

## ***Pressure Core Analysis***

**Company:** Murfin Drilling Company, Inc.  
**Well Name:** Carter-Colliver #1 CO<sub>2</sub> I  
**County:** Russell  
**State:** Kansas  
**Location:** 660 FSL 1320 FEL Sec. 28-T14S-R13W  
**Formation:** Lansing B/C (2871'-2894') Lansing G (2954'-2980')  
**Field:** Hall-Gurney

**Attn:** Alan Byrnes (Kansas Geological Survey)

**TR01-5024  
March 2001**

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# **TerraTek**

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400 Wakara Way  
Salt Lake City, Utah 84108 U.S.A.

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***Prepared by:***

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## **PRESSURE CORE ANALYSIS**

TerraTek received two pressure core barrels, each sealed barrel containing approximately ten feet of core. The core barrels equilibrated to a constant ambient temperature, after which technicians slowly opened the valves on each pressure core barrel and recorded the volume of gas expelled from each barrel. Four gas samples were taken, three from pressure core #1 (PC #1) and one from pressure core #2 (PC #2) over the course of the desorption analysis. The composition of the gas was determined using chromatography techniques in accordance with ASTM D 1945. By plotting the change in gas composition during the PC #1 desorption versus the cumulative desorbed gas percentage and fitting equations to the data, an "in-place" gas composition was calculated for the reservoir. Appendix A presents results for desorption and gas analysis.

After the desorption analysis, the pressure core barrels were opened and the core removed from the inner core liner. Additionally, the drilling mud contained in the pressure core barrels was collected and the volume of oil within the drilling mud measured. For both pressure cores, the drilling mud contained only a slight trace of oil. The cores were then wiped clean of drilling mud, fitted together and marked with appropriate footage depths. Finally, gamma radiation was measured and digital ultraviolet light photographs were taken for each core interval, the results of which are presented in Appendix B and Appendix C, respectively.

Fluid saturations, grain density, porosity, and permeability for each one foot section of core were determined using the following procedure: The cores were cut into foot long samples. From the first ten samples (PC #1), a section of core approximately 0.1 inch in length, was trimmed from the bottom of each foot long sample and used for retort saturation determination. The whole core samples were weighed, placed in Dean-Stark extractors, and extracted with toluene to determine the water content. The samples were cleaned further using an azeotropic mixture of chloroform/methanol and finally methanol to remove all of the remaining oil and salts. The cleaned samples were then placed in an oven to remove any solvent that might be left behind from the extraction process. The clean, dry samples were weighed and grain volume determined by the Boyle's law gas expansion technique using helium. Grain density was calculated by dividing the weight of the grains by the volume of the grains. The pore volume was calculated as the difference between the bulk volume and the grain volume. Porosity was then calculated by dividing the pore volume by the bulk volume. The results of these measurements are presented in (Table 1).

Water saturation was the volume of water collected from the Dean-Stark extraction divided by the pore volume, then converted to a percent. The oil saturations were calculated using the pre-Dean Stark sample weight minus the final dry weight minus the expelled water weight then dividing by an assumed oil density of 0.890 g/cm<sup>3</sup> to get a displaced oil volume. The oil volumes were then divided by the pore volumes and converted to a percent. Because of the unconsolidated nature of whole core samples 1-8, these samples were placed in pre-weighed canvas bags during the cleaning and drying process. Although the canvas bags were used,

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these samples exhibited minor grain loss during cleaning. The results of the water and oil saturation determinations are presented in (Table 1).

Further evaluation of samples 1-10 was conducted by retort analysis. First the consolidated pieces were weighed and bulk volumes determined by de-ionized water immersion. Representative portions of each sample, approximately 30 to 35 grams, were crushed, weighed and placed in individual downdraft retort vessels. The sealed retort vessels were heated to a temperature of 220° F to collect the interstitial water. Once the production of fluid had ceased, the retort vessels were elevated to a temperature of 1200° F to remove any remaining fluids, bound clay water and interstitial hydrocarbons. The retorted samples were removed after cooling and weighed prior to grain volume measurements by the Boyle's Law gas expansion technique using helium. The total porosity, grain density, and fluid saturations were then calculated for each sample (Table 2).

For permeability measurements, representative samples from each foot section were cut and end-trimmed to right cylinders. The vertical gas permeability ( $k_v$ ) of each sample was measured by mounting the sample in a Hassler coreholder and applying a confining pressure of 400 psi to eliminate gas by-pass around the core sample. Gas was then passed through the sample at a controlled flow rate and the pressure drop was measured across the sample. The flow of gas continued until the pressure drop across the sample stabilized. The gas permeability of each sample was then calculated (Table 1).

Horizontal gas permeability was measured for each sample in the maximum ( $k_{max}$ ) and 90° to maximum ( $k_{90}$ ) directions in a manner similar to the vertical gas permeability. For these measurements, each sample was mounted in a Hassler coreholder that allows flow across the sample in a horizontal direction (window openings directly across from each other on the sample). These windows were positioned with respect to the structure (bedding) of the sample so as to measure the permeability parallel ( $k_{max}$ ) and perpendicular ( $k_{90}$ ) to the maximum permeability direction. Again, 400 psi confining pressure was applied to eliminate gas by-pass around the core sample. Gas was passed through the sample at a controlled flow rate and the pressure drop was measured across the sample. The flow of gas continued until the pressure drop across the sample stabilized. The gas permeability was then calculated (Table 1).

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**Table 1. Whole Core Routine Analysis Results**

Sample Number	Sample Depth (ft)	Sample Length (in)	Sample Diameter (in)	Porosity (%)	Grain Density (g/cm <sup>3</sup> )	Gas Permeability (md)			Water Sat. (%)	Oil Sat. (%)
						Direction				
						k <sub>v</sub>	k <sub>max</sub>	k <sub>90</sub>		
1	2894.10-.25	1.940	2.470	32.54	2.75	94.91	101.04	94.63	47.57	7.13
2	2895.00	n/a	n/a	27.14	2.69	n/a	n/a	n/a	74.24	15.04
3	2896.15-.30	2.184	2.472	27.72	2.70	8.74	32.36	29.44	66.67	10.88
4	2897.00	0.933	2.42	29.82	2.71	177.18	n/a	n/a	64.49	10.06
5	2898.20-.30	1.392	2.453	29.14	2.71	10.12	19.94	18.96	75.37	12.02
6	2899.00-.15	2.017	2.464	16.95	2.70	0.42	12.98	8.55	86.97	9.57
7	2900.50-.65	1.909	2.468	22.17	2.69	2.16	7.63	5.87	77.97	14.73
8	2901.45-.65	2.495	2.45	19.44	2.70	0.17	1.60	1.37	55.39	9.04
9	2902.00-.15	2.113	2.455	20.69	2.70	0.57	1.40	0.77	69.86	11.85
10	2903.00-.20	2.745	2.462	22.02	2.68	0.75	2.35	1.62	43.55	10.49

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**Table 1 (cont.). Whole Core Routine Analysis Results**

