Dolan Integration Group
Geochemistry for Energy
11025 Dover Street Unit 800
Westminster, CO 80021
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**20033698**
Lab #:	**DIG-022413**
Client:	**Origins Laboratory**
Sample Name(s):	**Y003334-01 D**

Analytical Report

Job #:	20033698
Lab #:	DIG-022413
Client:	Origins Laboratory
Sample Name:	Y003334-01 D
Date Sampled:	03/17/20
Time Sampled:	11:00
Sample Description:	1L DIG Bottle
Sampling Notes:	
Date Received:	03/23/20
Date Analyzed:	Gas Composition: 3/24/20 δ13C: 03/27/20 δD: 03/26/20
Date Reported:	04/06/20
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	477196	76.13	-	-	-	
Oxygen + Argon (O_2+Ar)	47248	7.54	-	-	-	
Carbon Dioxide (CO_2)	19395	3.09	-	-	-	
Helium (He)[b]	na	na	-	-	-	Helium added to create headspace.
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	82216	13.12	99.07	-41.0	-156	
Ethane (C_2H_6)	768	0.12	0.93	-5.1	-	
Ethene (C_2H_4)	nd	nd	nd	-	-	
Propane (C_3H_8)	nd	nd	nd	-	-	
iso-Butane (C_4H_{10})	nd	nd	nd	-	-	
n-Butane (C_4H_{10})	nd	nd	nd	-	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	-	-	
n-Pentane (C_5H_{12})	nd	nd	nd	-	-	
Hexanes + (C_6H_{14})	nd	nd	nd	-	-	

Calculated Values:	
Total HCs (ppm)	82984
Gas Wetness (mol % C_2+/C_1+)	0.93
C_1/(C_2+C_3) (mol/mol)	107

[a] Analyte concentrations normalized to 100% (Mol. % is approximately equal to Vol. %)

[b] Addition of helium negates the ability to detect native helium and may negate the ability to detect hydrogen.

HC= Hydrocarbons

nd = not detected

na = not analyzed

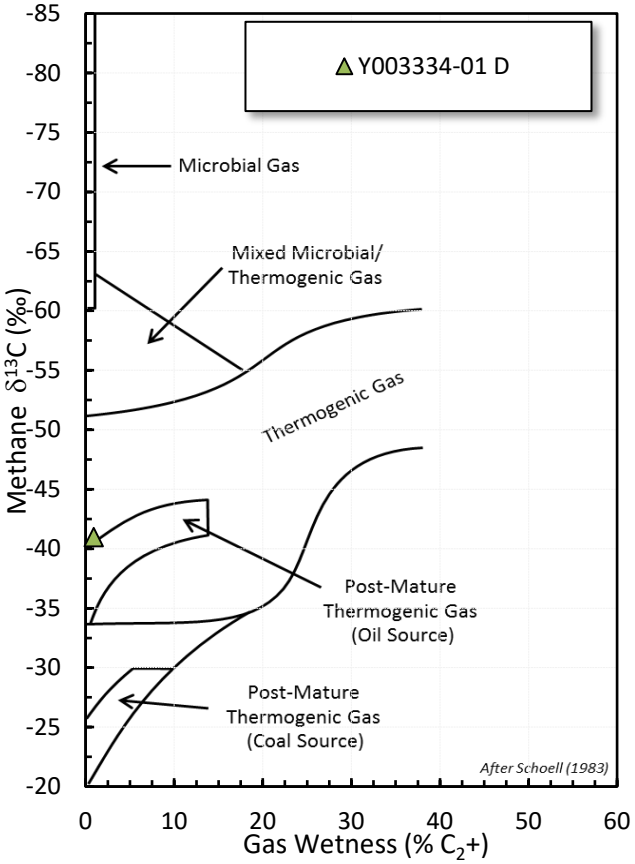
Stable isotope results based on multi-point laboratory calibration

Error $\delta^{13}C$ < 0.5 ‰

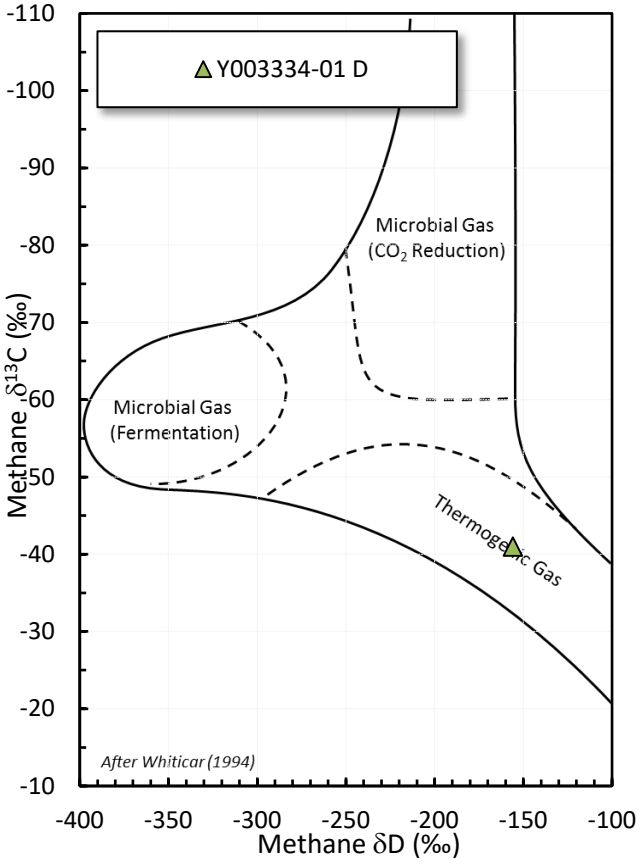
Error δD < 5.0 ‰

Stable Isotope Interpretive Plots

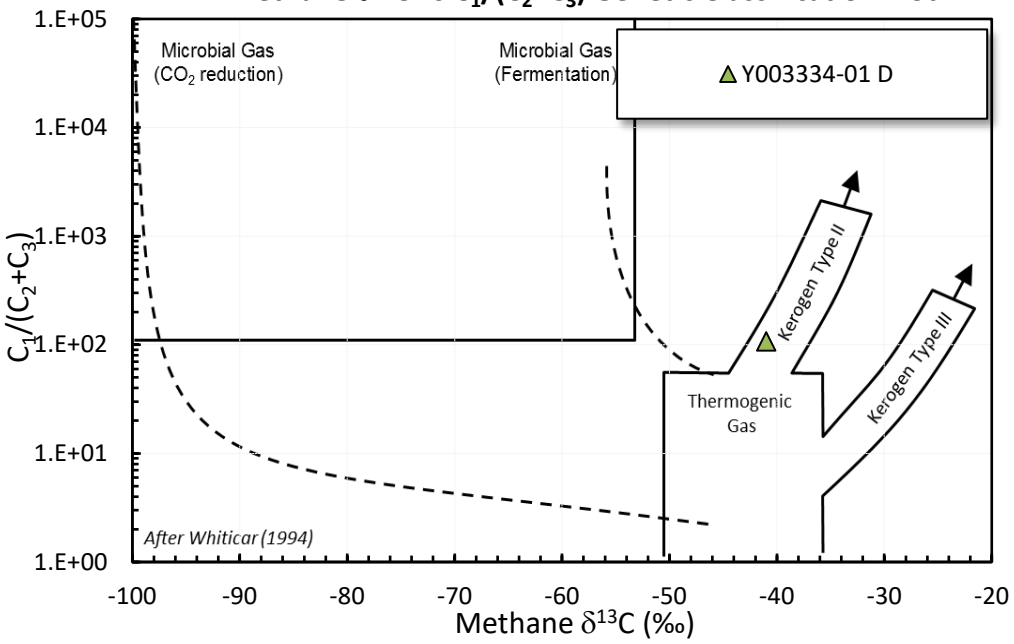
Methane vs Gas Wetness Genetic



Methane $\delta^{13}C$ vs δD Genetic Classification Plot



Methane $\delta^{13}C$ vs $C_1/(C_2+C_3)$ Genetic Classification Plot



Chain of Custody Form

JOB 20033698 20033702
DIG-022413-022417

dig Geochemistry for Energy
Dolan Integration Group
main 303.531.2030 • info@digforenergy.com • digforenergy.com
Office and Lab 11025 Dover St • Ste 800 • Westminster, CO 80021

