



dig
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 #: 21035516
Lab #: DIG-025045 - DIG-025046
Client: WSP
Well Name: Antelope Federal O34-K31-20HNB(459882)

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Client/Well Name: WSP / Antelope Federal O34-K31-20HNB(459882)
Job #: 21035516
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SAMPLE INFORMATION						COMPLETE GAS ANALYSIS															HYDROCARBON GAS ANALYSIS (normalized to total HC content)										BTU CONTENT*	
Job Number	Lab Number	Well Name	Sample Type	Sample Date	Sample Time	GC Date	N ₂ ppm	O ₂ + Ar ppm	CO ₂ ppm	C ₁ ppm	C ₂ ppm	C ₃ ppm	iC ₄ ppm	nC ₄ ppm	iC ₅ ppm	nC ₅ ppm	C ₆ + ppm	C ₆ H ₆ ppm	He ppm	H ₂ ppm	C ₁ mol%	C ₂ mol%	C ₃ mol%	iC ₄ mol%	nC ₄ mol%	iC ₅ mol%	nC ₅ mol%	C ₆ + mol%	Total Gas BTU/ft ³			
21035516	DIG-025045	Antelope Federal O34-K31-20HNB(459882) Bradenhead gas	Bradenhead gas	03/19/21	13:45	4/7/2021	344338	18170		15004	1062	290		76			137	198		654630	30.6	6.41	1.75		0.46			0.89	50			
21035516	DIG-025046	Antelope Federal O34-K31-20HNB(459882) Production gas	Production gas	03/19/21	14:25	4/7/2021	22607	4377	20975	617293	124600	97077	14712	52464	14824	20577	15437			345	64.5	13.09	10.14	1.54	6.48	1.55	2.15	1.61	1315			

SAMPLE INFORMATION						HYDROCARBON RATIOS				STABLE ISOTOPE ANALYSIS										Comments	
Job Number	Lab Number	Well Name	Sample Type	Sample Date	Sample Time	Total HC ppm	Weight % C to 10 C ₅	C ₂ /C ₁ -C ₅ mol/mol	Balance Ratio C ₆ -C ₁₀ /C ₁ -C ₅	Mass Spec date	δ ¹³ C ₁ ‰ VPDB	δ ¹³ C ₂ ‰ VPDB	δ ¹³ C ₃ ‰ VPDB	δ ¹³ C ₄ ‰ VPDB	δ ¹³ C ₅ ‰ VPDB	δ ¹³ C ₆ ‰ VPDB	δ ¹³ C _{CO₂} ‰ VPDB	δD ‰ VSMOW			
21035516	DIG-025045	Antelope Federal O34-K31-20HNB(459882) Bradenhead gas	Bradenhead gas	03/19/21	13:45	16589	9.4	11.3	43.9	4/8/2021	-55.7	-39.1					-292				
21035516	DIG-025046	Antelope Federal O34-K31-20HNB(459882) Production gas	Production gas	03/19/21	14:25	957074	35.5	2.8	3.7	4/8/2021	-51.7	-36.3	-31.7	-32.1	-29.7	-27.5	-28.9	-6.0	-285		

Stable isotope results based on multi-point laboratory calibration
low signal, interpret with caution

