ANALYSIS OF CHEROKEE GROUP CUTTINGS SAMPLES FOR GAS CONTENT -- DART CHEROKEE BASIN OPERATING COMPANY #A3-36 FIELDS; NW NE sec. 36-T.34S.-R.14E.; MONTGOMERY COUNTY, KANSAS

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SUMMARY

Seven cuttings samples from the Pennsylvanian Cherokee Group were collected from the Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS. The samples calculate as having the following gas contents:

- Excello Shale at 1040' to 1051' depth[1] (11 scf/ton)
- Iron Post at 1072' to 1074' depth[2] (74 scf/ton)
- Croweburg coal at 1108' to 1110' depth[2] (127 scf/ton)
- Mineral coal at 1158' to 1161' depth[2] (122 scf/ton)
- Weir-Pittsburg coal at 1237' to 1239' depth[2] (138 scf/ton)
- Rowe coal at 1475' to 1478' depth[2] (245 scf/ton)
- Riverton coal at 1498' to 1502' depth[2] (170 scf/ton)

[1]no coal in sample
[2]assuming accompanying dark shales in sample desorb 3 scf/ton

BACKGROUND

The Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS, was selected for cuttings desorption tests in association with an on-going coalbed gas research project at the Kansas Geological Survey. The samples were gathered March 10, 2005 by personnel from Dart Cherokee Basin L.L.C., and turned over to LeaAnn Davidson of the Kansas Geological Survey on March 14, 2005. Samples were obtained during normal drilling of the well, with no cessation of drilling before zones of interest (i.e., coals and dark shales in the Cherokee Group) were penetrated. The well was drilled using an air rotary rig owned by McPherson Drilling.

The samples were canistered, with surface time and canistering times noted. These samples were collected in canisters that were supplied by Dart Cherokee Basin L.L.C. and the Kansas Geological Survey. Lag times for samples to reach the surface (important for assessing lost gas) were determined by using the lag times from a nearby air-drilled well (Dart Cherokee Basin #CH-1 Holder; sec. 1-T.30S.-R.14E., Wilson County, KS), which was also drilled using this particular drilling rig. The lag times were determined by periodically noting the time it took for cuttings to reach the surface following resumption of drilling after new pipe was added to the drill string.

Seven cuttings samples from the Pennsylvanian Cherokee Groups were collected:

- Excello Shale at 1040' to 1051' depth (1684 grams dry wt.)
- Iron Post at 1072' to 1074' depth (391 grams dry wt.)
- Croweburg coal at 1108' to 1110' depth (322 grams dry wt.)
- Mineral coal at 1158' to 1161' depth (935 grams dry wt.)
- Weir-Pittsburg coal at 1237' to 1239' depth (315 grams dry wt.)
- Rowe coal at 1475' to 1478' depth (2240 grams dry wt.)
- Riverton coal at 1498' to 1502' depth (1190 grams dry wt.)

The cuttings were caught in kitchen strainers as they exited the air-stream pipe emptying to the mud pit. The samples were then washed in water while in the kitchen strainers to rid them of as much drilling mud as possible before the cuttings were placed in desorption canisters. Water with zephyrn chloride biocide was then added to the canisters, with a headspace of 1 to 2 inches being preserved at the top of the canister.

All samples were transported March 14th to the laboratory at the Kansas Geological Survey in Lawrence, KS and desorption measurements were continued at approximately 70 ˚F . Desorption measurements were periodically made until the canisters produced negligible gas with daily testing for at least two successive days.

DESORPTION MEASUREMENTS

The equipment and method for measuring desorption gas is that prescribed by McLennan and others (1995). The volumetric displacement apparatus is a set of connected dispensing burettes, one of which measures the gas evolved from the desorption canister. The other burette compensates for the compression that occurs when the desorbed gas displaces the water in the measuring burette. This compensation is performed by adjusting the cylinders so that their water levels are identical, then figuring the amount of gas that evolved by reading the difference in water level using the volumetric scale on the side of the burette.

The desorption canisters were obtained from SSD, Inc. in Grand Junction, CO. These canisters are 12.5 inches high (32 cm), 3 1/2 inches (9 cm) in diameter, and enclose a volume of approximately 150 cubic inches (2450 cm^3). The desorbed gas that collected in the desorption canisters was periodically released into the volumetric displacement apparatus and measured as a function of time, temperature, and atmospheric pressure.

The time and atmospheric pressure were measured in the field using a portable weather station (model BA928) marketed by Oregon Scientific (Tualatin, OR). The atmospheric pressure was displayed in millibars on this instrument, however, this measurement was not the actual barometric pressure, but rather an altitude-compensated barometric pressure automatically converted to a sea-level-equivalent pressure. In order to translate this measurement to actual atmospheric pressure, a regression correlation was determined over several weeks by comparing readings from the Oregon Scientific instrument to that from a pressure transducer in the Petrophysics Laboratory in the Kansas Geological Survey (Figure 1). The regression equation shown graphically in Figure 1 was entered into a spreadsheet and was used to automatically convert the millibar measurement to barometric pressure in pounds per square inch (psi).

A spreadsheet program written by K.D. Newell (Kansas Geological Survey) was used to convert all gas volumes at standard temperature and pressure. Conversion of gas volumes to standard temperature and pressure was by application of the perfect-gas equation, obtainable from basic college chemistry texts:

$n = PV/RT$

where n is moles of gas, T is degrees Kelvin (i.e., absolute temperature), V is in liters, and R is the universal gas constant, which has a numerical value depending on the units in which it is measured (for example, in the metric system R = 0.0820 liter atmosphere per degree mole). The number of moles of gas (i.e., the value n) is constant in a volumetric conversion, therefore the conversion equation, derived from the ideal gas equation, is:

$$(P_{stp}V_{stp})/(RT_{stp}) = (P_{rig}V_{rig})/(RT_{rig})$$

Customarily, standard temperature and pressure for gas volumetric measurements in the oil industry are 60 ˚F and 14.7 psi (see Dake, 1978, p. 13), therefore P_{stp}, V_{stp}, and T_{stp}, respectively, are pressure, volume, and temperature at standard temperature and pressure, where standard temperature is degrees Rankine (˚R = 460 + ˚F). P_{rig}, V_{rig}, and T_{rig}, respectively, are ambient pressure, volume, and temperature measurements taken at the rig site or in the desorption laboratory.

The universal gas constant R drops out as this equation is simplified and the determination of Vstp becomes:

$$V_{stp} = (T_{stp}/T_{rig})\ (P_{rig}/P_{stp})\ V_{rig}$$

The conversion calculations in the spreadsheet were carried out in the English metric system, as this is the customary measure system used in American coal and oil industry. V is therefore converted to cubic feet; P is psia; T is ˚R.

The desorbed gas was summed over the time period for which the coal samples evolved all of their gas.

Lost gas for samples (i.e., the gas lost from the sample from the time it was drilled, brought to the surface, to the time it was canistered) are normally determined using the direct method (Kissel and others, 1975; also see McLennan and others, 1995, p. 6.1-6.14) in which the cumulative gas evolved is plotted against the square root of elapsed time. Time zero is assumed to be the moment that the rock is cut and its cuttings circulated off bottom. Lost gas, however, had to be inferred for the samples collected from this well because no desorption apparatus was on site when those samples were collected. The procedure used to infer lost gas for these samples is outlined in the section below on Lost Gas.

LITHOLOGIC ANALYSIS

Upon removal from the canisters, the cuttings were washed of drilling mud, and dried in an oven at 150 ˚F for 1 to 3 days. After drying, the cuttings were weighed and then dry sieved into 5 size fractions: >0.0930", >0.0661", >0.0460", >0.0331", and <0.0331". For large sample sizes, the cuttings were ran through a sample splitter and a lesser portion (approximately 75 grams) was sieved and weighed, and the derived size-fraction ratios were applied to the entire sample.

The size fractions were then inspected and sorted by hand under a dissecting microscope. Three major lithologic categories were differentiated: coal, dark shales (generally Munsell rock colors N3 (dark gray), N2 (grayish black), and N1 (black) on dry surface), and lighter-colored lithologies and/or dark and light-colored carbonates. The lighter-colored lithologies are considered to be incapable of generating significant amounts of gas. After sorting, and for every size class, each of these three lithologic categories was weighed and the proportion of coal, dark shale, and light-colored lithologies were determined for the entire cuttings sample based on the weight percentages.

DATA PRESENTATION

Data and analyses accompanying this report are presented in the following order: 1) lag time to surface for the well cuttings, 2) data tables for the desorption analyses, 3) lost-gas graphs, 4) "lithologic component sensitivity analyses" showing the interdependence of gas evolved from dark shale versus coal in each sample, 5) a summary component analysis for all samples showing relative reliability of the data from all the samples, and 6) a desorption graph for all the samples.

Graph of Lag-time to Surface for Well Cuttings (Figure 2)
Lag time of cuttings to surface varied, but there is a general trend of longer lag times for greater depth. The lag times accepted for cuttings were taken to be a visual average of the trend (defined by the scatter of data points on this graph) at the depth at which the samples were taken.

Data Tables of the Desorption Analyses (Table 1)
These are the basic data used for lost-gas analysis and determination of total gas desorbed from the cuttings samples. Basic temperature, volume, and barometric measurements are listed at left. Farther to the right, these are converted to standard temperature, pressure, and volumes. The volumes are cumulatively summed, and converted to scf/ton based on the total weight of coal and dark shale in the sample. At the right of the table, the time of the measurements are listed and converted to hours (and square root of hours) since the sample was drilled.

Lost-Gas Graphs (Figure 3)
To infer an approximate lost-gas value for each sample, a correlation of the total gas desorbed from a sample after it had been canistered to its rate of lost gas was developed using desorption data accumulated for 42 cuttings samples obtained from air-drilled wells in the Cherokee basin in southeastern Kansas (Figure 3). The rate of lost gas used in this correlation was that amount of gas lost by the square root of 0.6 hours (the square root of 0.36 hours). By knowing the total gas given up by the sample after canistering (i.e., the

total gas desorbed) a hypothetical rate of lost-gas could be calculated using the a regression line:

lost gas rate per square root of 0.36 hours = 0.1241 X (total gas desorbed in ccs) + 48.14

Once the hypothetical lost-gas rate was calculated, the lost gas could be calculated by taking the square root of the bottom-hole to canister time (derived from subtracting the lag time from the surface time), and multiplying it times the hypothetical lost-gas rate. Analysis of the lithology of the cuttings used in this correlation revealed no consistent relationship (see Figure 3), therefore further refinement of the relationship of the rate of lost gas to the total gas desorbed after canistering is not possible at this time.

"Lithologic Component Sensitivity Analyses" (Figures 4-10)
The rapidity of penetration of an air-drilled well makes collection of pure lithologies from relatively thin-bedded strata difficult. Mixed lithologies are more the norm than the exception. Some of this mixing is due to cavings from strata farther up hole. The mixing may also be due to collection of two or more successively drilled lithologies in the kitchen sieve at the exit line, or differential lifting of relatively less-dense coal compared to other lithologies, all of which are more dense than coal.

The total gas evolved from the sample is due to gas being desorbed from both the coal and dark shale. Both lithologies are capable of generating gas, albeit the coal will be richer in gas than the dark-colored shale. Even though dark-colored shale is less rich in sorbed gas than coal, if a sample has a large proportion of dark, organic-rich shale and only a minor amount of coal, the total volume of gas evolved from the dark-shale component may be considerable. The lighter-colored lithologies are considered to be incapable of generating significant amounts of gas.

The total amount of gas evolved from a cuttings sample can be expressed by the following equation:

$$\text{Total gas (cm}^3) = [\text{weight}_{coal} \text{ (grams) X gas content}_{coal} \text{ (cm}^3\text{/gram)}] + [\text{weight}_{dark\ shale} \text{ (grams) X gas content}_{dark\ shale} \text{ (cm}^3\text{/gram)}]$$

A unique solution for gas content_{coal} in this equation is not possible because gas $\text{content}_{dark\ shale}$ is not known exactly. An answer can only be expressed as a linear solution to the above equation. The richer in gas the dark shales are, the poorer in gas the admixed coal has to be, and visa versa. If there is little dark shale in a sample, a relatively well constrained answer for gas content_{coal} can be obtained. Conversely, if considerable dark shale is in a sample, the gas content of a coal will be hard to precisely determine.