Sample Number	Sample Depth (ft)	Sample Length (in)	Sample Diameter (in)	Porosity (%)	Grain Density (g/cm <sup>3</sup> )	Gas Permeability (md)			Water Sat. (%)	Oil Sat. (%)
						Direction				
						k <sub>v</sub>	k <sub>max</sub>	k <sub>90</sub>		
11	2904-05	3.998	2.471	16.36	2.70	0.25	0.34	0.15	76.57	6.41
12	2905-06	3.904	2.473	14.87	2.69	0.37	0.73	0.17	83.47	7.82
13	2906-07	3.984	2.476	10.49	2.70	0.03	0.07	0.04	85.29	7.33
14	2907-08	3.888	2.463	8.49	2.70	0.02	0.07	0.05	76.38	10.33
15	2908-09	3.938	2.476	6.98	2.70	0.01	0.06	0.05	79.25	8.24
16	2909-10	4.022	2.479	2.54	2.69	0.01	0.15	0.05	89.22	3.34
17	2910-11	3.446	2.482	1.20	2.70	0.03	0.09	0.06	88.92	2.32
18	2911-12	3.620	2.427	1.57	2.70	0.01	0.04	0.03	88.46	7.20
19	2912-13	3.959	2.477	1.22	2.70	0.01	0.04	0.02	79.89	13.74
20	2913-14	3.997	2.480	1.45	2.70	0.01	0.01	0.01	71.07	11.93
21	2914.0-14.2	2.353	2.480	1.33	2.69	0.01	0.01	0.01	84.87	11.15

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**Table 2. Retort Analysis Results**

Sample Number	Depth (ft)	Bulk Density (g/cm <sup>3</sup> )	Grain Density (g/cm <sup>3</sup> )	Interstitial				Bound Water (% of BV)
				Effective Porosity (% of BV)	Water Saturation (% of PV)	Oil Saturation (% of PV)	Gas Saturation (% of PV)	
1	2894.9	2.18	2.75	30.4	78.7	8.4	12.8	0.9
2	2895.9	2.14	2.69	29.2	75.4	14.0	10.5	0.4
3	2896.9	2.24	2.70	24.6	73.0	13.1	14.0	0.2
4	2897.9	2.16	2.71	28.6	72.1	11.0	16.9	0.2
5	2898.9	2.20	2.71	26.9	73.8	13.6	12.6	0.0
6	2899.9	2.36	2.70	18.9	82.0	8.7	9.3	0.5
7	2900.9	2.09	2.69	35.3	91.2	8.7	0.1	0.4
8	2901.9	2.40	2.70	15.7	67.9	12.1	20.1	0.7
9	2902.9	2.06	2.70	37.3	93.9	6.0	0.1	0.2
10	2903.9	2.34	2.68	17.9	66.6	14.1	19.3	0.5

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**Appendix A**  
**Pressure Core Gas Desorption and  
Gas Chromatography Analysis**

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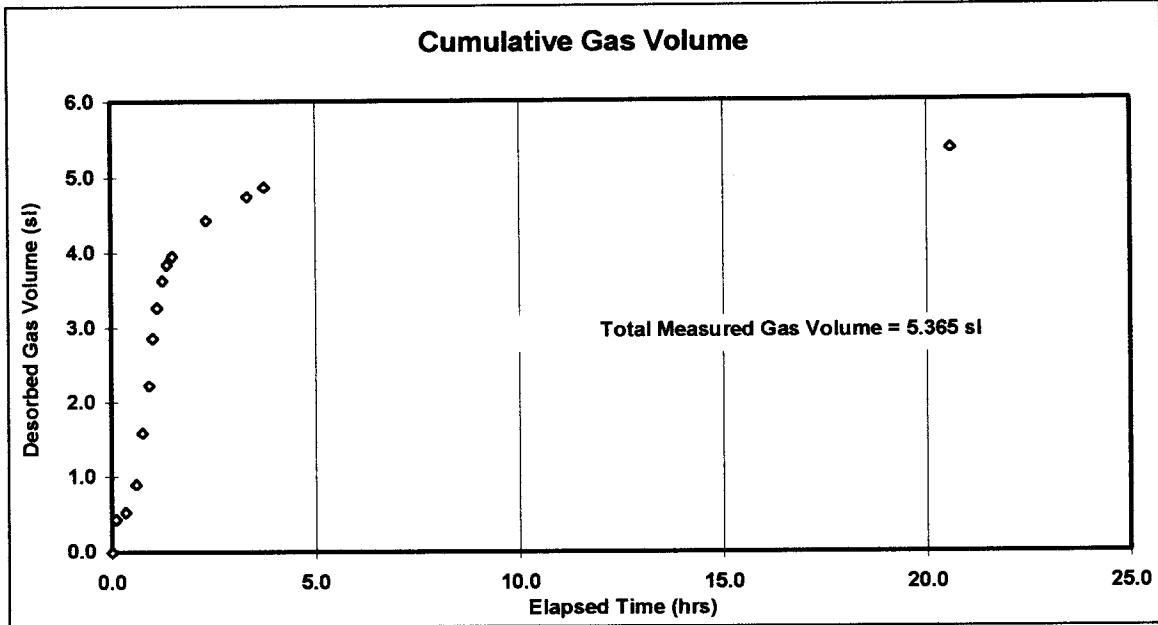
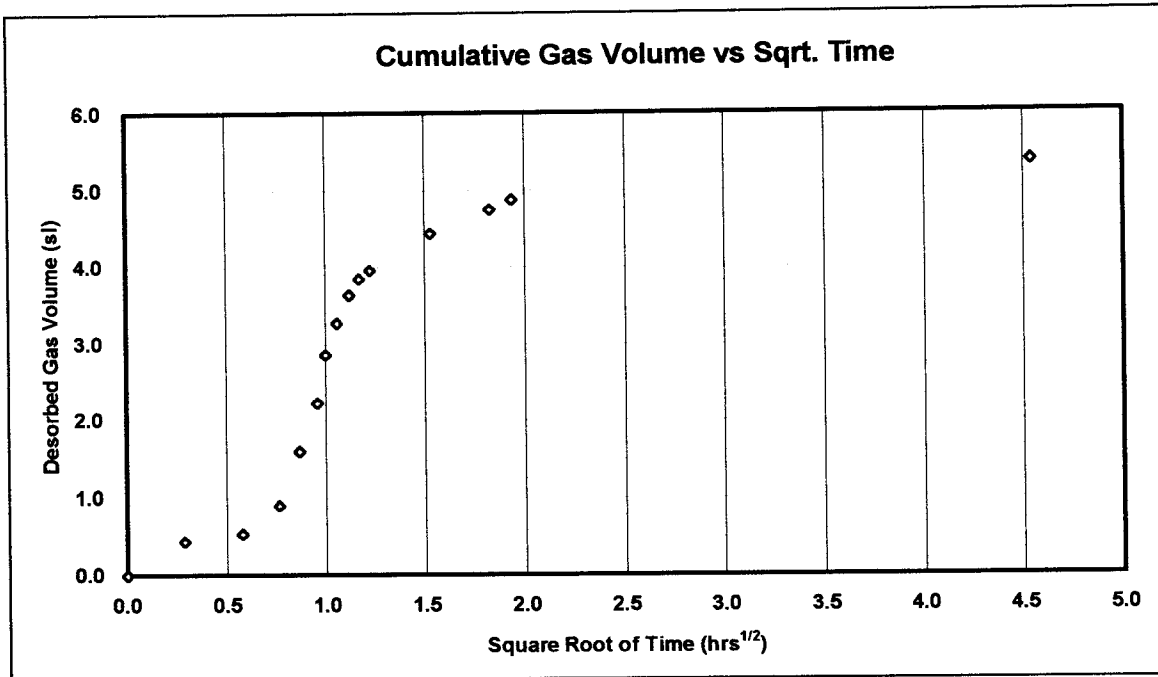
**Table A-1. Pressure Core Desorption for Pressure Core #1 (2894-2904 ft)**

