



**GAS ANALYSIS PPM**

B0A3367:X95818

MaxxID \_\_\_\_\_ Client ID \_\_\_\_\_ Meter Number \_\_\_\_\_ Laboratory Number \_\_\_\_\_  
 LIONHEAD ENGINEERING AND CONSULTING LTD. 14-06-020-02-W5M 100/14-06-020-02W5/00\*\*  
 Operator Name \_\_\_\_\_ LSD \_\_\_\_\_ Well ID \_\_\_\_\_  
 ROYALITE NO. 1 TD LIONHEAD  
 Well Name \_\_\_\_\_ Initials of Sampler \_\_\_\_\_ Sampling Company \_\_\_\_\_  
 TURNER VALLEY SOIL GAS TEDLAR BAG  
 Field or Area \_\_\_\_\_ Pool or Zone \_\_\_\_\_ Sample Point \_\_\_\_\_ Container Identity \_\_\_\_\_ Percent Full \_\_\_\_\_

Test Recovery \_\_\_\_\_ Sample Gathering Point \_\_\_\_\_ Solution Gas \_\_\_\_\_  
 Test Type \_\_\_\_\_ No. \_\_\_\_\_ Multiple Recovery \_\_\_\_\_  
 From: \_\_\_\_\_ Interval \_\_\_\_\_ To: \_\_\_\_\_ Elevations (m) \_\_\_\_\_  
 1198.5 1198.5  
 KB GRD  
 N 0.000000 W 0.000000  
 Production Rates \_\_\_\_\_ Gauge Pressures kPa \_\_\_\_\_ Temperature °C \_\_\_\_\_  
 Water m3/d Oil m3/d Gas 1000m3/d Source As Received Source As Received 21  
 GPS GPS  
 12009  
 Well Fluid Type \_\_\_\_\_ Licence No. \_\_\_\_\_  
 Date Sampled Start \_\_\_\_\_ Date Sampled End \_\_\_\_\_ Date Received 2010/10/26 Date Reported 2010/11/10 Date Reissued 2010/11/10 MW  
 Analyst \_\_\_\_\_

COMPOSITION		
Component	Mole Fraction As Rec'd	ppm (v/v)
H2	Trace	
He	Trace	
O2	0.1487	
N2	0.5614	
CO2	0.0059	
H2S	0.0000	
C1	0.2220	
C2	0.0334	
C3	0.0169	
IC4	0.0031	
NC4	0.0050	
IC5	0.0013	
NC5	0.0012	
C6	0.0007	710
C7+	0.0004	450
TOTAL	1.0000	

PROPERTIES					
Calculated Molar Mass Moisture Free as Sampled 22.0 Total		Calculated Gross Heating Value (MJ/m3) @ 101.325 kPa & 15°C 46.35 GPA 2172		Calculated Relative Densities Relative to Air @ 15°C 0.758 Moisture Free as Sampled	
On Site			Hydrogen Sulphide		
Gastec (ppm v/v)		Tutweiler (mole%)		In Lab	
				<1	
				Gastec (ppm v/v) Tutweiler (mole%) H2S from GC (mole%)	
Onsite analysis is required for accurate source H2S content. H2S degrades variably in all sample containers and is also matrix dependant.					
QC Check Std # 4015/8167 Date 2010/10/27 QC Passed Yes					
** Information not supplied by client -- data derived from LSD information Results relate only to items tested					

← Field Drager Reading 5 PPM H<sub>2</sub>S.

Remarks:



# GAS MIGRATION ANALYSIS

A967654:R91480

MaxxiD \_\_\_\_\_ Client ID \_\_\_\_\_ Meter Number 14-06-020-02-W5M Laboratory Number 100/14-06-020-02W5/00\*\*  
 LIONHEAD ENGINEERING AND CONSULTING LTD. ROYALITE NO. 1  
 Well Name TURNER VALLEY Sample Point DIGMAN #1 (GROUND) Container Identity TEDLAR BAG  
 Initials of Sampler N/A Sampling Company TEDLAR BAG

