Correlation of Field Barometer to KGS Petrophysics Lab Barometer

FIGURE 1.
Dart Cherokee Basin #A3-36 Fields, NW NE 36-T.34S.-R.14E., Montgomery County, KS
(based on lag times from Dart Cherokee Basin #CH-1 Holder; sec. 1-T.30S.-R.14E., Wilson County, KS)
lag-time to surface for well cuttings

FIGURE 2.

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Lag Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1072' to 1074' (Iron Post)</td>
<td>1041' to 1051' (Excello Sh.)</td>
</tr>
<tr>
<td>1108' to 1100' (Croweburg)</td>
<td>1072' to 1074' (Iron Post)</td>
</tr>
<tr>
<td>1158' to 1161' (Mineral)</td>
<td>1108' to 1100' (Croweburg)</td>
</tr>
<tr>
<td>1237' to 1239' (Weir-Pittsburg)</td>
<td>1158' to 1161' (Mineral)</td>
</tr>
<tr>
<td>1475' to 1478' (Rowe)</td>
<td>1237' to 1239' (Weir-Pittsburg)</td>
</tr>
<tr>
<td>1498' to 1502' (Riverton)</td>
<td>1475' to 1478' (Rowe)</td>
</tr>
</tbody>
</table>

measured lag time of cuttings to surface after pipe connections

FIGURE 2.
RELATIONSHIP of TOTAL GAS EVOLVED FROM a CUTTINGS SAMPLE to RATE of LOST-GAS (from 42 cuttings samples from air-drilled wells, Cherokee basin, southeastern Kansas)

REGRESSION LINE

\[ y = 0.1241 \times (x) + 48.14 \]

\[ r \text{ squared} = 0.81 \]

LOST-GAS ALGORITHM

\[ \text{ccs lost gas} = \sqrt[3]{X} (Y) \]

where \( X \) = bottom-hole to canister time (in hours)

(i.e., value \( Y \) from regression equation)

FIGURE 3.
Desorption Characteristics of Cuttings Samples
Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of Excello Shale from 1041' to 1051'

\[
\text{GAS CONTENT}_{\text{coal}} = \frac{\text{total gas desorbed} - (\text{(gas content}_{\text{dark shale}}) \times (\text{weight}_{\text{dark shale}}))}{\text{weight}_{\text{coal}}}
\]

Total gas desorbed (including estimated lost gas) = 468.9 ccs

Total Dry Weight of Sample = 1684.41 grams
- \( \text{weight}_{\text{light-colored lithologies}} = 332.59 \text{ grams (19.7%)} \)
- \( \text{weight}_{\text{dark shale}} = 1351.82 \text{ grams (80.3%)} \)
- \( \text{weight}_{\text{coal}} = 0.00 \text{ grams (0.0%)} \)

<table>
<thead>
<tr>
<th>sieve size</th>
<th>grams</th>
<th>% coal / % dark shale / % light-colored liths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.0930*</td>
<td>1120.19</td>
<td>0.00% / 82.20% / 17.71%</td>
</tr>
<tr>
<td>&gt;0.0661*</td>
<td>341.24</td>
<td>0.00% / 79.01% / 9.30%</td>
</tr>
<tr>
<td>&gt;0.0460*</td>
<td>159.73</td>
<td>0.00% / 73.33% / 7.72%</td>
</tr>
<tr>
<td>&gt;0.0331*</td>
<td>46.48</td>
<td>0.00% / 69.64% / 30.46%</td>
</tr>
<tr>
<td>&lt;0.0331*</td>
<td>16.77</td>
<td>0.00% / 65.00% / 35.00%</td>
</tr>
<tr>
<td>1684.41 TOTAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 4.
Desorption Characteristics of Cuttings Samples
Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Iron Post coal from 1072' to 1074'

GAS CONTENT_{coal} =
total gas desorbed - ((gas content_{dark shale}) * (weight_{dark shale}))
weight_{coal}

total gas desorbed
(including estimated lost gas) = 126.9 ccs

TOTAL DRY WEIGHT OF SAMPLE = 390.71 grams
weight_{light-colored lithologies} = 280.33 grams (71.8%)
weight_{dark shale} = 57.89 grams (14.8%)
weight_{coal} = 52.49 grams (13.4%)

sieve size | grams | % coal / % dark shale / % light-colored liths
--- | --- | --- / --- / ---
>0.0930" | 178.78 | 10.57% / 20.98% / 68.44%
>0.0661" | 89.28 | 22.11% / 11.30% / 66.58%
>0.0460" | 71.72 | 15.19% / 8.83% / 75.97%
>0.0331" | 32.18 | 7.41% / 11.11% / 81.48%
<0.0331" | 18.76 | 3.00% / 2.00% / 95.00%
390.71 TOTAL

