Vista GeoScience

Expert Environmental Support Services for Site Investigation & Remediation

July 6, 2017

Paul Schneider, HSE Manager
Anadarko Petroleum Corp.
Via E-mail:

RE: FINAL REPORT - VGS Project No. 17137.01:
Results of June 20, 2017, Sub-Slab Soil Gas Testing at 6312 Twilight Ave., Firestone, CO

Anadarko Petroleum Corporation requested that Vista GeoScience mobilize to 6312 Twilight Ave., Firestone, CO, to install sub-slab soil gas sampling devices (Vapor Pins™), and collect soil gas samples from below the basement concrete slab, for air and hydrocarbon analysis.

On June 20, 2017, a Vista GeoScience crew mobilized to the site and met with the a COGCC representative at an adjacent property. The crew calibrated a Thermo model TVA-1000 Flame Ionization Detector gas meter (FID), a Landtec model GEM5000 infra-red (IR) gas meter, and a Q-Rae lower explosive limit gas meter (LEL meter). They entered the home and investigated the entire basement area, primarily using the FID, which is capable of detecting 1.0 ppm, or greater, methane in air over background. The LEL and IR meters are used for testing higher gas concentrations, to check ambient air for hazardous conditions, and for purging soil gas sampling points before collecting samples.

The home was destroyed by a fire, and the basement area to be examined was exposed with no upper floors or roof remaining to cover it. The basement area has a significant amount of debris remaining on the floor, and required a ladder to access the basement floor area, since the stairs were not present. Pathways had been cleared in part of the floor area, allowing limited access to the concrete floor where the Vapor Pins were installed.

Five sub-slab soil gas sampling locations were proposed for the basement area: One in each corner, and one in the center of the basement. Due to debris present on the floor, there was no access to the northwest corner, so that point was not installed, leaving four locations where Vapor Pins were installed.

Before drilling any holes in the basement floors, the crew examined the area with the FID gas meter and Q-Rae to insure the ambient atmosphere was safe. No methane was detected at or above 1 ppm above ambient.

To access soil gas beneath the concrete slab, holes up to 1 ½" in diameter were drilled through the concrete floor, and Vapor Pins™ were installed in three corners of the basement, and one in the center.

The Vapor Pins™ were installed in a semi-permanent configuration so that the lid is flush with the surface, and can be sampled and monitored at a later date. The pins can also be easily removed, and the hole patched with concrete, at a later date. The attached sketch (Figure 1) shows all installed Vapor Pin locations in the basement. Photos and a description of the Vapor Pin devices (Figure 2 & 3) follows the sketch map.

The FID was used to measure subtle (down to 1.0 ppm methane over background) readings immediately after drilling the holes in the concrete to install the Vapor Pins. Readings ranged from 4 ppm to 46 ppm methane equivalent. This is common to measure low readings right after drilling a hole in concrete as any number of volatile organic compounds (VOCs) can be released and generated while drilling through the concrete.

After all of the Vapor Pins were installed, sub-slab soil gas samples were collected in 1-liter Cali-5-Bond gas sampling bags. Each Vapor Pin was connected to the IR gas meter, and a 3-way sampling valve using clean tubing. The Vapor Pin was purged using the IR until oxygen (O_2) and carbon dioxide (CO_2) readings were stable, which took 2 to 3 minutes at each location. The Landtec measured no methane (> 0.1%) at any of the locations. Oxygen ranged from 11.1% to 11.8%, and CO2 ranged from 0.4% to 2.4% at all four locations. After purging the sample point, the valve was switched to the hand-squeeze bulb pump, and after purging the bulb with 10 pumps, the sample gas bag was connected and filled. Each bag was labeled and samples were delivered to Dolan Integration Group in Westminster, CO, for air and hydrocarbon composition analysis and stable isotope analysis.

Table 1a and 1b summarize the results of the laboratory analyses, and the full laboratory reports are appended to the end of this report. Due to the lack of hydrocarbon detections in the samples, stable isotope analysis was not completed.

If there are any questions regarding these results, please feel free to contact us.

Best Regards,

[redacted] Digitally signed by John V. Fontana
DN: cn=John V. Fontana, o=Vista GeoScience LLC, ou, email=[redacted]=US
Date: 2017.07.06 15:53:37 -06'00'

John Fontana, PG, President & CEO
Vista GeoScience LLC

Figure 1. Sketch of 6312 Twilight Ave., Basement Area, showing location of installed VaporPin sub-slab sampling points; 6-20-17. (NOT TO SCALE)

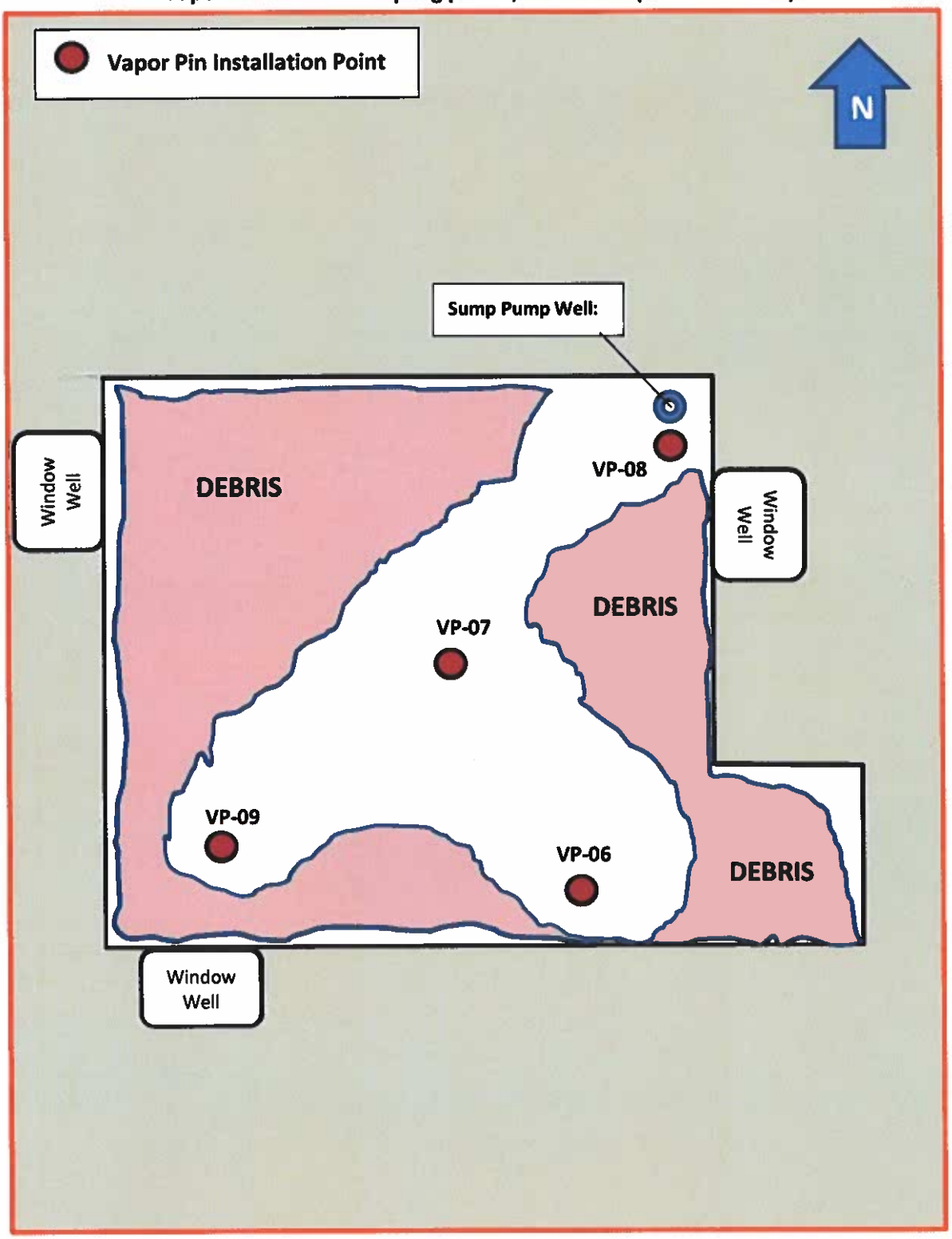


Figure 2. Vapor Pin™ Description.