Send Data to:	
Name:	Jennifer Pellegrini
Company:	Origins Laboratory
Address:	1725 W. 6th Ave
City, State:	Denver CO 80211
Phone:	303-433-1322
Email:	jpellegrini@originslab.com

Send invoice to (if different):	
Name:	
Company:	
Address:	
City, State:	
Phone:	
Email:	

Additional Information:	
AFE #:	
Project:	4003334
PO #:	
Location:	
Sampled By:	
Notes:	

Turnaround Time: ☐ Standard (≥ 10 business days) ☐ Rush (≥ 5 business days) ☐ Expedited Rush (≥ 3 business

Sample Description				Analysis Requested						
Container Number	Sample Identification	Date Sampled	Time	Gas Composition* N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+	RSK-175: N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+ with dissolved C_1, C_2, & C_3 (water samples only)	$\delta^{13}C$ Methane (Carbon)	δD Methane (Hydrogen)	$\delta^{13}C$ Ethane-Pentane (C_2-C_5 if present)	$\delta^{13}C$ CO_2 (if present)	Comments
4003334-01	mw-1	3/17/20	1100	Y		X	X			
4003334-02	mw-2		1200	Y		X	Y			
4003334-03	mw-3		1300	Y		X	~~Y~~			
4003334-04	mw-4		1430	Y		X	~~Y~~			
4003334-05	mw-5	↓	1345	Y		Y	Y			

Chain-of-Custody Record

Signature	Company	Date	Time
Relinquished by	Origins	3/23/20	1445
Received by	DIG	3/23/20	1445
Relinquished by			
Received by			
Relinquished by			
Received by			

*Gas composition vs RSK-175: Gas composition is a basic analysis of the concentration (ppm) of gases within the headspace of the sample (headspace is created at the lab). RSK-175 is a specific analysis technique combined with calculations to give the total dissolved gas of each species in the water sample (mg/L).
Why one or the other? Gas composition gives us a quick, general look at relative concentrations and ratios (e.g., gas wetness). RSK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 303-531-2030.

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project													
	10206	Dolan Integration Group		Origins Laboratory															
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab									
		3/17/20 11:00 AM		DIG-022413		GAS			Y003334-01 D	3/23/2020									
Batch	LabID	Lab Batch Identifier	Leach Date	Extract Date and Time	Extract Method	Start Date and Time	Conc Method	Init Vol	Final Vol	Init Vol Units	Final Vol Units	Analysis Date and Time	Report Basis	Comments	File Name	Column #			
	10206																		
Result	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value	Qualifier	Test Type	Result Text	Data Flag	Dilution	Fraction Type	MDC	Requested MDC	Detection Limit	Instrument Detection Limit	Method Detection Limit	Comments	AnalyticalBatchID
	O2+AR	OXYGEN + ARGON	SOP		MOL %	7.54									0.005	0.005	0.005		20033698
	124-38-9	CARBON DIOXIDE	SOP		MOL %	3.09									0.005	0.005	0.005		20033698
	7727-37-9	NITROGEN (N2)	SOP		MOL %	76.13									0.005	0.005	0.005		20033698
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	74-82-8	METHANE	SOP		MOL %	13.12									0.005	0.005	0.005		20033698
	74-84-0	ETHANE	SOP		MOL %	0.12									0.005	0.005	0.005		20033698
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	iC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	109-66-0	N-PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033698
	delta13C_C1	DELTA 13C C1	SOP		per mil	-41.0													20033698
	deltaD_C1	DELTA D C1	SOP		per mil	-156													20033698

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Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**20033699**
Lab #:	**DIG-022414**
Client:	**Origins Laboratory**
Sample Name(s):	**Y003334-02 D**

Analytical Report

Job #:	20033699
Lab #:	DIG-022414
Client:	Origins Laboratory
Sample Name:	Y003334-02 D
Date Sampled:	03/17/20
Time Sampled:	12:00
Sample Description:	1L DIG Bottle
Sampling Notes:	
Date Received:	03/23/20
Date Analyzed:	Gas Composition: 03/24/20 δ13C: 03/27/20 δD: 03/27/20
Date Reported:	04/06/20
Comments:	

Measured Values:	**Measured** ppm	**Analyte** mol %[a]	**HC** mol %	**$\delta^{13}C$** ‰ VPDB	**δD** ‰ VSMOW	**Comments**
Nitrogen (N_2)	322765	83.35	-	-	-	
Oxygen + Argon (O_2+Ar)	30079	7.77	-	-	-	
Carbon Dioxide (CO_2)	26063	6.73	-	-	-	
Helium (He)[b]	na	na	-	-	-	Helium added to create headspace.
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	8336	2.15	100.00	-38.7	90	dD confirmed through multiple runs
Ethane (C_2H_6)	nd	nd	nd	-	-	
Ethene (C_2H_4)	nd	nd	nd	-	-	
Propane (C_3H_8)	nd	nd	nd	-	-	
iso-Butane (C_4H_{10})	nd	nd	nd	-	-	
n-Butane (C_4H_{10})	nd	nd	nd	-	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	-	-	
n-Pentane (C_5H_{12})	nd	nd	nd	-	-	
Hexanes + (C_6H_{14})	nd	nd	nd	-	-	

Calculated Values:	
Total HCs (ppm)	8336
Gas Wetness (mol % C_2+/C_1+)	0.00
$C_1/(C_2+C_3)$ (mol/mol)	#DIV/0!

[a] Analyte concentrations normalized to 100% (Mol. % is approximately equal to Vol. %)

[b] Addition of helium negates the ability to detect native helium and may negate the ability to detect hydrogen.

HC= Hydrocarbons

nd = not detected

na = not analyzed

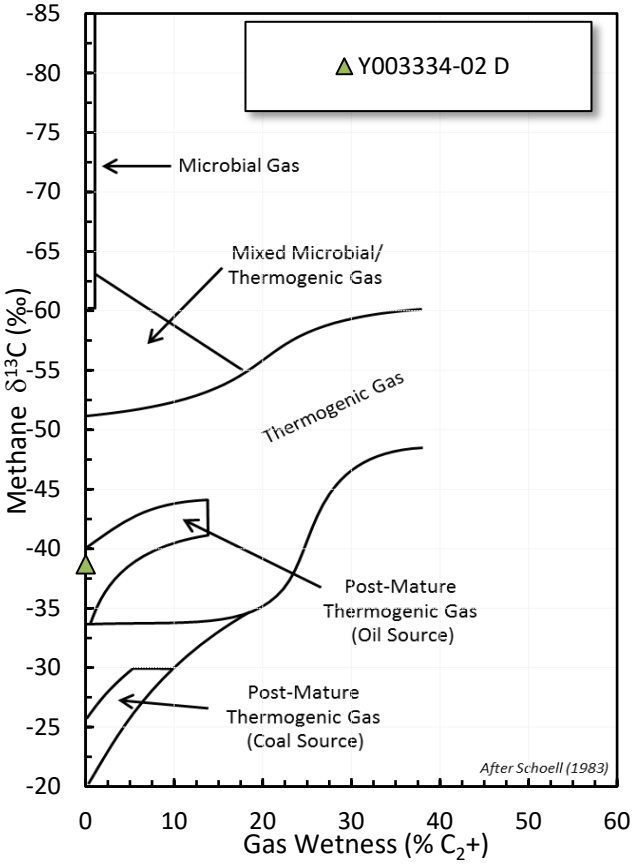
Stable isotope results based on multi-point laboratory calibration