Date (mm/dd/yr)	Time (hh:mm)	Elapsed Time (hrs)	Barometric Pressure (in Hg)	Ambient Temp. (°C)	Core Temp. (°C)	Measured Gas Volume (ml)	Corrected Volume (ml)	Cumulative Volume (l)	Cumulative Volume (sl)	Gas Sample
10/03/00	13:15	0.000								
10/03/00	13:20	0.083	25.19	22.1	22.1	534.0	534.00	0.534	0.438	
10/03/00	13:35	0.333	25.19	22.1	22.1	113.0	113.00	0.647	0.531	PC1-1
10/03/00	13:50	0.583	25.19	22.1	22.1	450.0	450.00	1.097	0.900	
10/03/00	14:00	0.750	25.19	22.1	22.1	844.0	844.00	1.941	1.593	
10/03/00	14:10	0.917	25.19	22.1	22.1	768.0	768.00	2.709	2.223	PC1-3
10/03/00	14:15	1.000	25.19	22.1	22.1	772.0	772.00	3.481	2.857	
10/03/00	14:22	1.117	25.19	22.1	22.1	498.0	498.00	3.979	3.266	
10/03/00	14:30	1.250	25.19	22.1	22.1	448.0	448.00	4.427	3.633	
10/03/00	14:37	1.367	25.19	22.1	22.1	261.0	261.00	4.688	3.848	
10/03/00	14:45	1.500	25.19	22.1	22.1	131.0	131.00	4.819	3.955	
10/03/00	15:35	2.333	25.19	22.1	22.1	585.0	585.00	5.404	4.435	PC1-4
10/03/00	16:35	3.333	25.19	22.1	22.1	380.0	380.00	5.784	4.747	
10/03/00	17:00	3.750	25.19	22.1	22.1	155.0	155.00	5.939	4.874	
10/04/00	09:50	20.583	25.19	22.1	22.1	598.0	598.00	6.537	5.365	

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Figure A-1. Cumulative Gas Versus Time PC#1 (2894-2904 ft)



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**Table A-2. Pressure Core Desorption for Pressure Core #2 (2904-2914 ft)**

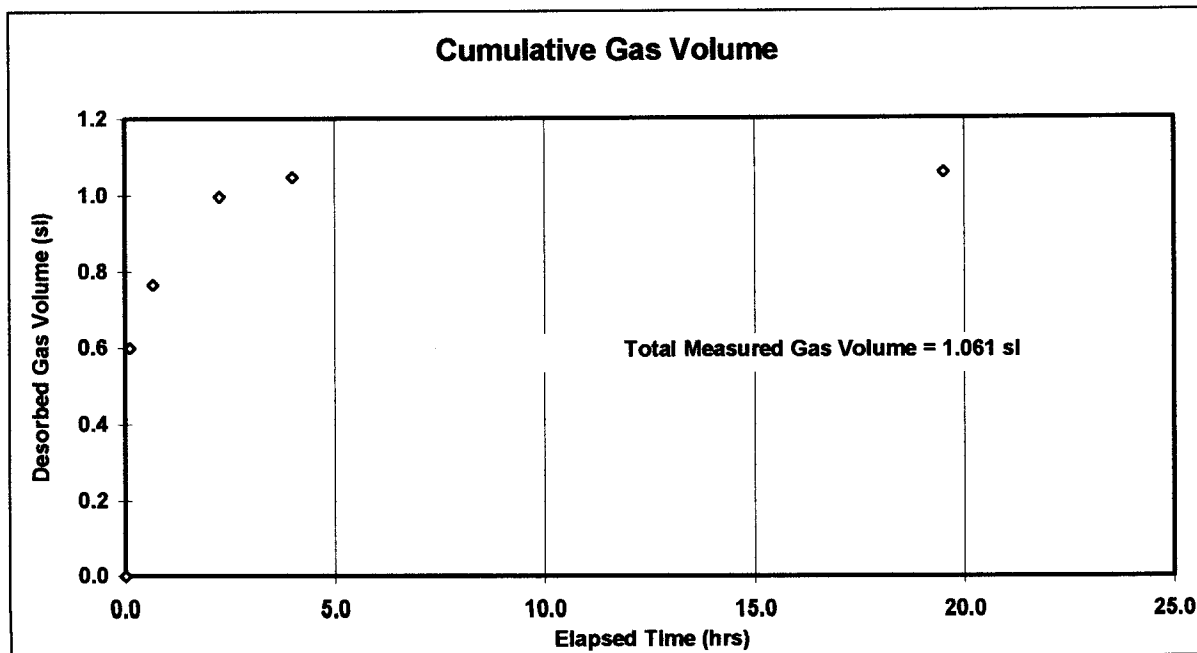
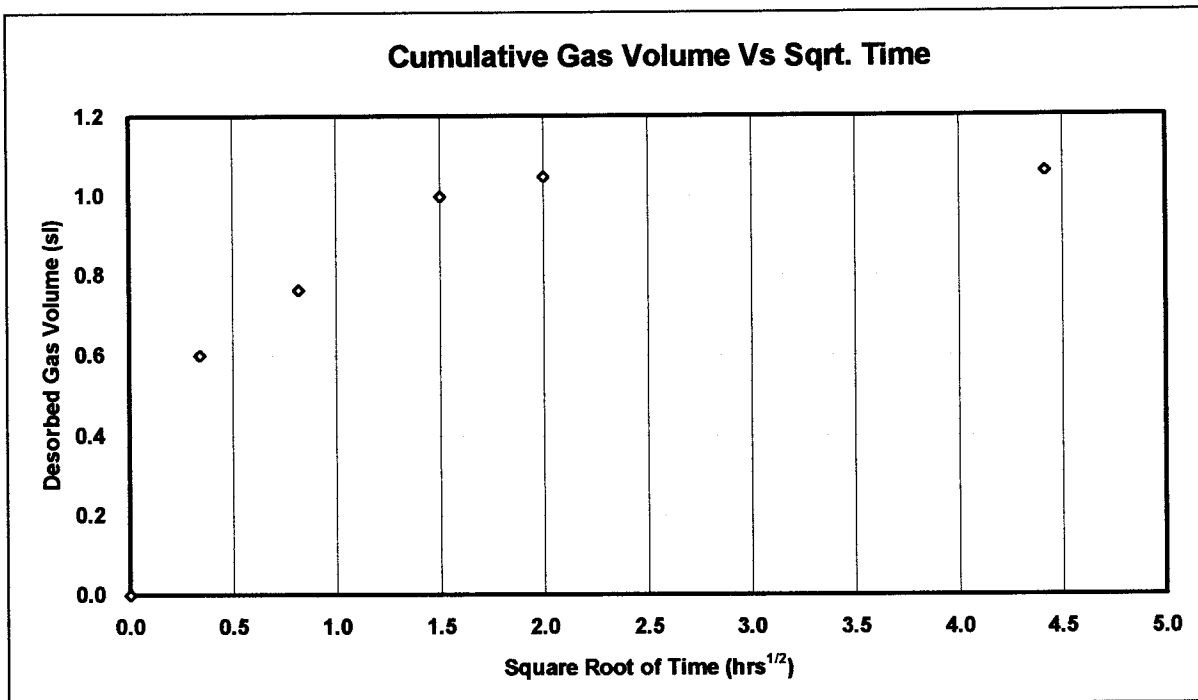
Date (mm/dd/yr)	Time (hh:mm)	Elapsed Time (hrs)	Barometric Pressure (in Hg)	Ambient Temp. (°C)	Core Temp. (°C)	Measured Gas Volume (ml)	Corrected Volume (ml)	Cumulative Volume (l)	Cumulative Volume (sl)	Gas Sample
10/04/00	13:00	0.000								
10/04/00	13:07	0.117	25.01	20.4	20.4	731.0	731.0	0.731	0.599	
10/04/00	13:40	0.667	25.01	20.4	20.4	202.0	202.0	0.933	0.765	PC2-1
10/04/00	15:15	2.250	25.01	20.4	20.4	284.0	284.0	1.217	0.998	
10/04/00	17:00	4.000	25.01	20.4	20.4	62.0	62.0	1.279	1.048	
10/05/00	08:30	19.500	25.01	20.4	20.4	15.0	15.0	1.294	1.061	