Vapor Pin™

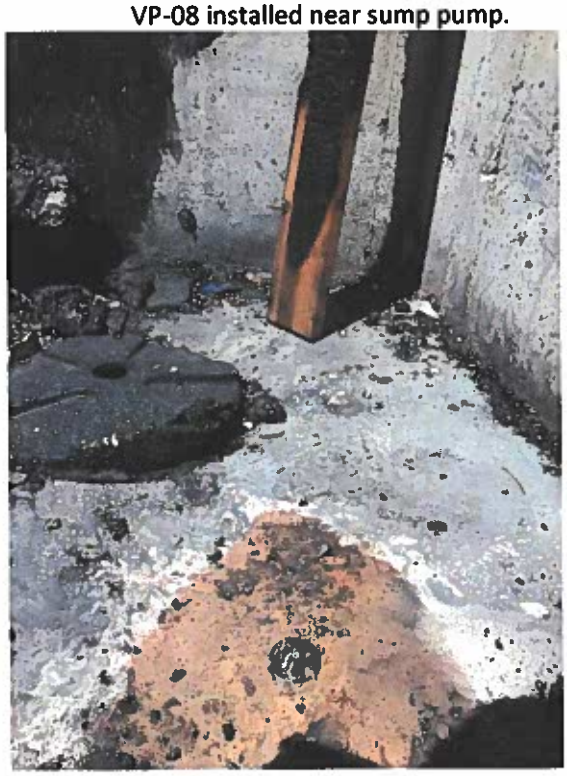
Stainless steel Vapor Pins™ were installed to access soil gas samples below the basement concrete slab. A 5/8" and 1½" diameter hole was drilled in the concrete. The 1 ½" hole allows the pin to be set flush below the surface, and protected by a secure stainless-steel screw-on cover. After drilling the holes, the Vapor Pins were installed by hammering them gently in place. The silicone seal around the pin seals it from room air so that gases can be pulled through the pin with a pump without cross contamination from room air.

Figure 3. Photos of installed Vapor Pin locations.

Vapor pin VP-06 installed near south wall.

Vapor pin VP-07 installed near center of basement.

VP-08 installed near sump pump.



VP-09 installed close to the southwest corner.

View of basement from ground level.

NW corner where vapor pin could not be installed due to debris.

Sub-Slab Soil Gas Laboratory Results Summary Tables

(See full laboratory reports for additional details)

Table 1a: Sub-Slab Soil Gas Analytical Results - AIR COMPOSITION

Sample ID	Location ID	Lab ID	Sample Container	Sample Date	Analysis Date	He	H2	O2 + Ar	CO2	N2	CO	δ13C of CO2
						mol%	mol%	mol%	mol%	mol%	ppm	o/ooVPDB B
VP06-602917-1438	VP-06	DIG-011376	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	15.50	2.58	81.92	9	-29.3
VP07-602917-1442	VP-07	DIG-011377	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	15.12	1.80	83.07	10	-29.4
VP08-602917-1445	VP-08	DIG-011378	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	15.66	3.70	80.63	12	-33.7
VP09-602917-1433	VP-09	DIG-011379	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	17.17	1.12	81.71	11	-23.8

Table 1b: Sub-Slab Soil Gas Analytical Results - HYDROCARBON COMPOSITION

Sample ID	Location ID	Lab ID	Sample Container	Sample Date	Analysis Date	C1	C2	C2=	C3	C3=	iC4	nC4	iC5	nC5	C6+
						mol%	mol%	mol%	mol%	mol%	mol%	mol%	mol%	mol%	mol%
VP06-602917-1438	VP-06	DIG-011376	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VP07-602917-1442	VP-07	DIG-011377	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VP08-602917-1445	VP-08	DIG-011378	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VP09-602917-1433	VP-09	DIG-011379	1L Cali-5-Bond	6/20/17	6/22/17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ABREVIATIONS:

ND – non-detect
C1 - methane
C2 - ethane
C2= - ethylene
C3 - propane
C3= - propylene
iC4 – iso-butane
nC4 – normal-butane
iC5 – iso-pentane
nC5 – normal-pentane
C6+ - hexane plus heavier hydrocarbons

o/oo VPDB - parts per thousand relative to the Vienna Pee Dee Belemnite Standard (carbon 13 isotope)

Note: mol% concentrations are normalized to 100% total. (Mol.% is approximately equal to Vol. %)

APC-NTSB-00001354

Appendix: Laboratory Reports

dig
Dolan Integration Group
Geochemistry for Energy
1317 West 121st Ave
Westminster, CO 80234
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**17060970**
Lab #:	**DIG-011376**
Client:	**Vista Geoscience**
Sample Name(s):	**VP06-062017-1438**

Analytical Report

dig

Job #:	17060970
Lab #:	DIG-011376
Client:	Vista Geoscience
Sample Name:	VP06-062017-1438
Date Sampled:	06/20/17
Time Sampled:	14:38
Sample Description:	cali-5-bond bag
Sampling Notes:	
Date Received:	06/20/17
Date Analyzed:	Gas Composition: 6/21/17, $\delta^{13}C$: 6/21/17, δD: na
Date Reported:	06/22/17
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	805795	81.92	-	-	-	
Oxygen + Argon (O_2+Ar)	152507	15.50	-	-	-	
Carbon Dioxide (CO_2)	25386	2.58	-	-29.3	-	
Carbon Monoxide (CO)	9	0.00	-	-	-	
Helium (He)[b]	nd	nd	-	-	-	
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	nd	nd	nd	nd	nd	
Ethane (C_2H_6)	nd	nd	nd	nd	-	
Ethene (C_2H_4)	nd	nd	nd	na	-	
Propane (C_3H_8)	nd	nd	nd	nd	-	
Propene (C_3H_6)	nd	nd	nd	na	-	
iso-Butane (C_4H_{10})	nd	nd	nd	nd	-	
n-Butane (C_4H_{10})	nd	nd	nd	nd	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
n-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
Hexanes + (C_6H_{14})	nd	nd	nd	na	-	

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

[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 ‰

Chain of Custody Form

dig

Job 17060970
DIG-011378 - 011379.

Send Data and Invoice to:

Name: DF David Fontana John Fontana
Company: Vista Geo Science
Address: 130 Capital Dr. Suite C, Golden, CO 80401
Phone: 303 - [redacted]
Fax: 303 - [redacted]
Email: [redacted]

AFE #:
Report Ctr:
Project: 17137.01
PO #: JVF051517
Location:
Sampled By: David Fontana

RUSH

Sample Description

Container #	Sample Identification	Date Sampled	Time	δ18O/δ2H-1 of water	Gas Composition $N_2, O_2, CO_2, He, H_2, C_1-C_6$ with dissolved C1, C2 & C3	$\delta^{13}C$ Methane (Carbon)	δD Methane (Hydrogen)	$\delta^{13}C$ Ethane-Pentane (C_{2+} if present)	Comments
VP-01	VP01-062017-1248	6/20/17	1248	X		X	X	X	+D13C CO2
VP-02	VP02-062017-1252	6/20/17	1252	X		X	X	X	" "
VP-03	VP03-062017-1237	6/20/17	1237	X		X	X	X	" "
VP-04	VP04-062017-1243	6/20/17	1243	X		X	X	X	" "
VP-05	VP05-062017-1232	6/20/17	1232	X		X	X	X	" "
VP-06	VP06-062017-1438	6/20/17	14.38	X		X	X	X	" "
VP-07	VP07-062017-1442	6/20/17	1442	X		X	X	X	" "
VP-08	VP08-062017-1445	6/20/17	1445	X		X	X	X	" "
VP-09	VP09-062017-1433	6/20/17	1433	X		X	X	X	" "