Error $\delta^{13}C$ < 0.5 ‰

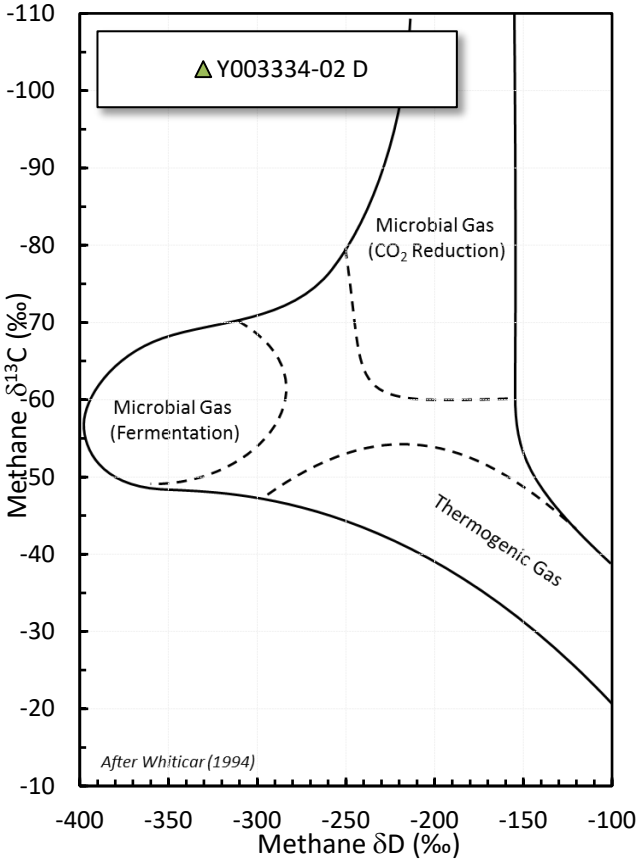
Error δD < 5.0 ‰

Stable Isotope Interpretive Plots

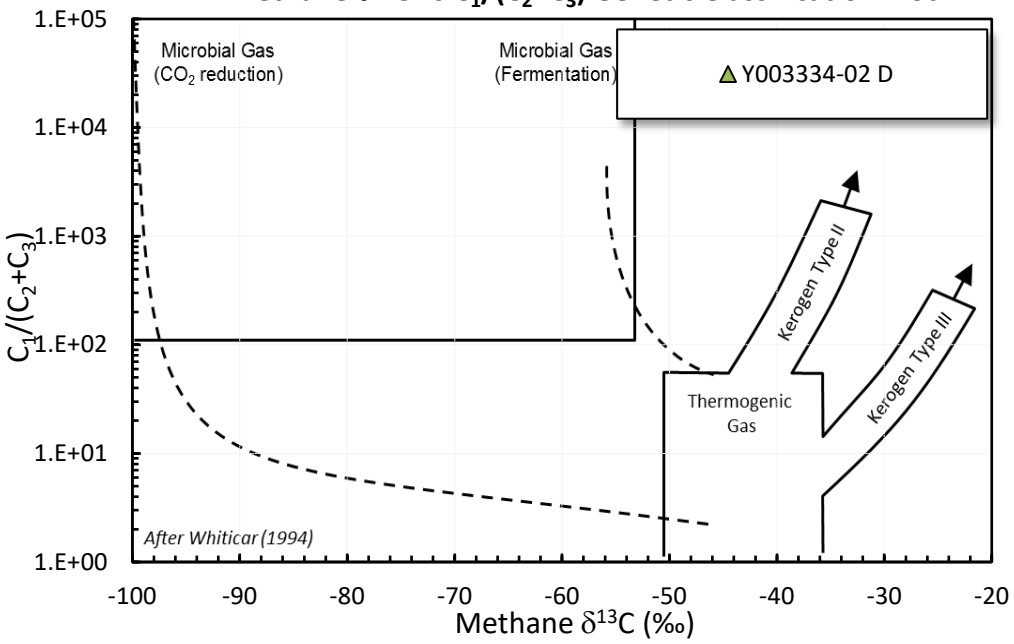
Methane vs Gas Wetness Genetic



Methane $\delta^{13}C$ vs δD Genetic Classification Plot



Methane $\delta^{13}C$ vs $C_1/(C_2+C_3)$ Genetic Classification Plot



Chain of Custody Form

JOB 20033698 20033702
DIG-022413-022417

dig Geochemistry for Energy
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main 303.531.2030 • info@digforenergy.com • digforenergy.com
Office and Lab 11025 Dover St • Ste 800 • Westminster, CO 80021

Send Data to:	
Name:	Jennifer Pellegrini
Company:	Origins Laboratory
Address:	1725 W. 6th Ave
City, State:	Denver CO 80211
Phone:	303-433-1322
Email:	jpellegrini@originslab.com

Send invoice to (if different):	
Name:	
Company:	
Address:	
City, State:	
Phone:	
Email:	

Additional Information:	
AFE #:	
Project:	4003334
PO #:	
Location:	
Sampled By:	
Notes:	

Turnaround Time: ☐ Standard (≥ 10 business days) ☐ Rush (≥ 5 business days) ☐ Expedited Rush (≥ 3 business

Sample Description				Analysis Requested						
Container Number	Sample Identification	Date Sampled	Time	Gas Composition* N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+	RSK-175: N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+ with dissolved C_1, C_2, & C_3 (water samples only)	$\delta^{13}C$ Methane (Carbon)	δD Methane (Hydrogen)	$\delta^{13}C$ Ethane-Pentane (C_2-C_5 if present)	$\delta^{13}C$ CO_2 (if present)	Comments
4003334-01	mw-1	3/17/20	1100	Y		X	X			
4003334-02	mw-2		1200	Y		X	Y			
4003334-03	mw-3		1300	Y		X	~~Y~~			
4003334-04	mw-4		1430	Y		X	~~Y~~			
4003334-05	mw-5	↓	1345	Y		Y	Y			

Chain-of-Custody Record

Signature	Company	Date	Time
Relinquished by	Origins	3/23/20	1445
Received by	DIG	3/23/20	1445
Relinquished by			
Received by			
Relinquished by			
Received by			

*Gas composition vs RSK-175: Gas composition is a basic analysis of the concentration (ppm) of gases within the headspace of the sample (headspace is created at the lab). RSK-175 is a specific analysis technique combined with calculations to give the total dissolved gas of each species in the water sample (mg/L).
Why one or the other? Gas composition gives us a quick, general look at relative concentrations and ratios (e.g., gas wetness). RSK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 303-531-2030.