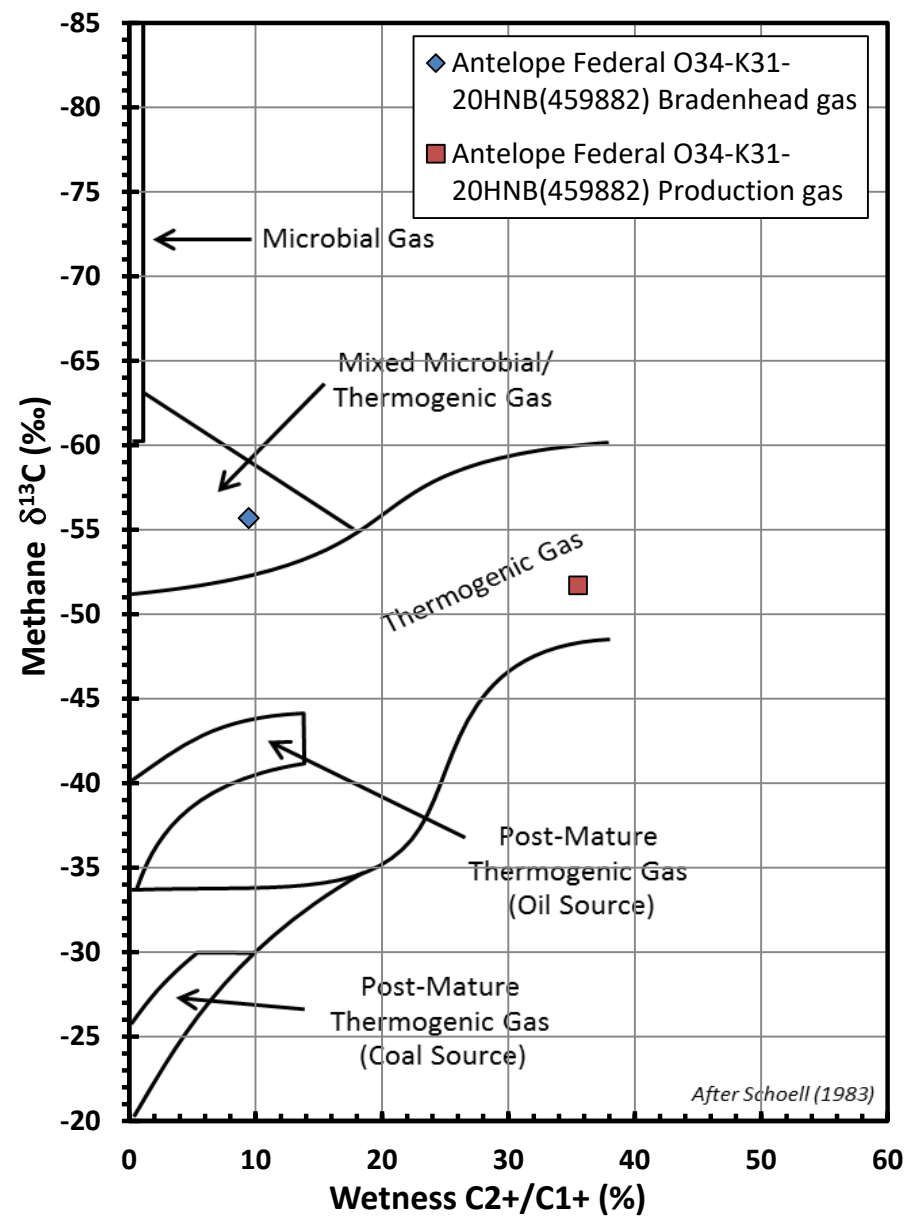
Precision δ¹³C < 0.5 ‰
Precision δD < 5 ‰

SPECIFIC GRAVITY*	
Total Gas Spec Grav	HCs only Spec Grav
0.909	0.628
0.942	0.928