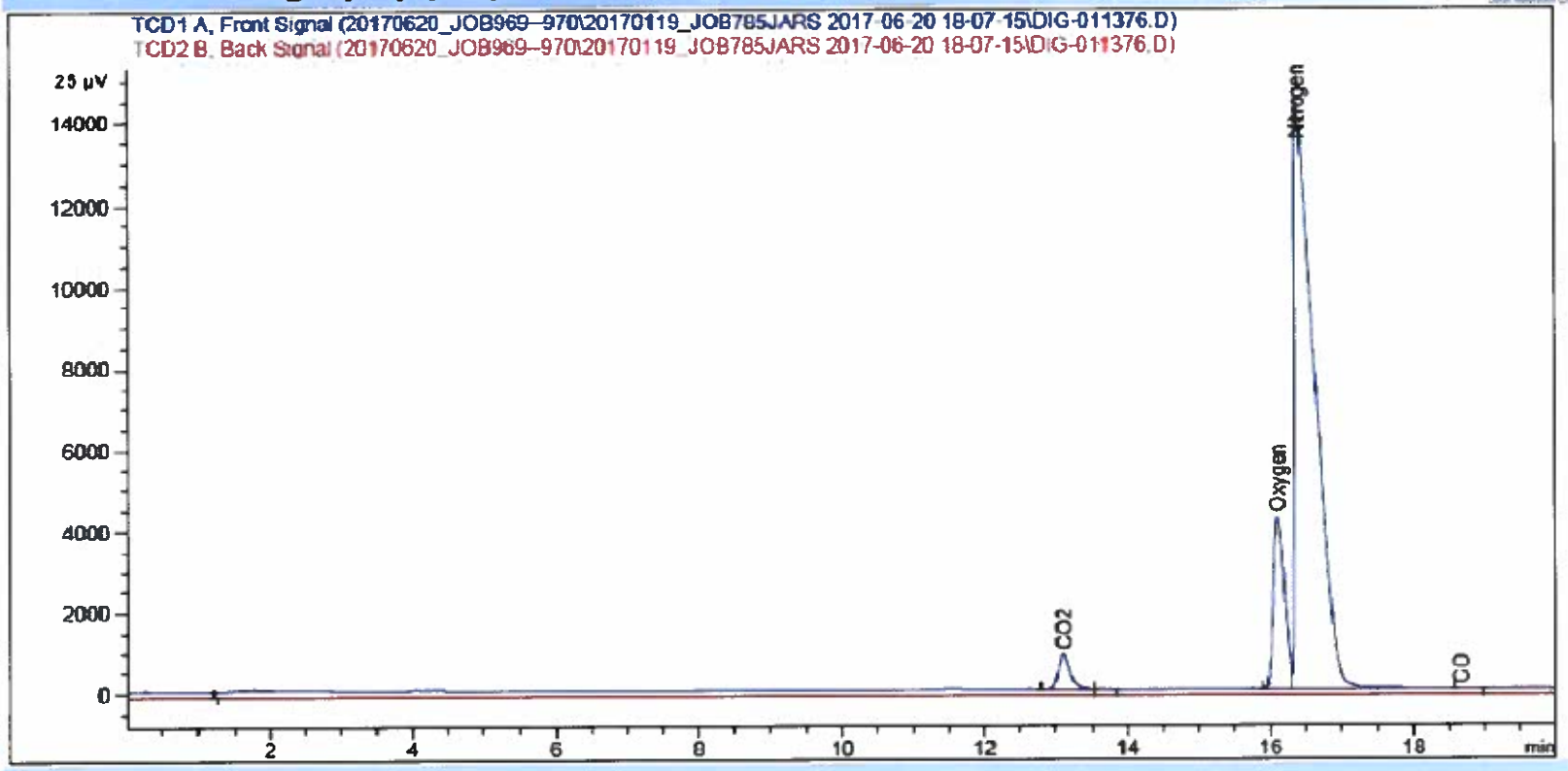
Chain-of-Custody Record

Signature	Company	Date	Time
Relinquished by David Fontana [redacted]	Vista Geo Science	6/20/17	1552
Received by [redacted]	DIG	6/20/17	16:00.
Relinquished by			
Received by			
Relinquished by			
Received by			

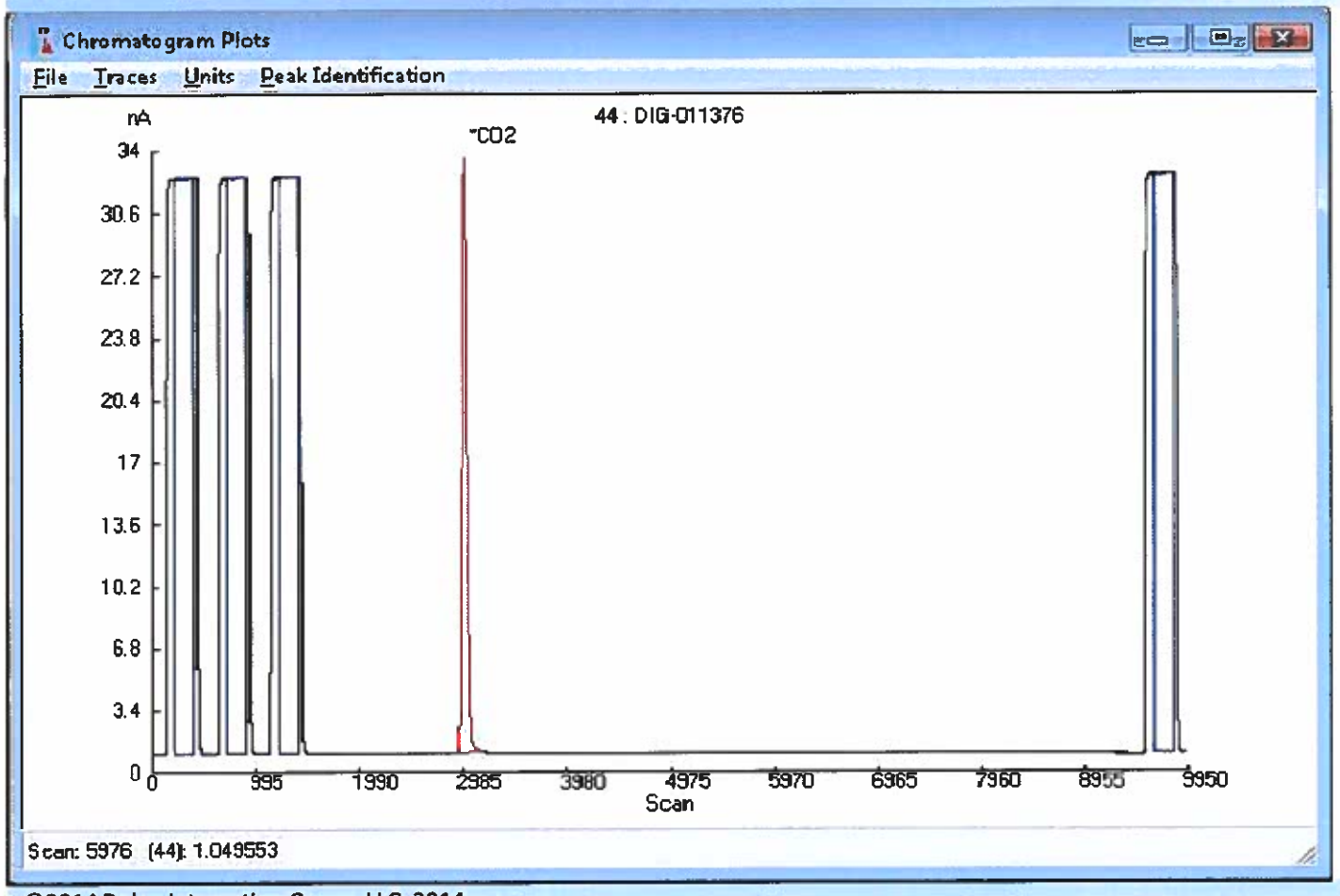
Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project														
		Dolan Integration Group		Vista Geoscience																
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab										
		6/20/17 2:38 PM		DIG-011376		Gas				6/20/2017										
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 #				
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 %	15.50									0.005	0.005	0.005		17060970	
	124-38-9	CARBON DIOXIDE	SOP		MOL %	2.58									0.005	0.005	0.005		17060970	
	7727-37-9	NITROGEN (N2)	SOP		MOL %	81.92									0.005	0.005	0.005		17060970	
	630-08-0	CARBON MONOXIDE	SOP		MOL %	0.00									0.005	0.005	0.005		17060970	
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	74-82-8	METHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	115-07-1	PROPENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	ICS	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	109-66-0	N PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970	
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.01	ND												17060970	
	deltaI3C_C1	DELTA 13C C1	SOP		per mil	nd	ND												17060970	
	deltaD_C1	DELTA D C1	SOP		per mil	nd	ND												17060970	
	deltaI3C_C2	DELTA 13C C2	SOP		per mil	nd	ND												17060970	
	deltaI3C_C3	DELTA 13C C3	SOP		per mil	nd	ND												17060970	
	deltaI3C_ic4	DELTA 13C iC4	SOP		per mil	nd	ND												17060970	
	deltaI3C_nC4	DELTA 13C nC4	SOP		per mil	nd	ND												17060970	
	deltaI3C_iC5	DELTA 13C iC5	SOP		per mil	nd	ND												17060970	
	deltaI3C_nC5	DELTA 13C nC5	SOP		per mil	nd	ND												17060970	
	deltaI3C_CO2	DELTA 13C CO2	SOP		per mil	-29.3													17060970	