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Figure A-2. Cumulative Gas Versus Time PC#2 (2904-2914 ft)

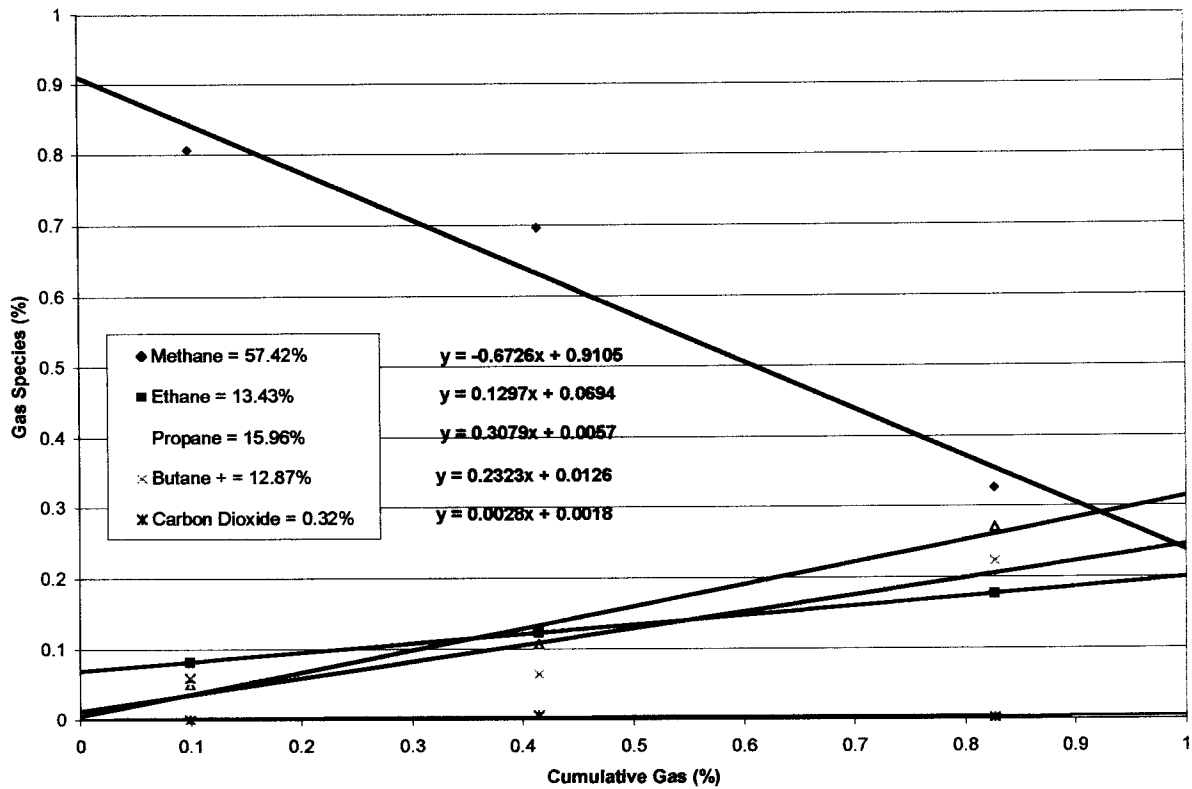


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**Table A-3. Summary of Gas Chromatography Analysis (Air-Free Basis).**

Sample No.	Gas Species (mole %)							
	Methane	Ethane	Propane	i-Butane	n-Butane	i-Pentane	n-Pentane +	Carbon Dioxide
PC1-1	80.71	8.21	7.09	1.07	2.71	0.08	0.13	0.00
PC1-3	69.67	12.35	10.73	2.21	3.89	0.25	0.23	0.67
PC1-4	32.63	17.65	27.15	6.71	11.62	2.02	1.94	0.25
PC2-1	61.63	12.30	11.36	2.81	7.43	1.82	2.35	0.30



**Figure 1. Gas Species (mole %) vs. Cumulative Gas (%), PC #1.**

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**Table A-4. Gas Chromatography Analysis for Sample PC1-1 (Air-Free Basis)**

Gas Component	Composition Mole %	Normalized Fractional Percent X <sub>i</sub> – Mole %	Specific Gravity Fraction X <sub>G<sub>i</sub></sub>	Gross Calorific Fraction X <sub>H<sub>i</sub></sub>	Compressibility Fraction X <sub>i(b)-½</sub>	Critical Temperature Fraction (°R)	Critical Pressure Fraction (psia)
<b>Hydrocarbons</b>							
Methane (CH <sub>4</sub> )	80.71	0.8071	0.4471	814.95	0.0352	276.87	538.98
Ethane (C <sub>2</sub> H <sub>6</sub> )	8.21	0.0821	0.0852	145.21	0.0075	45.14	58.11
Propane (C <sub>3</sub> H <sub>8</sub> )	7.09	0.0709	0.1079	178.47	0.0095	47.20	43.70
i-Butane (C <sub>4</sub> H <sub>10</sub> )	1.07	0.0107	0.0215	34.80	0.0019	7.86	5.66
n-Butane (C <sub>4</sub> H <sub>10</sub> )	2.71	0.0271	0.0544	88.40	0.0049	20.74	14.92
i-Pentane (C <sub>5</sub> H <sub>12</sub> )	0.08	0.0008	0.0020	3.21	0.0002	0.66	0.39
n-Pentane (C <sub>5</sub> H <sub>12</sub> )	0.13	0.0013	0.0032	5.22	0.0003	1.10	0.64
Hexane (C <sub>6</sub> H <sub>14</sub> )	Tr	0.0000	0.0000	0.00	0.0000	0.00	0.00
<b>Subtotals</b>	<b>100.00</b>	<b>1.0000</b>	<b>0.7213</b>	<b>1270.27</b>	<b>0.0595</b>	<b>399.56</b>	<b>662.40</b>
<b>Non-Hydrocarbons</b>							
Carbon Dioxide (CO <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Carbon Monoxide (CO)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Helium (He)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen (H <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen Sulfide (H <sub>2</sub> S)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Nitrogen (N <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Oxygen (O <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
<b>Subtotals</b>	<b>0.00</b>	<b>0.0000</b>	<b>0.0000</b>	<b>0.00</b>	<b>0.0000</b>	<b>0.00</b>	<b>0.00</b>
<b>Totals</b>	<b>100.00</b>	<b>1.0000</b>	<b>0.7213</b>	<b>1270.27</b>	<b>0.0595</b>	<b>399.56</b>	<b>662.40</b>
<b>Standard Temperature and Pressure Basis (STP = 60°F, 1 Atm)</b>							
				Pseudocritical Temp. (°R)		399.56	
Compressibility Factor z			0.9965	Pseudocritical Press. (psia)		662.40	
Ideal Specific Gravity of Mixture			0.7213	Wichert-Aziz Correction (°R)		0.0000	
Real Specific Gravity of Mixture			0.7236	Corrected Critical Temp. (°R)		399.56	
Ideal Gross Heating Value, Dry Basis (btu/scf)			1270.27	Corrected Critical Press. (psia)		662.40	
Real Gross Heating Value, Dry Basis (btu/scf)			1274.79				
Ideal Gross Heating Value, Sat. Basis (btu/scf)			1248.17				
Real Gross Heating Value, Sat. Basis (btu/scf)			1252.61				

