ANALYSIS OF CHEROKEE GROUP CUTTINGS SAMPLES FOR GAS CONTENT -- COLT ENERGY #1 HONEYCUTT WELL (sec. 6-T.31S.-R.17E.), MONTGOMERY COUNTY, KANSAS

By
K. David Newell

Kansas Geological Survey
The University of Kansas
1930 Constant Avenue
Lawrence, KS 66047

December, 2002

BACKGROUND

The Colt Energy #1 Honeycutt well in E2 NE SE sec. 6-T.31S.-R17E. (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 October 22, 2002 by K. David Newell of the Kansas Geological Survey, with well site collection aided by Jim Stegeman of Colt Energy. Samples were obtained during normal drilling of the well, with no cessation of drilling before zones of interest (i.e., coals in the Cherokee and Marmaton Group) were penetrated. The well was drilled using an air rotary rig operated by McPherson Drilling. Lag times for samples to reach the surface (important for assessing lost gas) were determined by noting the time delay for cuttings to reach the surface after resumption of drilling after new pipe was added to the drill string. This delay time was added to the time noted for the samples reaching the surface in order to determine the time the samples were off bottom.

Three cuttings samples from the Pennsylvanian Marmaton and Cherokee Groups were collected: Summit coal at 718-720', Rowe(?) coal at 1085-1086', and Riverton coal at 1144-1147'. These samples weighed 957, 566, and 809 grams, respectively.

The cuttings samples were caught in a kitchen strainer at the air stream exit at the mud pit. The samples were briefly rinsed in water, then placed in desorption canisters for testing. A temperature bath for the desorption canisters was on site, with temperature at approximately at 77 degrees F. The canistered samples were later that day transported to the laboratory at the Kansas Geological Survey and desorption measurements were continued at 80 degrees F ambient temperature for the Rowe(?) and the Riverton samples. The Summit was desorbed at 75 degrees F. Desorption measurements were periodically made until the canisters produced no more gas upon testing for at least two successive days. All cuttings were depleted of gas within about two weeks following collection.

DESORPTION MEASUREMENTS

Desorption volumes were measured by displacement of water in dual connected graduated glass cylinders, which enabled compensation for pressure necessary for displacement of water columns by the desorbed gas. Barometric pressures were recorded using a field barometer whose readings were correlated to a master barometer back at the Kansas Geological Survey. Gas volumes were converted in a spreadsheet to gas volumes at standard temperature and pressure.

LITHOLOGIC ANALYSIS

Upon removal of the cuttings from the canisters, the cuttings were washed of drilling mud, and then dried overnight in an oven at 150 degrees C. 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 inches. In case of large sample sizes, the cuttings were ran through a sample splitter and a lesser portion of them were sieved and weighed. The majority of cuttings – about 75% by weight – were caught in the largest sieve size, with usually successively less percentages caught in the smaller sieve sizes.

The size fractions were then inspected and sorted by had under a dissecting microscope. Three major lithologic categories were differentiated: coal, dark shales (generally GSA 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. After sorting, and for each size class, each of these three lithologic categories were weighed. Dividing the sample into size fractions aided in confidence and consistency of the lithologic sorting. Similarly sized cuttings were more easily compared to each other, and the weight-percentage results for the size classes also could be compared. The total weight of each of the lithologic categories in the entire cuttings sample was determined. In all cases the percentages of coal, dark shale and lighter-colored lithologies varied little (generally <10%) for each size category.

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

Lag time 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

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

Gas lost prior to the canistering of the sample was estimated by extrapolation of the first few data points after the sample was canistered. The linear characteristic of the initial desorption measurements was usually lost within the first hour after canistering, thus data are presented in the lost-gas graphs for only up to 1 hour after canistering. Lost-gas volumes derived from this analysis are incorporated in the data tables described above.