The lithologic-component-sensitivity-analysis diagram therefore expresses the bivariant nature inherent in the determination of gas content in mixed cuttings. The gas content of dark shales in Kansas can vary greatly. Proprietary desorption analyses of dark shales in cores from southeastern Kansas have registered as much as 50 scf/ton, but can be as low as 2-4 scf/ton.

A value of 3 scf/ton for average dark shale is based on the assay of the gas content of cores of dark shales in nearby wells. However, high-gamma-ray shales (such as the Excello Shale), also colloquially known as "hot shales", typically have more organic matter and associated gas content than dark shales with no excessive gamma-ray level. Determination of gas content for a coal associated with a "hot" shale therefore carries more uncertainty than if the coal were associated with a shale without a high gamma-ray value.

In general, shale gas content does not have to be very much greater that 10 scf/ton before the associated coal starts to have a gas content less than that of the dark shale. In all the lithologic-component-sensitivity-analysis diagrams, a “break-even” point is therefore noted where the gas content of the coal is equal to that of the dark shale. This “break-even” point corresponds to the minimum gas content assignable to the coal and maximum gas content assignable to the dark shale. It can also be thought of the scf/ton gas content of the cuttings sample minus the weight of any of the lighter-colored lithologies, which are assumed to have no inherent gas content. Conversely though, to assume that all the gas evolved from a cuttings sample is derived solely from the coal would result in an erroneously high gas content for the coal.

Summary Component Analysis for all Samples (Figure 11)
This diagram is a summary of the individual “lithologic component sensitivity analyses” for each sample, all set at a common scale. The steeper the angle of the line for a sample, the more uncertainty is attached to the results (i.e., $\textit{gas content}_{coal}$) for that sample. If the coal content is miniscule (i.e., < approximately 5%), the results are a better reflection of the $\textit{gas content}_{dark\ shale}$.

Desorption Graph (Figure 12)
This is a desorption graph (gas content per weight vs. square root of time) for all the samples. The rate at which gas is evolved from the samples is thus comparable at a common scale. The final value represents the standard cubic feet of gas per ton (scf/ton) calculated for the sample, using the combined weight of the coal and dark shale in the sample.

RESULTS and DISCUSSION

The Excello Shale sample at 1041'-1051' contained no coal, hence the Mulky coal, which underlies the Excello Shale, was likely not developed at this locality.

The best constrained data are those associated with the Iron Post (1072'-1074') and Weir-Pittsburg samples (1186'-1189'). The least constrained data are associated with the Rowe coal (1475'-1478'). Nevertheless, the desorption was very long-lived for this sample. All samples contained amounts of coal that are reasonable for determination of gas content, with assumption that the accompanying shales desorb 3 scf/ton.

REFERENCES

Dake, L.P., 1978, Fundamentals of Reservoir Engineering, Elsevier Scientific Publishing, New York, NY, 443 p.

Kissel, F.N., McCulloch, C.M., and Elder, C.H., 1975, The direct method of determining methane content of coals for ventilation design: U.S. Bureau of Mines, Report of Investigations, RI7767.

McLennan, J.D., Schafer, P.S., and Pratt, T.J., 1995, A guide to determining coalbed gas content: Gas Research Institute, Chicago, IL, Reference No. GRI-94/0396, 180 p.

FIGURES and TABLES

Correlation of Field Barometer to KGS Petrophysics Lab Barometer

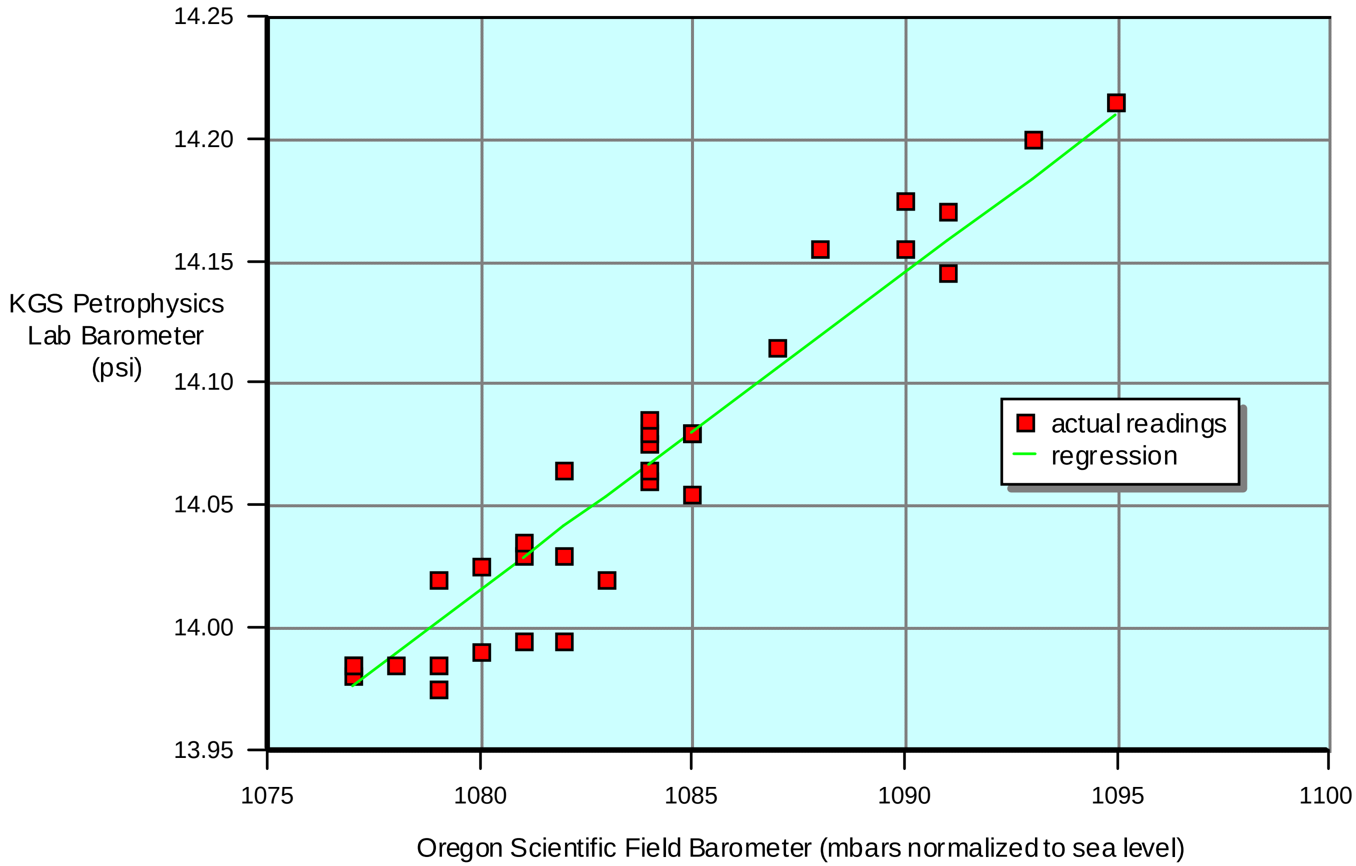


FIGURE 1.

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

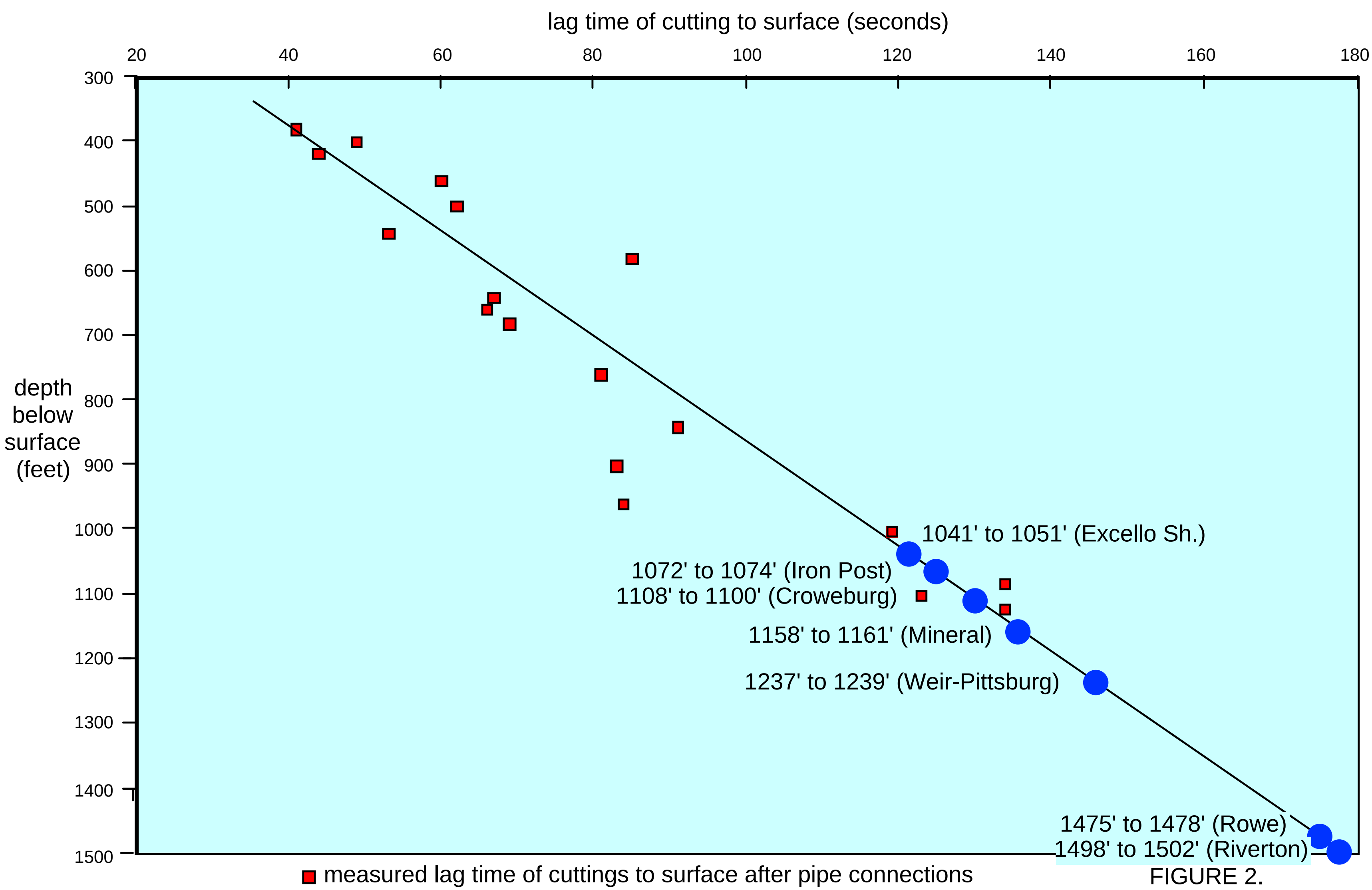
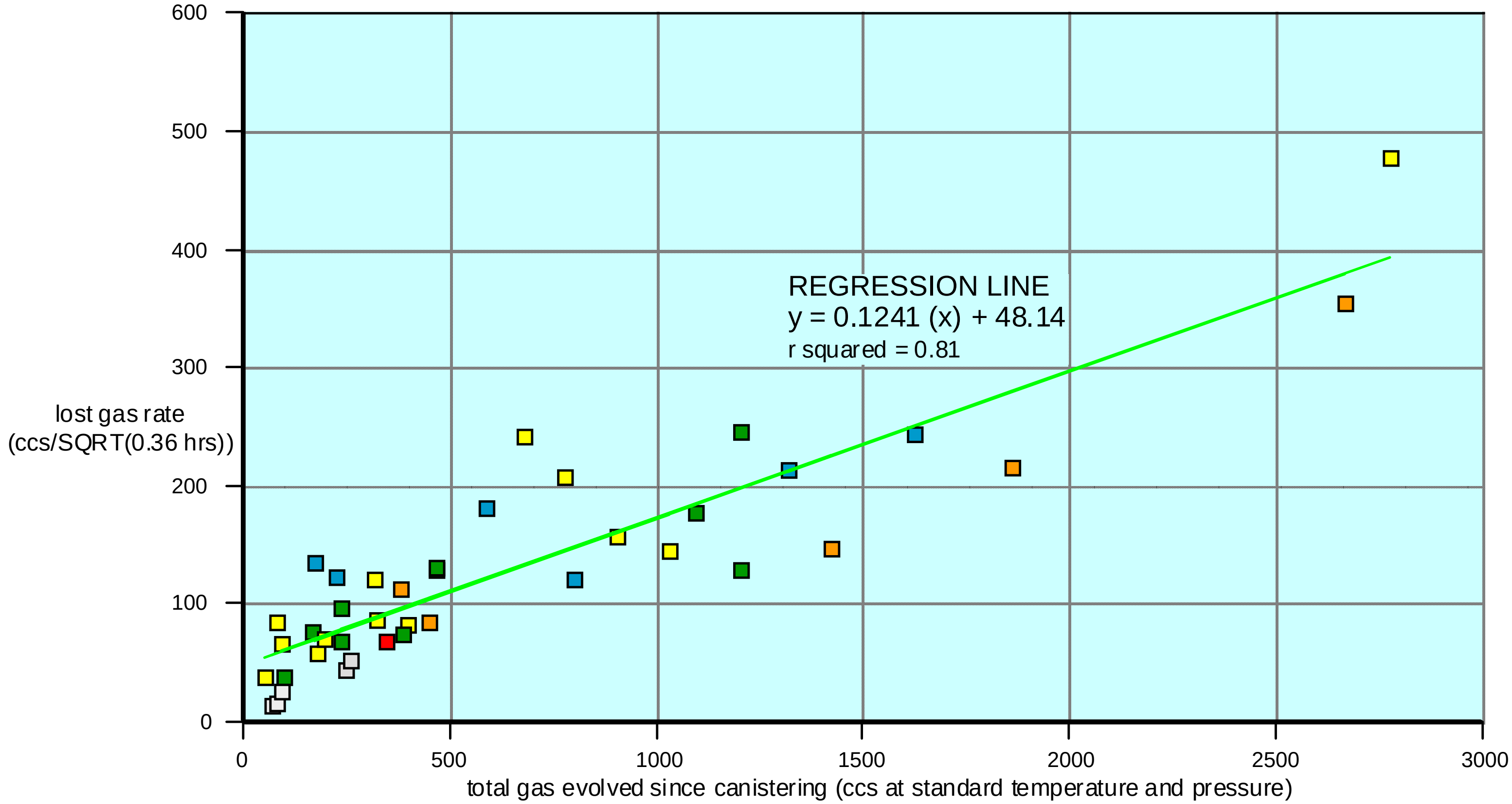
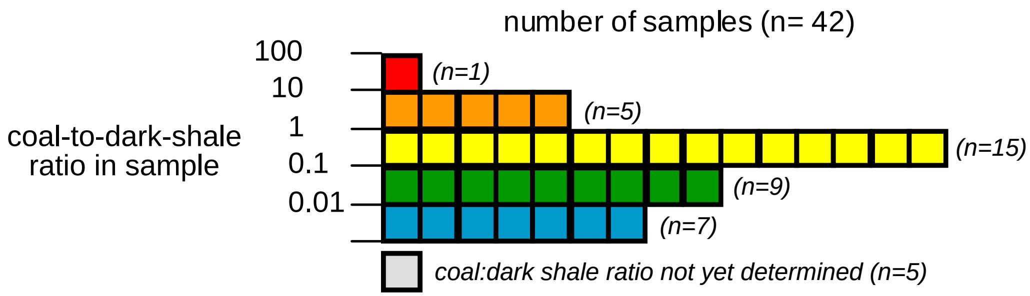