REFS: ASTM D 3588-81: Calculating Calorific Value And Specific Gravity (Relative Density) Of Gaseous Fuels.  
 GPA STANDARD 2172-76, 1972; GPA STANDARD 2145-82, 1982  
 McCoy, R.L., 1983, Microcomputer Programs For Petroleum Engineers, Volume 1: Reservoir Engineering  
 And Formation Evaluation: Gulf Publishing Company.

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**Table A-5. Gas Chromatography Analysis for Sample PC1-3 (Air-Free Basis)**

Gas Component	Composition Mole %	Normalized Fractional Percent X <sub>i</sub> -- Mole %	Specific Gravity Fraction X <sub>i</sub> G <sub>i</sub>	Gross Calorific Fraction X <sub>i</sub> H <sub>i</sub>	Compressibility Fraction X <sub>i</sub> (b) <sub>i</sub> <sup>-1/2</sup>	Critical Temperature Fraction (°R)	Critical Pressure Fraction (psia)
<b>Hydrocarbons</b>							
Methane (CH <sub>4</sub> )	69.67	0.6967	0.3859	703.47	0.0304	239.00	465.26
Ethane (C <sub>2</sub> H <sub>6</sub> )	12.35	0.1235	0.1282	218.44	0.0113	67.90	87.41
Propane (C <sub>3</sub> H <sub>8</sub> )	10.73	0.1073	0.1634	270.10	0.0144	71.43	66.13
i-Butane (C <sub>4</sub> H <sub>10</sub> )	2.21	0.0221	0.0443	71.89	0.0039	16.24	11.69
n-Butane (C <sub>4</sub> H <sub>10</sub> )	3.89	0.0389	0.0781	126.90	0.0071	29.77	21.42
i-Pentane (C <sub>5</sub> H <sub>12</sub> )	0.25	0.0025	0.0062	10.02	0.0006	2.07	1.23
n-Pentane (C <sub>5</sub> H <sub>12</sub> )	0.18	0.0018	0.0045	7.23	0.0004	1.52	0.88
Hexane (C <sub>6</sub> H <sub>14</sub> )	0.05	0.0005	0.0015	2.38	0.0001	0.46	0.22
<b>Subtotals</b>	<b>99.33</b>	<b>0.9933</b>	<b>0.8121</b>	<b>1410.43</b>	<b>0.0682</b>	<b>428.38</b>	<b>654.24</b>
<b>Non-Hydrocarbons</b>							
Carbon Dioxide (CO <sub>2</sub> )	0.67	0.0067	0.0102	0.00	0.0004	3.67	7.18
Carbon Monoxide (CO)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Helium (He)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen (H <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen Sulfide (H <sub>2</sub> S)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Nitrogen (N <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Oxygen (O <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
<b>Subtotals</b>	<b>0.67</b>	<b>0.0067</b>	<b>0.0102</b>	<b>0.00</b>	<b>0.0004</b>	<b>3.67</b>	<b>7.18</b>
<b>Totals</b>	<b>100.00</b>	<b>1.0000</b>	<b>0.8223</b>	<b>1410.43</b>	<b>0.0686</b>	<b>432.04</b>	<b>661.41</b>
<b>Standard Temperature and Pressure Basis (STP = 60°F, 1 Atm)</b>							
			Compressibility Factor z	0.9953	Pseudocritical Temp. (°R)		432.04
			Ideal Specific Gravity of Mixture	0.8223	Pseudocritical Press. (psia)		661.41
			Real Specific Gravity of Mixture	0.8258	Wichert-Aziz Correction (°R)		1.2864
			Ideal Gross Heating Value, Dry Basis (btu/scf)	1410.43	Corrected Critical Temp. (°R)		430.76
			Real Gross Heating Value, Dry Basis (btu/scf)	1417.10	Corrected Critical Press. (psia)		659.44
			Ideal Gross Heating Value, Sat. Basis (btu/scf)	1385.89			
			Real Gross Heating Value, Sat Basis (btu/scf)	1392.44			

REFS: ASTM D 3588-81: Calculating Calorific Value And Specific Gravity (Relative Density) Of Gaseous Fuels.  
 GPA STANDARD 2172-76, 1972; GPA STANDARD 2145-82, 1982  
 McCoy, R.L., 1983, Microcomputer Programs For Petroleum Engineers, Volume 1: Reservoir Engineering  
 And Formation Evaluation: Gulf Publishing Company.

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**Table A-6. Gas Chromatography Analysis for Sample PC1-4 (Air-Free Basis)**