"Lithologic Component Sensitivity Analyses"

The rapidity of penetration of an air-drilled well makes collection of pure lithologies rather difficult and problematic. Mixed lithologies are more the norm rather 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 content than the dark-colored shale. Although 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 total amount of gas evolved from a cuttings sample can be expressed by the following equation:

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

A unique solution for *gas content*$_{coal}$ in this equation is not possible because *gas content*$_{dark\ shale}$ is similarly not known. 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 analyses" therefore expresses the bivariant nature inherent in the analysis 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. For general understanding of the "lithologic component sensitivity analyses" diagrams, the calculated *gas content*$_{coal}$ is given for assumed *gas content*$_{dark\ shale}$ at 30 scf/ton and 50 scf/ton. In some cases, the resultant *gas content*$_{coal}$ is a negative number for 30 scf/ton and 50 scf/ton *gas content*$_{dark\ shale}$, hence it is impossible that *gas content*$_{dark\ shale}$ could be as high as 30 to 50 scf/ton. In such cases, the *gas content*$_{dark\ shale}$ has to be lower than 30-50 scf/ton. 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.

In all the "lithologic component sensitivity analyses" diagrams, a "break-even" point also is noted where the gas content of the coal is equal to that of the dark shale. This "break-even" point is likely the minimum gas content assignable to the coal and likely the 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.

Summary Component Analysis for all Samples
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., $gas\ content_{coal}$) for that sample. If the coal content is miniscule (i.e., < approximately 5%), the results are a better reflection of the $gas\ content_{dark\ shale}$.

Desorption Graph
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.

RESULTS and DISCUSSION

According to the summary component analysis, the most tightly constrained results were obtained for the Riverton coal. The percentage of dark shale in this sample was 76%, whereas coal was 21%. If this amount of dark shale has a relatively rich gas capacity of 50 scf/ton, the Riverton coal gas content assays to just 12 scf/ton. If the dark shale carries 30 scf/ton, the coal will assay at 84 scf/ton, and commensurately more gas content if the dark shale has less gas content. If the dark shale has no gas capacity at all (i.e., 0 scf/ton), the Riverton coal will hold 192 scf/ton. The "break-even point" at which the gas capacity of the shale is equal to that of the coal is 42 scf/ton. This point can also be thought of as the absolute minimum gas capacity for the coal and the absolute maximum gas capacity for the dark shale. If a nearby well has a gas content for dark shale near the Riverton coal, this value for $gas\ content_{dark\ shale}$.could be inserted into the equation for a reasonable estimate for $gas\ content_{coal}$.

Conversely, the Summit and Rowe(?) samples had only 8% and 13% coal content, respectively. Dark shale in these samples registered 67% and 65%, respectively. In both cases, the resultant gas content for the coals can vary greatly with only minor variation in the gas capacity for the associated dark shale.

In case of the Summit coal sample, its value may be better for estimating the gas content of the dark shale near the Summit coal, for no good coal was actually detected in the sample. What coal that was present could at best be described as a smutty coal that was difficult to distinguish from dark shale. In this case, 13 scf/ton should considered as perhaps an accurate measure of the sample. The Summit sample may be either a very poorly developed coal or perhaps the actual Summit coal was simply missed entirely during sample collection.