FIGURE 2.

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)





LOST-GAS ALGORITHM

ccs lost gas = $\sqrt{X}$ (Y)

where X = bottom-hole to canister time (in hours)
where Y = ccs lost gas at 0.36 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

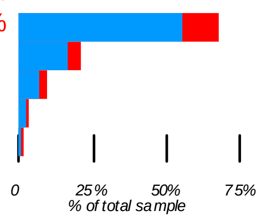
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of Excello Shale from 1041' to 1051'

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

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

TOTAL DRY WEIGHT OF SAMPLE = 1684.41 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 332.59 grams (19.7%)
$\text{weight}_{dark\ shale}$ = 1351.82 grams (80.3%)
weight_{coal} = 0.00 grams (0.0%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930"	1120.19	0.00% / 82.20% / 17.71%
>0.0661"	341.24	0.00% / 79.01% / 9.30%
>0.0460"	159.73	0.00% / 73.33% / 7.72%
>0.0331"	46.48	0.00% / 69.64% / 30.46%
<0.0331"	16.77	0.00% / 65.00% / 35.00%
	1684.41 TOTAL	



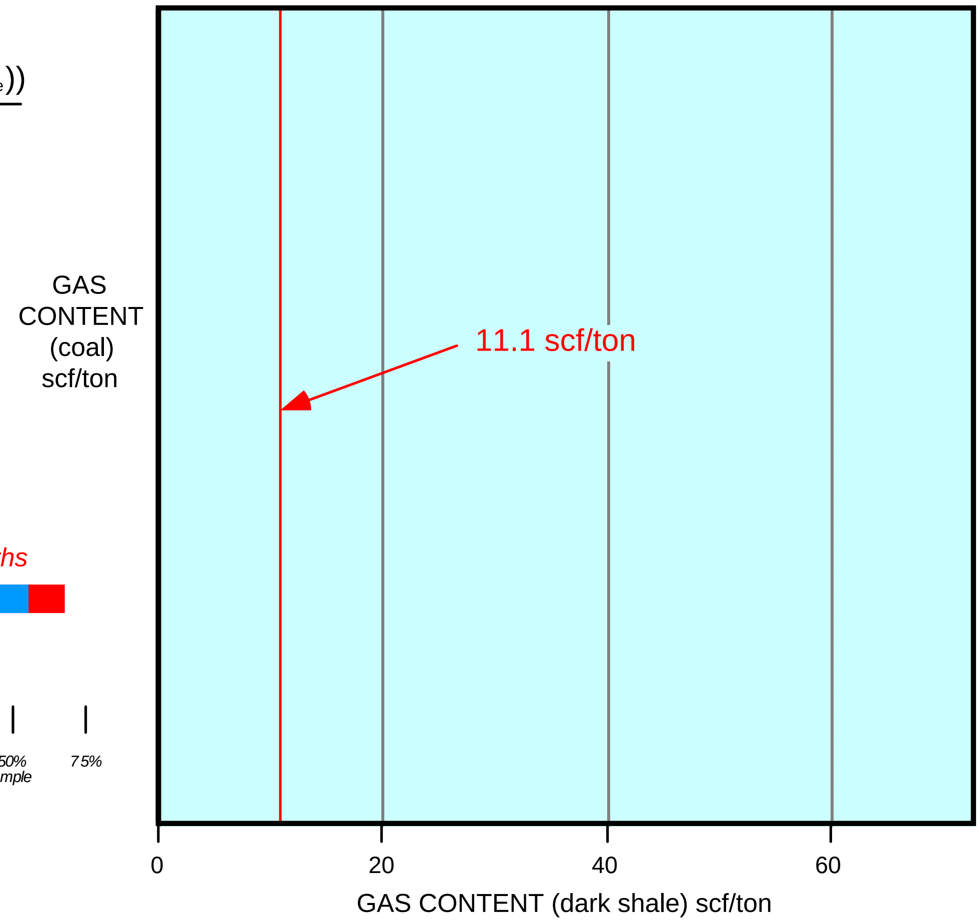


FIGURE 4.

Desorption Characteristics of Cuttings Samples

Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

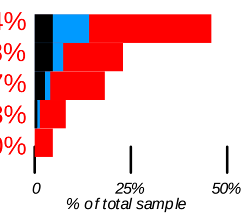
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Iron Post coal from 1072' to 1074'

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

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

TOTAL DRY WEIGHT OF SAMPLE = 390.71 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 280.33 grams (71.8%)
$\text{weight}_{dark\ shale}$ = 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	



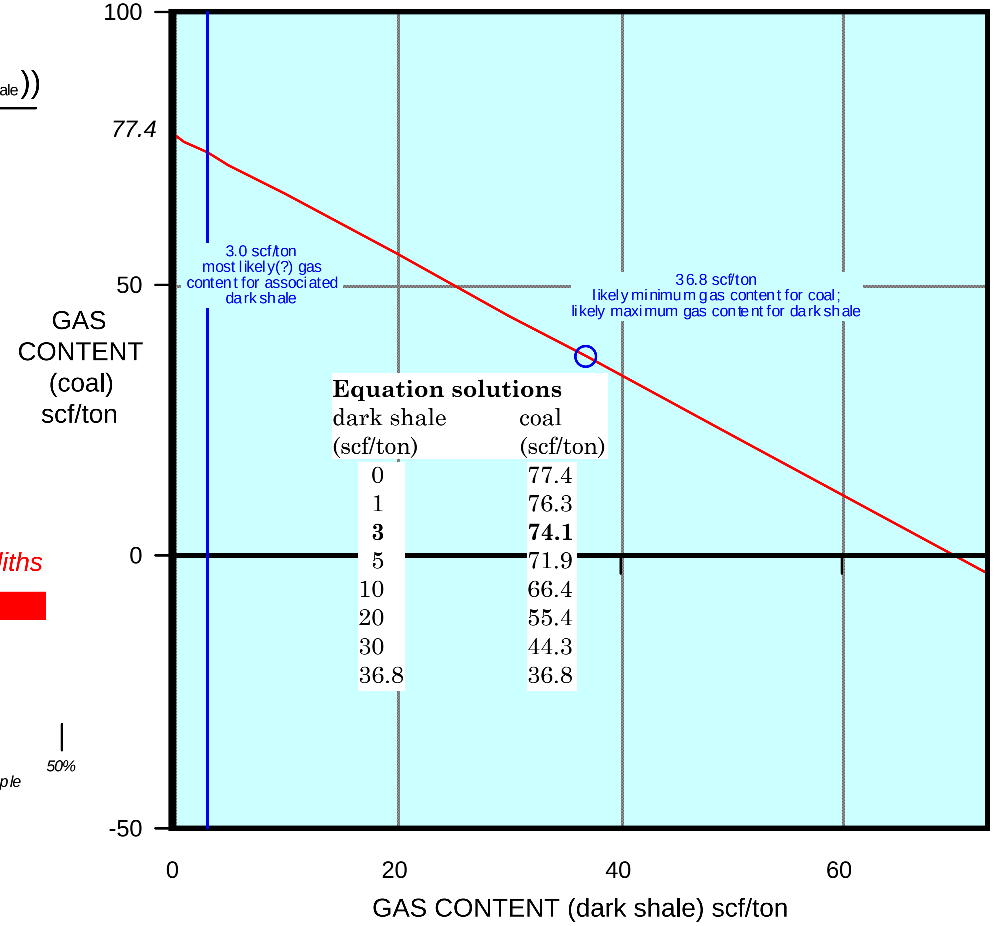


FIGURE 5.