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project												
	10206	Dolan Integration Group		Origins Laboratory														
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab								
		3/17/20 12:00 PM		DIG-022414		GAS			Y003334-02 D	3/23/2020								
Batch	LabID	Lab Batch Identifier	Leach Date	Extract Date and Time	Extract Method	Start Date and Time	Conc Method	Init Vol	Final Vol	Init Vol Units	Final Vol Units	Analysis Date and Time	Report Basis	Comments	File Name	Column #		
	10206																	
Result	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value	Qualifier	Test Type	Result Text	Data Flag	Dilution	Fraction Type	MDC	Requested MDC	Detection Limit	Instrument Detection Limit	Method Detection Limit	Comments	AnalyticalBatchID
	O2+AR	OXYGEN + ARGON	SOP		MOL %	7.77									0.005	0.005	0.005		20033699
	124-38-9	CARBON DIOXIDE	SOP		MOL %	6.73									0.005	0.005	0.005		20033699
	7727-37-9	NITROGEN (N2)	SOP		MOL %	83.35									0.005	0.005	0.005		20033699
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	74-82-8	METHANE	SOP		MOL %	2.15									0.005	0.005	0.005		20033699
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	iC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	109-66-0	N-PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033699
	delta13C_C1	DELTA 13C C1	SOP		per mil	-38.7													20033699
	deltaD_C1	DELTA D C1	SOP		per mil	90													20033699

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Geochemistry for Energy
11025 Dover Street Unit 800
Westminster, CO 80021
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**20033700**
Lab #:	**DIG-022415**
Client:	**Origins Laboratory**
Sample Name(s):	**Y003334-03 D**

Analytical Report

Job #:	20033700
Lab #:	DIG-022415
Client:	Origins Laboratory
Sample Name:	Y003334-03 D
Date Sampled:	03/17/20
Time Sampled:	13:00
Sample Description:	1L DIG Bottle
Sampling Notes:	
Date Received:	03/23/20
Date Analyzed:	Gas Composition: 03/24/20 δ13C: 03/27/20 δD: 03/27/20
Date Reported:	04/06/20
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	391765	87.12	-	-	-	
Oxygen + Argon (O_2+Ar)	24992	5.56	-	-	-	
Carbon Dioxide (CO_2)	28881	6.42	-	-	-	
Helium (He)[b]	na	na	-	-	-	Helium added to create headspace.
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	4053	0.90	100.00	-12.3	423	dD value confirmed by multiple runs
Ethane (C_2H_6)	nd	nd	nd	-	-	
Ethene (C_2H_4)	nd	nd	nd	-	-	
Propane (C_3H_8)	nd	nd	nd	-	-	
iso-Butane (C_4H_{10})	nd	nd	nd	-	-	
n-Butane (C_4H_{10})	nd	nd	nd	-	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	-	-	
n-Pentane (C_5H_{12})	nd	nd	nd	-	-	
Hexanes + (C_6H_{14})	nd	nd	nd	-	-	

Calculated Values:	
Total HCs (ppm)	4053
Gas Wetness (mol % C_2+/C_1+)	0.00
$C_1/(C_2+C_3)$ (mol/mol)	#DIV/0!

[a] Analyte concentrations normalized to 100% (Mol. % is approximately equal to Vol. %)

[b] Addition of helium negates the ability to detect native helium and may negate the ability to detect hydrogen.

HC= Hydrocarbons

nd = not detected

na = not analyzed

Stable isotope results based on multi-point laboratory calibration

Error $\delta^{13}C$ < 0.5 ‰

Error δD < 5.0 ‰

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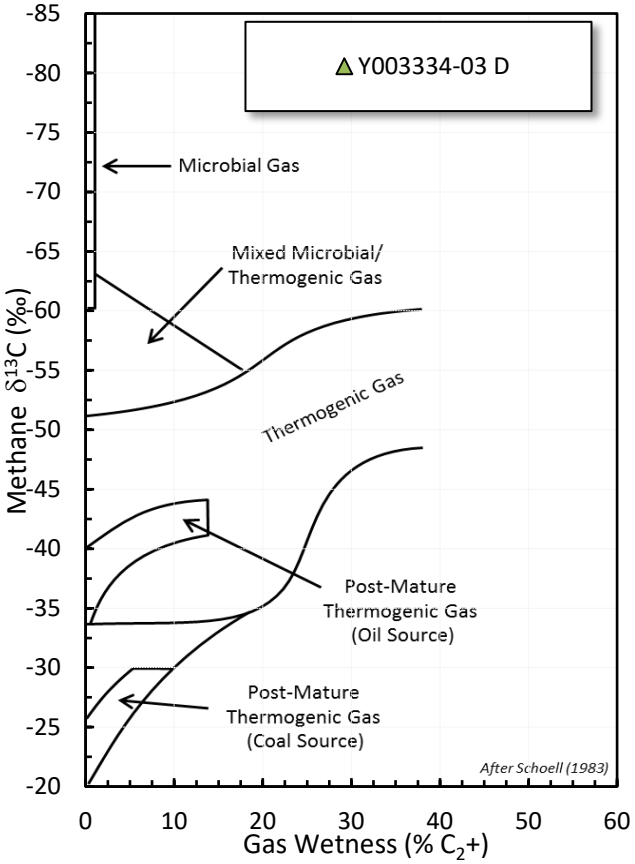
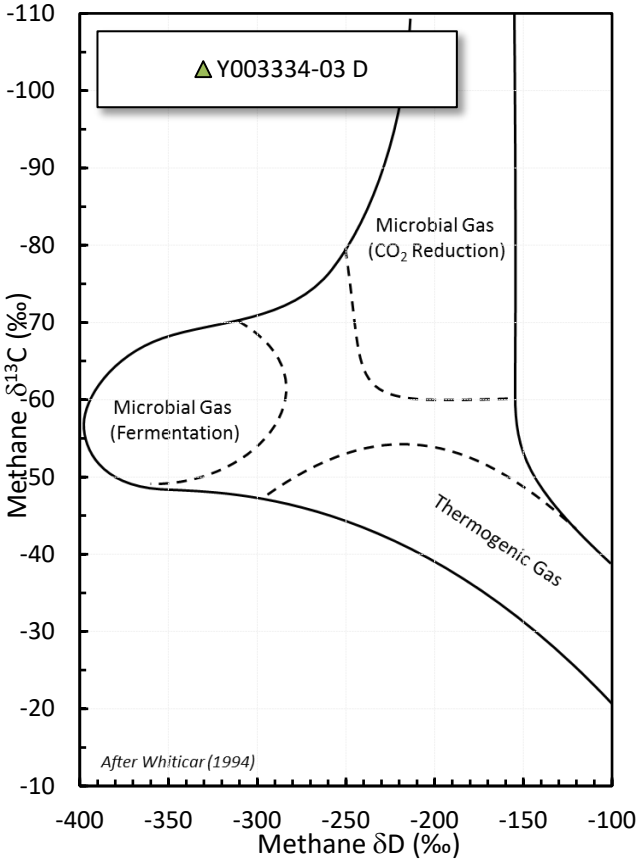
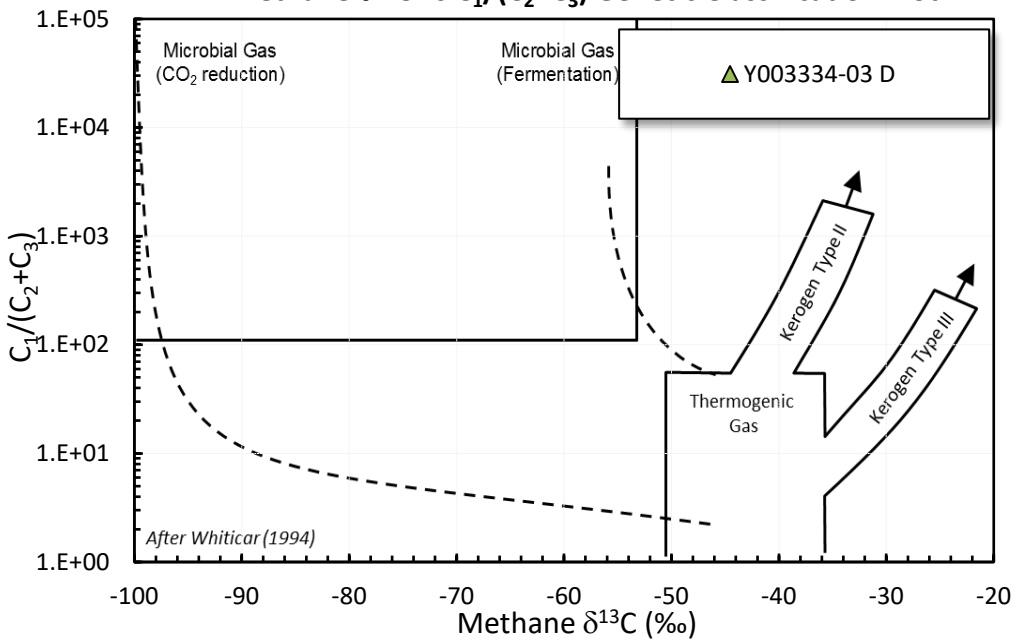
Methane vs Gas Wetness Genetic