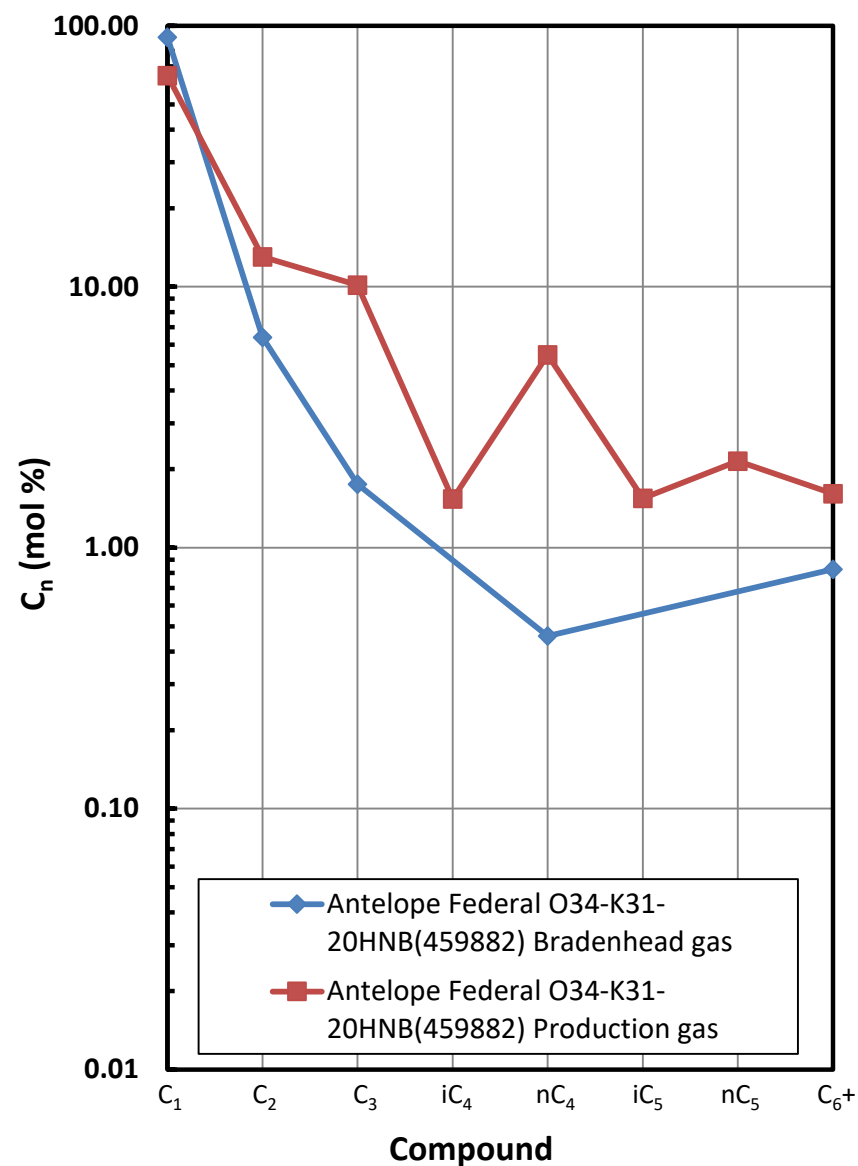
* As ideal gas, with gas concentrations normalized to 100%;
calculations based on GPA 2149-09 physical constants.