Test Recovery \_\_\_\_\_ Interval \_\_\_\_\_ Elevations (m) 1198.5 1198.5 Sample Gathering Point N 0.000000 Solution Gas W 0.000000  
 Test Type \_\_\_\_\_ No. \_\_\_\_\_ Multiple Recovery \_\_\_\_\_ From: \_\_\_\_\_ To: \_\_\_\_\_ KB GRD  
 Production Rates \_\_\_\_\_ Gauge Pressures kPa 21 Temperature °C \_\_\_\_\_ GPS 12009  
 Water m3/d Oil m3/d Gas 1000m3/d Source As Received Source As Received Wall Fluid Type Licence No.  
 Date Sampled Start \_\_\_\_\_ Date Sampled End \_\_\_\_\_ Date Received 2009/11/26 Date Reported 2009/12/09 Date Reissued 2009/12/09 Analyst MW ,DT1

COMPOSITION			
Component	Mole Fraction As Rec'd	ppm (v/v)	$\delta^{13}C_{\text{‰}}$
H2	0.0004		
He	0.0001		
O2	0.0038		
N2	0.0177		
CO2	0.0169		
H2S	0.0000		
C1	0.7589		-42.41
C2	0.1098		-29.79
C3	0.0531		-27.43
IC4	0.0096		-27.96
NC4	0.0161		-27.74
IC5	0.0045		
NC5	0.0041		
C6	0.0029		
C7+	0.0021		
TOTAL	1.0000		

PROPERTIES																					
Calculated Molar Mass Moisture Free as Sampled <b>21.6</b> Total	Calculated Gross Heating Value (MJ/m3) @ 101.325 kPa & 15°C <b>47.23</b> GPA 2172	Calculated Relative Densities Relative to Air @ 15°C <b>0.747</b> Moisture Free as Sampled																			
<table border="1"> <thead> <tr> <th colspan="2">On Site</th> <th colspan="2">Hydrogen Sulphide</th> <th colspan="2">In Lab</th> </tr> <tr> <th>Gastec (ppm v/v)</th> <th>Tutweiler (mole%)</th> <th>Gastec (ppm v/v)</th> <th>Tutweiler (mole%)</th> <th colspan="2">H2S from GC (mole%)</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td>&lt;1</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Onsite analysis is required for accurate source H2S content. H2S degrades variably in all sample containers and is also matrix dependant.</p>				On Site		Hydrogen Sulphide		In Lab		Gastec (ppm v/v)	Tutweiler (mole%)	Gastec (ppm v/v)	Tutweiler (mole%)	H2S from GC (mole%)				<1			
On Site		Hydrogen Sulphide		In Lab																	
Gastec (ppm v/v)	Tutweiler (mole%)	Gastec (ppm v/v)	Tutweiler (mole%)	H2S from GC (mole%)																	
		<1																			
$\delta^{13}C_{\text{‰}} = \left[ \left( \frac{^{13}C}{^{12}C}_{\text{sample}} - \frac{^{13}C}{^{12}C}_{\text{standard}} \right) / \left( \frac{^{13}C}{^{12}C}_{\text{standard}} \right) \right] * 1000$																					
INTERPRETATION																					
QC Check Std # 7540/5878 Date 2009/11/27 QC Passed Yes																					

\*\* Information not supplied by client -- data derived from LSD information Results relate only to items tested

Remarks:

### Dr. Karlis Muehlenbachs' Carbon Isotope Abundance

07-Dec-09	LSD	SEC	T	R	M	Company	Sample ID	13C1	13C2	13C3	13C4	13nC4	CO2
Dingman #1 Ground	14	6	20	2	5	Lionhead	A967654-R91480	-42.41	-29.79	-27.43	-27.96	-27.74	

Ground gas 14-6 has the isotopic fingerprint often seen in Turner Valley. Do not have enough production gas data in Turner Valley to nail down source, but the source of these gases may be the Rundle or the Brown Sandstone. Gas has not changed much over the last few years.

Carbon Isotope Abundance and Interpretations were done by Dr. Karlis Muehlenbachs at the University of Alberta  
Email: karlis.muehlenbachs@ualberta.ca



## Center of Seep, Test Hole Gas Summary

Maxxam File #: A740949 – G77168

Date Sampled: 2007/08/31

Well Name: ROYALITE #1

LSD: 100/14/06/020/02/w5/00

### Interpretations:

	<u>Maxxam</u>	<u>Dr. Muehlenbachs</u>
Center of Seep, Test Hole Gas Possible Depth	1200 1500	N/A
Center of Seep, Test Hole Gas Possible Geologic Formation:	Rundle	N/A

### Maxxam's Remarks:

- ◆ In discussion with Dan Stratton on Sept 24, 2007, we have amended the depth of the "Center of Seep gas to 1200 to 1500 m and the Rundle Formation. The original reasoning behind the 700 m depth and the Homess was based on the well card information.