Methane $\delta^{13}C$ vs δD Genetic Classification Plot



Methane $\delta^{13}C$ vs $C_1/(C_2+C_3)$ Genetic Classification Plot



Chain of Custody Form

JOB 20033698 20033702
DIG-022413-022417

dig Geochemistry for Energy
Dolan Integration Group

main 303.531.2030 • info@digforenergy.com • digforenergy.com
Office and Lab 11025 Dover St • Ste 800 • Westminster, CO 80021

Send Data to:	
Name:	Jennifer Pellegrini
Company:	Origins Laboratory
Address:	1725 W. 6th P
City, State:	Denver CO, 80211
Phone:	303-433-1322
Email:	jpellegrini@originslab.com

Send invoice to (if different):	
Name:	
Company:	
Address:	
City, State:	
Phone:	
Email:	

Additional Information:	
AFE #:	
Project:	4003334
PO #:	
Location:	
Sampled By:	
Notes:	

Turnaround Time: ☐ Standard (≤ 10 business days) ☐ Rush (≤ 5 business days) ☐ Expedited Rush (≤ 3 business

Sample Description				Analysis Requested						
Container Number	Sample Identification	Date Sampled	Time	Gas Composition* N_2, O_2+Ar, CO_2, He, H_2, C_1-C_6+	RSK-175: N_2, O_2+Ar, CO_2, He, H_2, C_1-C_6+ with dissolved C_1, C_2, & C_3 (water samples only)	$\delta^{13}C$ Methane (Carbon)	δD Methane (Hydrogen)	$\delta^{13}C$ Ethane-Pentane (C_2-C_5 if present)	$\delta^{13}C$ CO_2 (if present)	Comments
4003334-01	mw-1	3/17/20	1100	Y		X	X			
4003334-02	mw-2	↓	1200	Y		X	Y			
4003334-03	mw-3	↓	1300	Y		X	Y			
4003334-04	mw-4	↓	1430	Y		X	Y			
4003334-05	mw-5	↓	1345	Y		Y	Y			

Chain-of-Custody Record

	Signature	Company	Date	Time
Relinquished by		Origins	3/23/20	1445
Received by		DIG	3/23/20	1445
Relinquished by				
Received by				
Relinquished by				
Received by				

*Gas composition vs RSK-175. Gas composition is a basic analysis of the concentration (ppm) of gases within the headspace of the sample (headspace is created at the lab). RSK-175 is a specific analysis technique combined with calculations to give the total dissolved gas of each species in the water sample (mg/L).
Why one or the other? Gas composition gives us a quick, general look at relative concentrations and ratios (e.g., gas wetness). RSK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 303-531-2030.

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project												
	10206	Dolan Integration Group		Origins Laboratory														
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab								
		3/17/20 1:00 PM		DIG-022415		GAS			Y003334-03 D	3/23/2020								
Batch	LabID	Lab Batch Identifier	Leach Date	Extract Date and Time	Extract Method	Start Date and Time	Conc Method	Init Vol	Final Vol	Init Vol Units	Final Vol Units	Analysis Date and Time	Report Basis	Comments	File Name	Column #		
	10206																	
Result	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value	Qualifier	Test Type	Result Text	Data Flag	Dilution	Fraction Type	MDC	Requested MDC	Detection Limit	Instrument Detection Limit	Method Detection Limit	Comments	AnalyticalBatchID
	O2+AR	OXYGEN + ARGON	SOP		MOL %	5.56									0.005	0.005	0.005		20033700
	124-38-9	CARBON DIOXIDE	SOP		MOL %	6.42									0.005	0.005	0.005		20033700
	7727-37-9	NITROGEN (N2)	SOP		MOL %	87.12									0.005	0.005	0.005		20033700
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	74-82-8	METHANE	SOP		MOL %	0.90									0.005	0.005	0.005		20033700
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	iC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	109-66-0	N-PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033700
	delta13C_C1	DELTA 13C C1	SOP		per mil	-12.3													20033700
	deltaD_C1	DELTA D C1	SOP		per mil	423													20033700

Dolan Integration Group
Geochemistry for Energy
11025 Dover Street Unit 800
Westminster, CO 80021
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**20033701**
Lab #:	**DIG-022416**
Client:	**Origins Laboratory**
Sample Name(s):	**Y003334-04 D**

Analytical Report

Job #:	20033701
Lab #:	DIG-022416
Client:	Origins Laboratory
Sample Name:	Y003334-04 D
Date Sampled:	03/17/20
Time Sampled:	14:30
Sample Description:	1L DIG Bottle
Sampling Notes:	
Date Received:	03/23/20
Date Analyzed:	Gas Composition: 03/24/20 δ13C: 03/27/20 δD: 03/26/20
Date Reported:	04/06/20
Comments:	

Measured Values:	**Measured** ppm	**Analyte** mol %[a]	**HC** mol %	**$\delta^{13}C$** ‰ VPDB	**δD** ‰ VSMOW	**Comments**
Nitrogen (N_2)	160396	32.32	-	-	-	
Oxygen + Argon (O_2+Ar)	5039	1.02	-	-	-	
Carbon Dioxide (CO_2)	19712	3.97	-	-	-	
Helium (He)[b]	na	na	-	-	-	Helium added to create headspace.
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	291214	58.68	93.61	-42.6	-177	
Ethane (C_2H_6)	19621	3.95	6.31	-22.3	-	
Ethene (C_2H_4)	nd	nd	nd	-	-	
Propane (C_3H_8)	211	0.04	0.07	-	-	
iso-Butane (C_4H_{10})	50	0.01	0.02	-	-	
n-Butane (C_4H_{10})	nd	nd	nd	-	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	-	-	
n-Pentane (C_5H_{12})	nd	nd	nd	-	-	
Hexanes + (C_6H_{14})	nd	nd	nd	-	-	

Calculated Values:	
Total HCs (ppm)	311097
Gas Wetness (mol % C_2+/C_1+)	6.39
$C_1/(C_2+C_3)$ (mol/mol)	15

[a] Analyte concentrations normalized to 100% (Mol. % is approximately equal to Vol. %)

[b] Addition of helium negates the ability to detect native helium and may negate the ability to detect hydrogen.