Gas Component	Composition Mole %	Normalized Fractional Percent X <sub>i</sub> -- Mole %	Specific Gravity Fraction X <sub>i</sub> G <sub>i</sub>	Gross Calorific Fraction X <sub>i</sub> H <sub>i</sub>	Compressibility Fraction X <sub>i</sub> (b) <sup>-1/2</sup>	Critical Temperature Fraction (°R)	Critical Pressure Fraction (psia)
<b>Hydrocarbons</b>							
Methane (CH <sub>4</sub> )	32.63	0.3263	0.1807	329.47	0.0142	111.93	217.90
Ethane (C <sub>2</sub> H <sub>6</sub> )	17.65	0.1765	0.1832	312.18	0.0162	97.03	124.93
Propane (C <sub>3</sub> H <sub>8</sub> )	27.15	0.2715	0.4133	683.44	0.0364	180.73	167.33
i-Butane (C <sub>4</sub> H <sub>10</sub> )	6.71	0.0671	0.1346	218.26	0.0117	49.30	35.50
n-Butane (C <sub>4</sub> H <sub>10</sub> )	11.65	0.1165	0.2338	380.04	0.0213	89.16	64.16
i-Pentane (C <sub>5</sub> H <sub>12</sub> )	2.02	0.0202	0.0503	80.99	0.0046	16.74	9.91
n-Pentane (C <sub>5</sub> H <sub>12</sub> )	1.70	0.0170	0.0423	68.31	0.0040	14.37	8.31
Hexane (C <sub>6</sub> H <sub>14</sub> )	0.24	0.0024	0.0071	11.41	0.0007	2.19	1.05
<b>Subtotals</b>	<b>99.75</b>	<b>0.9975</b>	<b>1.2455</b>	<b>2084.10</b>	<b>0.1091</b>	<b>561.46</b>	<b>629.08</b>
<b>Non-Hydrocarbons</b>							
Carbon Dioxide (CO <sub>2</sub> )	0.25	0.0025	0.0038	0.00	0.0002	1.37	2.68
Carbon Monoxide (CO)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Helium (He)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen (H <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen Sulfide (H <sub>2</sub> S)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Nitrogen (N <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Oxygen (O <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
<b>Subtotals</b>	<b>0.25</b>	<b>0.0025</b>	<b>0.0038</b>	<b>0.00</b>	<b>0.0002</b>	<b>1.37</b>	<b>2.68</b>
<b>Totals</b>	<b>100.00</b>	<b>1.0000</b>	<b>1.2493</b>	<b>2084.10</b>	<b>0.1093</b>	<b>562.83</b>	<b>631.75</b>
<b>Standard Temperature and Pressure Basis (STP = 60°F, 1 Atm)</b>							
			0.9881			Pseudocritical Temp. (°R)	562.83
Compressibility Factor z			1.2493			Pseudocritical Press. (psia)	631.75
Ideal Specific Gravity of Mixture			1.2639			Wichert-Aziz Correction (°R)	0.5379
Real Specific Gravity of Mixture							
Ideal Gross Heating Value, Dry Basis (btu/scf)			2084.10			Corrected Critical Temp. (°R)	562.29
Real Gross Heating Value, Dry Basis (btu/scf)			2109.30			Corrected Critical Press. (psia)	631.15
Ideal Gross Heating Value, Sat. Basis (btu/scf)			2047.84				
Real Gross Heating Value, Sat. Basis (btu/scf)			2072.60				

REFS: ASTM D 3588-81: Calculating Calorific Value And Specific Gravity (Relative Density) Of Gaseous Fuels.  
 GPA STANDARD 2172-76, 1972; GPA STANDARD 2145-82, 1982  
 McCoy, R.L., 1983, Microcomputer Programs For Petroleum Engineers, Volume 1: Reservoir Engineering  
 And Formation Evaluation: Gulf Publishing Company.

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**Table A-7. Gas Chromatography Analysis for Sample PC2-1 (Air-Free Basis)**

Gas Component	Composition Mole %	Normalized Fractional Percent X <sub>i</sub> -- Mole %	Specific Gravity Fraction X <sub>i</sub> G <sub>i</sub>	Gross Calorific Fraction X <sub>i</sub> H <sub>i</sub>	Compressibility Fraction X <sub>i</sub> (b) <sub>i</sub> -½	Critical Temperature Fraction (°R)	Critical Pressure Fraction (psia)
<b>Hydrocarbons</b>							
Methane (CH <sub>4</sub> )	61.63	0.6163	0.3414	622.29	0.0269	211.42	411.57
Ethane (C <sub>2</sub> H <sub>6</sub> )	12.30	0.1230	0.1277	217.55	0.0113	67.62	87.06
Propane (C <sub>3</sub> H <sub>8</sub> )	11.36	0.1136	0.1729	285.96	0.0152	75.62	70.01
i-Butane (C <sub>4</sub> H <sub>10</sub> )	2.81	0.0281	0.0564	91.40	0.0049	20.64	14.87
n-Butane (C <sub>4</sub> H <sub>10</sub> )	7.43	0.0743	0.1491	242.37	0.0136	56.86	40.92
i-Pentane (C <sub>5</sub> H <sub>12</sub> )	1.82	0.0182	0.0453	72.97	0.0041	15.08	8.93
n-Pentane (C <sub>5</sub> H <sub>12</sub> )	2.32	0.0232	0.0578	93.23	0.0055	19.61	11.34
Hexane (C <sub>6</sub> H <sub>14</sub> )	0.03	0.0003	0.0009	1.43	0.0001	0.27	0.13
<b>Subtotals</b>	<b>99.70</b>	<b>0.9970</b>	<b>0.9515</b>	<b>1627.21</b>	<b>0.0816</b>	<b>467.14</b>	<b>644.81</b>
<b>Non-Hydrocarbons</b>							
Carbon Dioxide (CO <sub>2</sub> )	0.30	0.0030	0.0046	0.00	0.0002	1.64	3.21
Carbon Monoxide (CO)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Helium (He)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen (H <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Hydrogen Sulfide (H <sub>2</sub> S)	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Nitrogen (N <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
Oxygen (O <sub>2</sub> )	0.00	0.0000	0.0000	0.00	0.0000	0.00	0.00
<b>Subtotals</b>	<b>0.30</b>	<b>0.0030</b>	<b>0.0046</b>	<b>0.00</b>	<b>0.0002</b>	<b>1.64</b>	<b>3.21</b>
<b>Totals</b>	<b>100.00</b>	<b>1.0000</b>	<b>0.9561</b>	<b>1627.21</b>	<b>0.0818</b>	<b>468.78</b>	<b>648.03</b>
<b>Standard Temperature and Pressure Basis (STP = 60°F, 1 Atm)</b>							
Compressibility Factor z				0.9933	Pseudocritical Temp. (°R)		468.78
Ideal Specific Gravity of Mixture				0.9561	Pseudocritical Press. (psia)		648.03
Real Specific Gravity of Mixture				0.9621	Wichert-Aziz Correction (°R)		0.6325
Ideal Gross Heating Value, Dry Basis (btu/scf)				1627.21	Corrected Critical Temp. (°R)		468.15
Real Gross Heating Value, Dry Basis (btu/scf)				1638.17	Corrected Critical Press. (psia)		647.15
Ideal Gross Heating Value, Sat. Basis (btu/scf)				1598.90			
Real Gross Heating Value, Sat. Basis (btu/scf)				1609.66			

REFS: ASTM D 3588-81: Calculating Calorific Value And Specific Gravity (Relative Density) Of Gaseous Fuels.

GPA STANDARD 2172-76, 1972; GPA STANDARD 2145-82, 1982

McCoy, R.L., 1983, Microcomputer Programs For Petroleum Engineers, Volume 1: Reservoir Engineering

And Formation Evaluation: Gulf Publishing Company.