APC-NTSB-00001359

Gas Chromatography (GC) Chromatogram



Gas Chromatography - Combustion - Isotope Ratio Mass Spectrometry (GC-C-IRMS) Chromatogram



Gas Chromatography - Pyrolysis - Isotope Ratio Mass Spectrometry (GC-P-IRMS) Chromatogram

* Methane concentration too low for stable hydrogen isotope analysis

dig
Dolan Integration Group

Geochemistry for Energy

1317 West 121st Ave
Westminster, CO 80234
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**17060970**
Lab #:	**DIG-011377**
Client:	**Vista Geoscience**
Sample Name(s):	**VP07-062017-1442**

Analytical Report

dig

Job #:	17060970
Lab #:	DIG-011377
Client:	Vista Geoscience
Sample Name:	VP07-062017-1442
Date Sampled:	06/20/17
Time Sampled:	14:42
Sample Description:	cali-5-bond bag
Sampling Notes:	
Date Received:	06/20/17
Date Analyzed:	Gas Composition: 6/21/17, $\delta^{13}C$: 6/21/17, δD: na
Date Reported:	06/22/17
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	815370	83.07	-	-	-	
Oxygen + Argon (O_2+Ar)	148445	15.12	-	-	-	
Carbon Dioxide (CO_2)	17690	1.80	-	-29.4	-	
Carbon Monoxide (CO)	10	0.00	-	-	-	
Helium (He)[b]	nd	nd	-	-	-	
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	nd	nd	nd	nd	nd	
Ethane (C_2H_6)	nd	nd	nd	nd	-	
Ethene (C_2H_4)	nd	nd	nd	na	-	
Propane (C_3H_8)	nd	nd	nd	nd	-	
Propene (C_3H_6)	nd	nd	nd	na	-	
iso-Butane (C_4H_{10})	nd	nd	nd	nd	-	
n-Butane (C_4H_{10})	nd	nd	nd	nd	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
n-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
Hexanes + (C_6H_{14})	nd	nd	nd	na	-	

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

[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 ‰

Chain of Custody Form

dig

Job 17060970
DIG-011370 - 011379.

Send Data and Invoice to:

Name: DF David Fontana, John Fontana
Company: Vista GeoScience
Address: 130 Capital Dr. Suite C, Golden, CO 80401
Phone: [redacted]
Fax:
Email: [redacted]

AFE #:
Report Ctr:
Project: 17137.01
PO #: JVF051517
Location:
Sampled By: David Fontana

RUSH

Sample Description

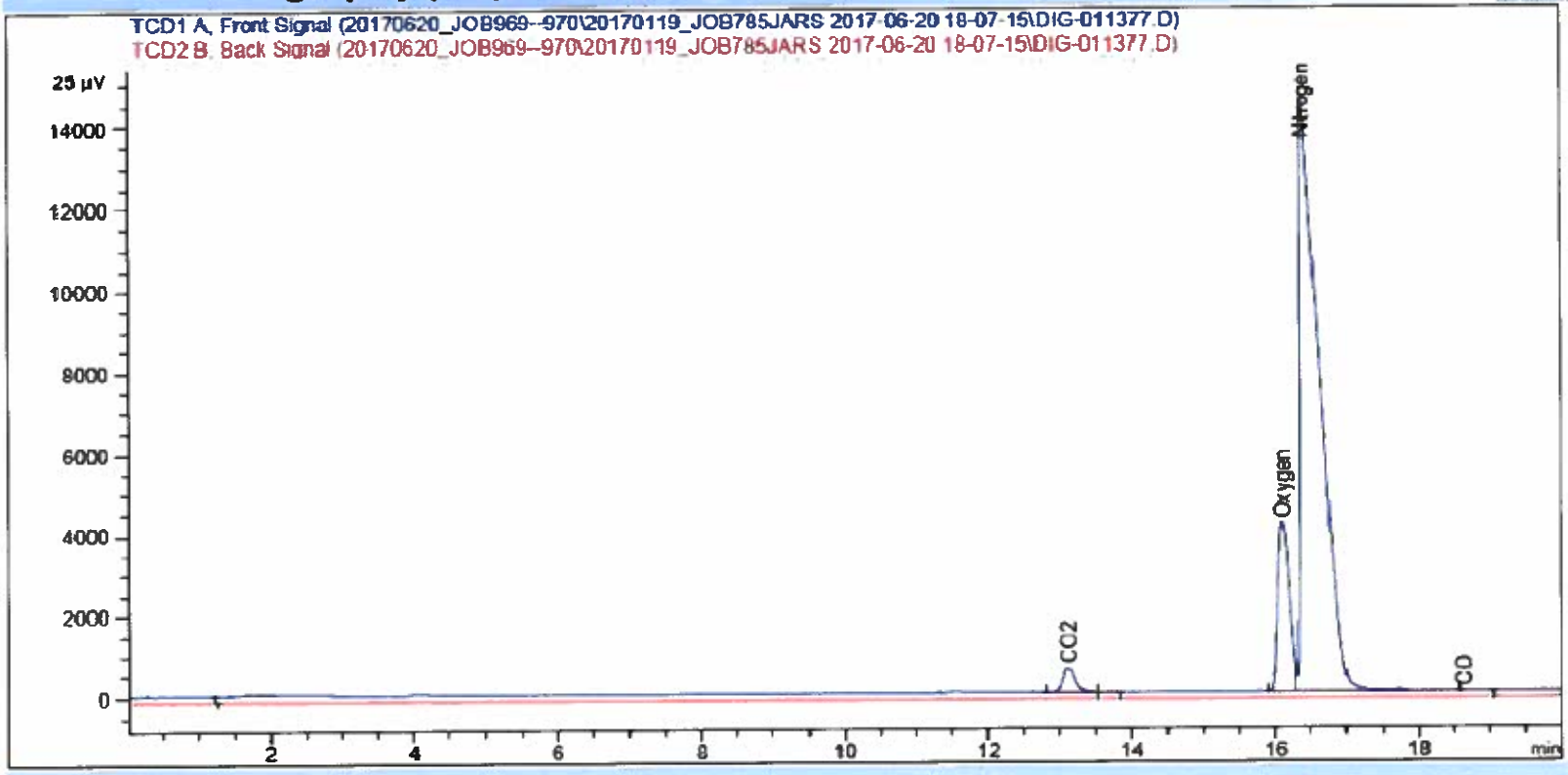
Container #	Sample Identification	Date Sampled	Time	δ18O/δ16 and H-2/H-1 of water	Gas Composition $N_2, O_2, CO_2, He, H_2, C_1-C_6$ with dissolved C_1, C_2 & CO_2	δ13C Methane (Carbon)	δD Methane (Hydrogen)	δ13C Ethane-Pentane (C_{2+} if present)	Comments
VP-01	VP01-062017-1248	6/20/17	1248	X		X	X	X	+D13C CO2
VP-02	VP02-062017-1252	6/20/17	1252	X		X	X	X	" "
VP-03	VP03-062017-1237	6/20/17	1237	X		X	X	X	" "
VP-04	VP04-062017-1243	6/20/17	1243	X		X	X	X	" "
VP-05	VP05-062017-1232	6/20/17	1232	X		X	X	X	" "
VP-06	VP06-062017-1438	6/20/17	14.38	X		X	X	X	" "
VP-07	VP07-062017-1442	6/20/17	1442	X		X	X	X	" "
VP-08	VP08-062017-1445	6/20/17	1445	X		X	X	X	" "
VP-09	VP09-062017-1433	6/20/17	1433	X		X	X	X	" "