HC= Hydrocarbons

nd = not detected

na = not analyzed

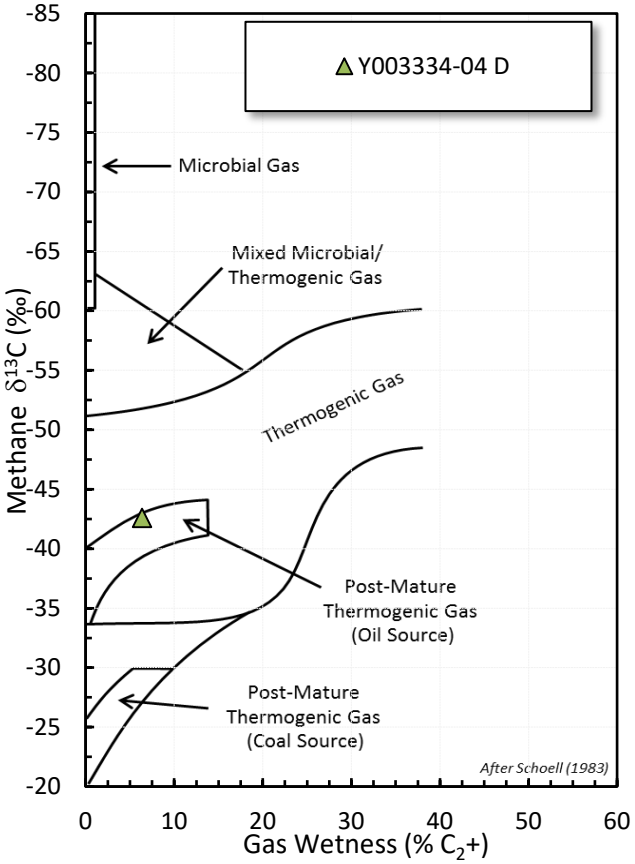
Stable isotope results based on multi-point laboratory calibration

Error $\delta^{13}C$ < 0.5 ‰

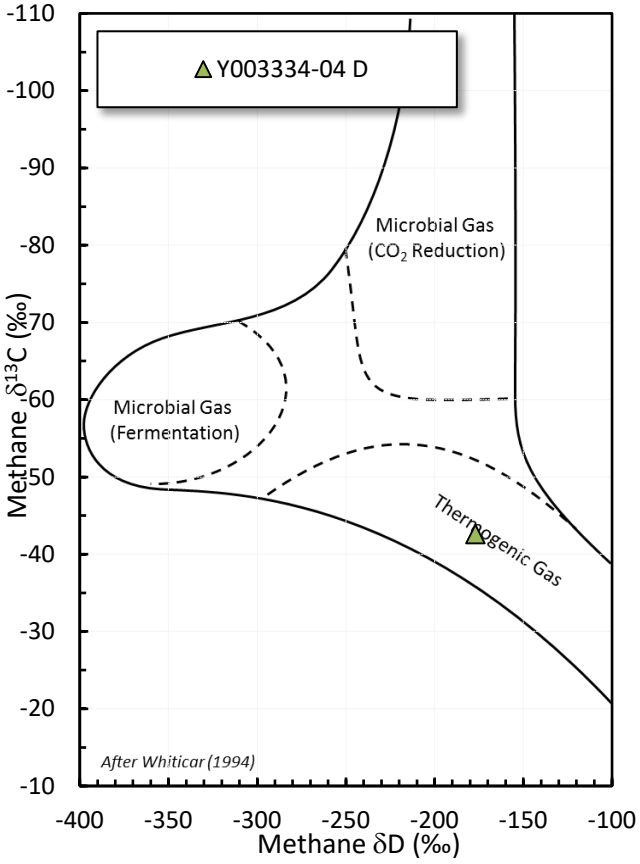
Error δD < 5.0 ‰

Stable Isotope Interpretive Plots

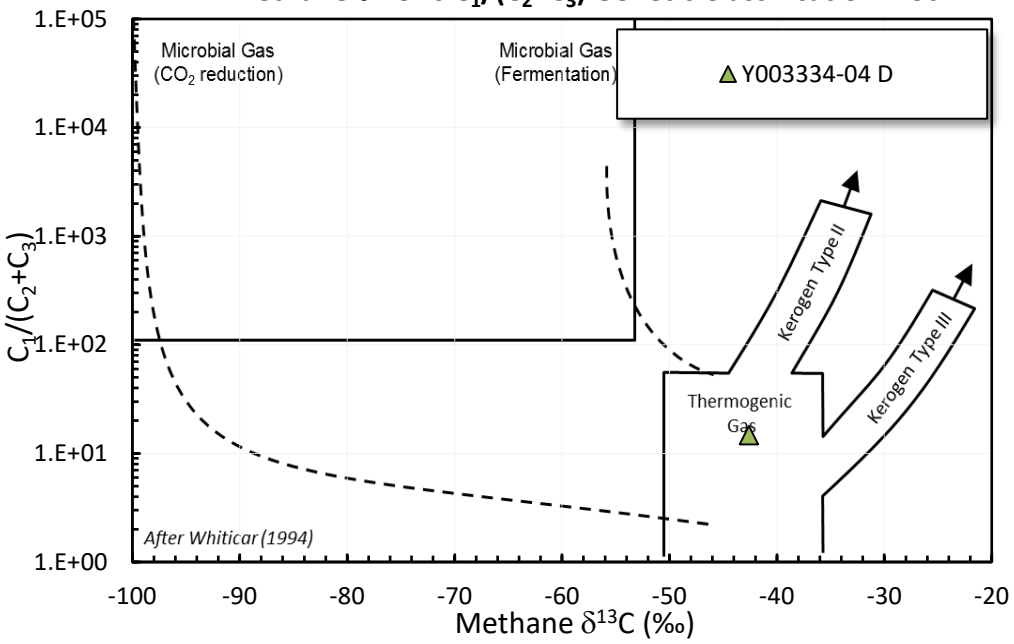
Methane vs Gas Wetness Genetic



Methane $\delta^{13}C$ vs δD Genetic Classification Plot



Methane $\delta^{13}C$ vs $C_1/(C_2+C_3)$ Genetic Classification Plot



Chain of Custody Form

JOB 20033698 20033702
DIG-022413-022417

dig Geochemistry for Energy
Dolan Integration Group
main 303.531.2030 • info@digforenergy.com • digforenergy.com
Office and Lab 11025 Dover St • Ste 800 • Westminster, CO 80021

Send Data to:	
Name:	Jennifer Pellegrini
Company:	Origins Laboratory
Address:	1725 W. 6th Ave
City, State:	Denver CO 80211
Phone:	303-433-1322
Email:	jpellegrini@originslab.com

Send invoice to (if different):	
Name:	
Company:	
Address:	
City, State:	
Phone:	
Email:	

Additional Information:	
AFE #:	
Project:	4003334
PO #:	
Location:	
Sampled By:	
Notes:	

Turnaround Time: ☐ Standard (≥ 10 business days) ☐ Rush (≥ 5 business days) ☐ Expedited Rush (≥ 3 business

Sample Description				Analysis Requested						
Container Number	Sample Identification	Date Sampled	Time	Gas Composition* N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+	RSK-175: N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+ with dissolved C_1, C_2, & C_3 (water samples only)	$\delta^{13}C$ Methane (Carbon)	δD Methane (Hydrogen)	$\delta^{13}C$ Ethane-Pentane (C_2-C_5 if present)	$\delta^{13}C$ CO_2 (if present)	Comments
4003334-01	mw-1	3/17/20	1100	Y		X	X			
4003334-02	mw-2		1200	Y		X	Y			
4003334-03	mw-3		1300	Y		X	~~Y~~			
4003334-04	mw-4		1430	Y		X	~~Y~~			
4003334-05	mw-5	↓	1345	Y		Y	Y			

Chain-of-Custody Record

Signature	Company	Date	Time
Relinquished by	Origins	3/23/20	1445
Received by	DIG	3/23/20	1445
Relinquished by			
Received by			
Relinquished by			
Received by			

*Gas composition vs RSK-175: Gas composition is a basic analysis of the concentration (ppm) of gases within the headspace of the sample (headspace is created at the lab). RSK-175 is a specific analysis technique combined with calculations to give the total dissolved gas of each species in the water sample (mg/L).
Why one or the other? Gas composition gives us a quick, general look at relative concentrations and ratios (e.g., gas wetness). RSK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 303-531-2030.