Equation solutions
dark shale coal
(scf/ton) (scf/ton)
0 77.4
1 76.3
3 74.1
5 71.9
10 66.4
20 55.4
30 44.3
36.8 36.8

3.0 scf/ton most likely (?) gas content for associated dark shale
likely minimum gas content for coal
36.8 scf/ton likely maximum gas content for dark shale

FIGURE 5.
Desorption Characteristics of Cuttings Samples
Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Croweburg coal from 1108' to 1110'

\[
\text{GAS CONTENT}_{\text{coal}} = \frac{\text{total gas desorbed} - ((\text{gas content}_{\text{dark shale}}) \times (\text{weight}_{\text{dark shale}}))}{\text{weight}_{\text{coal}}}
\]

Total gas desorbed (including estimated lost gas) = 204.4 ccs

TOTAL DRY WEIGHT OF SAMPLE = 322.04 grams
weight_{light-colored lithologies} = 105.46 grams (32.8%)
weight_{dark shale} = 169.18 grams (53.5%)
weight_{coal} = 47.40 grams (14.7%)

<table>
<thead>
<tr>
<th>sieve size</th>
<th>grams</th>
<th>% coal / % dark shale / % light-colored liths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.0930&quot;</td>
<td>192.65</td>
<td>12.61% / 56.67% / 30.73%</td>
</tr>
<tr>
<td>&gt;0.0661&quot;</td>
<td>72.77</td>
<td>20.89% / 49.53% / 29.58%</td>
</tr>
<tr>
<td>&gt;0.0460&quot;</td>
<td>47.34</td>
<td>15.30% / 47.01% / 37.69%</td>
</tr>
<tr>
<td>&gt;0.0331&quot;</td>
<td>6.28</td>
<td>8.24% / 17.65% / 74.12%</td>
</tr>
<tr>
<td>&lt;0.0331&quot;</td>
<td>3.00</td>
<td>5.00% / 20.00% / 75.00%</td>
</tr>
</tbody>
</table>

322.04 TOTAL

Equation solutions

<table>
<thead>
<tr>
<th>dark shale (scf/ton)</th>
<th>coal (scf/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>138.1</td>
</tr>
<tr>
<td>3</td>
<td>134.5</td>
</tr>
<tr>
<td>5</td>
<td>127.4</td>
</tr>
<tr>
<td>10</td>
<td>120.3</td>
</tr>
<tr>
<td>15</td>
<td>102.4</td>
</tr>
<tr>
<td>25</td>
<td>84.6</td>
</tr>
<tr>
<td>30</td>
<td>48.9</td>
</tr>
</tbody>
</table>

30.2 scf/ton
likely maximum gas content for dark shale
likely minimum gas content for coal
most likely gas content for associated dark shale

FIGURE 6.
Desorption Characteristics of Cuttings Samples
Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Mineral coal from 1158' to 1161'

GAS CONTENT_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{dark\ shale}) \times (\text{weight}_{dark\ shale}))}{\text{weight}_{coal}}

\text{total gas desorbed (including estimated lost gas)} = 248.6 \text{ ccs}

\text{TOTAL DRY WEIGHT OF SAMPLE} = 935.21 \text{ grams}

\text{weight}_{light-colored\ lithologies} = 520.74 \text{ grams (55.7%)}
\text{weight}_{dark\ shale} = 357.76 \text{ grams (38.3%)}
\text{weight}_{coal} = 56.71 \text{ grams (6.1%)}

sieve size grams % coal / % dark shale / % light-colored liths
\begin{tabular}{lccc}
>0.0930" & 426.25 & 4.48% / 32.68% / 62.83% \\
>0.0661" & 269.94 & 9.66% / 38.94% / 51.40% \\
>0.0460" & 181.51 & 5.03% / 47.80% / 47.17% \\
>0.0331" & 39.58 & 5.62% / 44.94% / 49.44% \\
<0.0331" & 17.93 & 1.00% / 49.00% / 50.00% \\
\end{tabular}

\text{935.21 TOTAL}

\text{Equation solutions}

\begin{tabular}{l|c|c}
\hline
\text{dark\ shale} & \text{coal} & \\
\text{(scf/ton)} & \text{(scf/ton)} & \\
\hline
0 & 140.4 \\
1 & 134.1 \\
3 & 121.5 \\
5 & 108.9 \\
10 & 77.46 \\
15 & 45.8 \\
18 & 26.9 \\
19.2 & 19.2 \\
\hline
\end{tabular}

