	0.0110
C24	0.08	0.00	0.00	0.0010	0.52	0.00	0.01	0.0050
C25	0.07	0.00	0.00	0.0010	0.62	0.00	0.01	0.0060
C26	0.05	0.00	0.00	0.0000	0.22	0.00	0.00	0.0020
C27	0	0.00	0.00	0.0000	0.09	0.00	0.00	0.0010
C28	0.31	0.00	0.00	0.0030	0.03	0.00	0.00	0.0000
C29	0	0.00	0.00	0.0000	0.15	0.00	0.00	0.0010
C30	0	0.00	0.00	0.0000	0.02	0.00	0.00	0.0000
C31	0.01	0.00	0.00	0.0000	0.03	0.00	0.00	0.0000
C32	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C33	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C34	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C35	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C36	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C37	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C38	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C39	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000
C40	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000

% Identified Peaks	25.37	12.89
Specific Gravity	0.831	0.827
API Gravity	38.7	39.6

Table 3 - Thermal desorption of samples 13807 and 13826 analyzed and quantified using thermal desorption-gas chromatography.

ERCB Various Wells	13807 666.00 m				13826 1086.50 m			
	Normalized Area %	*Mol Fraction*	*Mass Fraction*	*Volume Fraction*	*Normalized Area %*	*Mol Fraction*	*Mass Fraction*	*Volume Fraction*
Cyclopentane	1.19	0.02	0.01	0.0130	0.4	0.01	0.00	0.0040
C6	0.74	0.01	0.01	0.0090	0.18	0.00	0.00	0.0020
Methylcyclopentane	1.2	0.02	0.01	0.0130	0.13	0.00	0.00	0.0010
Benzene	0.25	0.00	0.00	0.0020	0.06	0.00	0.00	0.0010
Cyclohexane	2.96	0.05	0.03	0.0300	0.24	0.01	0.00	0.0020
C7	0.93	0.01	0.01	0.0110	0.01	0.00	0.00	0.0000
Methylcyclohexane	0.13	0.00	0.00	0.0010	0.01	0.00	0.00	0.0000
Toluene	7.92	0.12	0.08	0.0730	0.94	0.02	0.01	0.0090
C8	2.18	0.03	0.02	0.0250	0.71	0.01	0.01	0.0080
Ethylbenzene	3.33	0.04	0.03	0.0310	1.22	0.02	0.01	0.0110
m,p-Xylene	13.51	0.17	0.14	0.1250	4.45	0.08	0.05	0.0410
o-Xylene	5.38	0.07	0.05	0.0490	2.33	0.04	0.02	0.0210
C9	2.29	0.02	0.02	0.0250	1.56	0.02	0.02	0.0170
Trimethylbenzene	6.41	0.07	0.06	0.0580	6.45	0.11	0.06	0.0580
C10	4.37	0.04	0.04	0.0480	2.07	0.03	0.02	0.0220
C11	4.52	0.04	0.05	0.0480	3.81	0.05	0.04	0.0400
C12	7.53	0.06	0.08	0.0790	5.59	0.07	0.06	0.0590
C13	6.73	0.05	0.07	0.0700	4.96	0.05	0.05	0.0520
C14	7.67	0.05	0.08	0.0800	4.61	0.05	0.05	0.0480
C15	5.52	0.04	0.06	0.0570	4.08	0.04	0.04	0.0420
C16	3.37	0.02	0.03	0.0350	3.07	0.03	0.03	0.0310
C17	1.89	0.01	0.02	0.0190	4.02	0.03	0.04	0.0410
Pristane	1.73	0.01	0.02	0.0180	3.9	0.03	0.04	0.0390
C18	1.68	0.01	0.02	0.0170	4.55	0.04	0.05	0.0460
Phytane	1.43	0.01	0.01	0.0140	4.7	0.03	0.05	0.0470
C19	1.08	0.01	0.01	0.0110	2.4	0.02	0.02	0.0240
C20	1.19	0.01	0.01	0.0120	3.01	0.02	0.03	0.0300
C21	1.44	0.01	0.01	0.0140	4.35	0.03	0.04	0.0430
C22	0	0.00	0.00	0.0000	4.59	0.03	0.05	0.0450
C23	0.38	0.00	0.00	0.0040	3.44	0.02	0.03	0.0350
C24	0.56	0.00	0.01	0.0060	2.8	0.02	0.03	0.0280
C25	0.12	0.00	0.00	0.0010	2.85	0.02	0.03	0.0280
C26	0.32	0.00	0.00	0.0030	2.92	0.02	0.03	0.0290
C27	0.02	0.00	0.00	0.0000	2.03	0.01	0.02	0.0200
C28	0.02	0.00	0.00	0.0000	1.86	0.01	0.02	0.0180
C29	0.02	0.00	0.00	0.0000	1.61	0.01	0.02	0.0160
C30	0	0.00	0.00	0.0000	0.71	0.00	0.01	0.0070
C31	0	0.00	0.00	0.0000	1.66	0.01	0.02	0.0170
C32	0	0.00	0.00	0.0000	0.81	0.00	0.01	0.0080
C33	0	0.00	0.00	0.0000	0.34	0.00	0.00	0.0030
C34	0	0.00	0.00	0.0000	0.34	0.00	0.00	0.0030
C35	0	0.00	0.00	0.0000	0.19	0.00	0.00	0.0020
C36	0	0.00	0.00	0.0000	0.05	0.00	0.00	0.0000
C37	0	0.00	0.00	0.0000	0.01	0.00	0.00	0.0000
C38	0	0.00	0.00	0.0000	0.01	0.00	0.00	0.0000
C39	0	0.00	0.00	0.0000	0.01	0.00	0.00	0.0000
C40	0	0.00	0.00	0.0000	0	0.00	0.00	0.0000

% Identified Peaks	14.76	11.35
Specific Gravity	0.822	0.860
API Gravity	40.6	33.1

Table 4 – Simulated distillation of samples 11221, 11222, and 13256 analyzed and quantified using thermal desorption-gas chromatography.

ERCB Various Wells	11221 732.80 m		11222 736.40 m		13256 1820.53 m	
	Temperature (°C)	*Carbon Number*	*Temperature (°C)*	*Carbon Number*	*Temperature (°C)*	*Carbon Number*
0.5%	58	C6	62	C6	70	C6
5.0%	75	C6	105	C7	165	C10
10.0%	123	C8	163	C10	199	C11
15.0%	160	C9	192	C11	216	C12
20.0%	182	C10	212	C12	227	C13
25.0%	198	C11	226	C13	235	C13
30.0%	211	C12	237	C13	238	C13
35.0%	219	C12	247	C14	245	C14
40.0%	228	C13	256	C14	250	C14
45.0%	235	C13	265	C15	253	C14
50.0%	242	C13	276	C15	257	C14
55.0%	250	C14	287	C16	262	C15
60.0%	258	C14	298	C17	267	C15
65.0%	268	C15	309	C17	270	C15
70.0%	282	C16	317	C18	276	C15
75.0%	303	C17	329	C19	283	C16
80.0%	330	C19	340	C20	289	C16
85.0%	345	C20	353	C21	301	C17
90.0%	369	C22	368	C22	315	C18
95.0%	432	C28	386	C24	348	C20
99.5%	523	C40	508	C38	484	C34

Table 5 – Simulated distillation of samples 13285, 13807, and 13826 analyzed and quantified using thermal desorption-gas chromatography.

ERCB Various Wells	13285 1611.55 m		13807 666.00 m		13826 1086.50 m	
	Temperature (°C)	*Carbon Number*	*Temperature (°C)*	*Carbon Number*	*Temperature (°C)*	*Carbon Number*
0.5%	60	C6	61	C6	74	C6
5.0%	83	C6	85	C7	160	C9
10.0%	119	C8	123	C8	187	C11
15.0%	150	C9	147	C9	208	C12
20.0%	180	C10	169	C10	223	C12
25.0%	205	C11	185	C10	236	C13
30.0%	222	C12	200	C11	250	C14
35.0%	236	C13	213	C12	262	C15
40.0%	246	C14	222	C12	277	C15
45.0%	254	C14	231	C13	291	C16
50.0%	261	C14	239	C13	307	C17
55.0%	269	C15	247	C14	321	C18
60.0%	276	C15	255	C14	335	C19
65.0%	283	C16	264	C15	350	C20
70.0%	292	C16	275	C15	363	C21
75.0%	303	C17	289	C16	375	C23
80.0%	315	C18	308	C17	390	C24
85.0%	330	C19	330	C19	409	C26
90.0%	353	C21	353	C21	430	C28
95.0%	379	C23	383	C23	454	C31
99.5%	485	C34	506	C38	511	C38

CONCLUSIONS

Thermal desorption of six core samples from various wells were determined and quantified using Agilent ChemStation and Agilent SimDis. Hydrocarbon paraffins, aromatics and napthenes were detected and quantified. Analyzed samples are mainly dominated by C6-C40 straight chained alkane hydrocarbons, aromatic hydrocarbons, and napthenes. Initial and final boiling points were determined using simulated distillation methods.