Chain-of-Custody Record

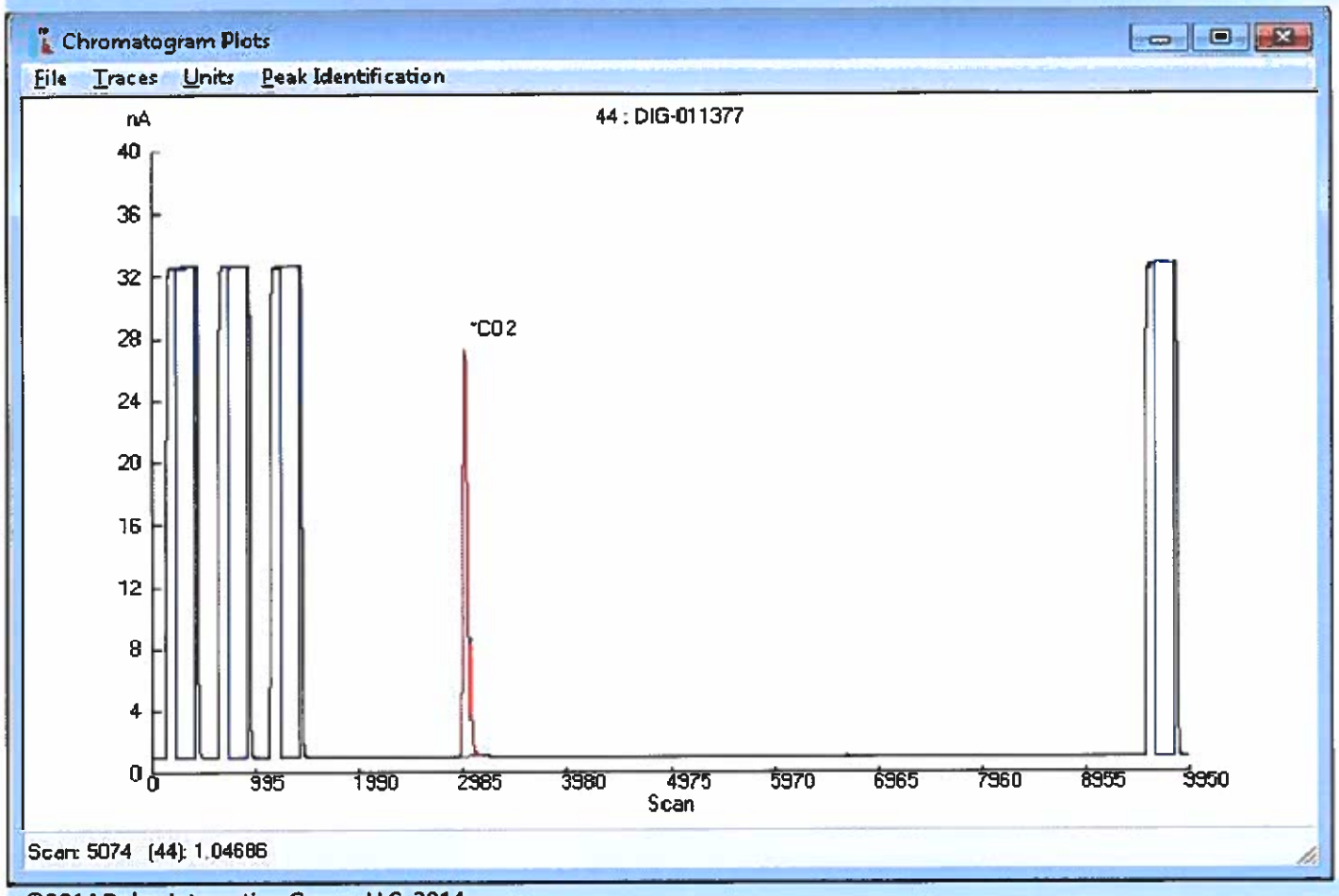
	Signature	Company	Date	Time
Relinquished by	David Fontana [redacted]	Vista GeoScience	6/20/17	1552
Received by	[redacted]	DIG	6/20/17	16:00.
Relinquished by				
Received by				
Relinquished by				
Received by				

Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project															
		Dolan Integration Group		Vista Geoscience																	
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											
		6/20/17 2:42 PM		DIG-033377		Gas				6/28/2017											
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 #					
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 %	15.12									0.005	0.005	0.005		17060970		
	124-38-9	CARBON DIOXIDE	SOP		MOL %	1.80									0.005	0.005	0.005		17060970		
	7727-37-9	NITROGEN (N2)	SOP		MOL %	83.07									0.005	0.005	0.005		17060970		
	630-08-0	CARBON MONOXIDE	SOP		MOL %	0.00									0.005	0.005	0.005		17060970		
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	74-82-8	METHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	115-07-1	PROPENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	IC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	109-66-0	N PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970		
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.01	ND												17060970		
	delta13C_C1	DELTA 13C C1	SOP		per mil	nd	ND												17060970		
	deltaD_C1	DELTA D C1	SOP		per mil	nd	ND												17060970		
	delta13C_C2	DELTA 13C C2	SOP		per mil	nd	ND												17060970		
	delta13C_C3	DELTA 13C C3	SOP		per mil	nd	ND												17060970		
	delta13C_ic4	DELTA 13C iC4	SOP		per mil	nd	ND												17060970		
	delta13C_nC4	DELTA 13C nC4	SOP		per mil	nd	ND												17060970		
	delta13C_iC5	DELTA 13C iC5	SOP		per mil	nd	ND												17060970		
	delta13C_nC5	DELTA 13C nC5	SOP		per mil	nd	ND												17060970		
	delta13C_CO2	DELTA 13C CO2	SOP		per mil	-29.4													17060970		

Gas Chromatography (GC) Chromatogram



Gas Chromatography - Combustion - Isotope Ratio Mass Spectrometry (GC-C-IRMS) Chromatogram



Gas Chromatography - Pyrolysis - Isotope Ratio Mass Spectrometry (GC-P-IRMS) Chromatogram

* Methane concentration too low for stable hydrogen isotope analysis

dig
Dolan Integration Group
Geochemistry for Energy
1317 West 121st Ave
Westminster, CO 80234
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**17060970**
Lab #:	**DIG-011378**
Client:	**Vista Geoscience**
Sample Name(s):	**VP08-062017-1445**

Analytical Report

dig

Job #:	17060970
Lab #:	DIG-011378
Client:	Vista Geoscience
Sample Name:	VP08-062017-1445
Date Sampled:	06/20/17
Time Sampled:	14:45
Sample Description:	cali-5-bond bag
Sampling Notes:	
Date Received:	06/20/17
Date Analyzed:	Gas Composition: 6/21/17, $\delta^{13}C$: 6/21/17, δD: na
Date Reported:	06/22/17
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	790905	80.63	-	-	-	
Oxygen + Argon (O_2+Ar)	153605	15.66	-	-	-	
Carbon Dioxide (CO_2)	36337	3.70	-	-33.7	-	
Carbon Monoxide (CO)	12	0.00	-	-	-	
Helium (He)[b]	nd	nd	-	-	-	
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	nd	nd	nd	nd	nd	
Ethane (C_2H_6)	nd	nd	nd	nd	-	
Ethene (C_2H_4)	nd	nd	nd	na	-	
Propane (C_3H_8)	nd	nd	nd	nd	-	
Propene (C_3H_6)	nd	nd	nd	na	-	
iso-Butane (C_4H_{10})	nd	nd	nd	nd	-	
n-Butane (C_4H_{10})	nd	nd	nd	nd	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
n-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
Hexanes + (C_6H_{14})	nd	nd	nd	na	-	

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

[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 ‰

Chain of Custody Form

dig

Job 17060970
DIG-011378 - 011379.