INTERPRETIVE PLOTS

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

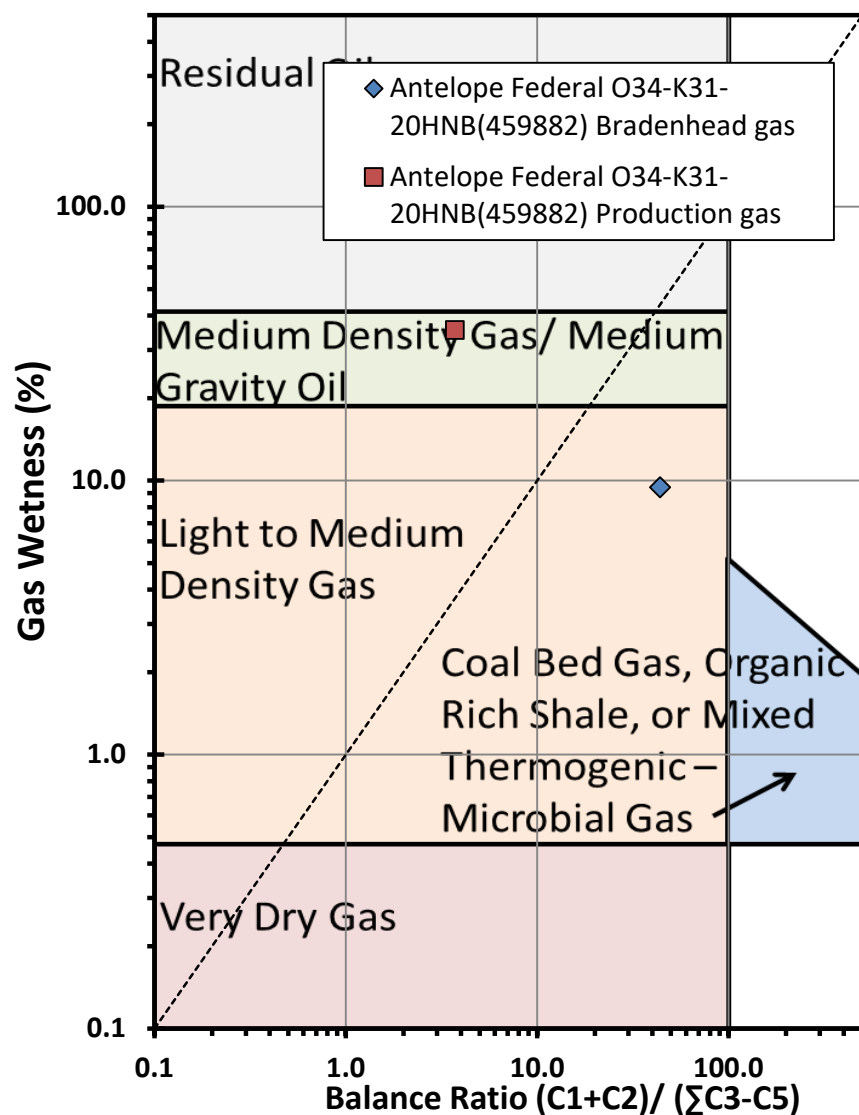


Hydrocarbon Composition Plot

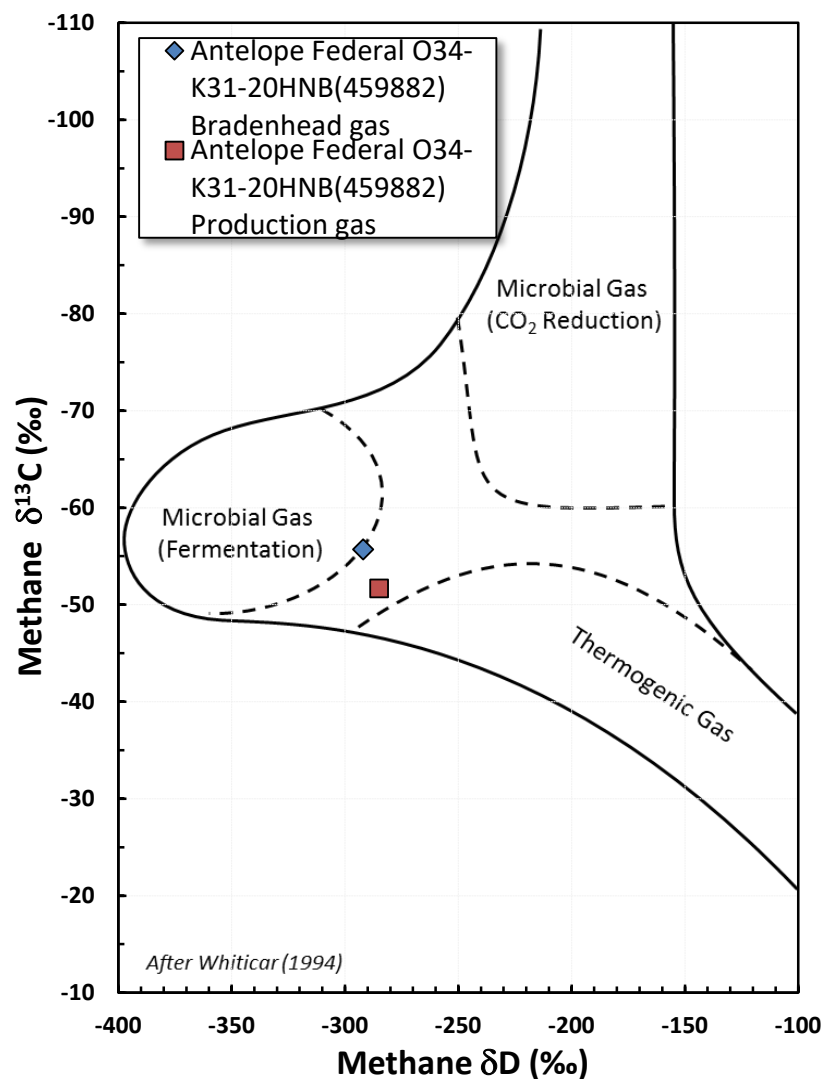


INTERPRETIVE PLOTS

Haworth Ratio Plot - Characterization of Hydrocarbon Type

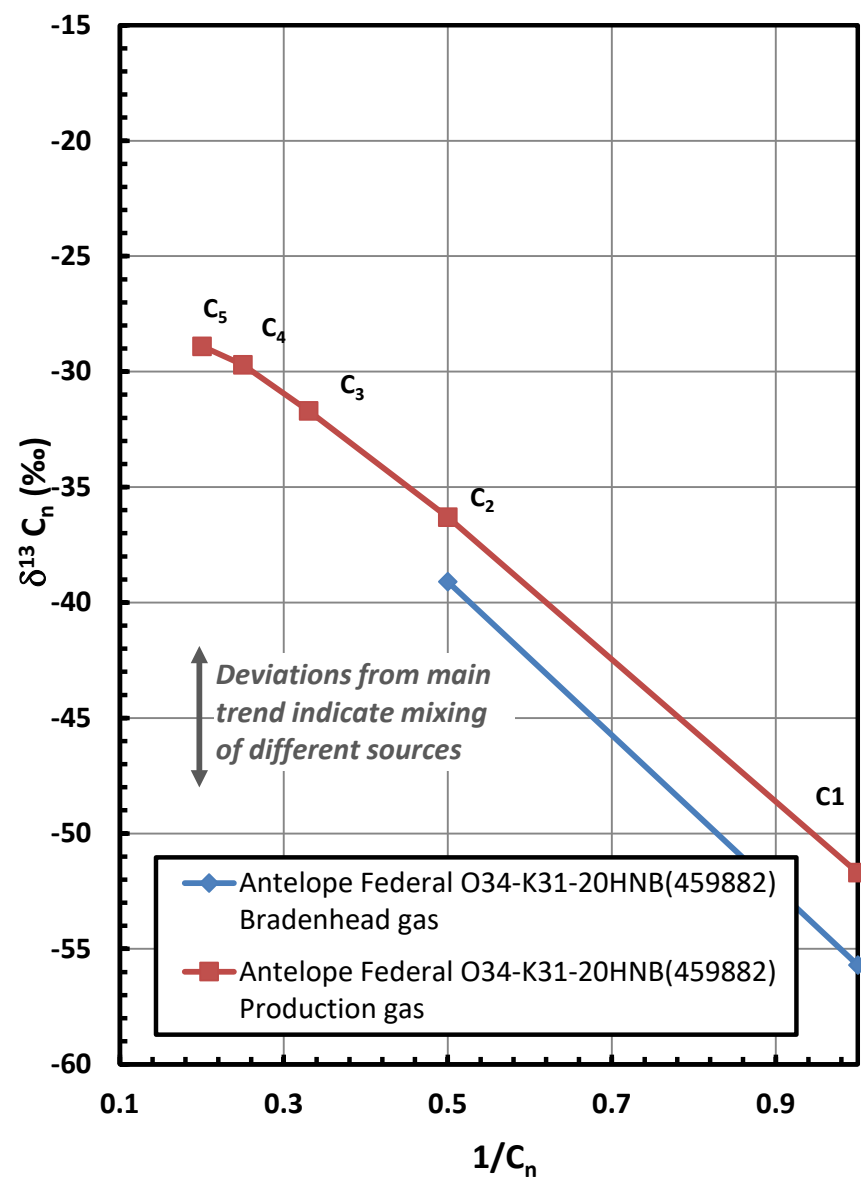


Methane $\delta^{13}C$ vs δD Genetic Classification Plot

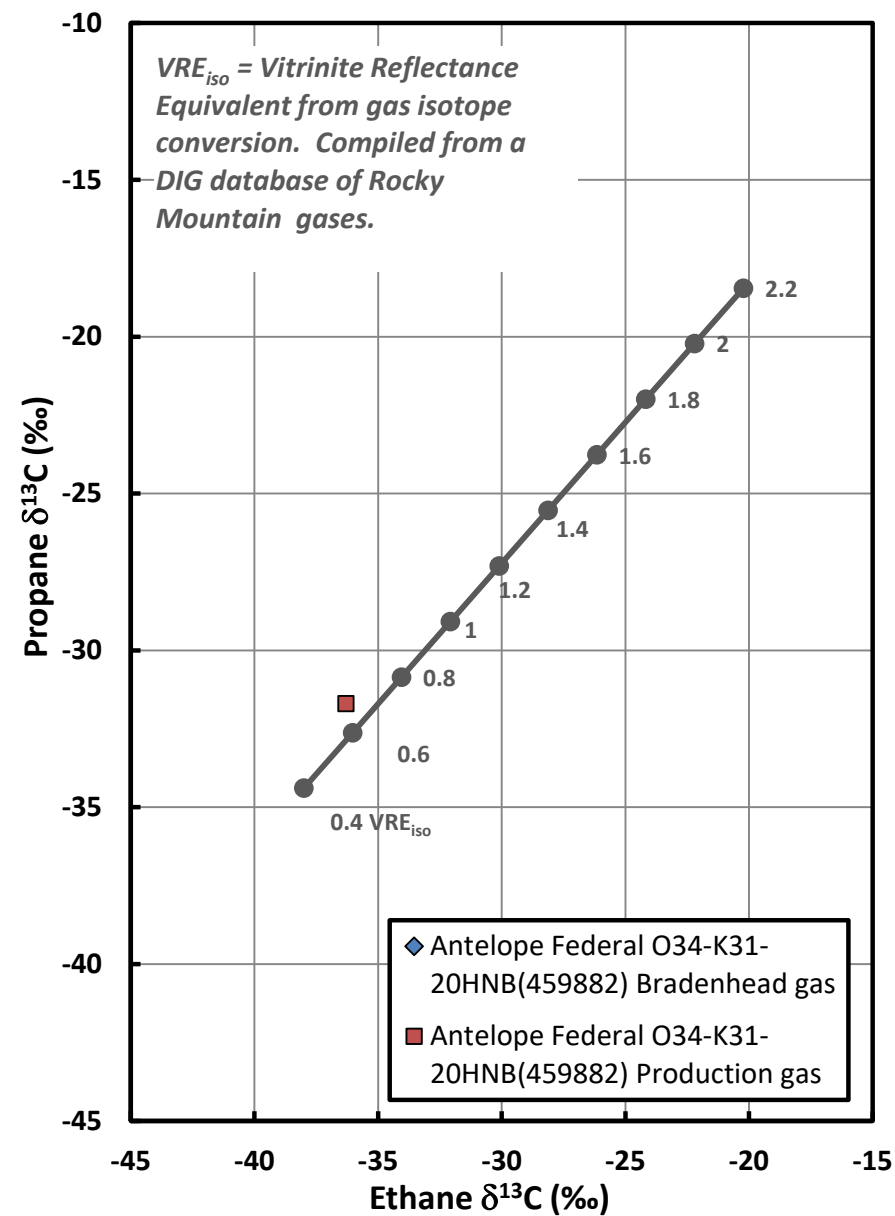


INTERPRETIVE PLOTS

Mixing Plot

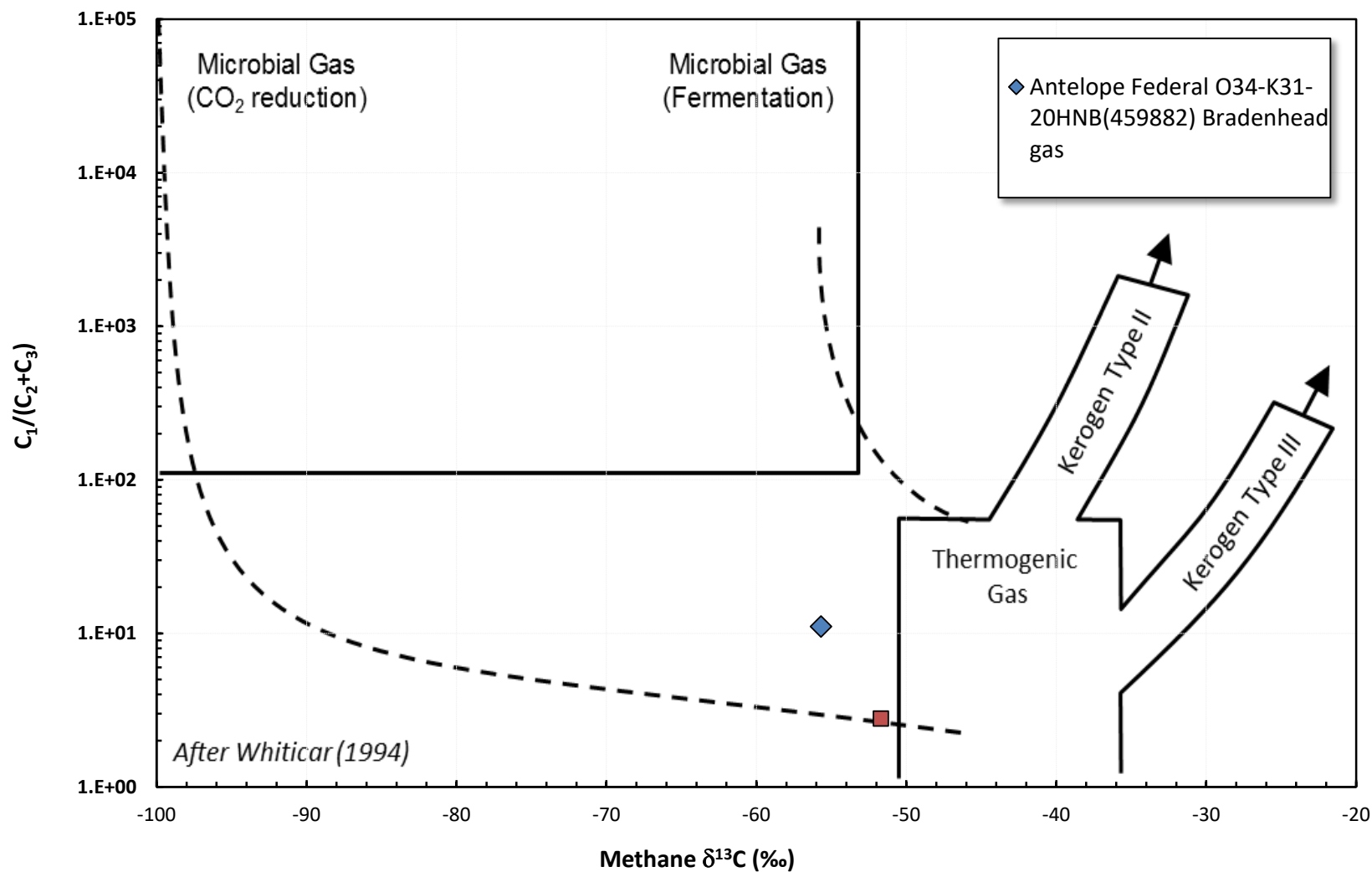