Sample 11221 of the Viking Formation was found to be dominated by heavy condensates (47%) with significant light condensate content (36%). The IBP was determined to be 58°C with a carbon number of C6. The FBP was determined to be 523°C with a carbon number of C40. Hydrocarbon rich zones were identified in the range of C6 to C16 and a modal peak of C13. Aromatic hydrocarbons were identified, dominated by ethylbenzene and xylenes (2-4%). Napthene hydrocarbons were identified with cyclohexane most predominant (3%). The calculated API gravity of this sample is 42.6°API.

Sample 11222 of the Westgate Formation showed a larger presence of heavy condensates (67%) than light condensates (16%). The IBP was determined as 62°C with a carbon number of C6, and a FBP of 508°C with a carbon number of C38. Hydrocarbon rich zones were identified in the range of C10 to C23 and a modal peak of C14. Aromatics were present (5%), composed of compounds that ranged from <1% to 1.5%. Napthenes were present (2%), with each component <1%. The calculated API gravity of this sample is 37.4°API.

Sample 13256 from the Cardium Formation was determined to have a greater amount of heavy condensates (77%) than light condensates (15%). The IBP was determined to be 70°C with a carbon number of C6, and a FBP of 484°C with a carbon number of C34. The hydrocarbon rich zone ranged from C11 to C16 with a modal peak of C14. There were some aromatics present (3%) and <1% of napthene content. The calculated API gravity of this sample is 38.7°API

The analyzed sample 13285 from the Cardium Formation was found to be dominated by heavy condensates (53%), with significant light condensates (19%). The IBP was determined to be 60°C with a carbon number of C6, and a FBP of 485°C with a carbon number of C34. The hydrocarbon rich zone ranges from C6 to C20. Also present in the sample are aromatics (16%), which are predominantly made up of toluene, ethylbenzene and xylenes in this sample. The naphthalene component (6%) is dominated by cyclohexane. The calculated API gravity of this sample is 39.6°API.

Sample 13807 from the Wilrich Formation showed a large component of aromatics (37%), with lesser amounts of heavy condensates (32%) and light condensates (23%). Napthenes were present as a minor component (5%). The IBP was determined as 61°C with a carbon number of C6, with a FBP of 506°C and a carbon number of C38. The hydrocarbon rich zone ranged from C7 to C16 with a modal peak of C8. The calculated API gravity of this sample is 40.6°API.

From the Exshaw Formation, sample 13826 was analyzed and yielded a large heavy condensate (61%) component with a lesser light condensate portion (14%). There was a significant aromatic portion (15%), composed primarily of xylenes. The IBP was determined to be 74°C with a carbon number of C6, and a FBP of 511°C with a carbon number of C38. The hydrocarbon rich zone ranged from C8 to C27 with a modal peak of C9. The calculated API gravity of this sample is 33.1°API.

Comparison of sample results from this project yielded no obvious trends in hydrocarbon content, peak indicators, or simulated distillation results.

Principal Authors:

R. Marc Bustin, PhD, P.Geo, FRSC
Technical Advisor
Trican Geological Solutions

Ron Brezovski, P.Geol
President
Trican Geological Solutions

Brent Nassichuk, MSc
Technical Manager
Trican Geological Solutions

Cory Twemlow, BSc, P.Chem
Lab Manager
Trican Geological Solutions

APPENDIX A: ANALYSIS, METHODS AND OUTPUTS

Methods and sample details

An Agilent gas chromatograph equipped with a thermal inlet is used to separate and quantify the components of a solid or liquid sample. Samples are introduced to the thermal inlet using an automatic gripper arm where they are thermally desorbed. Volatilized hydrocarbons are separated using an Agilent chromatography column, which has a temperature rating of 325°C, a length of 30m, a diameter of 320 µm, and a bore size of 0.25 µm. The column is composed of a silicate coating, allowing for separation of components based on physical properties.

The detector used by the Agilent is a Flame Ionization Detector or FID. The FID will combust the separated compounds, giving them a charge. These charged particles will then collide with the detector and lose their charge. The FID responds to this change in charge and graphs the results with time on the X axis and response on the Y axis, allowing us to see 'peaks' in response which relate to concentration.

Before any unknown samples were analyzed, rigorous calibration standards were run and identified at various concentrations. Inlet and oven parameters were adjusted and then set based on the calibration standards. The parameters have been designed so that each component elutes out independently allowing individual components to be easily distinguished. The calibrations and inlet and oven parameters are applied to the unknown samples to identify and quantify each hydrocarbon component. The conditions are applied such that direct comparison can be made to S1 values from the source rock analysis (SRA).

There are two sample forms the Agilent TD-GC can analyse:

Solid – Powdered method

The sample material used for solid thermal desorption is ground to a homogenous particle size of ~2 micrometres using a puck and ring mill. The sample is loaded into a deactivated glass GC inlet liner that is placed in a sample holder tray. The liner with sample will be introduced to the thermal inlet by means of an automatic gripper arm.

Liquid method

The sample material used for liquid thermal desorption is either a concentrated liquid sample (e.g. invert) or liquid sample that has been extracted by Dean Stark from a rock sample. The sample is then placed in a 2ml glass vial with a PTFE cap. The sample will be introduced to the thermal inlet by means of an automatic direct syringe injection.

TD-GC Peak Patterns - Explained

Figure 1 shows the raw gas chromatogram of a hydrocarbon rich sample. The figure illustrates peak retention times and relative abundance of the major hydrocarbons. The sample in **Figure 1** shows that straight chained hydrocarbons (alkanes) make up a large component of the sample, while the aromatic hydrocarbons and napthenes make up a relatively small component of the overall composition. It must be noted that not all peaks can be identified as standards are not available for minor compounds. Simulated Distillation must be applied to further resolve the H-C groupings based on boiling points. Quantification may not reflect the true percentage of these hydrocarbon concentrations but a relative or normalized percentage.

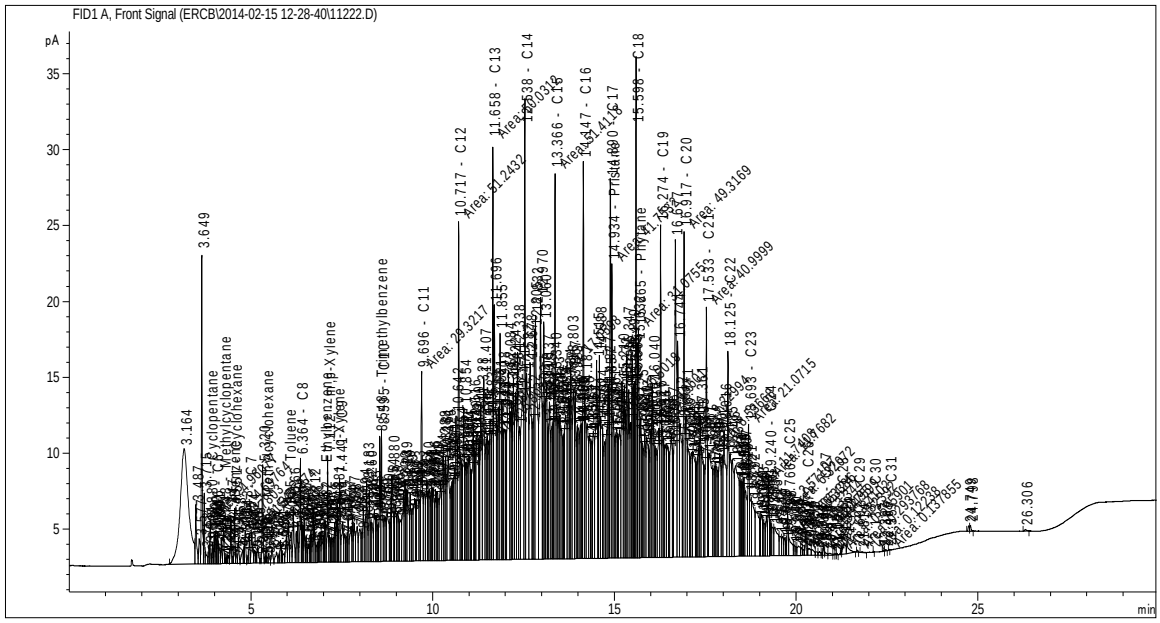
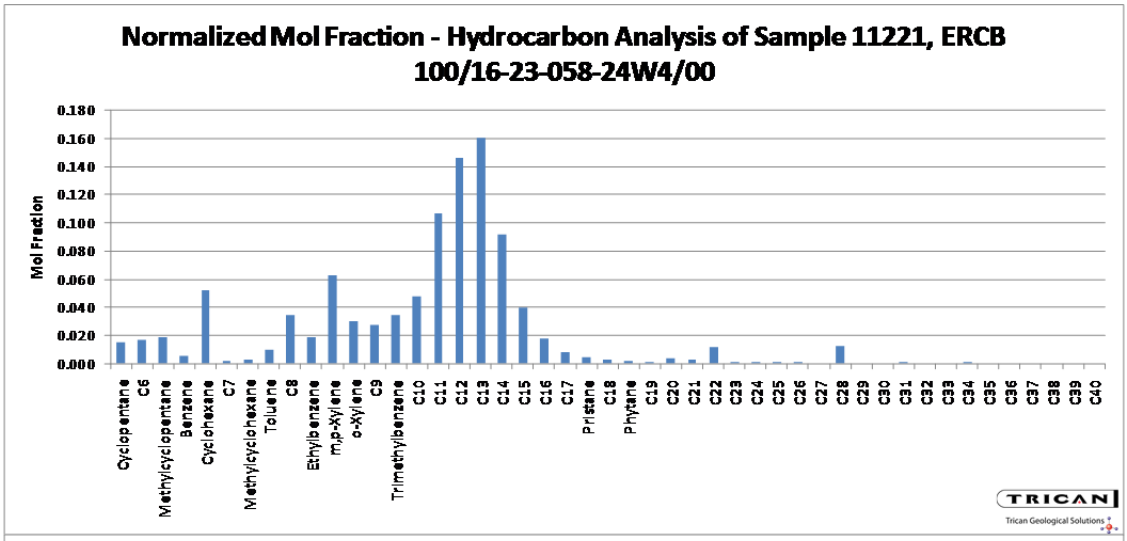