### Dr. Karlis Muehlenbachs' Remarks (University of Alberta):

- ◆ Seep gas 14-6 has the isotopic fingerprint often seen in Turner Valley. Do not have enough production gas data in Turner Valley to nail down source, but the source of these gases may be the Rundle or the Brown Sandstone..

- ◆ Maxxam's interpretation and remarks were done by Janet Hay
- ◆ Email: janet.hay@maxxamanalytics.com
- ◆ The University of Alberta interpretation and remarks were done by Dr. Karlis Muehlenbachs
- ◆ Email: karlis.muehlenbachs@ualberta.ca

A740949:G77168

LIONHEAD ENGINEERING AND CONSULTING LTD.	SHALLOW	CENTER OF SEEP, FROM TEST HOLE	TEDLAR BAG
Sample Point I.D.	Client I.D.	Motor Number	Laboratory Number
Operator Name	LSD	Well ID	Company
ROYALITE #1	N/A	LIONHEAD	TEDLAR BAG
Well Name	Name of Sampler	Container Identity	Percent Full
TURNER VALLEY	SHALLOW	CENTER OF SEEP, FROM TEST HOLE	TEDLAR BAG
Field or Area	Pool or Zone	Sample Point	Percent Full

2007/08/31 13:00	2007/09/04	2007/09/10	2007/09/27	MW ,JH1
Date Sampled Start	Date Sampled End	Date Received	Date Reported	Date Reissued
Date Sampled Start	Date Sampled End	Date Received	Date Reported	Date Reissued
Date Sampled Start	Date Sampled End	Date Received	Date Reported	Date Reissued

COMPOSITION			
Component	Mole Fraction As Rec'd	ppm (v/v)	δ <sup>13</sup> C ‰
H2	Trace		
He	Trace		
O2	0.0334		
N2	0.1805		
CO2	0.0233		-9.51
H2S	Trace		
C1	0.5965		-43.99
C2	0.0890		-30.30
C3	0.0440		-27.24
IC4	0.0084		-26.73
NC4	0.0140		-27.79
IC5	0.0038		
NC5	0.0033		
C6	0.0022		
C7+	0.0016		
TOTAL	1.0000		

PROPERTIES			
Calculated Mole Weight Moisture Free as Sampled  <div style="text-align: center; font-size: 1.2em;">22.4</div> Total	Calculated Gross Heating Value (MJ/m3) @ 101.325 kPa & 15°C  <div style="text-align: center; font-size: 1.2em;">37.00</div> GPA 2172	Calculated Relative Densities Relative to Air @15°C  <div style="text-align: center; font-size: 1.2em;">0.774</div> Moisture Free as Sampled	
Hydrogen Sulphide			
On Site		In Lab	
2 Gaslec (ppm v/v)	_____ Tubular (mole%)	_____ Gaslec (ppm v/v)	_____ Tubular (mole%)
Onsite analysis is required for accurate source H2S content. H2S degrades variably in all sample containers and is also matrix dependant.			
$\delta^{13}C_{\infty} \text{‰} = \left[ \left( \frac{^{13}C}{^{12}C} \right)_{\text{sample}} - \left( \frac{^{13}C}{^{12}C} \right)_{\text{standard}} \right] / \left( \frac{^{13}C}{^{12}C} \right)_{\text{standard}} * 1000$			
INTERPRETATION			
QC Check Std # 7540/1651    Date 2007/09/05    QC Passed <u>Yes</u>			
** Information not supplied by client - data derived from LSD information      Results relate only to items tested			

Remarks:

### Dr. Karlis Muehlenbachs' Carbon Isotope Abundance

Sept. 9, 07	USD	SEC	1	R	M	Company	Sample ID	13C1	13C2	13C3	13iC4	13nC4	CO2
center of seep, test hole	14	6	20	2	5	Lionhead	A740949-G77168	-43.99	-30.3	-27.24	-26.73	-27.79	-9.51

Seep gas 14 n has the isotopic fingerprint often seen in Turner Valley. Do not have enough production gas data in Turner Valley to nail down source, but the source of these gases may be the Rundel or the Brown Sandstone.

Carbon Isotope Abundance and Interpretations were done by Dr. Karlis Muehlenbachs at the University of Alberta  
Email: [karlis.muehlenbachs@ualberta.ca](mailto:karlis.muehlenbachs@ualberta.ca)