Desorption Characteristics of Cuttings Samples

Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

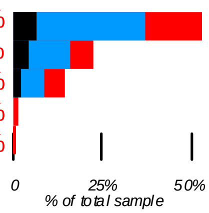
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Croweburg coal from 1108' to 1110'

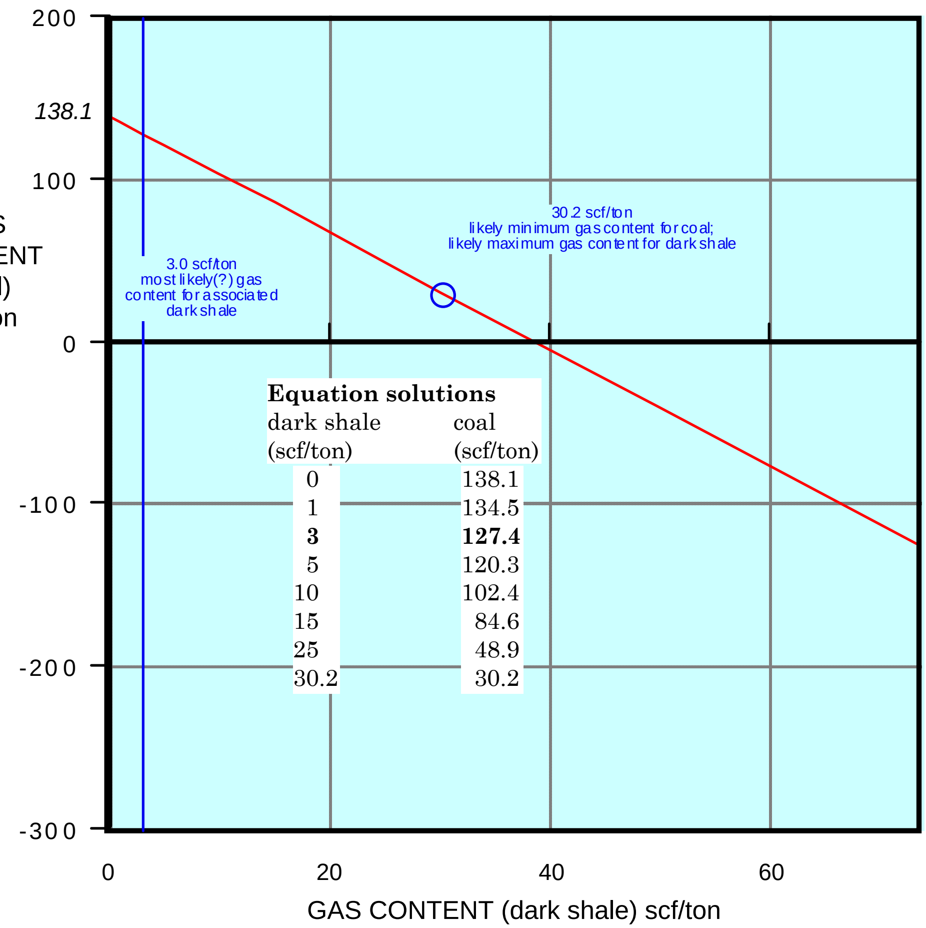
$$\text{GAS CONTENT}_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{dark\ shale}) * (\text{weight}_{dark\ shale}))}{\text{weight}_{coal}}$$

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

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

sieve size	grams	% coal / % dark shale / % light-colored liths
>0.0930"	192.65	12.61% / 56.67% / 30.73%
>0.0661"	72.77	20.89% / 49.53% / 29.58%
>0.0460"	47.34	15.30% / 47.01% / 37.69%
>0.0331"	6.28	8.24% / 17.65% / 74.12%
<0.0331"	3.00	5.00% / 20.00% / 75.00%
	322.04 TOTAL	





Equation solutions

dark shale (scf/ton)	coal (scf/ton)
0	138.1
1	134.5
3	**127.4**
5	120.3
10	102.4
15	84.6
25	48.9
30.2	30.2

FIGURE 6.

Desorption Characteristics of Cuttings Samples

Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

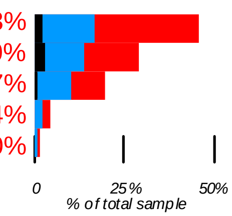
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Mineral coal from 1158' to 1161'

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

total gas desorbed
(including estimated lost gas) = 248.6 ccs

TOTAL DRY WEIGHT OF SAMPLE = 935.21 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 520.74 grams (55.7%)
$\text{weight}_{dark\ shale}$ = 357.76 grams (38.3%)
weight_{coal} = 56.71 grams (6.1%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>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%
	935.21 TOTAL	



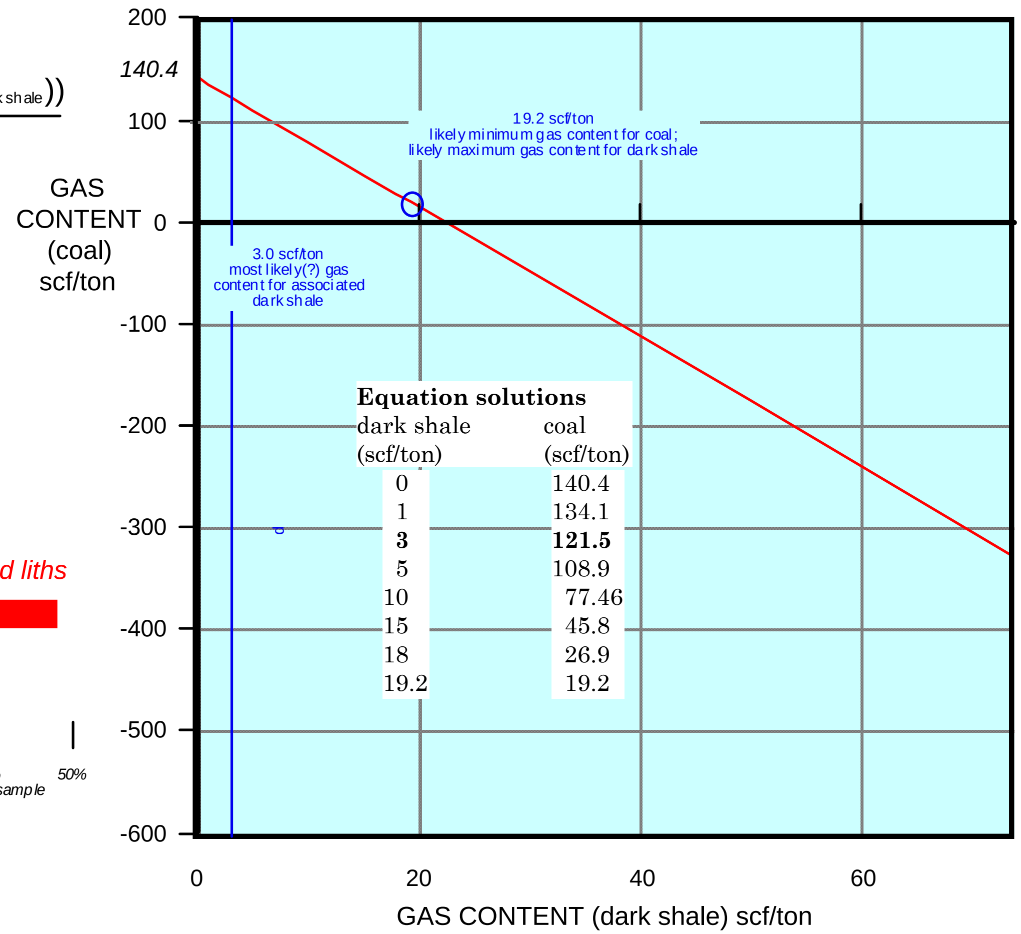


FIGURE 7.

Desorption Characteristics of Cuttings Samples

Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

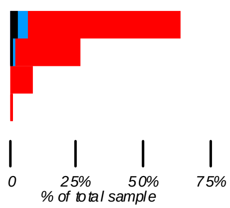
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Weir-Pittsburg coal from 1237' to 1239'

$$\text{GAS CONTENT}_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{darkshale}) * (\text{weight}_{darkshale}))}{\text{weight}_{coal}}$$

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

TOTAL DRY WEIGHT OF SAMPLE = 314.62 grams
$\text{weight}_{\text{light-colored lithologies}}$ = 284.51 grams (90.4%)
$\text{weight}_{\text{darkshale}}$ = 15.65 grams (5.0%)
$\text{weight}_{\text{coal}}$ = 14.46 grams (4.6%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930"	197.63	5.16% / 6.04% / 88.80%
>0.0661"	83.62	4.46% / 3.27% / 92.27%
>0.0460"	28.40	1.76% / 3.23% / 95.01%
>0.0331"	3.48	0.70% / 1.40% / 97.91%
<0.0331"	1.49	0.60% / 1.20% / 98.20%
	314.62 TOTAL	



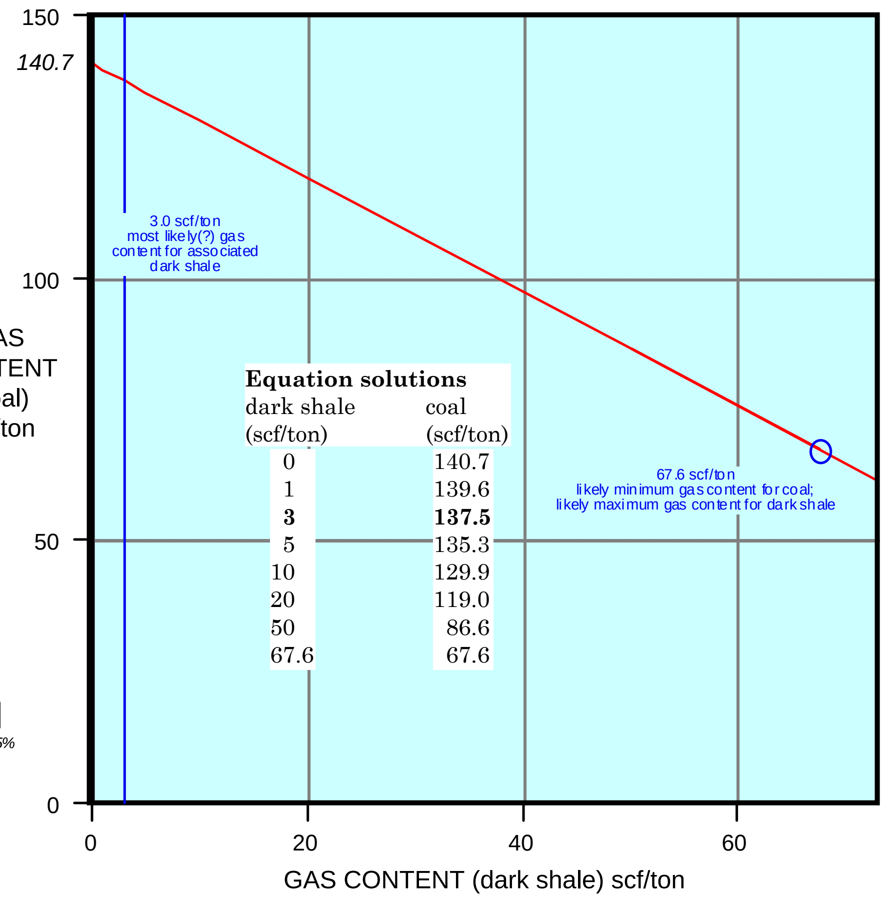


FIGURE 8.

Desorption Characteristics of Cuttings Samples

Dart Cherokee Basin #A3-36 Fields, NW NE 36-T.34S.-R.14E., Montgomery County, KS

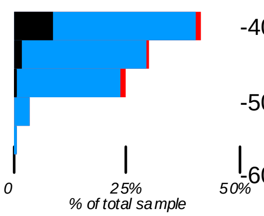
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Rowe coal from 1475' to 1478'

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

total gas desorbed
(including estimated lost gas) = 2056.5 ccs

TOTAL DRY WEIGHT OF SAMPLE = 2240.20 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 64.54 grams (2.9%)
$\text{weight}_{dark\ shale}$ = 1930.28 grams (86.2%)
weight_{coal} = 245.38 grams (11.0%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>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%
	2240.20 TOTAL	



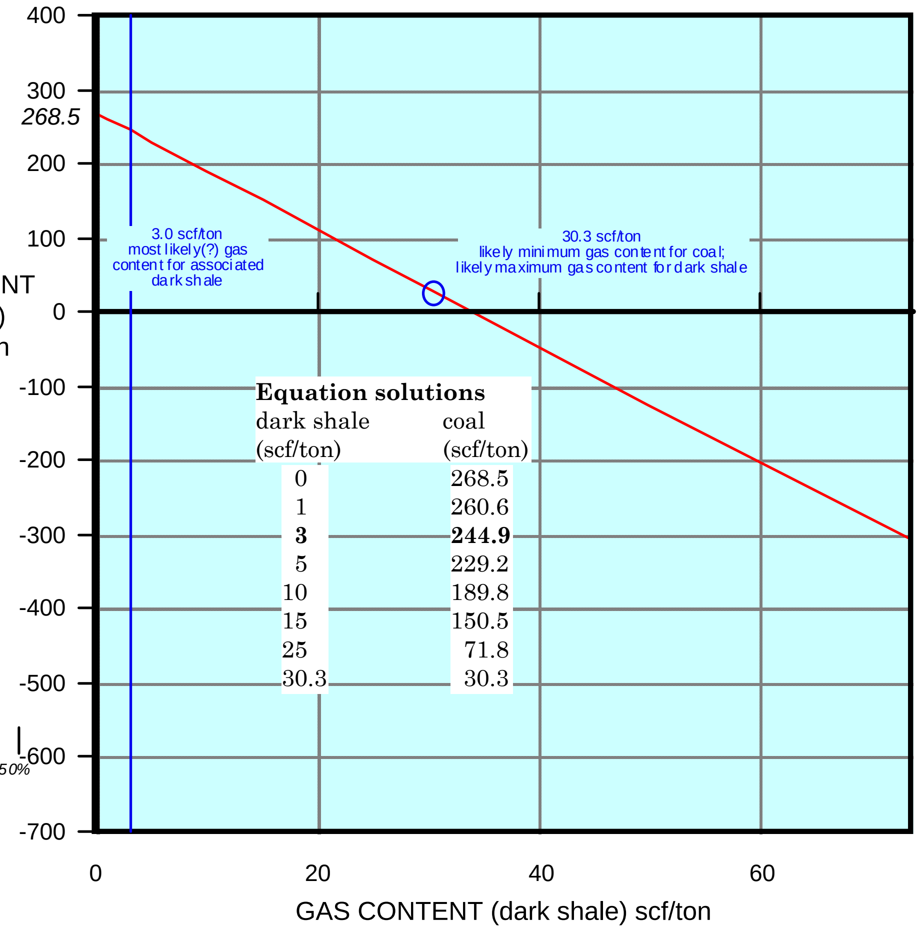


FIGURE 9.