Send Data and invoice to:

Name: David Fontana of John Fontana
Company: Vista GeoScience
Address: 130 Capital Dr. Suite C, Golden, CO 80401
Phone: [redacted]
Fax:
Email: [redacted]

AFE #:
Report Ctr:
Project: 17137.01
PO #: JVF051517
Location:
Sampled By: David Fontana

RUSH

Sample Description

Container #	Sample Identification	Date Sampled	Time	δ18O-16 and H-2/H-1 of water	Gas Composition $H_2, O_2, CO_2, He, H_2, C_1$-$C_6$+ with dissolved C_1, C_2 & CO_2	δ13C Methane (Carbon)	δD Methane (Hydrogen)	δ13C Ethane-Pentane (C_{2+} if present)	Comments
VP-01	VP01-062017-1248	6/20/17	1248	X		X	X	X	+D13C CO2
VP-02	VP02-062017-1252	6/20/17	1252	X		X	X	X	" "
VP-03	VP03-062017-1237	6/20/17	1237	X		X	X	X	" "
VP-04	VP04-062017-1243	6/20/17	1243	X		X	X	X	" "
VP-05	VP05-062017-1232	6/20/17	1232	X		X	X	X	" "
VP-06	VP06-062017-1438	6/20/17	1438	X		X	X	X	" "
VP-07	VP07-062017-1442	6/20/17	1442	X		X	X	X	" "
VP-08	VP08-062017-1445	6/20/17	1445	X		X	X	X	" "
VP-09	VP09-062017-1433	6/20/17	1433	X		X	X	X	" "

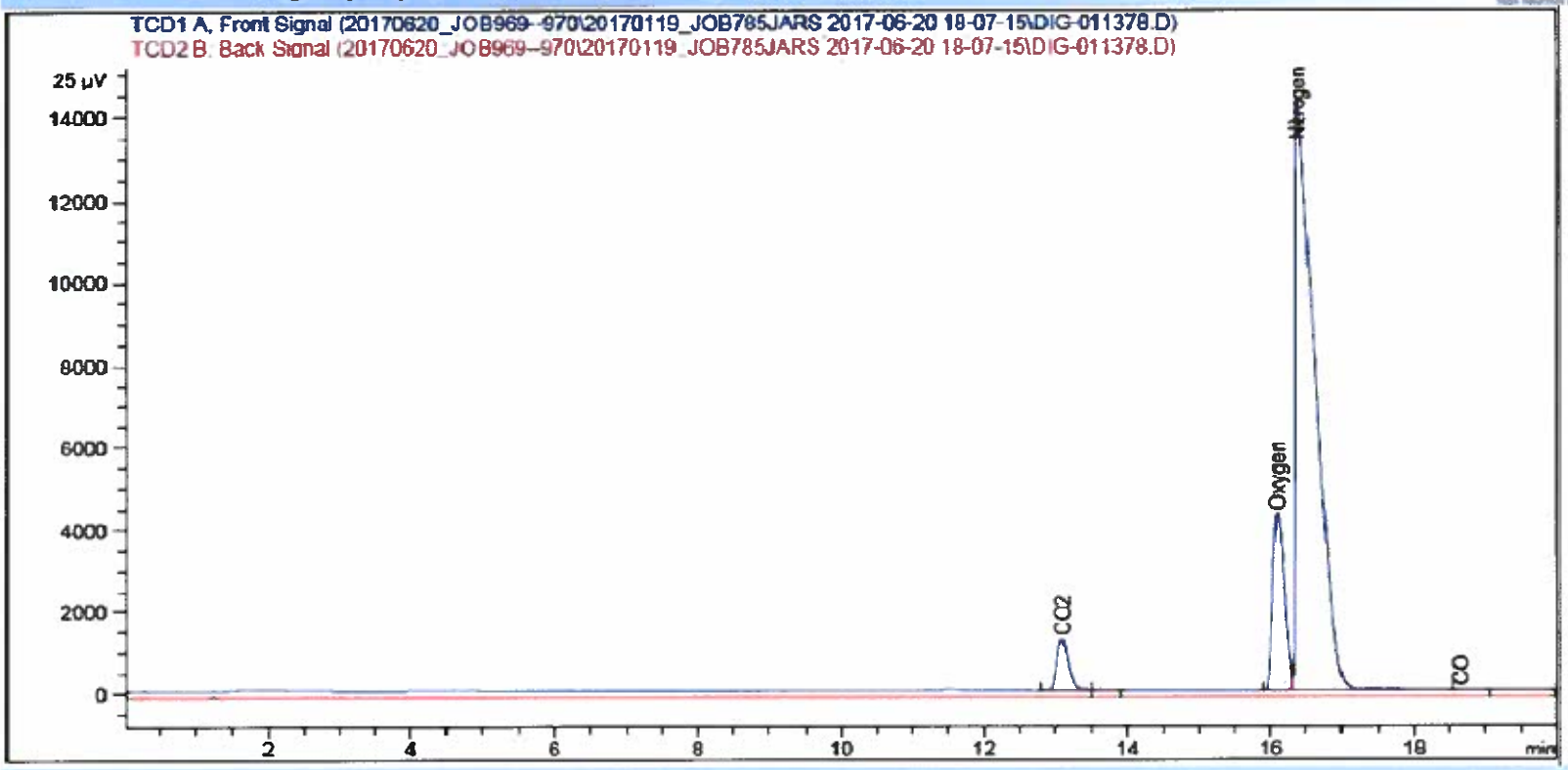
Chain-of-Custody Record

Signature	Company	Date	Time
Relinquished by David Fontana [redacted]	Vista GeoScience	6/20/17	1552
Received by [redacted]	DIG	6/20/17	16:00
Relinquished by			
Received by			
Relinquished by			
Received by			

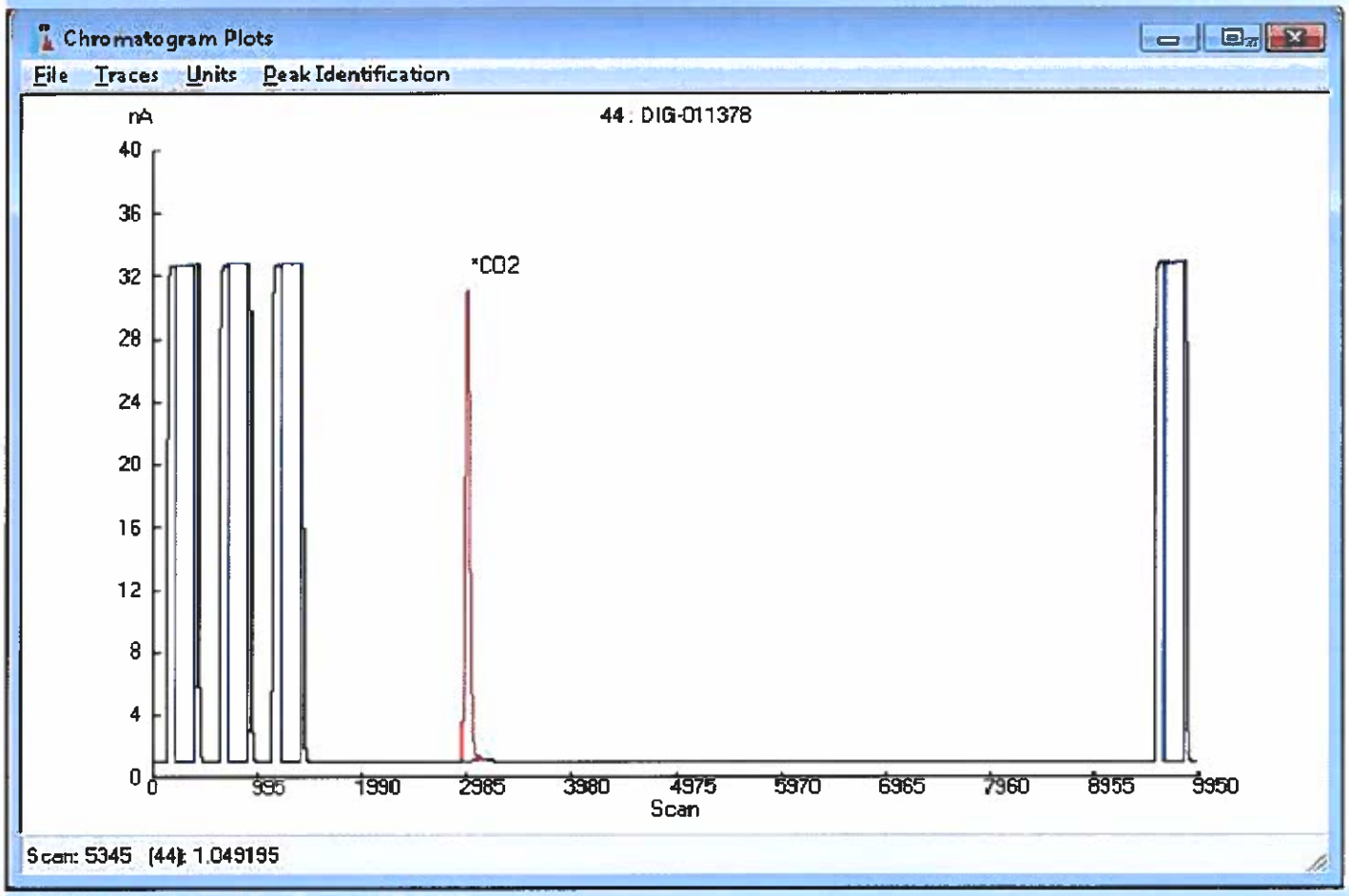
Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project													
		Dolan Integration Group																	
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Member	Chain of Custody ID	Date Received by Lab									
		6/20/17 1:45 PM				GAS													
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 #			
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 %	15.66									0.005	0.005	0.005		17060970
	124-38-9	CARBON DIOXIDE	SOP		MOL %	3.71									0.005	0.005	0.005		17060970
	7727-37-9	NITROGEN (N2)	SOP		MOL %	80.63									0.005	0.005	0.005		17060970
	630-08-0	CARBON MONOXIDE	SOP		MOL %	0.00									0.005	0.005	0.005		17060970
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	74-82-8	METHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	115-07-1	PROPENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	IC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	109-66-0	N-PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	9211[illegible]	C6+ (hexanes +)	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970
	delta13C_C1	DELTA 13C C1	SOP		per mil	nd	ND												17060970
	delta0_C1	DELTA D C1	SOP		per mil	nd	ND												17060970
	delta13C_C2	DELTA 13C C2	SOP		per mil	nd	ND												17060970
	delta13C_C3	DELTA 13C C3	SOP		per mil	nd	ND												17060970
	delta13C_iC4	DELTA 13C iC4	SOP		per mil	nd	ND												17060970
	delta13C_nC4	DELTA 13C nC4	SOP		per mil	nd	ND												17060970
	delta13C_iC5	DELTA 13C iC5	SOP		per mil	nd	ND												17060970
	delta13C_nC5	DELTA 13C nC5	SOP		per mil	nd	ND												17060970
	delta13C_CO2	DELTA 13C CO2	SOP		per mil	-33.7													17060970