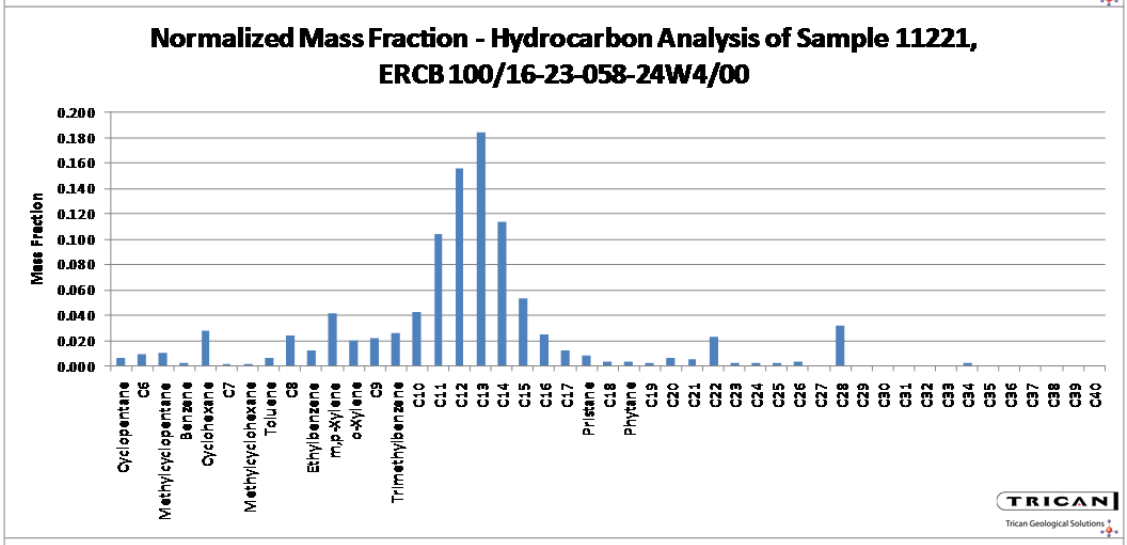
Figure 1: An example of a gas chromatogram of sample 11222 displaying typical hydrocarbons identified in these samples. Aromatic hydrocarbons (benzene, ethylbenzene, toluene, trimethylbenzene, and o,m,p-xylenes), paraffins (alkanes) and napthenes are present.

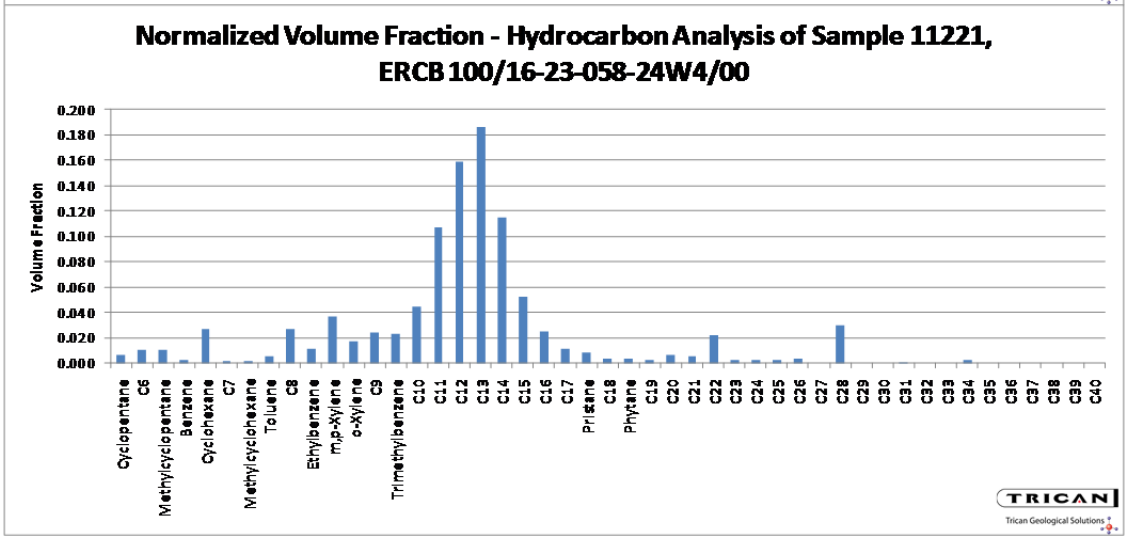
APPENDIX B: MOLE, MASS AND VOLUME FRACTION PLOTS

***Note that mole, mass and volume fractions have been normalized and assume a total hydrocarbon recovery from the gas chromatography.**