Desorption Characteristics of Cuttings Samples

Dart Cherokee Basin #A3-36 Fields, 36-T.34S.-R.14E., Montgomery County, KS

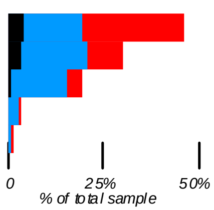
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Riverton coal from 1498' to 1502'

$$\text{GAS CONTENT}_{coal} = \frac{\text{total gas desorbed} - ((\text{gas content}_{dark\,shale}) * (\text{weight}_{dark\,shale}))}{\text{weight}_{coal}}$$

total gas desorbed
(including estimated lost gas) = 627.1 ccs

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



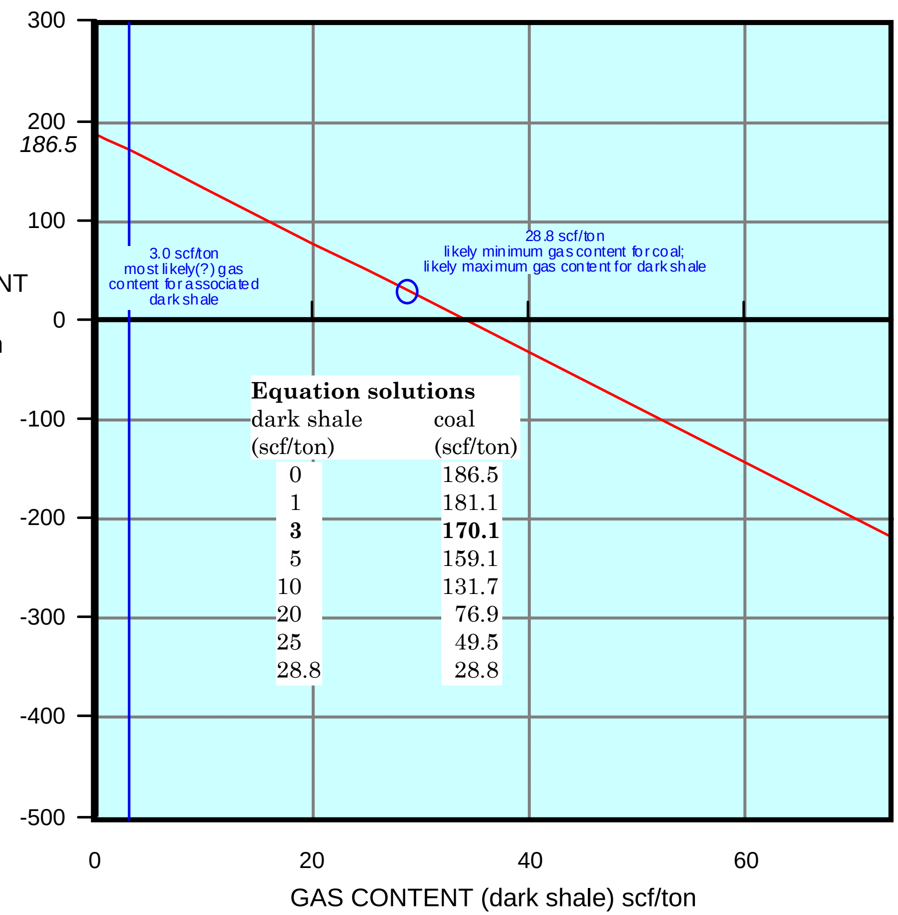


FIGURE 10.

surface
100'
200'
300'
400'
500'
600'
700'
800'
900'
1000'

1041'-1051' Excello Shale
1072'-1074' Iron Post
1108'-1110' Croweburg
1158'-1161' Mineral

1200'

1237'-1239' Weir-Pittsburg

1400'

1475'-1478' Rowe
1498'-1502' Riverton

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

UNIT	coal in sample	scf/ton w/ shale @ 3 scf/ton	maximum scf/ton	minimum scf/ton
Excello Shale	----	----	----	11.1
Iron Post	13%	74.1	77.4	36.8
Croweburg	15%	127.4	138.1	30.2
Mineral	6%	121.5	140.4	19.2
Weir-Pittsburg	5%	137.5	140.7	67.6
Rowe	11%	244.9	268.5	30.3
Riverton	9%	170.1	186.5	28.8

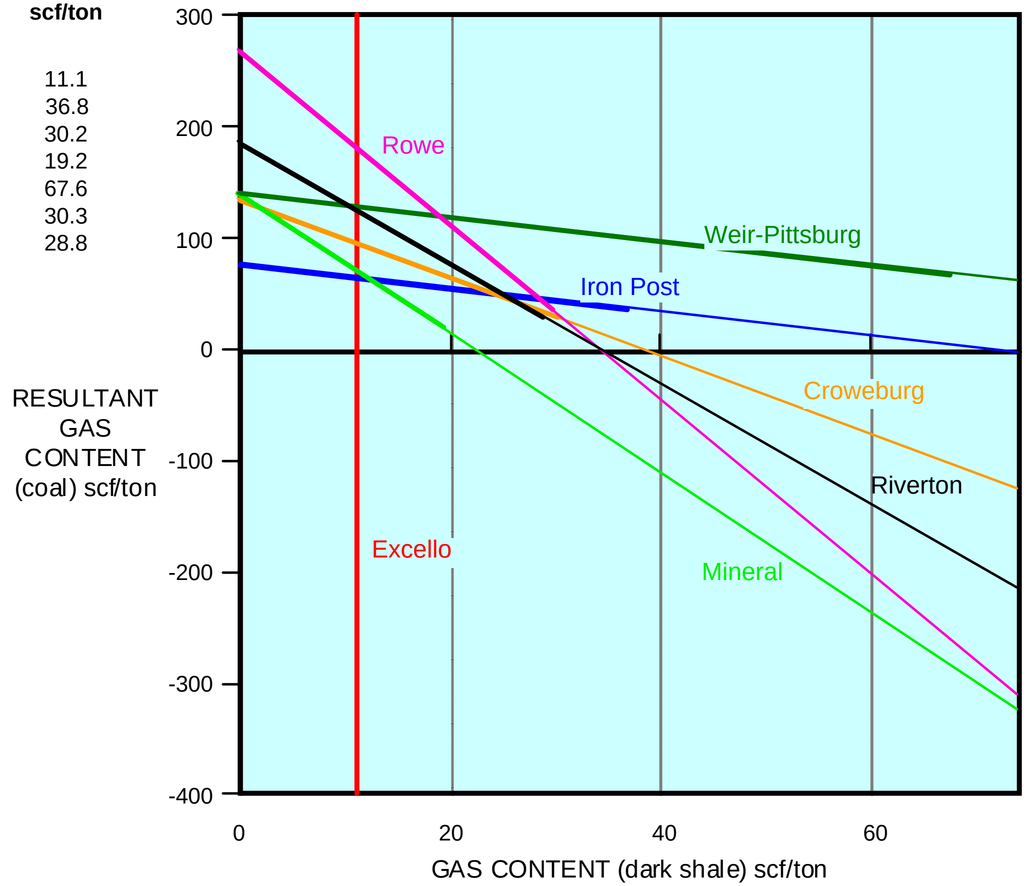


FIGURE 11.

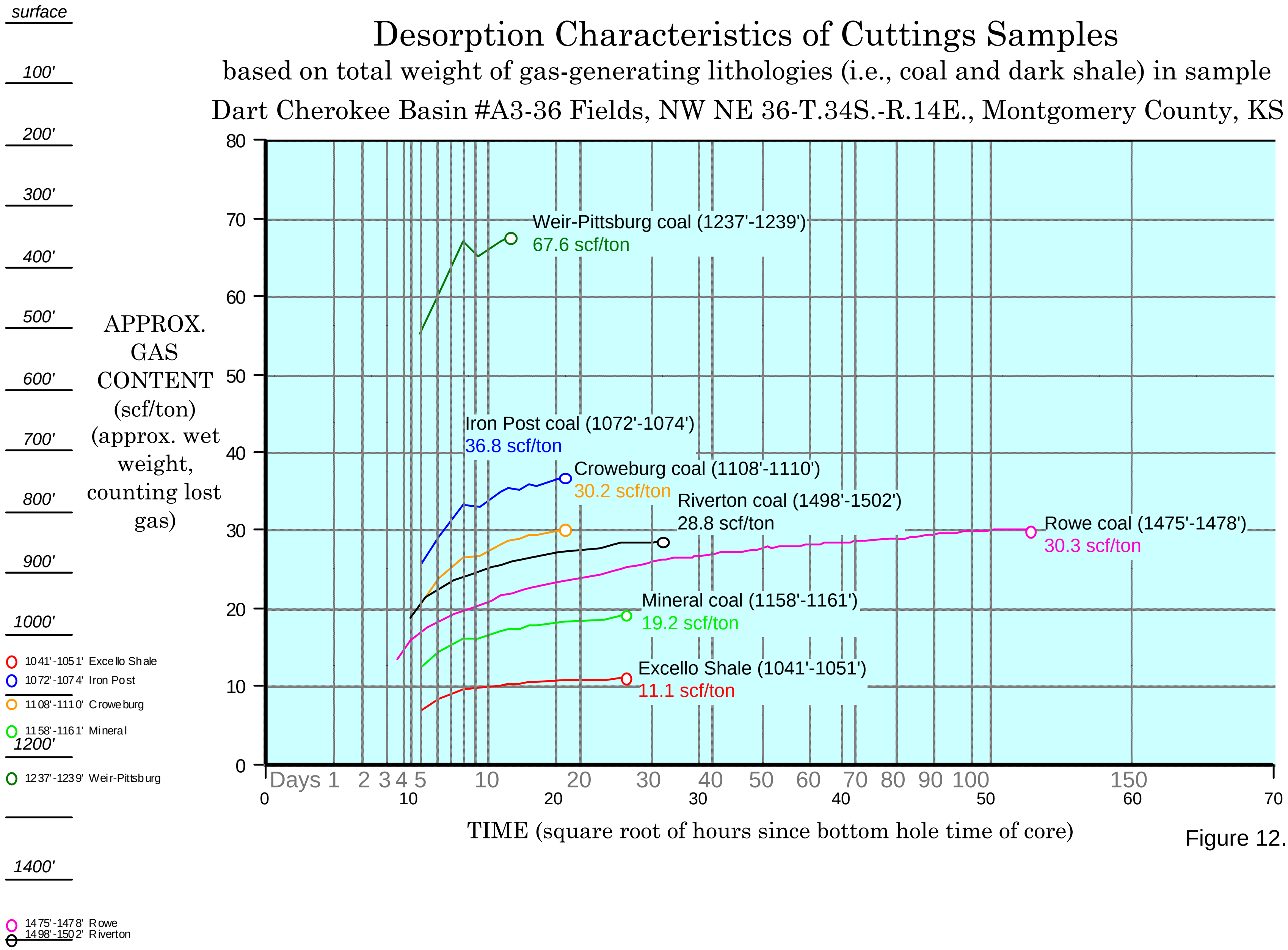

Desorption Characteristics of Cuttings Samples
based on total weight of gas-generating lithologies (i.e., coal and dark shale) in sample
Dart Cherokee Basin #A3-36 Fields, NW NE 36-T.34S.-R.14E., Montgomery County, KS
surface
100'
200'
300'
400'
500'
600'
700'
800'
900'
1000'
1200'
1400'
1041'-1051' Excello Shale
1072'-1074' Iron Post
1108'-1110' Croweburg
1158'-1161' Mineral
1237'-1239' Weir-Pittsburg
1475'-1478' Rowe
1498'-1502' Riverton
APPROX. GAS CONTENT (scf/ton) (approx. wet weight, counting lost gas)
0
10
20
30
40
50
60
70
80
Weir-Pittsburg coal (1237'-1239')
67.6 scf/ton
Iron Post coal (1072'-1074')
36.8 scf/ton
Croweburg coal (1108'-1110')
30.2 scf/ton
Riverton coal (1498'-1502')
28.8 scf/ton
Rowe coal (1475'-1478')
30.3 scf/ton
Mineral coal (1158'-1161')
19.2 scf/ton
Excello Shale (1041'-1051')
11.1 scf/ton
Days 1 2 3 4 5 10 20 30 40 50 60 70 80 90 100 150
0 10 20 30 40 50 60 70
TIME (square root of hours since bottom hole time of core)

Figure 12.