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project													
	10206	Dolan Integration Group		Origins Laboratory															
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab									
		3/17/20 2:30 PM		DIG-022416		GAS			Y003334-04 D	3/23/2020									
Batch	LabID	Lab Batch Identifier	Leach Date	Extract Date and Time	Extract Method	Start Date and Time	Conc Method	Init Vol	Final Vol	Init Vol Units	Final Vol Units	Analysis Date and Time	Report Basis	Comments	File Name	Column #			
	10206																		
Result	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value	Qualifier	Test Type	Result Text	Data Flag	Dilution	Fraction Type	MDC	Requested MDC	Detection Limit	Instrument Detection Limit	Method Detection Limit	Comments	AnalyticalBatchID
	O2+AR	OXYGEN + ARGON	SOP		MOL %	1.06									0.005	0.005	0.005		20033701
	124-38-9	CARBON DIOXIDE	SOP		MOL %	4.14									0.005	0.005	0.005		20033701
	7727-37-9	NITROGEN (N2)	SOP		MOL %	33.65									0.005	0.005	0.005		20033701
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	74-82-8	METHANE	SOP		MOL %	61.10									0.005	0.005	0.005		20033701
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	74-98-6	PROPANE	SOP		MOL %	0.04									0.005	0.005	0.005		20033701
	75-28-5	ISOBUTANE	SOP		MOL %	0.01									0.005	0.005	0.005		20033701
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	iC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	109-66-0	N-PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033701
	delta13C_C1	DELTA 13C C1	SOP		per mil	-42.6													20033701
	deltaD_C1	DELTA D C1	SOP		per mil	-177													20033701

Dolan Integration Group
Geochemistry for Energy
11025 Dover Street Unit 800
Westminster, CO 80021
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**20033702**
Lab #:	**DIG-022417**
Client:	**Origins Laboratory**
Sample Name(s):	**Y003334-05 D**

Analytical Report

Job #:	20033702
Lab #:	DIG-022417
Client:	Origins Laboratory
Sample Name:	Y003334-05 D
Date Sampled:	03/17/20
Time Sampled:	13:45
Sample Description:	1L DIG Bottle
Sampling Notes:	
Date Received:	03/23/20
Date Analyzed:	Gas Composition: 03/24/20 δ13C: 03/27/20 δD: 03/26/20
Date Reported:	04/06/20
Comments:	

Measured Values:	**Measured ppm**	**Analyte mol %[a]**	**HC mol %**	**$\delta^{13}C$ ‰ VPDB**	**δD ‰ VSMOW**	**Comments**
Nitrogen (N_2)	182027	31.93	-	-	-	
Oxygen + Argon (O_2+Ar)	30899	5.42	-	-	-	
Carbon Dioxide (CO_2)	11766	2.06	-	-	-	
Helium (He)[b]	na	na	-	-	-	Helium added to create headspace.
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	287882	50.50	83.34	-42.4	-189	
Ethane (C_2H_6)	47717	8.37	13.81	-25.8	-	
Ethene (C_2H_4)	nd	nd	nd	-23.2	-	
Propane (C_3H_8)	6919	1.21	2.00	-	-	
iso-Butane (C_4H_{10})	893	0.16	0.26	-	-	
n-Butane (C_4H_{10})	1314	0.23	0.38	-	-	
iso-Pentane (C_5H_{12})	338	0.06	0.10	-	-	
n-Pentane (C_5H_{12})	203	0.04	0.06	-	-	
Hexanes + (C_6H_{14})	147	0.03	0.04	-	-	

Calculated Values:	
Total HCs (ppm)	345412
Gas Wetness (mol % C_2+/C_1+)	16.66
C_1/(C_2+C_3) (mol/mol)	5

[a] Analyte concentrations normalized to 100% (Mol. % is approximately equal to Vol. %)

[b] Addition of helium negates the ability to detect native helium and may negate the ability to detect hydrogen.

HC= Hydrocarbons

nd = not detected

na = not analyzed

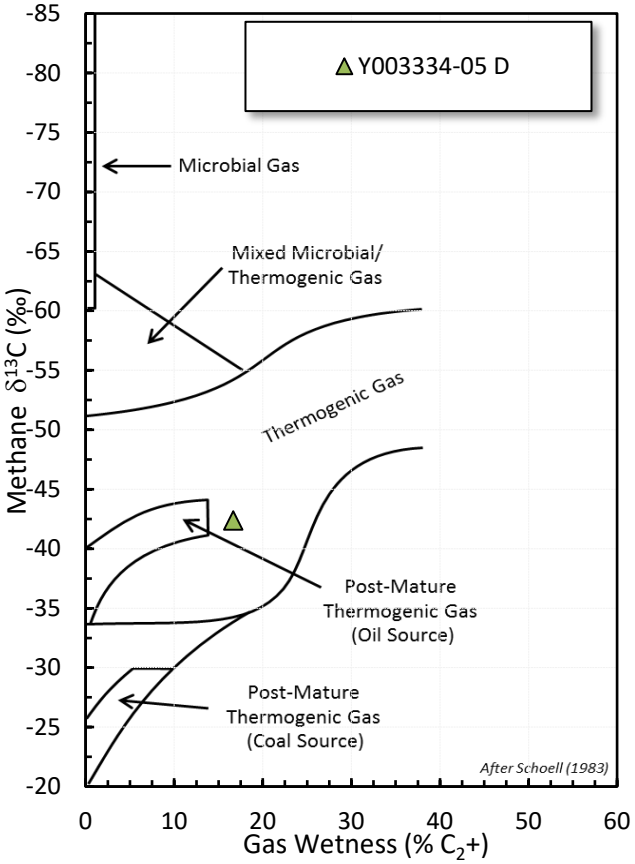
Stable isotope results based on multi-point laboratory calibration