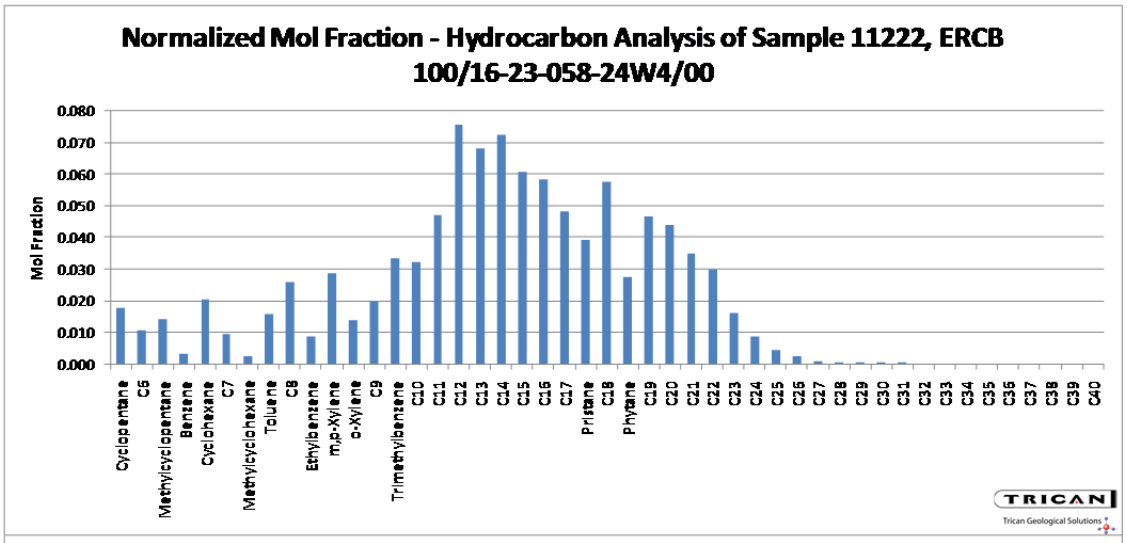
11221 – 732.80m

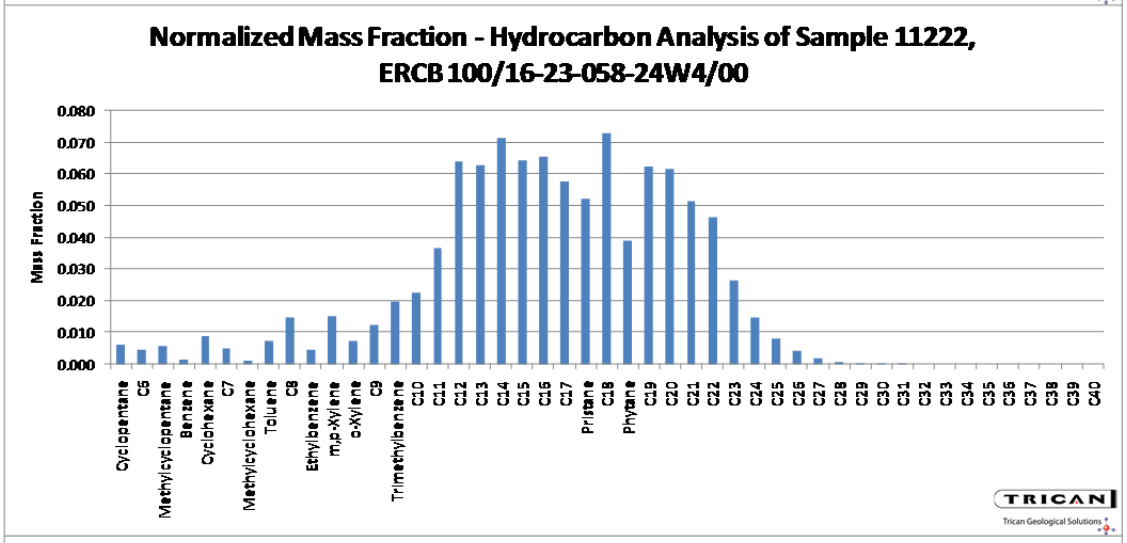


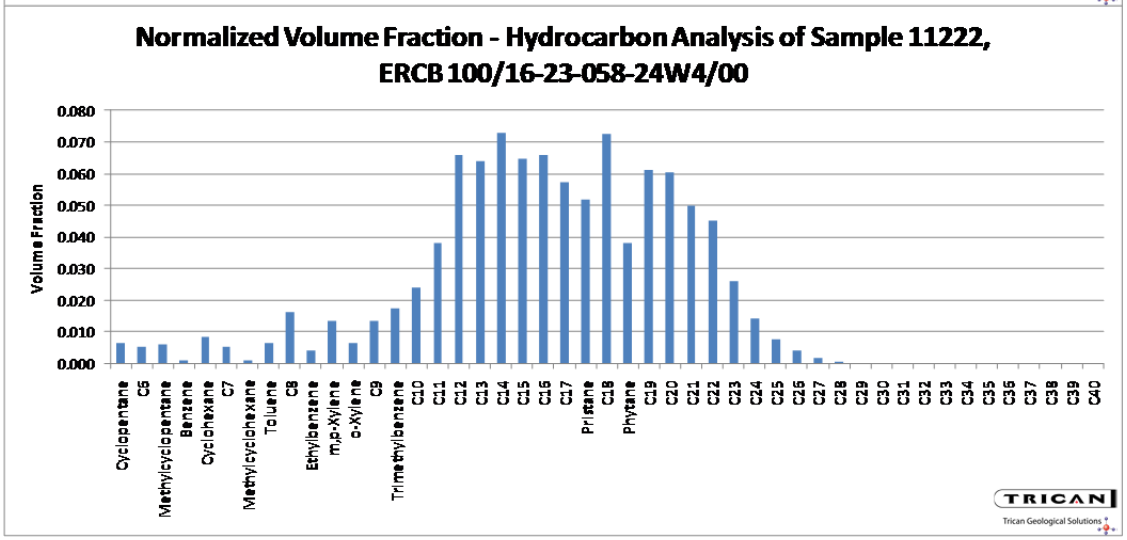




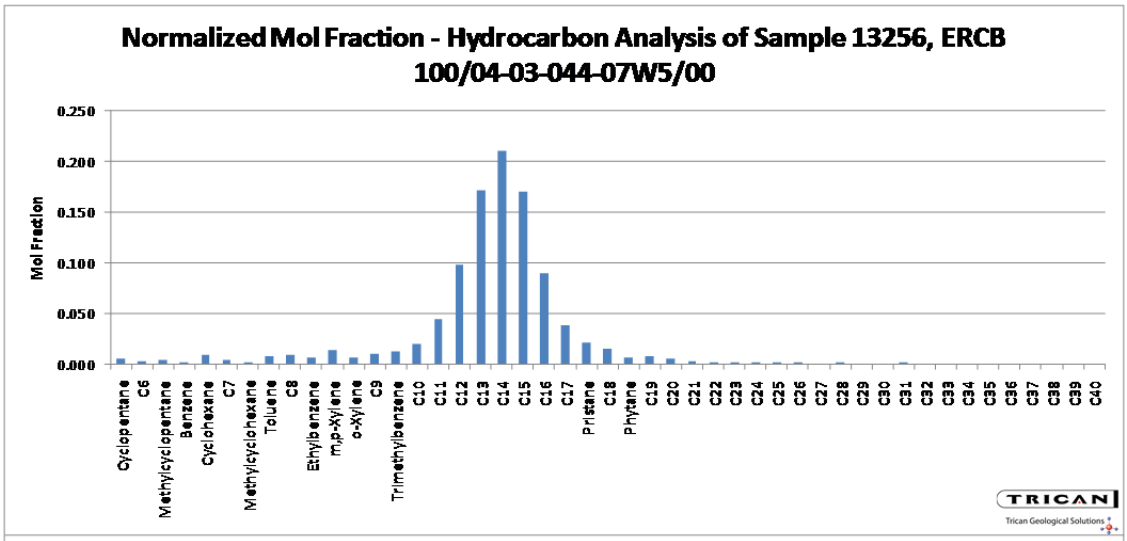
11222 – 736.40m

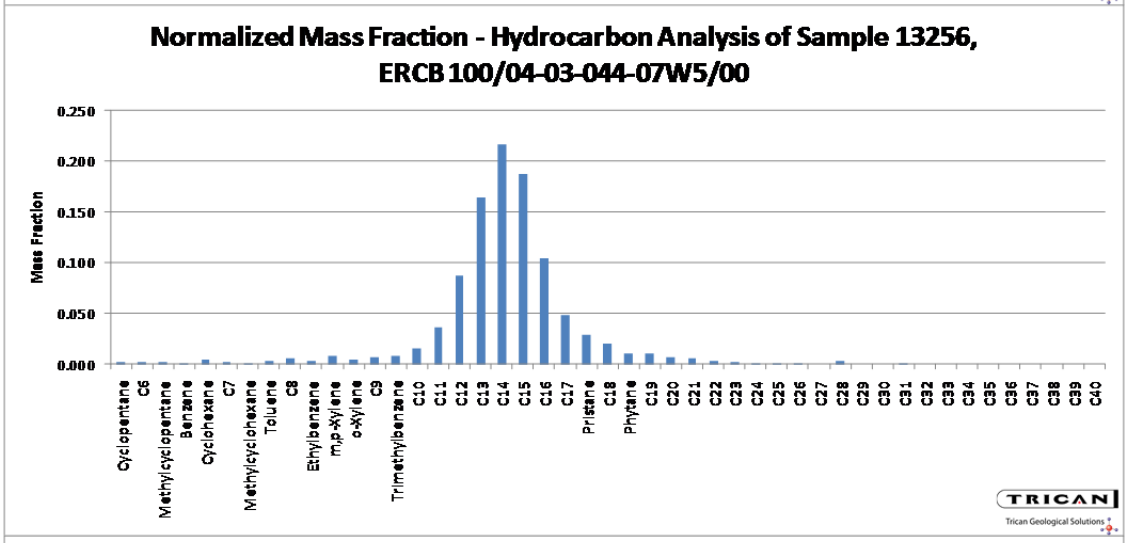