TABLE 1 -- Desorption data for DART CHEROKEE BASIN FIELDS #A3-36; NW NE 36-T.34S.-R.14E., Montgomery Co., KS

SAMPLE:	1041' to 1051' (Excello Shale) cuttings in SSD canister 9										NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved					
		lbs.	grams								est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
dry sample weight:		2.9803	1351.82								26	off bottom	at surface	in canister	3.9	minutes
												3/10/2005 13:27	3/10/2005 13:29	############	0.066	hours
RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		0.256038192	SQRT (hrs)
measured cc	measured T (F	measured (	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)	
288	70	1089	0.0102	530	14.135	0.00959506	271.70	0.00959506	271.70	6.44	7.06	3/15/2005 11:15	117:47:51	117:43:55	10.85345567	
66	71	1086	0.0023	531	14.096	0.002188681	61.98	0.011783741	333.68	7.91	8.52	3/16/2005 12:43	143:15:51	143:11:55	11.96930101	
45	69	1071	0.0016	529	13.901	0.001477235	41.83	0.013260976	375.51	8.90	9.52	3/18/2005 10:31	189:03:51	188:59:55	13.75006061	
12	68	1084	0.0004	528	14.070	0.000399466	11.31	0.013660442	386.82	9.17	9.78	3/19/2005 16:36	219:08:51	219:04:55	14.80363131	
17	68	1075	0.0006	528	13.953	0.000561212	15.89	0.014221654	402.71	9.54	10.16	3/21/2005 14:06	264:38:51	264:34:55	16.26799004	
7	68	1075	0.0002	528	13.953	0.000231087	6.54	0.014452741	409.25	9.70	10.32	3/22/2005 9:20	283:52:51	283:48:55	16.84876356	
4	68	1081	0.0001	528	14.031	0.000132787	3.76	0.014585527	413.01	9.79	10.40	3/23/2005 12:46	311:18:51	311:14:55	17.64409722	
6	70	1077	0.0002	530	13.979	0.000197694	5.60	0.014783222	418.61	9.92	10.54	3/24/2005 12:32	335:04:51	335:00:55	18.30521328	
3	69	1082	0.0001	529	14.044	9.94938E-05	2.82	0.014882716	421.43	9.99	10.60	3/25/2005 9:21	355:53:51	355:49:55	18.86524582	
11	70	1075	0.0004	530	13.953	0.000361767	10.24	0.015244482	431.67	10.23	10.85	3/28/2005 9:37	428:09:51	428:05:55	20.69212813	
3	69	1084	0.0001	529	14.070	9.96777E-05	2.82	0.01534416	434.50	10.30	10.91	4/2/2005 15:49	554:21:51	554:17:55	23.5449393	
6	69	1072	0.0002	529	13.914	0.000197149	5.58	0.015541309	440.08	10.43	11.05	4/4/2005 14:13	600:45:51	600:41:55	24.51049095	
3	70	1071	0.0001	530	13.901	9.82965E-05	2.78	0.015639605	442.86	10.50	11.11	4/5/2005 12:12	622:44:51	622:40:55	24.95490934	
0	71	1075	0	531	13.953	0	0.00	0.015639605	442.86	10.50	11.11	4/6/2005 9:25	643:57:51	643:53:55	25.37644906	
-2	71	1084	-7E-05	531	14.070	-6.62015E-05	-1.87	0.015573403	440.99	10.45	11.07	4/8/2005 9:22	691:54:51	691:50:55	26.30426138	
DESORPTION TERMINATED 4/08/2005 DUE TO NO GAS BEING EVOLVED, sample dried at 150 degrees F for 2 days																
SAMPLE:	1072' to 1074' (Iron Post coal) cuttings in SSD canister 6										NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved					
		lbs.	grams								est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
dry sample weight:		0.2433	110.38								15	off bottom	at surface	in canister	3.7	minutes
												3/10/2005 13:49	3/10/2005 13:51	############	0.061	hours
RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		0.247206616	SQRT (hrs)
measured cc	measured T (F	measured (	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)	
78	70	1089	0.0028	530	14.135	0.002598662	73.59	0.002598662	73.59	21.36	25.71	3/15/2005 11:38	117:48:25	117:44:45	10.85389075	
13	71	1086	0.0005	531	14.096	0.000431104	12.21	0.003029766	85.79	24.90	29.26	3/16/2005 12:44	142:54:25	142:50:45	11.95436926	
15	69	1071	0.0005	529	13.901	0.000492412	13.94	0.003522178	99.74	28.95	33.30	3/18/2005 10:32	188:42:25	188:38:45	13.73706462	
-1	68	1084	-4E-05	528	14.070	-3.32888E-05	-0.94	0.003488889	98.79	28.67	33.03	3/19/2005 16:36	218:46:25	218:42:45	14.79099764	
7	68	1075	0.0002	528	13.953	0.000231087	6.54	0.003719976	105.34	30.57	34.93	3/21/2005 14:07	264:17:25	264:13:45	16.25700704	
2	68	1075	7E-05	528	13.953	6.60249E-05	1.87	0.003786001	107.21	31.12	35.47	3/22/2005 9:22	283:32:25	283:28:45	16.83865427	
-1	68	1081	-4E-05	528	14.031	-3.31967E-05	-0.94	0.003752804	106.27	30.84	35.20	3/23/2005 12:47	310:57:25	310:53:45	17.63397132	
3	70	1077	0.0001	530	13.979	9.88472E-05	2.80	0.003851651	109.07	31.66	36.01	3/24/2005 12:33	334:43:25	334:39:45	18.29545329	
-1	69	1082	-4E-05	529	14.044	-3.31646E-05	-0.94	0.003818487	108.13	31.38	35.74	3/25/2005 9:21	355:31:25	355:27:45	18.85533376	
4	70	1075	0.0001	530	13.953	0.000131551	3.73	0.003950038	111.85	32.46	36.82	3/28/2005 9:38	427:48:25	427:44:45	20.68349449	
-4	69	1084	-0.0001	529	14.070	-0.000132904	-3.76	0.003817135	108.09	31.37	35.73	4/2/2005 15:45	553:55:25	553:51:45	23.53558181	
DESORPTION TERMINATED 4/02/2005 DUE TO NO GAS BEING EVOLVED, sample air dried for 8 days																
SAMPLE:	1108' to 1110' (Croweburg coal) cuttings in SSD canister Null										NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved					
		lbs.	grams								est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
dry sample weight:		0.4775	216.58								21	off bottom	at surface	in canister	5.1	minutes
												3/10/2005 14:09	3/10/2005 14:11	############	0.085	hours
RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		0.291070820	SQRT (hrs)
measured cc	measured T (F	measured (	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)	
127	70	1089	0.0045	530	14.135	0.004231155	119.81	0.004231155	119.81	17.72	20.83	3/15/2005 11:25	117:15:40	117:10:35	10.82871697	
21	71	1086	0.0007	531	14.096	0.000696398	19.72	0.004927553	139.53	20.64	23.75	3/16/2005 12:45	142:35:40	142:30:35	11.94129157	
20	69	1071	0.0007	529	13.901	0.000656549	18.59	0.005584102	158.12	23.39	26.50	3/18/2005 10:32	188:22:40	188:17:35	13.72507843	
2	68	1084	7E-05	528	14.070	6.65777E-05	1.89	0.00565068	160.01	23.67	26.78	3/19/2005 16:37	218:27:40	218:22:35	14.78043	
10	68	1075	0.0004	528	13.953	0.000330124	9.35	0.005980804	169.36	25.05	28.16	3/21/2005 14:08	263:58:40	263:53:35	16.24739295	
4	68	1075	0.0001	528	13.953	0.00013205	3.74	0.006112854	173.10	25.60	28.71	3/22/2005 9:21	283:11:40	283:06:35	16.82838211	
1	68	1081	4E-05	528	14.031	3.31967E-05	0.94	0.006146051	174.04	25.74	28.85	3/23/2005 12:47	310:37:40	310:32:35	17.62463554	
4	70	1077	0.0001	530	13.979	0.000131796	3.73	0.006277847	177.77	26.30	29.40	3/24/2005 12:34	334:24:40	334:19:35	18.28691092	
0	69	1082	0	529	14.044	0	0.00	0.006277847	177.77	26.30	29.40	3/25/2005 9:20	355:10:40	355:05:35	18.84616082	
6	70	1075	0.0002	530	13.953	0.000197327	5.59	0.006475174	183.36	27.12	30.23	3/28/2005 9:38	427:28:40	427:23:35	20.67553573	
-5	69	1084	-0.0002	529	14.070	-0.00016613	-4.70	0.006309045	178.65	26.43	29.53	4/2/2005 15:46	553:36:40	553:31:35	23.52894199	
DESORPTION TERMINATED 4/02/2005 DUE TO NO GAS BEING EVOLVED, sample air dried for 8 days																

SAMPLE: 1158' to 1161' (Mineral coal) cuttings in SSD canister 1

NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved

	lbs.	grams
dry sample weight:	0.9138	414.47

est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
23	off bottom	at surface	in canister	5.4	minutes
	3/10/2005 14:34	3/10/2005 14:37	############	0.089	hours
				0.298607881	SQRT (hrs)

RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		
measured cc	measured T (F	measured I	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)
147	70	1089	0.0052	530	14.135	0.004897479	138.68	0.004897479	138.68	10.72	12.50	3/15/2005 11:12	116:37:06	116:31:45	10.79899687
27	71	1086	0.001	531	14.096	0.000895369	25.35	0.005792848	164.03	12.68	14.46	3/16/2005 12:45	142:10:06	142:04:45	11.92343631
22	69	1071	0.0008	529	13.901	0.000722204	20.45	0.006515052	184.49	14.26	16.04	3/18/2005 10:38	188:03:06	187:57:45	13.71319316
3	68	1084	0.0001	528	14.070	9.98665E-05	2.83	0.006614918	187.31	14.48	16.26	3/19/2005 16:38	218:03:06	217:57:45	14.76657261
11	68	1075	0.0004	528	13.953	0.000363137	10.28	0.006978055	197.60	15.27	17.05	3/21/2005 14:08	263:33:06	263:27:45	16.23427444
3	68	1075	0.0001	528	13.953	9.90373E-05	2.80	0.007077093	200.40	15.49	17.27	3/22/2005 9:22	282:47:06	282:41:45	16.81621242
2	68	1081	7E-05	528	14.031	6.63934E-05	1.88	0.007143486	202.28	15.64	17.41	3/23/2005 12:49	310:14:06	310:08:45	17.61348915
5	70	1077	0.0002	530	13.979	0.000164745	4.67	0.007308231	206.95	16.00	17.77	3/24/2005 12:34	333:59:06	333:53:45	18.2752565
1	69	1082	4E-05	529	14.044	3.31646E-05	0.94	0.007341396	207.88	16.07	17.85	3/25/2005 9:20	354:45:06	354:39:45	18.83485245
8	70	1075	0.0003	530	13.953	0.000263103	7.45	0.007604499	215.33	16.64	18.42	3/28/2005 9:39	427:04:06	426:58:45	20.66563169
3	69	1084	0.0001	529	14.070	9.96777E-05	2.82	0.007704177	218.16	16.86	18.64	4/2/2005 15:49	553:14:06	553:08:45	23.52094811
6	69	1072	0.0002	529	13.914	0.000197149	5.58	0.007901325	223.74	17.29	19.07	4/4/2005 14:13	599:38:06	599:32:45	24.48744576
2	70	1071	7E-05	530	13.901	6.5531E-05	1.86	0.007966856	225.60	17.44	19.22	4/5/2005 12:11	621:36:06	621:30:45	24.93194069
0	71	1075	0	531	13.953	0	0.00	0.007966856	225.60	17.44	19.22	4/6/2005 9:25	642:50:06	642:44:45	25.35419098
-1	71	1084	-4E-05	531	14.070	-3.31008E-05	-0.94	0.007933755	224.66	17.37	19.14	4/8/2005 9:22	690:47:06	690:41:45	26.28278905