Error $\delta^{13}C$ < 0.5 ‰

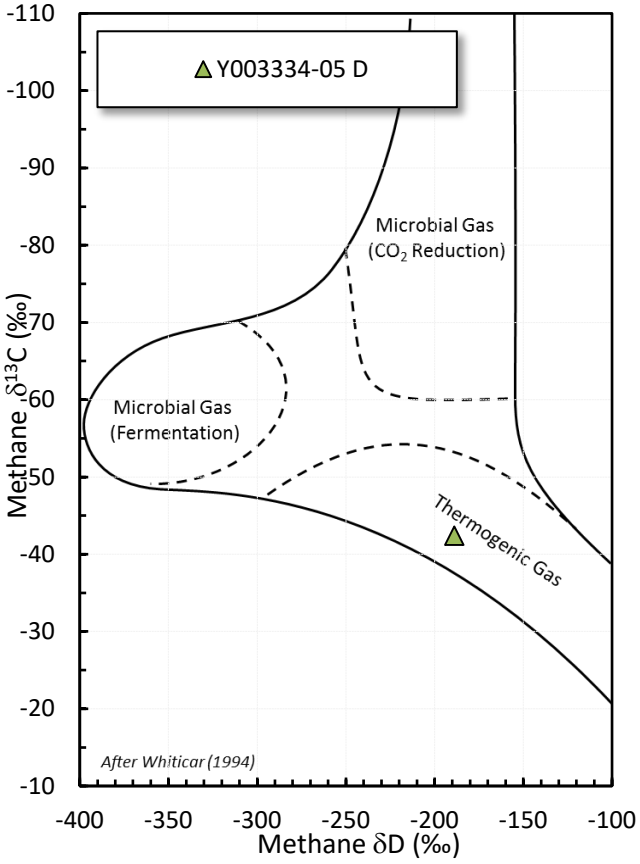
Error δD < 5.0 ‰

Stable Isotope Interpretive Plots

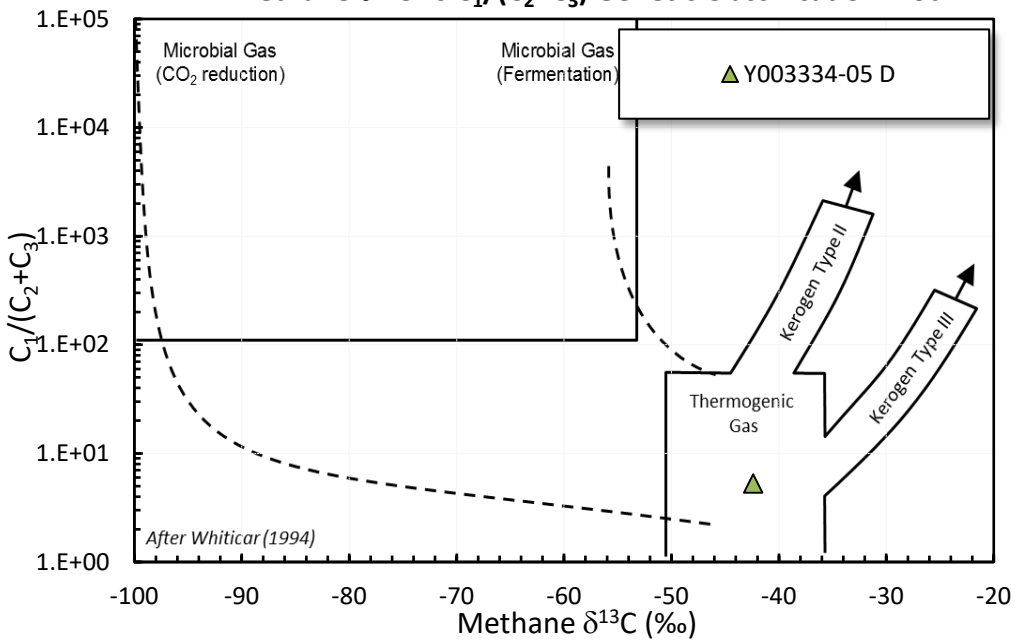
Methane vs Gas Wetness Genetic



Methane $\delta^{13}C$ vs δD Genetic Classification Plot



Methane $\delta^{13}C$ vs $C_1/(C_2+C_3)$ Genetic Classification Plot



Chain of Custody Form

JOB 20033698 20033702
DIG-022413-022417

dig Geochemistry for Energy
Dolan Integration Group
main 303.531.2030 • info@digforenergy.com • digforenergy.com
Office and Lab 11025 Dover St • Ste 800 • Westminster, CO 80021

Send Data to:	
Name:	Jennifer Pellegrini
Company:	Origins Laboratory
Address:	1725 W. 6th Ave
City, State:	Denver CO 80211
Phone:	303-433-1322
Email:	jpellegrini@originslab.com

Send invoice to (if different):	
Name:	
Company:	
Address:	
City, State:	
Phone:	
Email:	

Additional Information:	
AFE #:	
Project:	4003334
PO #:	
Location:	
Sampled By:	
Notes:	

Turnaround Time: ☐ Standard (≥ 10 business days) ☐ Rush (≥ 5 business days) ☐ Expedited Rush (≥ 3 business

Sample Description				Analysis Requested						
Container Number	Sample Identification	Date Sampled	Time	Gas Composition* N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+	RSK-175: N_2, O_2+Ar, CO_2, He, H_2,C_1-C_6+ with dissolved C_1, C_2, & C_3 (water samples only)	$\delta^{13}C$ Methane (Carbon)	δD Methane (Hydrogen)	$\delta^{13}C$ Ethane-Pentane (C_2-C_5 if present)	$\delta^{13}C$ CO_2 (if present)	Comments
4003334-01	mw-1	3/17/20	1100	Y		X	X			
4003334-02	mw-2		1200	Y		X	Y			
4003334-03	mw-3		1300	Y		X	~~Y~~			
4003334-04	mw-4		1430	Y		X	~~Y~~			
4003334-05	mw-5	↓	1345	Y		Y	Y			

Chain-of-Custody Record

Signature	Company	Date	Time
Relinquished by	Origins	3/23/20	1445
Received by	DIG	3/23/20	1445
Relinquished by			
Received by			
Relinquished by			
Received by			

*Gas composition vs RSK-175: Gas composition is a basic analysis of the concentration (ppm) of gases within the headspace of the sample (headspace is created at the lab). RSK-175 is a specific analysis technique combined with calculations to give the total dissolved gas of each species in the water sample (mg/L).
Why one or the other? Gas composition gives us a quick, general look at relative concentrations and ratios (e.g., gas wetness). RSK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 303-531-2030.

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project												
	10206	Dolan Integration Group		Origins Laboratory														
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab								
		3/17/20 1:45 PM		DIG-022417		GAS				3/23/2020								
Batch	LabID	Lab Batch Identifier	Leach Date	Extract Date and Time	Extract Method	Start Date and Time	Conc Method	Init Vol	Final Vol	Init Vol Units	Final Vol Units	Analysis Date and Time	Report Basis	Comments	File Name	Column #		
	10206																	
Result	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value	Qualifier	Test Type	Result Text	Data Flag	Dilution	Fraction Type	MDC	Requested MDC	Detection Limit	Instrument Detection Limit	Method Detection Limit	Comments	AnalyticalBatchID
	O2+AR	OXYGEN + ARGON	SOP		MOL %	5.42									0.005	0.005	0.005		20033702
	124-38-9	CARBON DIOXIDE	SOP		MOL %	2.06									0.005	0.005	0.005		20033702
	7727-37-9	NITROGEN (N2)	SOP		MOL %	31.93									0.005	0.005	0.005		20033702
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033702
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033702
	74-82-8	METHANE	SOP		MOL %	50.50									0.005	0.005	0.005		20033702
	74-84-0	ETHANE	SOP		MOL %	8.37									0.005	0.005	0.005		20033702
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		20033702
	74-98-6	PROPANE	SOP		MOL %	1.21									0.005	0.005	0.005		20033702
	75-28-5	ISOBUTANE	SOP		MOL %	0.16									0.005	0.005	0.005		20033702
	106-97-8	N-BUTANE	SOP		MOL %	0.23									0.005	0.005	0.005		20033702
	iC5	ISOPENTANE	SOP		MOL %	0.06									0.005	0.005	0.005		20033702
	109-66-0	N-PENTANE	SOP		MOL %	0.04									0.005	0.005	0.005		20033702
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.03									0.005	0.005	0.005		20033702
	delta13C_C1	DELTA 13C C1	SOP		per mil	-42.4													20033702
	deltaD_C1	DELTA D C1	SOP		per mil	-189													20033702