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## **Appendix B**

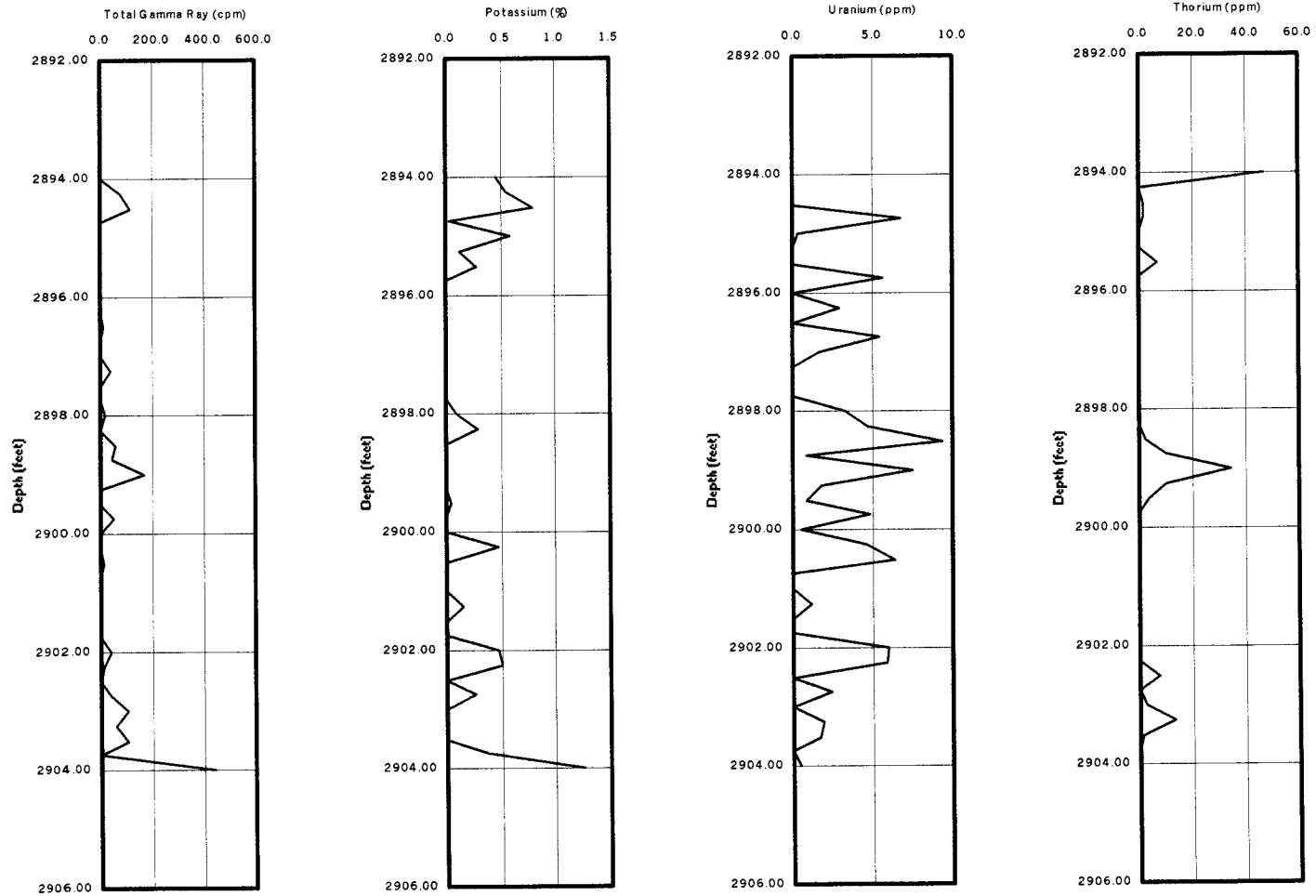
### **Spectral Gamma Log**

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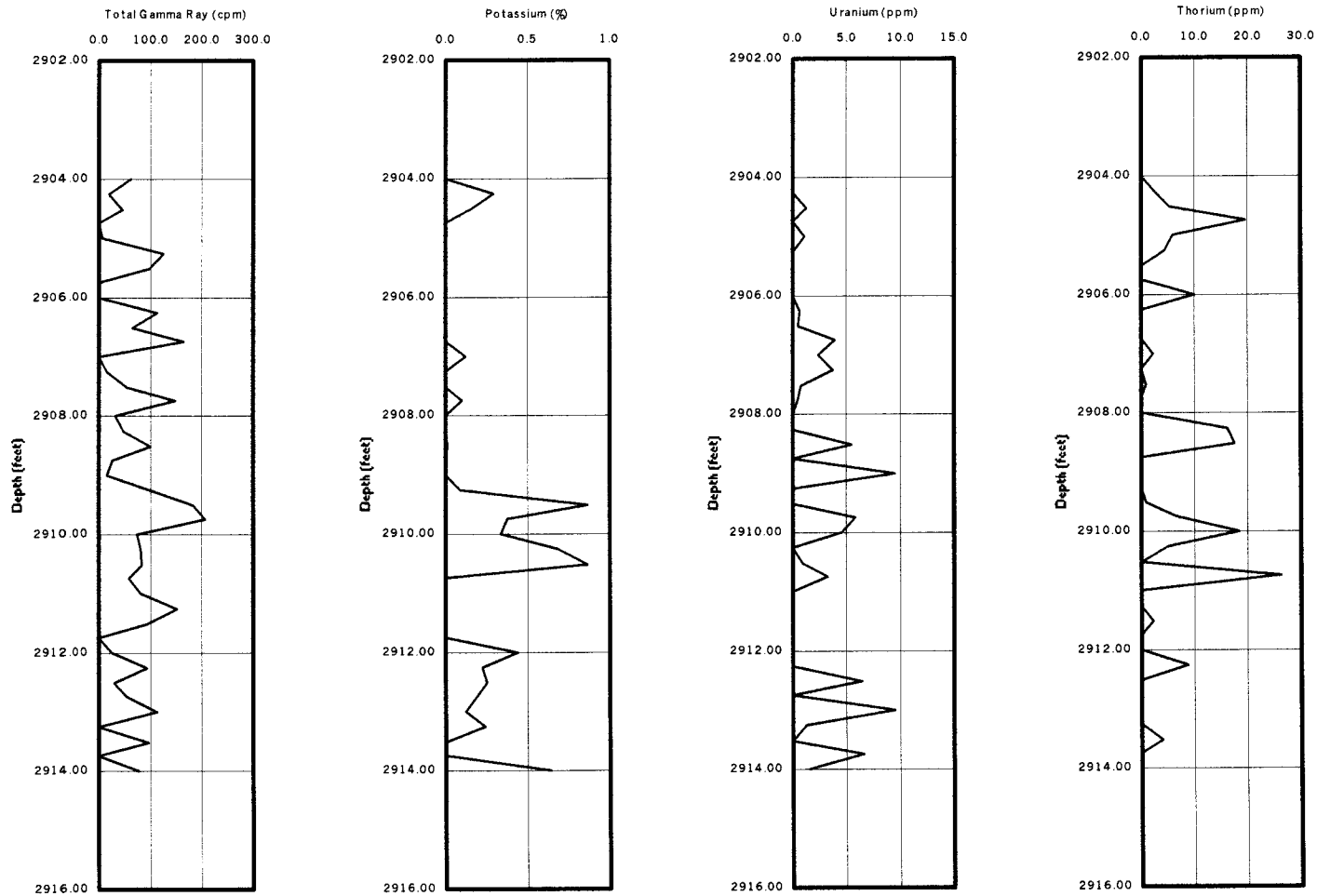
### Total and Spectral Gamma Ray Log for PC #1.