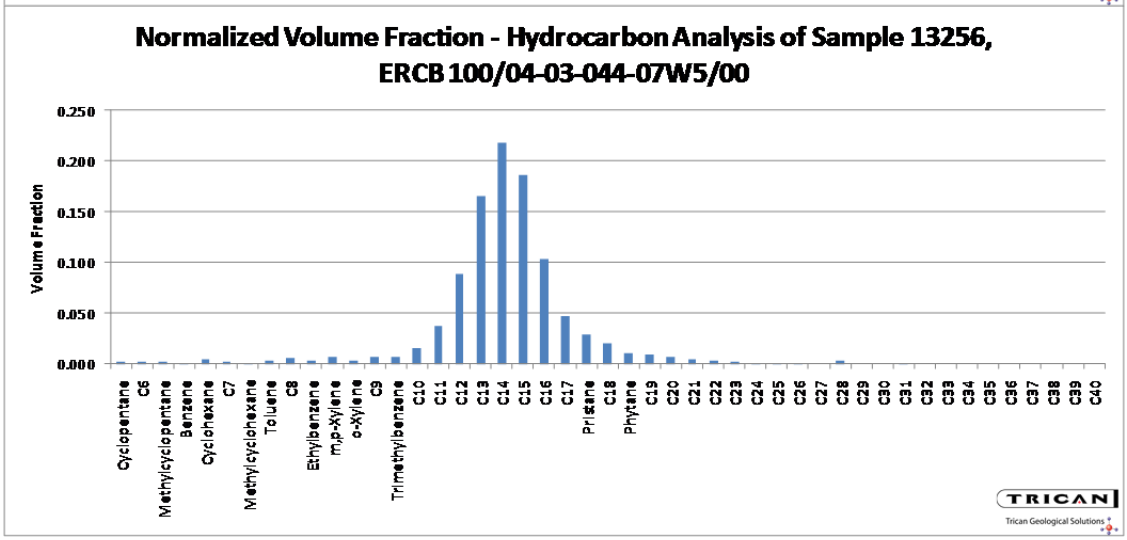




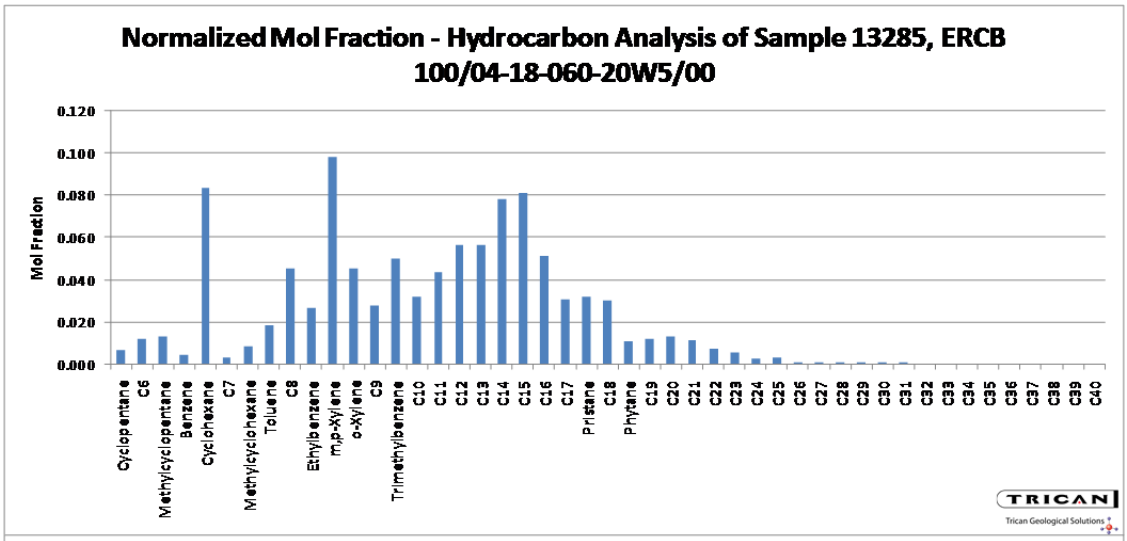
13256 – 1820.53m

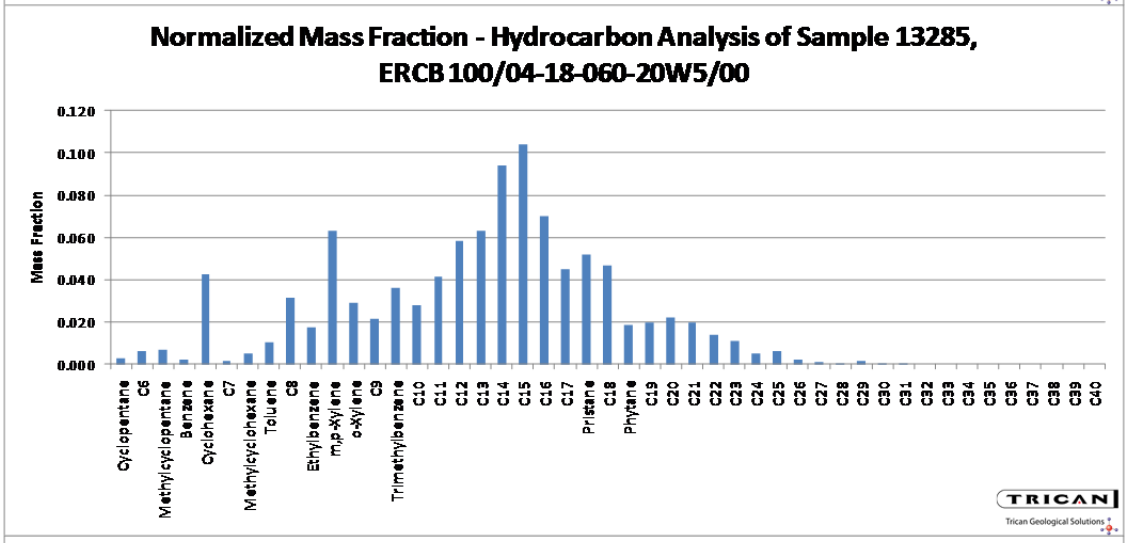


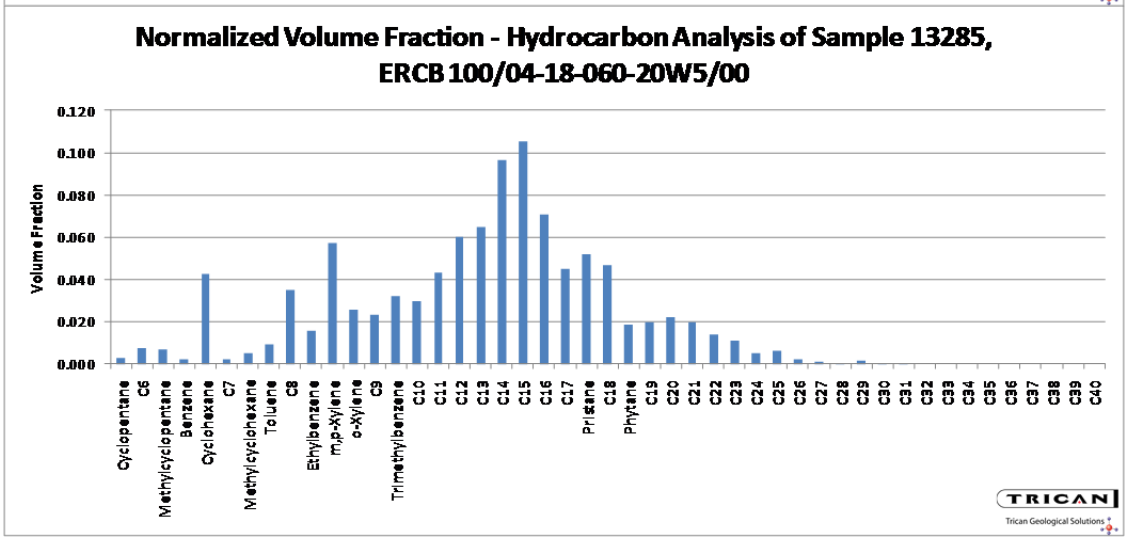




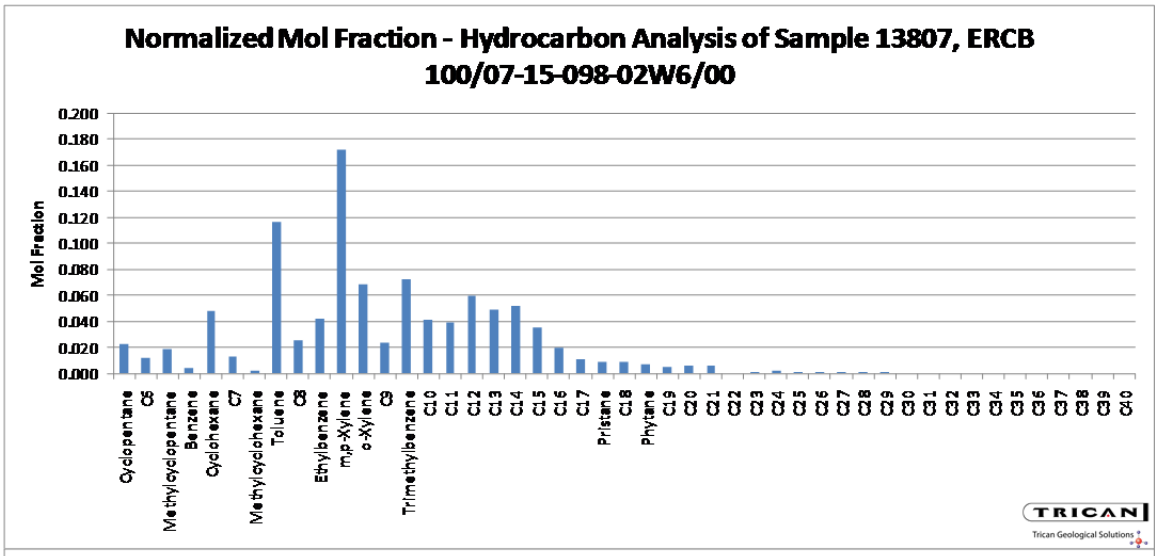