APC-NTSB-00001373

Gas Chromatography (GC) Chromatogram



Gas Chromatography - Combustion - Isotope Ratio Mass Spectrometry (GC-C-IRMS) Chromatogram



Gas Chromatography - Pyrolysis - Isotope Ratio Mass Spectrometry (GC-P-IRMS) Chromatogram

* Methane concentration too low for stable hydrogen isotope analysis

Dolan Integration Group

Geochemistry for Energy

1317 West 121st Ave
Westminster, CO 80234
p: 303.531.2030

Hydrocarbon Gas Composition and Stable Isotopes
Data and Interpretation

Job #:	**17060970**
Lab #:	**DIG-011379**
Client:	**Vista Geoscience**
Sample Name(s):	**VP09-062017-1433**

Analytical Report

dig

Job #:	17060970
Lab #:	DIG-011379
Client:	Vista Geoscience
Sample Name:	VP09-062017-1433
Date Sampled:	06/20/17
Time Sampled:	14:33
Sample Description:	cali-5-bond bag
Sampling Notes:	
Date Received:	06/20/17
Date Analyzed:	Gas Composition: 6/21/17, $\delta^{13}C$: 6/21/17, δD: na
Date Reported:	06/22/17
Comments:	

Measured Values:	Measured ppm	Analyte mol %[a]	HC mol %	$\delta^{13}C$ ‰ VPDB	δD ‰ VSMOW	Comments
Nitrogen (N_2)	800336	81.71	-	-	-	
Oxygen + Argon (O_2+Ar)	168153	17.17	-	-	-	
Carbon Dioxide (CO_2)	11004	1.12	-	-23.8	-	
Carbon Monoxide (CO)	11	0.00	-	-	-	
Helium (He)[b]	nd	nd	-	-	-	
Hydrogen (H_2)	nd	nd	-	-	-	
Methane (CH_4)	nd	nd	nd	nd	nd	
Ethane (C_2H_6)	nd	nd	nd	nd	-	
Ethene (C_2H_4)	nd	nd	nd	na	-	
Propane (C_3H_8)	nd	nd	nd	nd	-	
Propene (C_3H_6)	nd	nd	nd	na	-	
iso-Butane (C_4H_{10})	nd	nd	nd	nd	-	
n-Butane (C_4H_{10})	nd	nd	nd	nd	-	
iso-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
n-Pentane (C_5H_{12})	nd	nd	nd	nd	-	
Hexanes + (C_6H_{14})	nd	nd	nd	na	-	

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

[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 ‰

Chain of Custody Form

dig

Job 17060970
DIG-011370 – 011379.

Send Data and Invoice to:

Name: Dawidt John Fontana
Company: Vista GeoScience
Address: 130 Capital Dr. Suite C, Golden, CO 80401
Phone: [redacted]
Fax:
Email: [redacted]

AFE #:
Report Ctr:
Project: 17137.01
PO #: JVF051517
Location:
Sampled By: DavidFontana

RUSH

Sample Description

Container #	Sample Identification	Date Sampled	Time	δ18O/D-16 and H-2/H-1 of water	Gas Composition $N_2, O_2, CO_2, He, H_2, C_1-C_4+$ with dissolved C_1, C_2 & C_3	δ13C Methane (Carbon)	δD Methane (Hydrogen)	δ13C (Ethane-Pentane (C_{2+} if present)	Comments
VP-01	VP01-062017-1248	6/20/17	1248	X		X	X	X	+D13C CO2
VP-02	VP02-062017-1252	6/20/17	1252	X		X	X	X	" "
VP-03	VP03-062017-1237	6/20/17	1237	X		X	X	X	" "
VP-04	VP04-062017-1243	6/20/17	1243	X		X	X	X	" "
VP-05	VP05-062017-1232	6/20/17	1232	X		X	X	X	" "
VP-06	VP06-062017-1438	6/20/17	14.38	X		X	X	X	" "
VP-07	VP07-062017-1442	6/20/17	1442	X		X	X	X	" "
VP-08	VP08-062017-1445	6/20/17	1445	X		X	X	X	" "
VP-09	VP09-062017-1433	6/20/17	1433	X		X	X	X	" "