Ethane - Propane Maturity Plot



INTERPRETIVE PLOTS

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



Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project
Sample	10206	Dolan Integration Group	WSP			
Batch	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix
Result	LabID	Lab Batch Identifier	Leach Date	9/19/21 13:45	DMS-025045	GAS
	10206	21035516		Extract Date and Time	Extract Method	Start Date and Time
					Conc Method	Init Vol
						Chain of Custody ID
						Analytical Lab
						Final Vol Units
						Final Vol Units
						Analysis Date and Time
						Report Basis
						Comments
						File Name
						Column #
	CAS Number	Analysis Name	Analysis Method	Analytical Method Modifier	Unit	Result Value
	O2-NAR	OXYGEN + ARGON	SOP		MOL %	1.76
	124-38-9	CARBON DIOXIDE	SOP		MOL %	0.01
	7727-37-9	NITROGEN (N2)	SOP		MOL %	33.30
	7440-59-7	Helium	SOP		MOL %	0.01
	1333-74-0	HYDROGEN	SOP		MOL %	63.32
	74-82-8	METHANE	SOP		MOL %	1.45
	74-84-0	ETHANE	SOP		MOL %	0.10
	74-85-1	ETHENE	SOP		MOL %	0.02
	74-98-6	PROPANE	SOP		MOL %	0.03
	79-28-5	ISOBUTANE	SOP		MOL %	0.01
	106-97-8	N-BUTANE	SOP		MOL %	0.01
	ICS	ISOPENTANE	SOP		MOL %	0.01
	109-66-0	N-PENTANE	SOP		MOL %	0.01
	92112-69-1+	C6+ (Hexanes +)	SOP		MOL %	0.01
	delta13C_C1	DELTA 13C C1	SOP		per mil	-55.7
	deltaD_C1	DELTA D C1	SOP		per mil	-292
	delta13C_C2	DELTA 13C C2	SOP		per mil	-39.1
	BTU	BRITISH THERMAL UNITS	SOP		BTU/cubic foot	50
	SpGrav	SPECIFIC GRAVITY	SOP		No Unit	0.959