13285 – 1611.55m

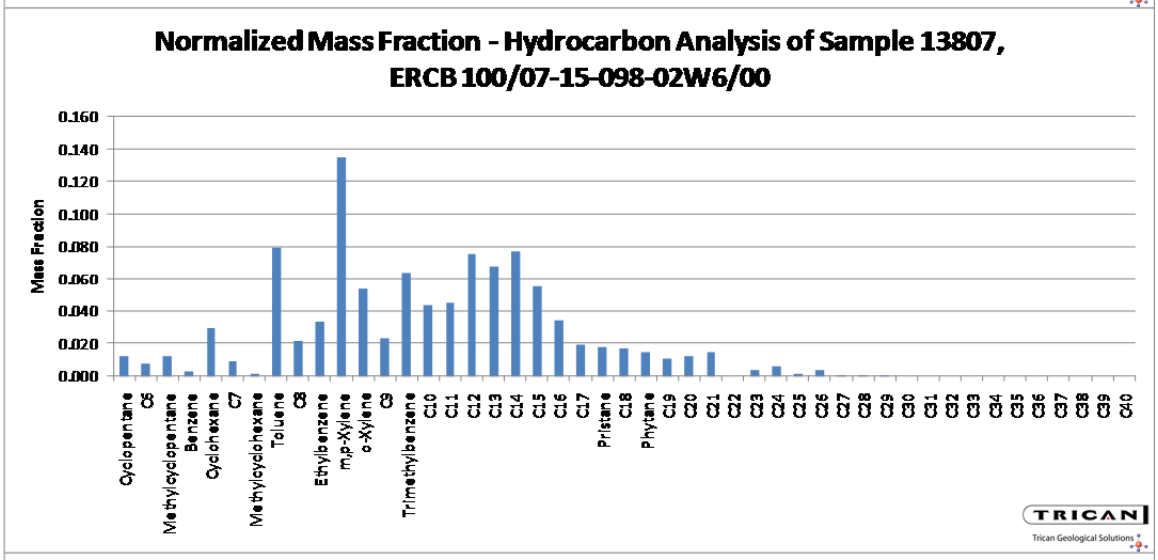


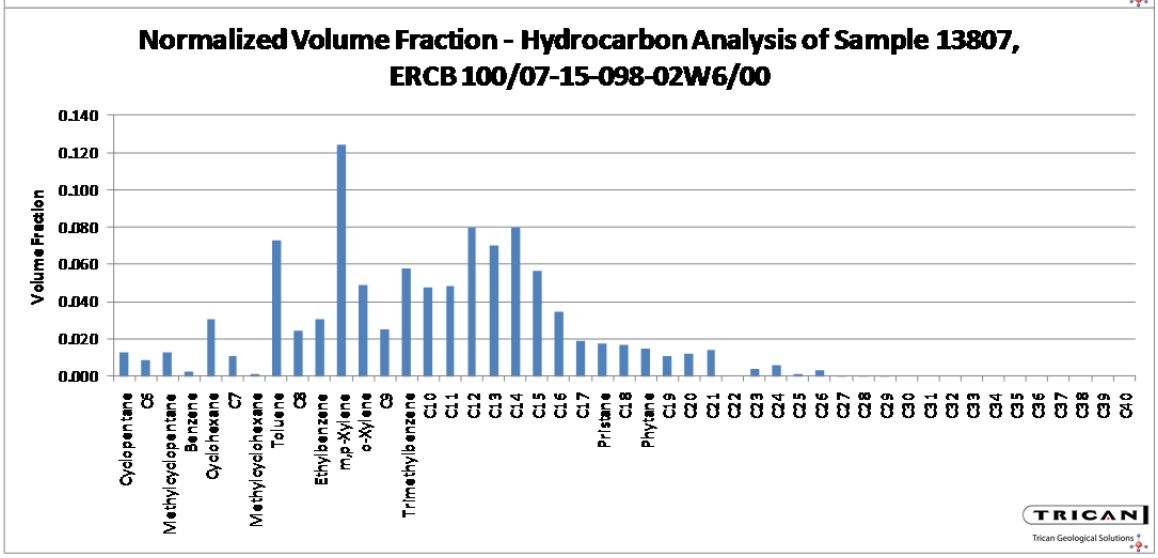




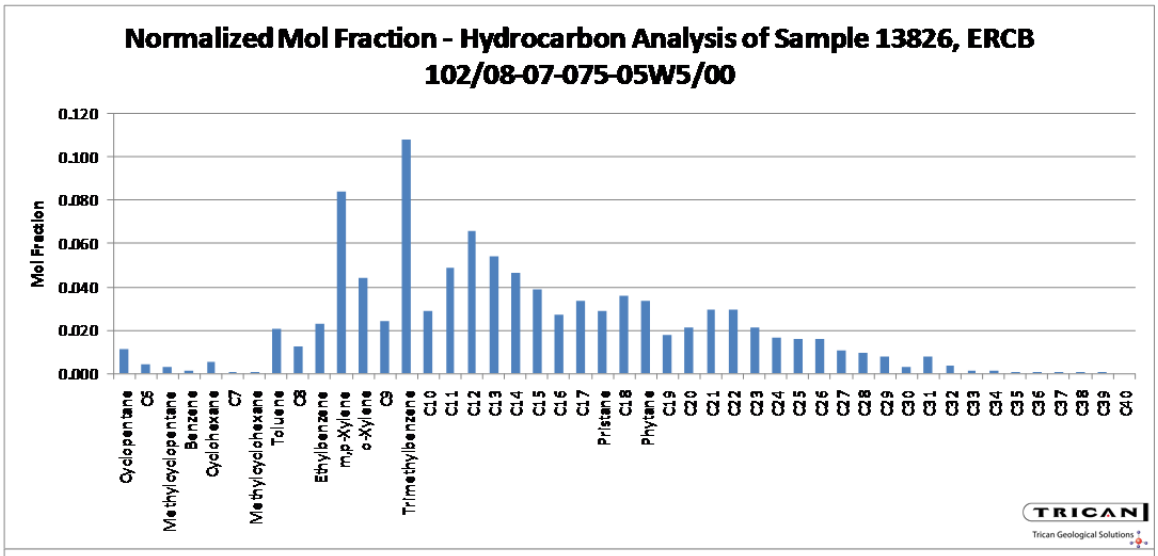
13807 – 666.00m

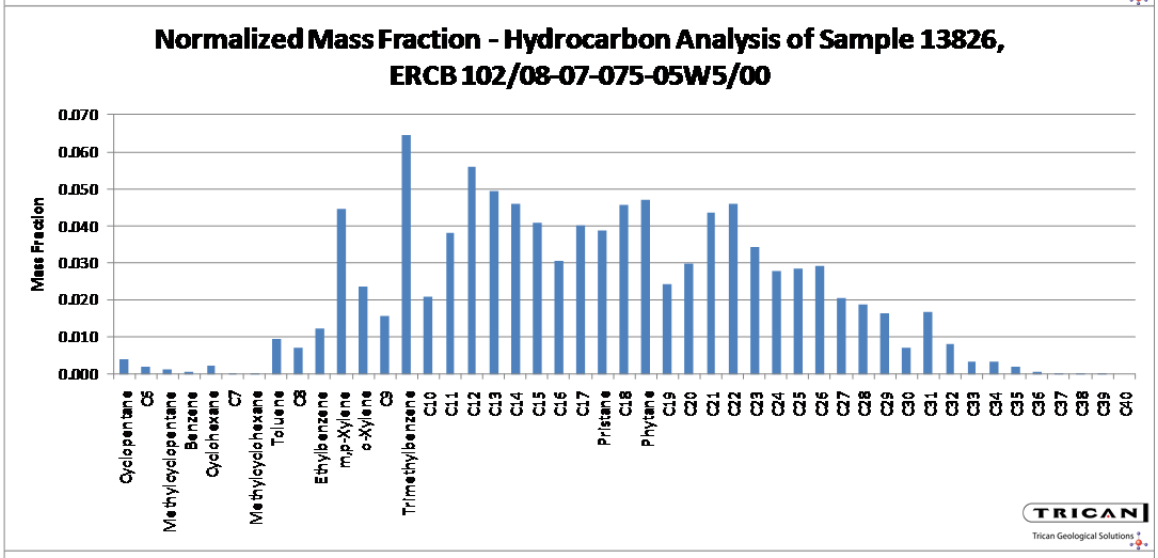


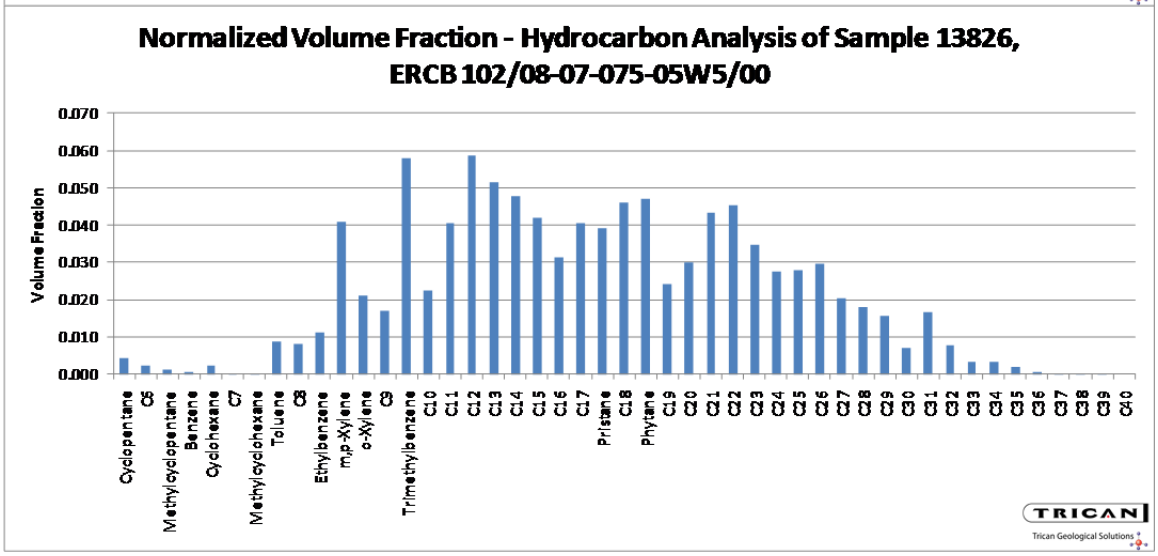