\text{FIGURE 7.}
Desorption Characteristics of Cuttings Samples
Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Weir-Pittsburg coal from 1237' to 1239'

\[
\text{GAS CONTENT}_{\text{coal}} = \frac{\text{total gas desorbed} - ((\text{gas content}_{\text{dark shale}}) \times (\text{weight}_{\text{dark shale}}))}{\text{weight}_{\text{coal}}}
\]

total gas desorbed (including estimated lost gas) = 63.5 ccs

TOTAL DRY WEIGHT OF SAMPLE = 314.62 grams
weight_{light-colored lithologies} = 284.51 grams (90.4%)
weight_{dark shale} = 15.65 grams (5.0%)
weight_{coal} = 14.46 grams (4.6%)

<table>
<thead>
<tr>
<th>sieve size</th>
<th>grams</th>
<th>% coal / % dark shale / % light-colored liths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.0930&quot;</td>
<td>197.63</td>
<td>5.16% / 6.04% / 88.80%</td>
</tr>
<tr>
<td>&gt;0.0661&quot;</td>
<td>83.62</td>
<td>4.46% / 3.27% / 92.27%</td>
</tr>
<tr>
<td>&gt;0.0460&quot;</td>
<td>28.40</td>
<td>1.76% / 3.23% / 95.01%</td>
</tr>
<tr>
<td>&gt;0.0331&quot;</td>
<td>3.48</td>
<td>0.70% / 1.40% / 97.91%</td>
</tr>
<tr>
<td>&lt;0.0331&quot;</td>
<td>1.49</td>
<td>0.60% / 1.20% / 98.20%</td>
</tr>
</tbody>
</table>

314.62 TOTAL

FIGURE 8.
Desorption Characteristics of Cuttings Samples  
Dart Cherokee Basin #A3-36 Fields, NW NE 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Rowe coal from 1475' to 1478'

\[
\text{GAS CONTENT}_{\text{coal}} = \frac{\text{total gas desorbed} - ((\text{gas content}_{\text{dark shale}}) \times (\text{weight}_{\text{dark shale}}))}{\text{weight}_{\text{coal}}}
\]

\[
\begin{align*}
\text{total gas desorbed} &\text{ (including estimated lost gas)} = 2056.5 \text{ ccs} \\
\text{TOTAL DRY WEIGHT OF SAMPLE} &\text{ = 2240.20 grams} \\
\text{weight}_{\text{light-colored lito}} &\text{ = 64.54 grams (2.9%)} \\
\text{weight}_{\text{dark shale}} &\text{ = 1930.28 grams (86.2%)} \\
\text{weight}_{\text{coal}} &\text{ = 245.38 grams (11.0%)}
\end{align*}
\]

\[
\begin{array}{c|c|c|c}
\text{sieve size} & \text{grams} & \% \text{coal} / \% \text{dark shale} / \% \text{light-colored lito} \\
\hline
>0.0930" & 927.26 & 20.99% / 76.31% / 2.70% \\
>0.0661" & 666.71 & 5.23% / 93.11% / 1.66% \\
>0.0460" & 552.77 & 2.68% / 93.39% / 3.93% \\
>0.0331" & 81.30 & 1.19% / 91.70% / 7.11% \\
<0.0331" & 12.16 & 1.00% / 91.00% / 8.00% \\
\hline
\end{array}
\]

\[
\begin{align*}
\text{sieve size} &\text{ grams} & \% \text{coal} / \% \text{dark shale} / \% \text{light-colored lito} \\
\hline
>0.0930" & 927.26 & 20.99% / 76.31% / 2.70% \\
>0.0661" & 666.71 & 5.23% / 93.11% / 1.66% \\
>0.0460" & 552.77 & 2.68% / 93.39% / 3.93% \\
>0.0331" & 81.30 & 1.19% / 91.70% / 7.11% \\
<0.0331" & 12.16 & 1.00% / 91.00% / 8.00% \\
\hline
\end{align*}
\]

\[
\begin{align*}
\text{weight}_{\text{coal}} &\text{ = 245.38 grams (11.0%)} \\
\text{TOTAL DRY WEIGHT OF SAMPLE} &\text{ = 2240.20 grams} \\
\text{weight}_{\text{light-colored lito}} &\text{ = 64.54 grams (2.9%)} \\
\text{weight}_{\text{dark shale}} &\text{ = 1930.28 grams (86.2%)} \\
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]

\[
\begin{align*}
\text{GAS CONTENT}_{\text{coal}} &\text{ = 3.0 scf/ton most likely gas content for associated dark shale} \\
\text{likely minimum gas content for coal} &\text{ = 1.00% / 91.00% / 8.00%} \\
\text{likely maximum gas content for dark shale} &\text{ = 30.3 scf/ton}
\end{align*}
\]
Desorption Characteristics of Cuttings Samples
Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Riverton coal from 1498' to 1502'