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**Total and Spectral Gamma Ray Log for PC #2.**



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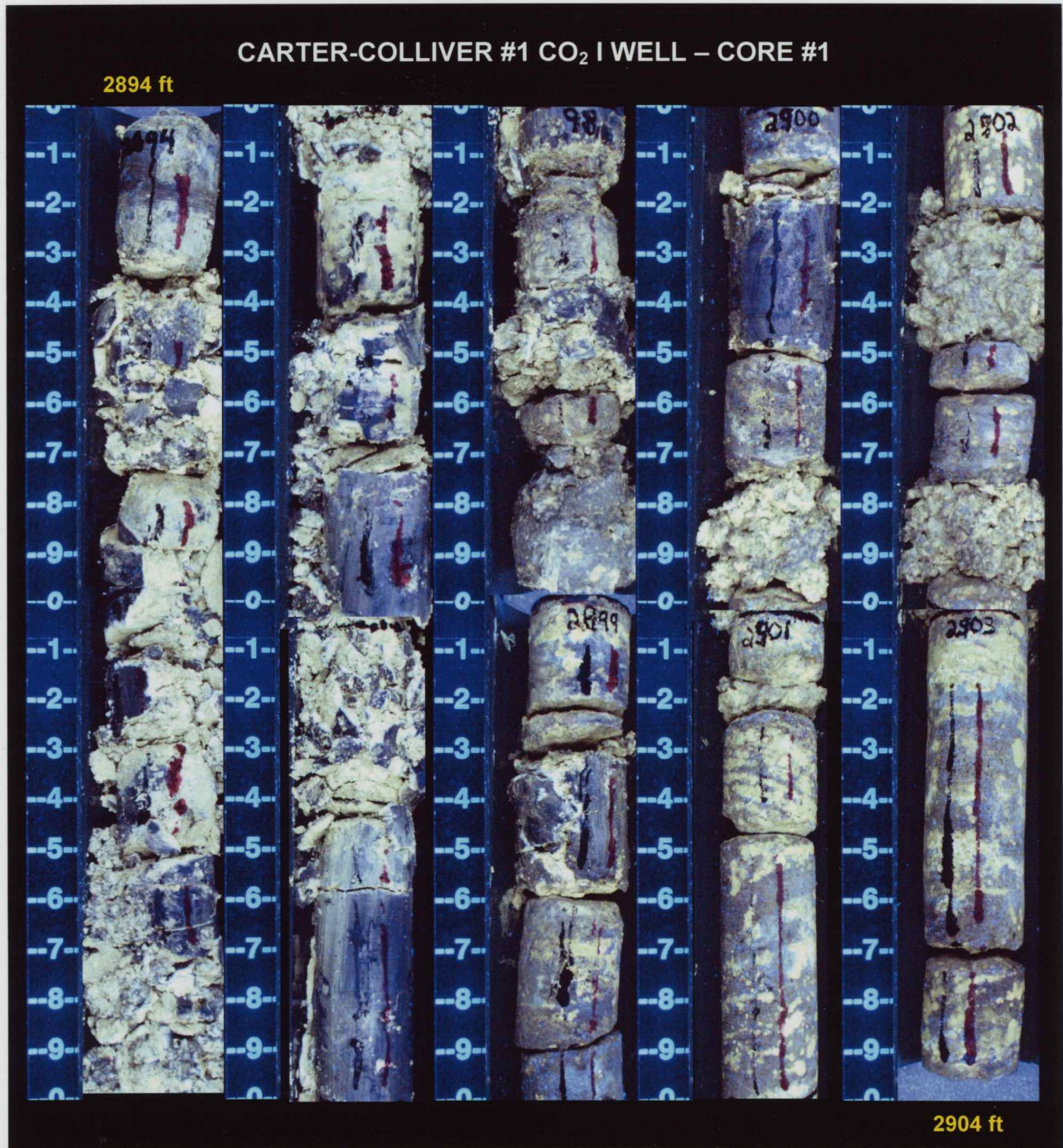
## **Appendix C**

### ***Digital Ultraviolet Light Images of Core***

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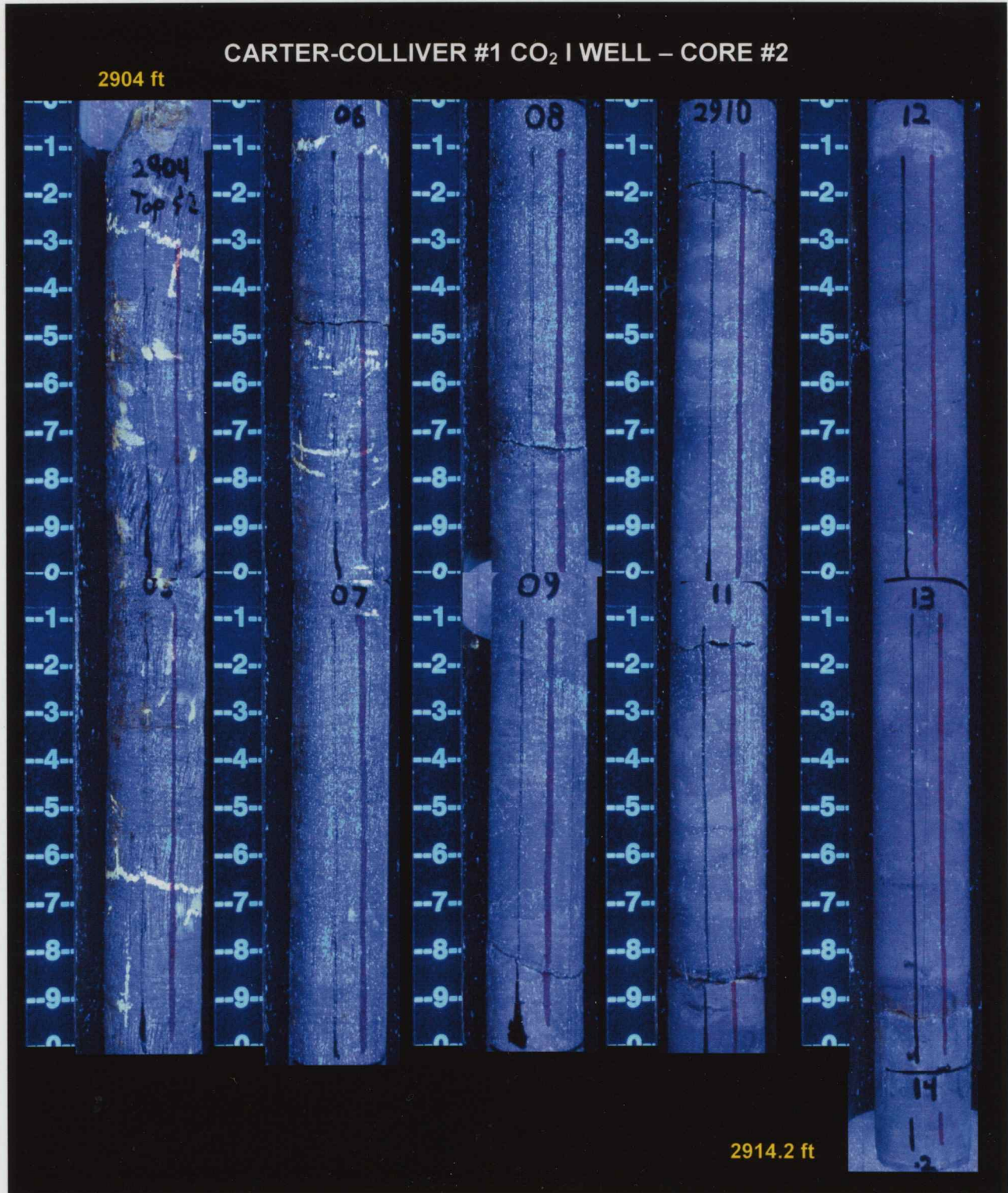
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