DESORPTION TERMINATED 4/08/2005 DUE TO NO GAS BEING EVOLVED, sample dried at 150 degrees F for 2 days

SAMPLE: 1237' to 1239' (Weir-Pittsburg coal) cuttings in Dart SSD canister 4

NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved

	lbs.	grams
dry sample weight:	0.0664	30.11

est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
16	off bottom	at surface	in canister	5.5	minutes
	3/10/2005 15:03	3/10/2005 15:07	############	0.092	hours
				0.304138126	SQRT (hrs)

RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		
measured cc	measured T (F	measured I	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)
38	70	1089	0.0013	530	14.135	0.001266015	35.85	0.001266015	35.85	38.14	55.16	3/15/2005 11:22	116:18:11	116:12:38	10.78438944
5	71	1086	0.0002	531	14.096	0.000165809	4.70	0.001431824	40.54	43.13	60.16	3/16/2005 12:46	141:42:11	141:36:38	11.90390926
7	69	1071	0.0002	529	13.901	0.000229792	6.51	0.001661616	47.05	50.06	67.08	3/18/2005 10:34	187:30:11	187:24:38	13.69317551
-2	68	1084	-7E-05	528	14.070	-6.65777E-05	-1.89	0.001595038	45.17	48.05	65.07	3/19/2005 16:38	217:34:11	217:28:38	14.75024482
2	68	1075	7E-05	528	13.953	6.60249E-05	1.87	0.001661063	47.04	50.04	67.06	3/21/2005 14:09	263:05:11	262:59:38	16.21993801
0.5	68	1075	2E-05	528	13.953	1.65062E-05	0.47	0.00167757	47.50	50.54	67.56	3/22/2005 9:22	282:18:11	282:12:38	16.80187655
-2	68	1081	-7E-05	528	14.031	-6.63934E-05	-1.88	0.001611176	45.62	48.54	65.56	3/23/2005 12:49	309:45:11	309:39:38	17.59980271
1	70	1077	4E-05	530	13.979	3.29491E-05	0.93	0.001644125	46.56	49.53	66.55	3/24/2005 12:35	333:31:11	333:25:38	18.26252234

DESORPTION TERMINATED 3/24/2005 DUE TO NO GAS BEING EVOLVED, sample air dried for 16 days

SAMPLE: 1475' to 1478' (Rowe coal) cuttings in SSD canister 3

NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved

	lbs.	grams
dry sample weight:	4.7965	2175.66

est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
114	off bottom	at surface	in canister	9.3	minutes
	3/11/2005 8:54	3/11/2005 8:57	3/11/2005 9:03	0.155	hours
				0.393700394	SQRT (hrs)

RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		
measured cc	measured T (F	measured I	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)
850	69	1085	0.03	529	14.083	0.028268073	800.46	0.028268073	800.46	11.79	13.47	3/14/2005 18:44	81:49:30	81:40:12	9.045717219
175	70	1089	0.0062	530	14.135	0.005830332	165.10	0.034098404	965.56	14.22	15.90	3/15/2005 11:06	98:11:30	98:02:12	9.909170836
118	71	1086	0.0042	531	14.096	0.003913096	110.81	0.038011501	1076.36	15.85	17.53	3/16/2005 12:46	123:51:30	123:42:12	11.12916589
121	69	1071	0.0043	529	13.901	0.00397212	112.48	0.041983621	1188.84	17.51	19.18	3/18/2005 10:34	169:39:30	169:30:12	13.0252959
66	68	1084	0.0023	528	14.070	0.002197063	62.21	0.044180684	1251.05	18.42	20.10	3/19/2005 16:39	199:44:30	199:35:12	14.13299921
71	68	1075	0.0025	528	13.953	0.002343884	66.37	0.046524568	1317.42	19.40	21.08	3/21/2005 14:09	245:14:30	245:05:12	15.6601937
37	68	1075	0.0013	528	13.953	0.001221461	34.59	0.047746028	1352.01	19.91	21.59	3/22/2005 9:23	264:28:30	264:19:12	16.26268735
32	68	1081	0.0011	528	14.031	0.001062295	30.08	0.048808323	1382.09	20.35	22.03	3/23/2005 12:50	291:55:30	291:46:12	17.08581283
29	70	1077	0.001	530	13.979	0.000955523	27.06	0.049763845	1409.15	20.75	22.43	3/24/2005 12:36	315:41:30	315:32:12	17.76771417
21	69	1082	0.0007	529	14.044	0.000696457	19.72	0.050460302	1428.87	21.04	22.72	3/25/2005 9:19	336:24:30	336:15:12	18.3414376
53	70	1075	0.0019	530	13.953	0.001743057	49.36	0.052203359	1478.23	21.77	23.45	3/28/2005 9:39	408:44:30	408:35:12	20.21736053
65	69	1084	0.0023	529	14.070	0.002159684	61.16	0.054363043	1539.38	22.67	24.35	4/2/2005 15:47	534:52:30	534:43:12	23.12736474
37	69	1072	0.0013	529	13.914	0.001215749	34.43	0.055578793	1573.81	23.17	24.85	4/4/2005 14:14	581:19:30	581:10:12	24.11068228
18	70	1071	0.0006	530	13.901	0.000589779	16.70	0.056168572	1590.51	23.42	25.10	4/5/2005 12:11	603:16:30	603:07:12	24.56165711
13	71	1075	0.0005	531	13.953	0.000426737	12.08	0.056595309	1602.59	23.60	25.28	4/6/2005 9:26	624:31:30	624:22:12	24.99049819
17	71	1084	0.0006	531	14.070	0.000562713	15.93	0.057158022	1618.53	23.83	25.51	4/8/2005 9:21	672:26:30	672:17:12	25.93148023
17	69	1073	0.0006	529	13.927	0.000559109	15.83	0.05771713	1634.36	24.07	25.74	4/9/2005 14:20	701:25:30	701:16:12	26.48442939
16	70	1074	0.0006	530	13.940	0.000525716	14.89	0.058242847	1649.25	24.29	25.96	4/10/2005 10:21	721:26:30	721:17:12	26.85966617
16	71	1066	0.0006	531	13.836	0.000520818	14.75	0.058763665	1664.00	24.50	26.18	4/11/2005 17:03	752:08:30	751:59:12	27.42520131
9	73	1075	0.0003	533	13.953	0.000294325	8.33	0.05905799	1672.33	24.63	26.30	4/12/2005 14:12	773:17:30	773:08:12	27.80812231
6	73	1085	0.0002	533	14.083	0.000198042	5.61	0.059256031	1677.94	24.71	26.39	4/13/2005 12:20	795:25:30	795:16:12	28.20327995
8	69	1091	0.0003	529	14.161	0.000267524	7.58	0.059523555	1685.51	24.82	26.50	4/15/2005 10:59	842:04:30	841:55:12	29.01852856
8	70	1089	0.0003	530	14.135	0.000266529	7.55	0.059790085	1693.06	24.93	26.61	4/16/2005 15:44	870:49:30	870:40:12	29.50974415
7	71	1089	0.0002	531	14.135	0.000232774	6.59	0.060022859	1699.65	25.03	26.71	4/17/2005 10:55	890:00:30	889:51:12	29.83300745
11	72	1082	0.0004	532	14.044	0.000362753	10.27	0.060385612	1709.92	25.18	26.86	4/18/2005 11:22	914:27:30	914:18:12	30.24001213
13	69	1076	0.0005	529	13.966	0.000428749	12.14	0.060814361	1722.06	25.36	27.04	4/20/2005 21:06	972:11:30	972:02:12	31.17998824
8	70	1072	0.0003	530	13.914	0.000262369	7.43	0.06107673	1729.49	25.47	27.15	4/21/2005 17:08	992:13:30	992:04:12	31.49960317
3	67	1081	0.0001	527	14.031	9.97791E-05	2.83	0.061176509	1732.32	25.51	27.19	4/22/2005 16:04	1015:09:30	1015:00:12	31.86154945
-4	64	1091	-0.0001	524	14.161	-0.000135038	-3.82	0.061041471	1728.50	25.45	27.13	4/23/2005 10:47	1033:52:30	1033:43:12	32.15392667
1	63	1083	4E-05	523	14.057	3.35761E-05	0.95	0.061075047	1729.45	25.47	27.15	4/24/2005 13:40	1060:45:30	1060:36:12	32.56928512
14	68	1071	0.0005	528	13.901	0.000460455	13.04	0.061535501	1742.48	25.66	27.34	4/25/2005 19:26	1090:31:30	1090:22:12	33.02309798
4	66	1082	0.0001	526	14.044	0.000133415	3.78	0.061668916	1746.26	25.71	27.39	4/27/2005 16:57	1136:02:30	1135:53:12	33.7052172
10	68	1080	0.0004	528	14.018	0.00033166	9.39	0.062000576	1755.65	25.85	27.53	4/28/2005 15:04	1158:09:30	1158:00:12	34.03172539
17	68	1082	0.0006	528	14.044	0.000564866	16.00	0.062565442	1771.65	26.09	27.77	4/29/2005 16:30	1183:35:30	1183:26:12	34.40336708
11	66	1086	0.0004	526	14.096	0.000368248	10.43	0.06293369	1782.08	26.24	27.92	4/30/2005 18:56	1210:01:30	1209:52:12	34.78541361
-8	68	1089	-0.0003	528	14.135	-0.000267539	-7.58	0.062666151	1774.50	26.13	27.81	5/1/2005 18:36	1233:41:30	1233:32:12	35.1239472
5	70	1089	0.0002	530	14.135	0.000166581	4.72	0.062832732	1779.22	26.20	27.88	5/2/2005 20:28	1259:33:30	1259:24:12	35.49025688
2	66	1093	7E-05	526	14.187	6.73857E-05	1.91	0.062900118	1781.13	26.23	27.91	5/5/2005 6:46	1317:51:30	1317:42:12	36.30231857
7	65	1081	0.0002	525	14.031	0.000233705	6.62	0.063133822	1787.74	26.32	28.00	5/6/2005 18:36	1353:41:30	1353:32:12	36.79254906
3	68	1078	0.0001	528	13.992	9.93137E-05	2.81	0.063233136	1790.56	26.37	28.04	5/7/2005 16:45	1375:50:30	1375:41:12	37.09233973
5	67	1074	0.0002	527	13.940	0.000165222	4.68	0.063398358	1795.23	26.44	28.11	5/8/2005 18:06	1401:11:30	1401:02:12	37.4324948
3	68	1077	0.0001	528	13.979	9.92216E-05	2.81	0.063497579	1798.04	26.48	28.16	5/9/2005 15:00	1422:05:30	1421:56:12	37.71063069
6	69	1075	0.0002	529	13.953	0.0001977	5.60	0.06369528	1803.64	26.56	28.24	5/10/2005 20:12	1451:17:30	1451:08:12	38.09582217
4	73	1078	0.0001	533	13.992	0.000131176	3.71	0.063826456	1807.36	26.61	28.29	5/11/2005 17:17	1472:22:30	1472:13:12	38.37153893
3	71	1081	0.0001	531	14.031	9.90275E-05	2.80	0.063925483	1810.16	26.66	28.33	5/12/2005 20:50	1499:55:30	1499:46:12	38.7288652