GAS CONTENT_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{\text{dark shale}}) \times \text{weight}_{\text{dark shale}})}{\text{weight}_{\text{coal}}}

\text{total gas desorbed (including estimated lost gas)} = 627.1 \text{ ccs}

\text{TOTAL DRY WEIGHT OF SAMPLE} = 1190.47 \text{ grams}
\text{weight}_{\text{light-colored lithologies}} = 492.50 \text{ grams (41.4%)}
\text{weight}_{\text{dark shale}} = 590.26 \text{ grams (49.6%)}
\text{weight}_{\text{coal}} = 107.71 \text{ grams (9.1%)}

sieve size | grams  | % coal / % dark shale / % light-colored liths
---|---|---
>0.0930" | 544.29 | 9.38% / 32.54% / 58.08%
>0.0661" | 353.54 | 11.76% / 57.65% / 30.59%
>0.0460" | 231.76 | 5.47% / 73.18% / 21.35%
>0.0331" | 44.43  | 4.26% / 70.92% / 24.82%
<0.0331" | 16.47  | 3.60% / 50.00% / 47.00%

\text{1190.47 TOTAL}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure10}
\caption{FIGURE 10.}
\end{figure}

Equation solutions

<table>
<thead>
<tr>
<th>dark shale</th>
<th>coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>scf/ton</td>
<td>scf/ton</td>
</tr>
<tr>
<td>0</td>
<td>186.5</td>
</tr>
<tr>
<td>1</td>
<td>181.1</td>
</tr>
<tr>
<td>3</td>
<td>170.1</td>
</tr>
<tr>
<td>5</td>
<td>159.1</td>
</tr>
<tr>
<td>10</td>
<td>131.7</td>
</tr>
<tr>
<td>20</td>
<td>76.9</td>
</tr>
<tr>
<td>25</td>
<td>49.5</td>
</tr>
<tr>
<td>28.8</td>
<td>28.8</td>
</tr>
</tbody>
</table>

likely minimum gas content for coal
likely maximum gas content for dark shale

3.0 scf/ton
most likely (?) gas content for associated dark shale
28.8 scf/ton

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
0 50 100 150 200 250 300 350 400 450 500
GAS CONTENT (coal) scf/ton
GAS CONTENT (dark shale) scf/ton

0% of tbl/sample
50% of tbl/sample

% of tbl/sample

GAS CONTENT_{coal} (scf/ton)
GAS CONTENT_{dark shale} (scf/ton)
**Desorption Characteristics of Cuttings Samples**
Dart Cherokee Basin #A3-36 Fields, NW NE 36-T.34S.-R.14E., Montgomery County, KS

LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for all samples

<table>
<thead>
<tr>
<th>UNIT</th>
<th>coal in sample</th>
<th>scf/ton w/ shale @ 3 scf/ton</th>
<th>maximum scf/ton</th>
<th>minimum scf/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excello Shale</td>
<td>13%</td>
<td>74.1</td>
<td>77.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Iron Post</td>
<td>6%</td>
<td>121.5</td>
<td>140.4</td>
<td>19.2</td>
</tr>
<tr>
<td>Croweburg</td>
<td>5%</td>
<td>137.5</td>
<td>140.7</td>
<td>67.6</td>
</tr>
<tr>
<td>Mineral</td>
<td>11%</td>
<td>244.9</td>
<td>268.5</td>
<td>30.3</td>
</tr>
<tr>
<td>Weir-Pittsburg</td>
<td>9%</td>
<td>170.1</td>
<td>186.5</td>
<td>28.8</td>
</tr>
</tbody>
</table>

FIGURE 11.
Desorption Characteristics of Cuttings Samples
based on total weight of gas-generating lithologies (i.e., coal and dark shale) in sample
Dart Cherokee Basin #A3-36 Fields, NW NE 36-T.34S.-R.14E., Montgomery County, KS

Figure 12.