13826 – 1086.50m

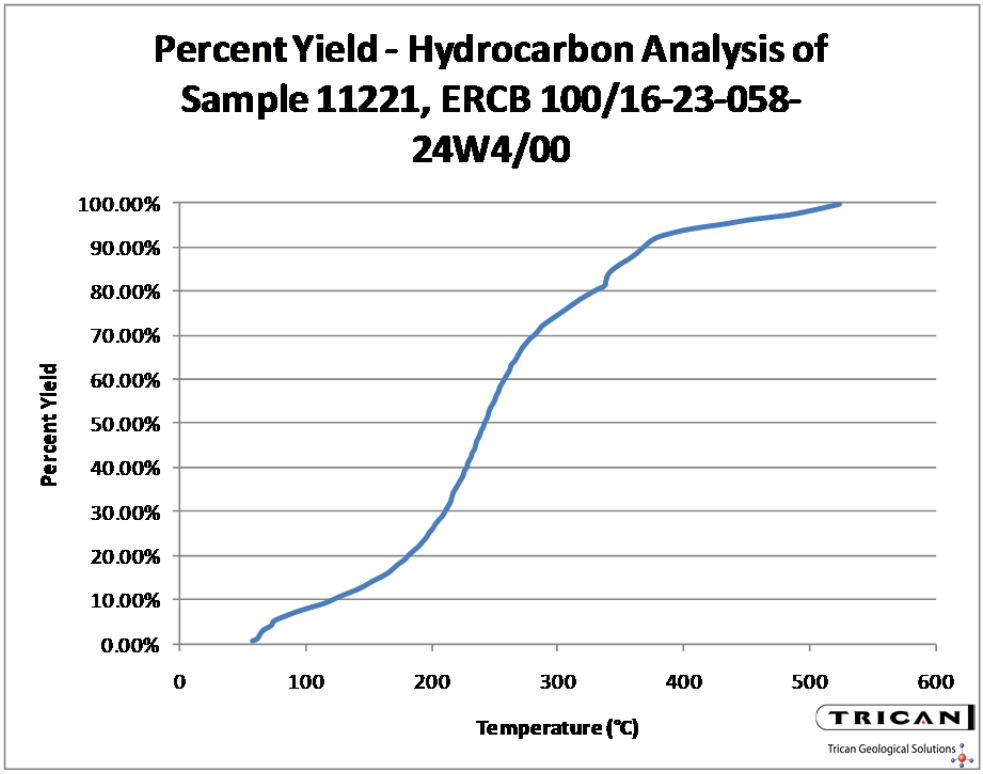




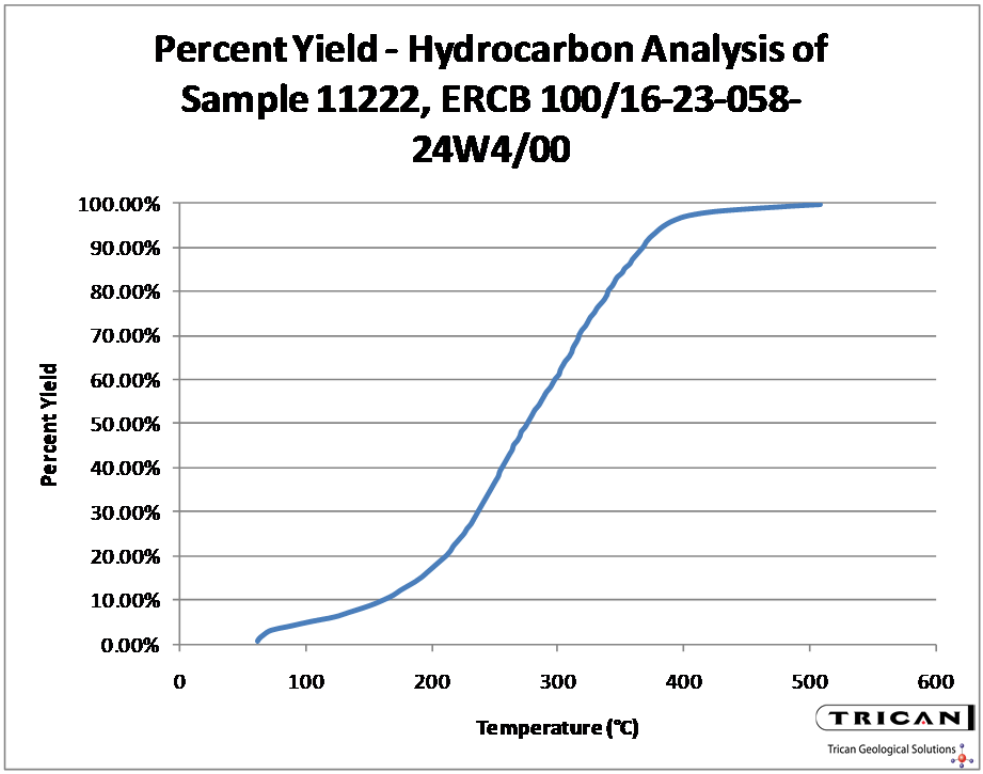


APPENDIX C: SIMULATED DISTILLATION %YIELD PLOTS

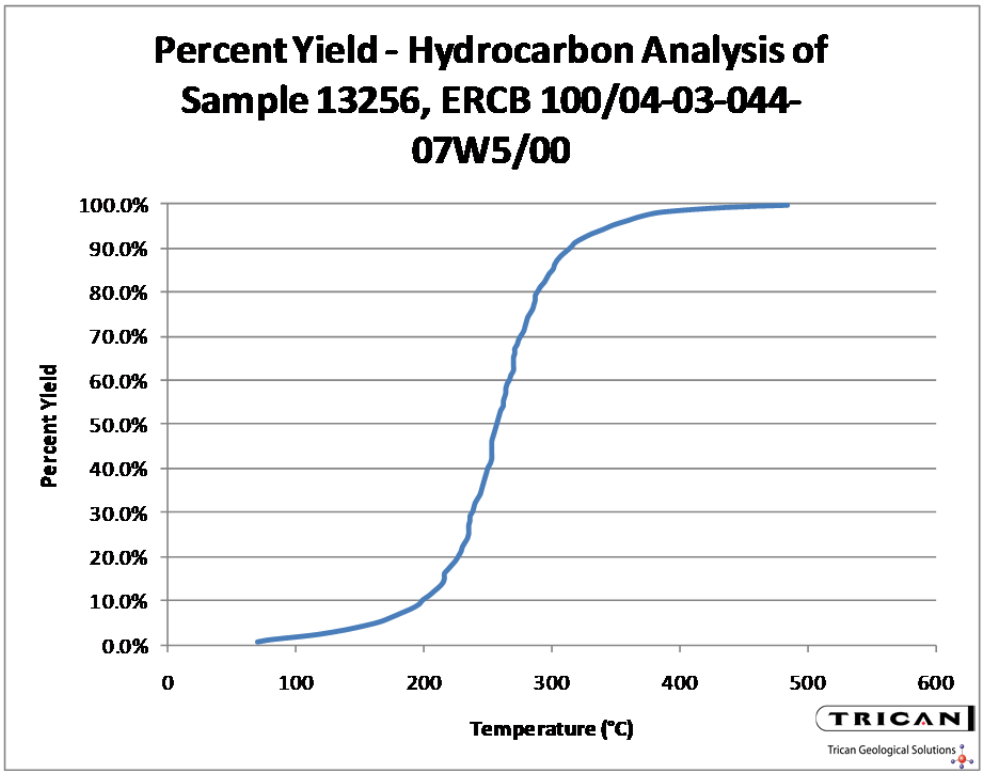
11221 – 732.80m



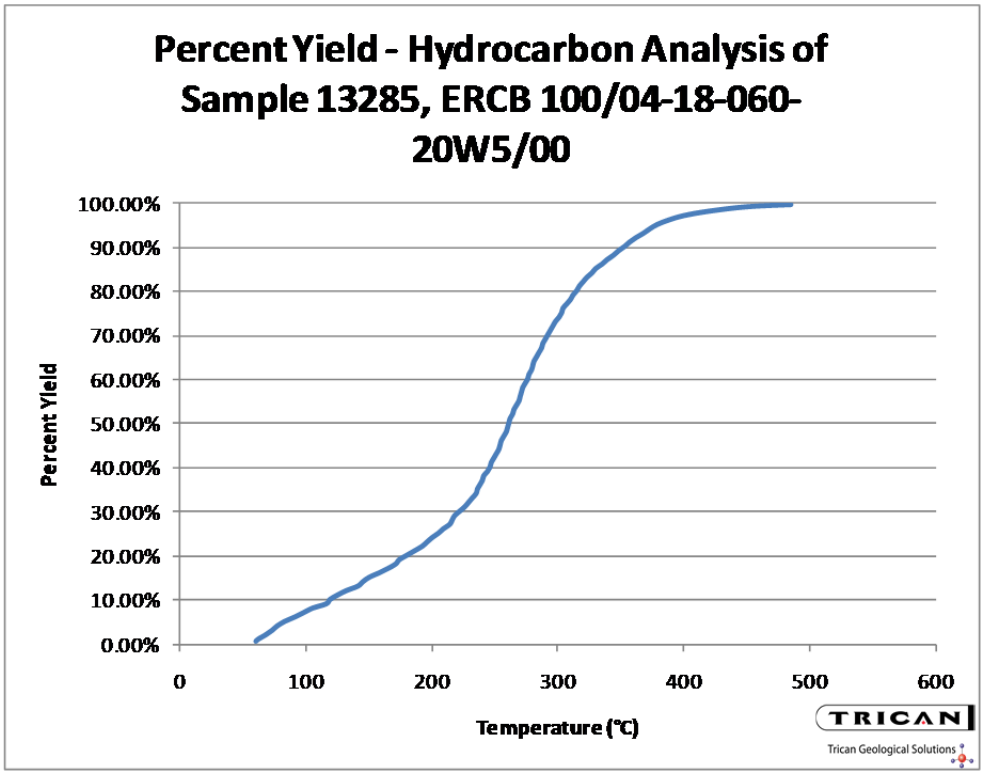