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project
Sample	10206	Dolan Integration Group		WSP		
	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix
		3/19/21 14:25		DIG-025048	FHOS	GAS
Batch	LabiD	Lab Batch Identifier	Leach Date	Extract Date and Time	Extract Method	Start Date and Time
	10206	210355516				
Result	CAS Number	Analysis Name	Analytical Method Modifier	Unit	Result Value	Qualifier
O2+AR	OXYGEN + ARGON	SOP		MOL %	0.44	
124-38-9	CARBON DIOXIDE	SOP		MOL %	2.09	
7727-37-9	NITROGEN (N2)	SOP		MOL %	2.25	
7440-59-7	Helium	SOP		MOL %	0.01	ND
1333-74-0	HYDROGEN	SOP		MOL %	0.03	
74-82-8	METHANE	SOP		MOL %	61.40	
74-84-0	ETHANE	SOP		MOL %	12.40	
74-85-1	ETHENE	SOP		MOL %	0.01	ND
74-98-6	PROPANE	SOP		MOL %	9.66	
75-28-5	ISOBUTANE	SOP		MOL %	1.46	
106-97-8	N-BUTANE	SOP		MOL %	5.22	
iCS	ISENTPANE	SOP		MOL %	1.47	
109-66-0	N-PENTANE	SOP		MOL %	2.05	
92112-69-1+	C6+ (hexanes +)	SOP		MOL %	1.54	
deltai3C_C1	DELTA 13C C1	SOP		per mil	-51.7	
deltad_C1	DELTA D C1	SOP		per mil	-285	
deltai3C_C2	DELTA 13C C2	SOP		per mil	-36.3	
deltai3C_C3	DELTA 13C C3	SOP		per mil	-22.7	
deltai3C_C4	DELTA 13C iC4	SOP		per mil	-32.1	
deltai3C_nc4	DELTA 13C nC4	SOP		per mil	-29.7	
deltai3C_iC5	Delta 13C iC5	SOP		per mil	-27.5	
deltai3C_nc5	Delta 13C nC5	SOP		per mil	-28.9	
deltai3C_CO2	DELTA 13C CO2	SOP		per mil	0.0	
BTU	BRITISH THERMAL UNITS	SOP		BTU/cuft	1515	
SpGrav	SPECIFIC GRAVITY	SOP		No Unit	0.942	



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JOB 21035516
DIG-025045

Additional Information:
AFE #:
Project:
PQ #: TE034520047, Task 1.00
Location: White Lake 0-20 Pad
Sampled By: WSP
Notes:

[illegible]

Signature	Company	Date	Time
Received by <i>Alan Bullock</i>	WSP	3/26/21	13:07
Received by <i>Kerry Maff</i>	DIG	3/26/21	13:07
Received by			
Received 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 liquid). Questions? Give us a call at 303.431.2030.



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DIG-025046

Additional Information:
A/E #:
Project:
PQ #: TE034520047, Task 1.00
Location: <i>4740 Rte 0-20 Pond</i>
Sampled By: <i>WSP</i>
Notes:

[illegible]

Chain-of-Custody Record			
Signature	Company	Date	Time
Relinquished by <i>Drew Butler</i>	WSP	3/26/21	13:07
Received by <i>Kelly May</i>	DIG	3/26/21	13:07
Relinquished by			
Received by			
Relinquished by			
Received by			

¹Gas composition via RGK-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). RGK-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). RGK-175 gives us an exact total of gas present in the sample (headspace and dissolved in the water). Questions? Give us a call at 202-651-2020