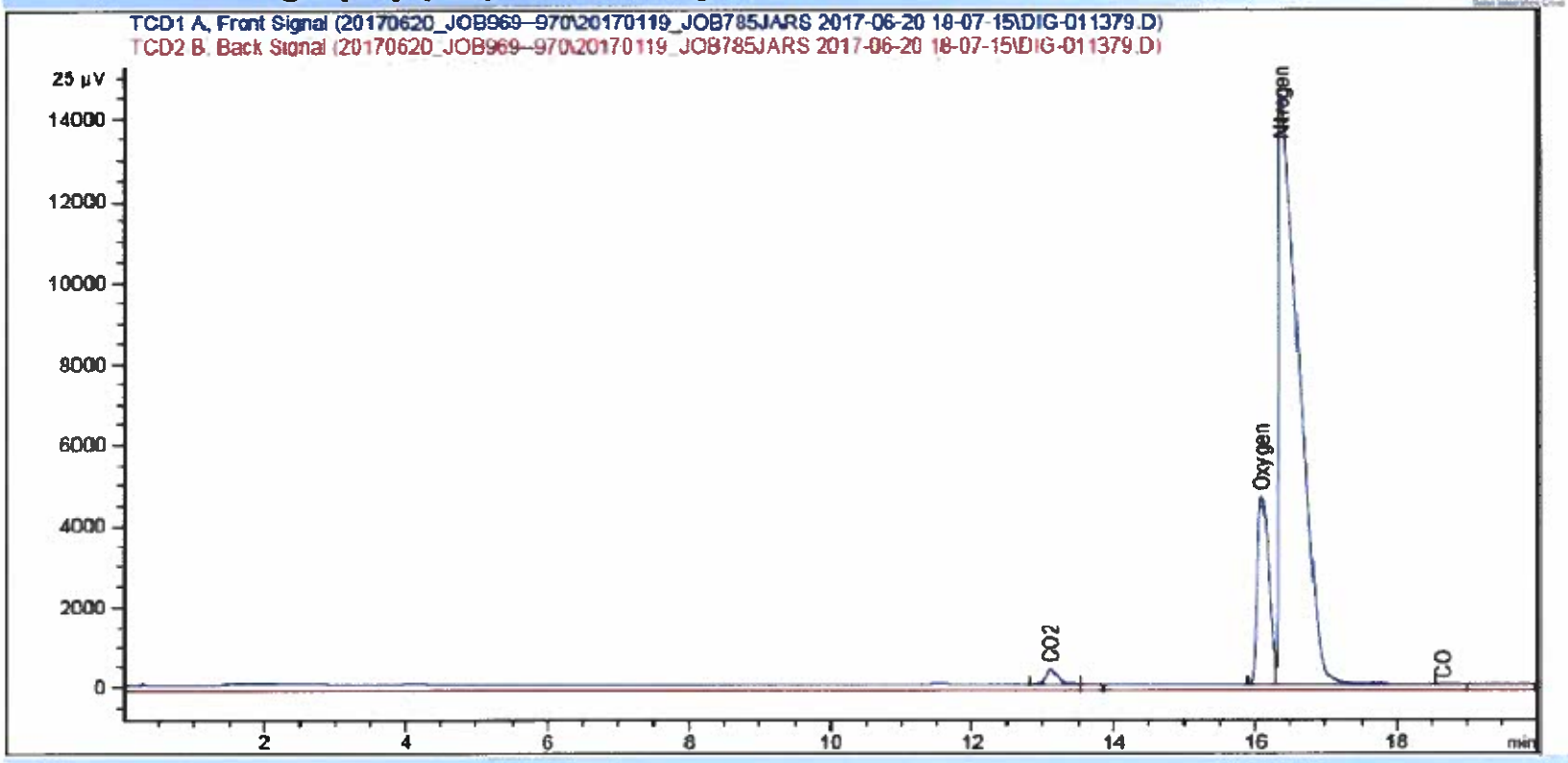
Chain-of-Custody Record

	Signature	Company	Date	Time
Relinquished by	DavidFontana [redacted]	VistaGeoScience	6/20/17	1552
Received by	[redacted]	DIG	6/20/17	16:00.
Relinquished by				
Received by				
Relinquished by				
Received by				

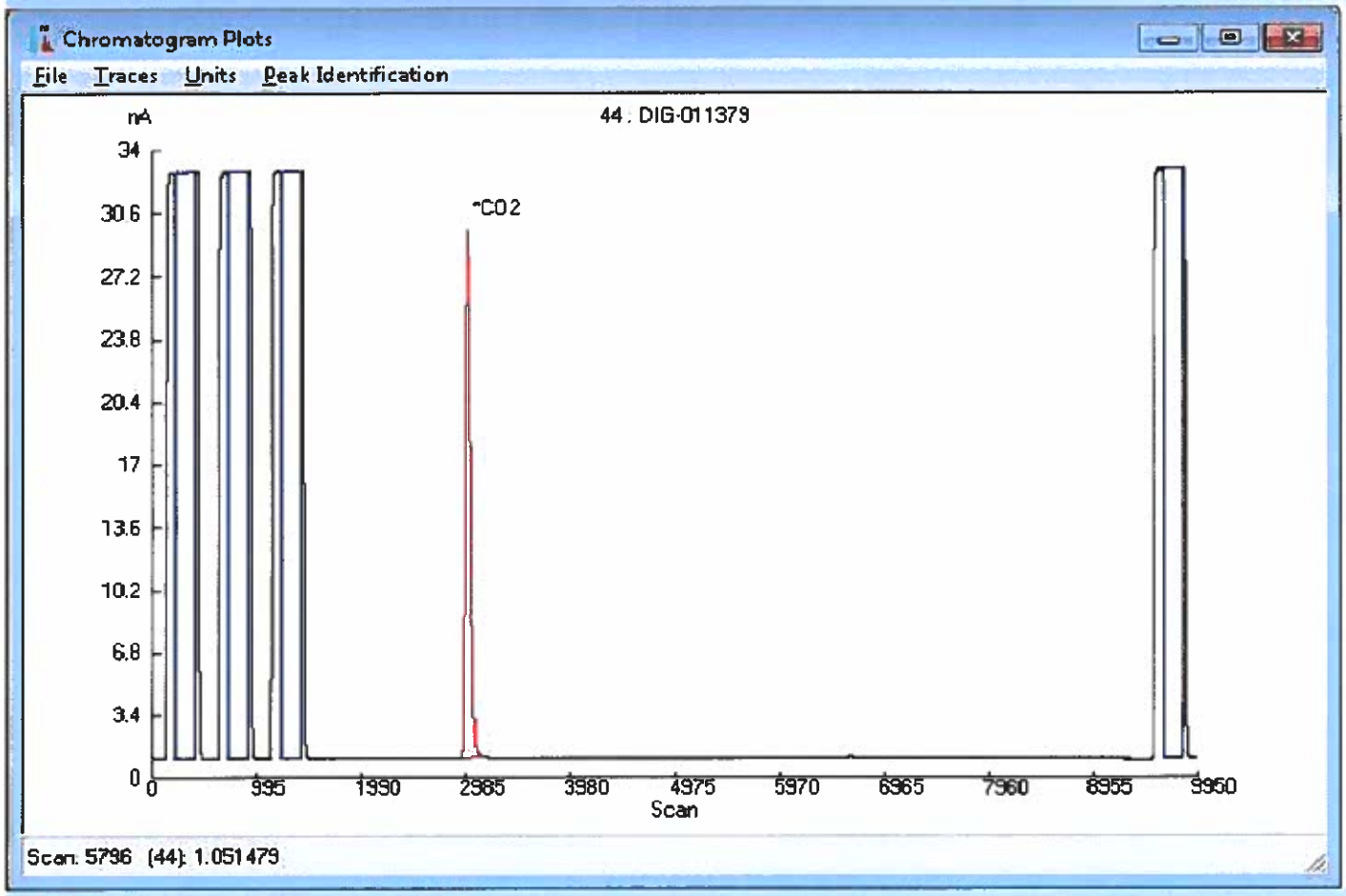
Organization	Reporting Organization	Reporting Organization Name	Order Number	Entity Requesting Analysis	Purpose	Project																
		Dolan Integration Group		[illegible]																		
Sample	COGCC Facility No.	Sample Date and Time	API #	LAB Sample ID	Sample Type	Matrix	Comments	Project Number	Chain of Custody ID	Date Received by Lab												
		6/20/17 2:33 PM		DN-011379	[illegible]	Gas				6/20/2017												
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 #						
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 %	17.17									0.005	0.005	0.005		17060970			
	124-38-9	CARBON DIOXIDE	SOP		MOL %	1.12									0.005	0.005	0.005		17060970			
	7727-37-9	NITROGEN (NU)	SOP		MOL %	81.71									0.005	0.005	0.005		17060970			
	630-08-0	CARBON MONOXIDE	SOP		MOL %	0.00									0.005	0.005	0.005		17060970			
	7440-59-7	Helium	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	1333-74-0	HYDROGEN	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	74-82-8	METHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	74-84-0	ETHANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	74-85-1	ETHENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	74-98-6	PROPANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	115-07-1	PROPENE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	75-28-5	ISOBUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	106-97-8	N-BUTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	IC5	ISOPENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	109-66-0	N-PENTANE	SOP		MOL %	0.01	ND								0.005	0.005	0.005		17060970			
	92112-69-1+	C6+ (hexanes +)	SOP		MOL %	0.02	ND								0.005	0.005	0.005		17060970			
	delta13C_C1	DELTA 13C C1	SOP		per mil	nd	ND												17060970			
	deltaD_C1	DELTA D C1	SOP		per mil	nd	ND												17060970			
	delta13C_C2	DELTA 13C C2	SOP		per mil	nd	ND												17060970			
	delta13C_C3	DELTA 13C C3	SOP		per mil	nd	ND												17060970			
	delta13C_ic4	DELTA 13C iC4	SOP		per mil	nd	ND												17060970			
	delta13C_nC4	DELTA 13C nC4	SOP		per mil	nd	ND												17060970			
	delta13C_IC5	DELTA 13C IC5	SOP		per mil	nd	ND												17060970			
	delta13C_nC5	DELTA 13C nC5	SOP		per mil	nd	ND												17060970			
	delta13C_C02	DELTA 13C CO2	SOP		per mil	-23.8													17060970			

APC-NTSB-0000380

Gas Chromatography (GC) Chromatogram



Gas Chromatography - Combustion - Isotope Ratio Mass Spectrometry (GC-C-IRMS) Chromatogram



Gas Chromatography - Pyrolysis - Isotope Ratio Mass Spectrometry (GC-P-IRMS) Chromatogram

* Methane concentration too low for stable hydrogen isotope analysis