11222 – 736.40m



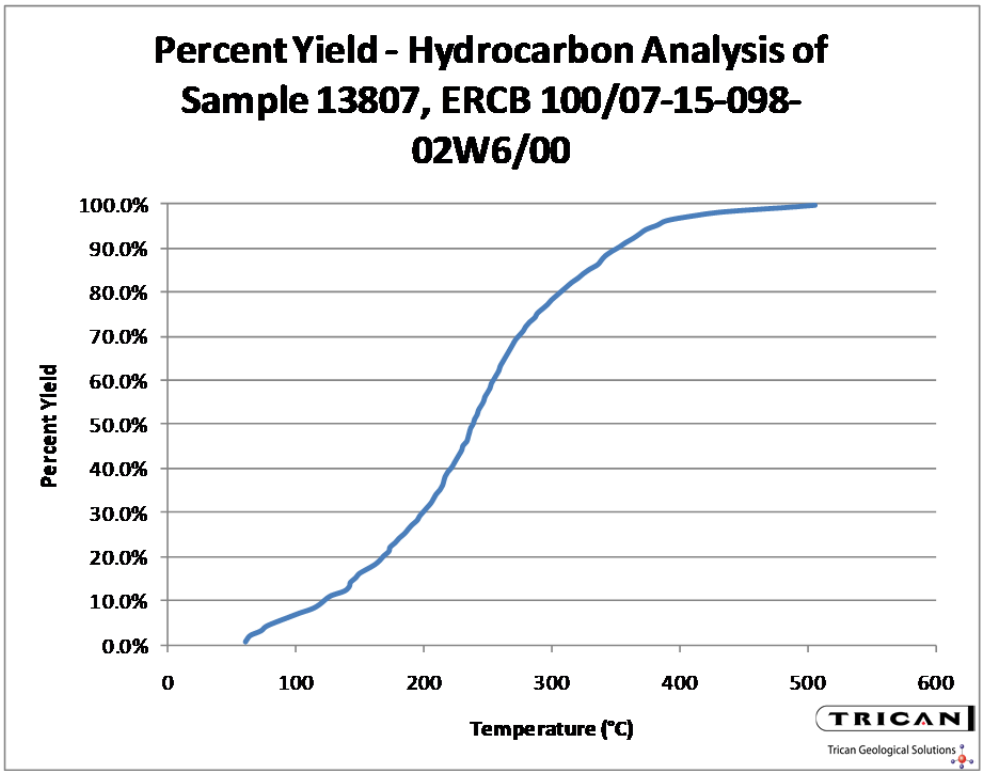
13256 – 1820.53m



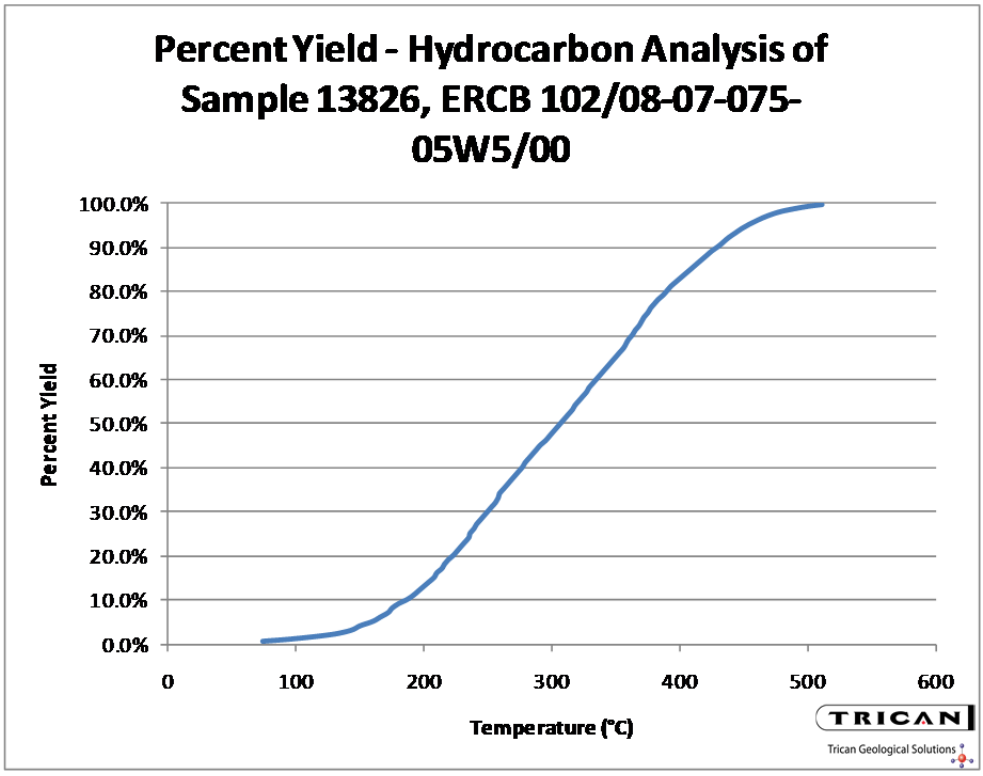
13285 – 1611.55m



13807 – 666.00m



13826 –1086.50m



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