2	68	1085	7E-05	528	14.083	6.66391E-05	1.89	0.063992122	1812.05	26.68	28.36	5/14/2005 13:08	1540:13:30	1540:04:12	39.2457004
-1	66	1090	-4E-05	526	14.148	-3.36004E-05	-0.95	0.063958522	1811.10	26.67	28.35	5/15/2005 11:02	1562:07:30	1561:58:12	39.52372705
3	66	1080	0.0001	526	14.018	9.98763E-05	2.83	0.064058398	1813.92	26.71	28.39	5/16/2005 16:09	1591:14:30	1591:05:12	39.8903706
9	68	1072	0.0003	528	13.914	0.000296283	8.39	0.064354681	1822.31	26.83	28.51	5/18/2005 18:31	1641:36:30	1641:27:12	40.51676608
5	68	1075	0.0002	528	13.953	0.000165062	4.67	0.064519743	1826.99	26.90	28.58	5/19/2005 20:05	1667:10:30	1667:01:12	40.83105436
2	71	1081	7E-05	531	14.031	6.60183E-05	1.87	0.064585762	1828.86	26.93	28.61	5/20/2005 12:09	1683:14:30	1683:05:12	41.02732829
5	71	1076	0.0002	531	13.966	0.000164282	4.65	0.064750044	1833.51	27.00	28.68	5/21/2005 16:01	1711:06:30	1710:57:12	41.36554524
3	72	1081	0.0001	532	14.031	9.88413E-05	2.80	0.064848885	1836.31	27.04	28.72	5/22/2005 10:08	1729:13:30	1729:04:12	41.58395123
7	71	1085	0.0002	531	14.083	0.000231919	6.57	0.065080804	1842.88	27.14	28.82	5/26/2005 16:09	1831:14:30	1831:05:12	42.79300955
3	70	1084	0.0001	530	14.070	9.94896E-05	2.82	0.065180294	1845.69	27.18	28.86	5/27/2005 14:26	1853:31:30	1853:22:12	43.05258413
3	70	1080	0.0001	530	14.018	9.91225E-05	2.81	0.065279417	1848.50	27.22	28.90	5/28/2005 15:12	1878:17:30	1878:08:12	43.33926241
3	70	1078	0.0001	530	13.992	9.8939E-05	2.80	0.065378356	1851.30	27.26	28.94	5/29/2005 16:21	1903:26:30	1903:17:12	43.6284502
0	70	1082	0	530	14.044	0	0.00	0.065378356	1851.30	27.26	28.94	5/30/2005 14:21	1925:26:30	1925:17:12	43.87985491
6	70	1080	0.0002	530	14.018	0.000198245	5.61	0.065576601	1856.92	27.34	29.02	6/1/2005 11:15	1970:20:30	1970:11:12	44.3885308
5	70	1077	0.0002	530	13.979	0.000164745	4.67	0.065741346	1861.58	27.41	29.09	6/2/2005 14:18	1997:23:30	1997:14:12	44.69218798
7	71	1075	0.0002	531	13.953	0.000229782	6.51	0.065971127	1868.09	27.51	29.19	6/3/2005 17:05	2024:10:30	2024:01:12	44.9908324
4	71	1071	0.0001	531	13.901	0.000130815	3.70	0.066101943	1871.79	27.56	29.24	6/4/2005 12:50	2043:55:30	2043:46:12	45.20978876
5	72	1079	0.0002	532	14.005	0.000164431	4.66	0.066266373	1876.45	27.63	29.31	6/6/2005 11:40	2090:45:30	2090:36:12	45.72481092
6	73	1074	0.0002	533	13.940	0.000196034	5.55	0.066462407	1882.00	27.71	29.39	6/7/2005 23:24	2126:29:30	2126:20:12	46.11389884
6	73	1072	0.0002	533	13.914	0.000195669	5.54	0.066658076	1887.54	27.79	29.47	6/8/2005 17:04	2144:09:30	2144:00:12	46.30505732
6	73	1077	0.0002	533	13.979	0.000196582	5.57	0.066854658	1893.11	27.88	29.56	6/10/2005 12:01	2187:06:30	2186:57:12	46.76653005
12	73	1074	0.0004	533	13.940	0.000392068	11.10	0.067246726	1904.21	28.04	29.72	6/13/2005 12:03	2259:08:30	2258:59:12	47.53042885
2	73	1079	7E-05	533	14.005	6.56489E-05	1.86	0.067312375	1906.07	28.07	29.75	6/14/2005 18:11	2289:16:30	2289:07:12	47.84636872
2	73	1081	7E-05	533	14.031	6.57706E-05	1.86	0.067378146	1907.93	28.09	29.77	6/16/2005 21:08	2340:13:30	2340:04:12	48.37587209
4	73	1086	0.0001	533	14.096	0.00013215	3.74	0.067510295	1911.67	28.15	29.83	6/19/2005 13:11	2404:16:30	2404:07:12	49.03340698
3	74	1087	0.0001	534	14.109	9.90177E-05	2.80	0.067609313	1914.48	28.19	29.87	6/20/2005 14:42	2429:47:30	2429:38:12	49.292917
2	74	1088	7E-05	534	14.122	6.60725E-05	1.87	0.067675385	1916.35	28.22	29.90	6/21/2005 9:22	2448:27:30	2448:18:12	49.48189905
7	74	1085	0.0002	534	14.083	0.000230616	6.53	0.067906002	1922.88	28.31	29.99	6/23/2005 9:51	2496:56:30	2496:47:12	49.96940731
5	70	1081	0.0002	530	14.031	0.000165357	4.68	0.068071359	1927.56	28.38	30.06	6/25/2005 15:47	2550:52:30	2550:43:12	50.50618774
3	73	1082	0.0001	533	14.044	9.87471E-05	2.80	0.068170106	1930.36	28.42	30.10	6/27/2005 11:05	2594:10:30	2594:01:12	50.93304428
4	71	1077	0.0001	531	13.979	0.000131548	3.73	0.068301654	1934.08	28.48	30.16	6/29/2005 15:07	2646:12:30	2646:03:12	51.4413096
2	74	1081	7E-05	534	14.031	6.56474E-05	1.86	0.068367301	1935.94	28.51	30.19	7/1/2005 15:05	2694:10:30	2694:01:12	51.90544287
3	74	1082	0.0001	534	14.044	9.85622E-05	2.79	0.068465864	1938.73	28.55	30.23	7/4/2005 13:13	2764:18:30	2764:09:12	52.57669002
0	75	1086	0	535	14.096	0	0.00	0.068465864	1938.73	28.55	30.23	7/5/2005 14:36	2789:41:30	2789:32:12	52.81753181
2	74	1083	7E-05	534	14.057	6.57689E-05	1.86	0.068531633	1940.59	28.58	30.25	7/6/2005 16:57	2816:02:30	2815:53:12	53.06638924
0	74	1085	0	534	14.083	0	0.00	0.068531633	1940.59	28.58	30.25	7/7/2005 11:20	2834:25:30	2834:16:12	53.23931818
2	74	1085	7E-05	534	14.083	6.58903E-05	1.87	0.068597523	1942.46	28.60	30.28	7/9/2005 12:13	2883:18:30	2883:09:12	53.69644619
0	74	1081	0	534	14.031	0	0.00	0.068597523	1942.46	28.60	30.28	7/11/2005 15:05	2934:10:30	2934:01:12	54.16802562

DESORPTION TERMINATED 7/11/2005 DUE TO NO GAS BEING EVOLVED, sample air dried for 35 Days

SAMPLE:	1498' to 1502' (Riverton coal) cuttings in SSD canister 7										NOTE: los gas is estimated by time interval between at surface and canister times, and total gas evolved					
		lbs.	grams								est. lost gas (cc) =	TIME 0F:			elapsed time (off bottom to canistering)	
dry sample weight:		1.5387	697.97								48	off bottom	at surface	in canister	9.7	minutes
												3/11/2005 9:11	3/11/2005 9:14	3/11/2005 9:20	0.162	hours
RIG/LAB MEASUREMENTS			CONVERSION OF RIG/LAB MEASUREMENTS TO STP (@60 deg					CUMULATIVE VOLUMES		SCF/TON	SCF/TON		TIME SINCE		0.402423216	SQRT (hrs)
measured cc	measured T (F	measured I	cubic ft	absolute T (R	psia	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP	without lost gas	with lost gas	TIME OF MEASUI	off bottom	in canister	SQRT hrs. (since off bottom)	
384	70	1089	0.0136	530	14.135	0.012793414	362.27	0.012793414	362.27	16.63	18.83	3/15/2005 11:30	98:18:58	98:09:15	9.915448104	
63	71	1086	0.0022	531	14.096	0.002089195	59.16	0.014882609	421.43	19.34	21.55	3/16/2005 12:48	123:36:58	123:27:15	11.11827824	
50	69	1071	0.0018	529	13.901	0.001641372	46.48	0.016523981	467.91	21.48	23.68	3/18/2005 10:36	169:24:58	169:15:15	13.01599443	
14	68	1084	0.0005	528	14.070	0.000466044	13.20	0.016990025	481.10	22.08	24.29	3/19/2005 16:40	199:28:58	199:19:15	14.12383722	
23	68	1075	0.0008	528	13.953	0.000759286	21.50	0.017749311	502.60	23.07	25.27	3/21/2005 14:10	244:58:58	244:49:15	15.65192569	
8	68	1075	0.0003	528	13.953	0.0002641	7.48	0.018013411	510.08	23.41	25.62	3/22/2005 9:23	264:11:58	264:02:15	16.25421313	
7	68	1081	0.0002	528	14.031	0.000232377	6.58	0.018245788	516.66	23.72	25.92	3/23/2005 12:51	291:39:58	291:30:15	17.07823501	
10	70	1077	0.0004	530	13.979	0.000329491	9.33	0.018575278	525.99	24.14	26.35	3/24/2005 12:36	315:24:58	315:15:15	17.75995808	
3	69	1082	0.0001	529	14.044	9.94938E-05	2.82	0.018674772	528.81	24.27	26.48	3/25/2005 9:18	336:06:58	335:57:15	18.3334697	
17	70	1075	0.0006	530	13.953	0.000559094	15.83	0.019233866	544.64	25.00	27.20	3/28/2005 9:41	408:29:58	408:20:15	20.21136919	
12	69	1084	0.0004	529	14.070	0.000398711	11.29	0.019632577	555.93	25.52	27.72	4/2/2005 15:48	534:36:58	534:27:15	23.12176704	
11	69	1072	0.0004	529	13.914	0.000361439	10.23	0.019994016	566.17	25.99	28.19	4/4/2005 14:14	581:02:58	580:53:15	24.10496722	
3	70	1071	0.0001	530	13.901	9.82965E-05	2.78	0.020092312	568.95	26.12	28.32	4/5/2005 12:10	602:58:58	602:49:15	24.55570764	
1	71	1075	4E-05	531	13.953	3.28259E-05	0.93	0.020125138	569.88	26.16	28.36	4/6/2005 9:26	624:14:58	624:05:15	24.98498438	
-1	71	1084	-4E-05	531	14.070	-3.31008E-05	-0.94	0.020092037	568.94	26.11	28.32	4/8/2005 9:21	672:09:58	672:00:15	25.92616653	
1	69	1073	4E-05	529	13.927	3.28887E-05	0.93	0.020124926	569.87	26.16	28.36	4/9/2005 14:20	701:08:58	700:59:15	26.47922666	
2	70	1074	7E-05	530	13.940	6.57146E-05	1.86	0.020190641	571.73	26.24	28.45	4/10/2005 10:21	721:09:58	721:00:15	26.85453614	
8	71	1066	0.0003	531	13.836	0.000260409	7.37	0.02045105	579.11	26.58	28.78	4/11/2005 17:04	751:52:58	751:43:15	27.42048099	
0	73	1075	0	533	13.953	0	0.00	0.02045105	579.11	26.58	28.78	4/12/2005 14:13	773:01:58	772:52:15	27.80346701	
-1	73	1085	-4E-05	533	14.083	-3.3007E-05	-0.93	0.020418043	578.17	26.54	28.74	4/13/2005 12:20	795:08:58	794:59:15	28.19839436	
DESORPTION TERMINATED 4/13/2005 DUE TO NO GAS BEING EVOLVED, sample air dried for 7 Days																