OPPORTUNITY FOR FURTHER STUDY

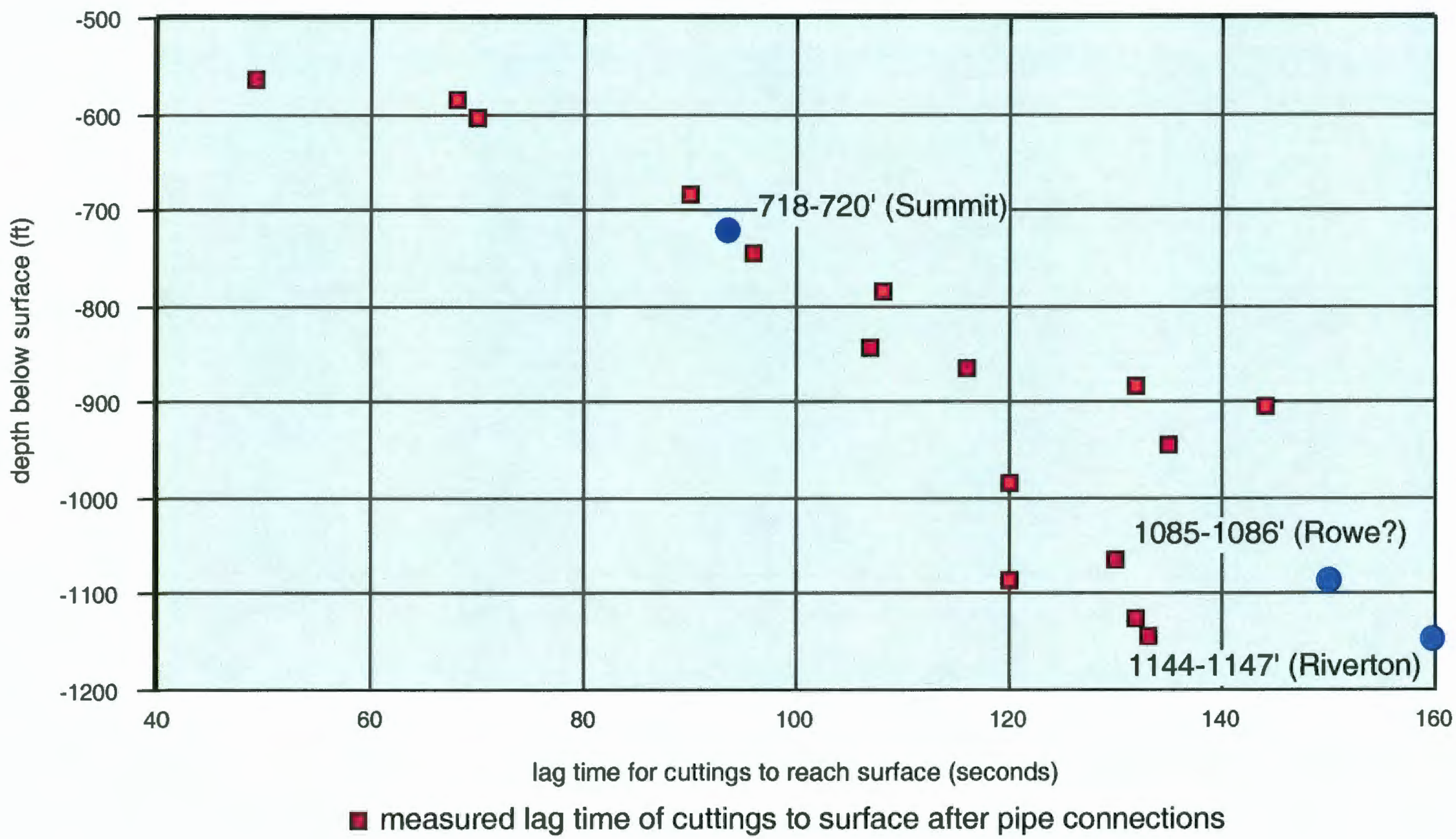
The samples obtained for this study were gathered during normal drilling, and no special provisions during drilling were made to high-grade the sample quality. Nevertheless, reasonable results were obtained for some of the samples. Better results likely can be obtained by ceasing drilling just above the coal and circulating up cuttings in the annulus so as to clean the hole before collecting the coal sample. Slow drilling ahead, about one foot at a time until a good coal sample is obtained, will also do much to high-grade the cuttings sample. However, these sampling tactics may be a difficult proposition if the driller is paid by the foot.

Sieving and separating cuttings by density at the drill site may also be a tactic by which more coal could be concentrated in a cuttings sample. A calcium chloride solution at 1.2 grams/cc density (in which some shales would sink more readily than the coal) may be adequate to concentrate coal in the cuttings sample.

In any case, data may also be obtained that can provide a solution to the problem posed by the respective gas contents of the dark shale vs. coal. If a reasonable proxy for the relative gas content of a dark shale stratigraphically adjacent to a coal could be found, this relationship could provide a unique solution to the equations expressed in "lithologic component sensitivity analyses". An inverse ratio of the density, total organic carbon, or ash content of the coals vs. shales may mimic that of their gas contents. Such data need to be tested from cores before it can reliably applied to cuttings, however.

The utility of cuttings for a relatively rapid gas analysis of coals in a well could be realized with employment of a sample splitter on site at the well. A portion of the cuttings collected could be saved separately from the portion that is canistered. While the canistered cuttings are desorbing, lithologic analysis of the uncanistered cuttings split could be proceeding. Upon completion of their outgassing, the canistered cuttings need only be washed and weighed. The lithologic weight ratios derived from the concurrent study of the uncanistered cuttings could then be applied to the canistered cuttings for a rapid gas analysis which could be available as soon as the desorption process is finished, likely within a couple of weeks of drilling.

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County, KS
lag-time to surface for well cuttings



SAMPLE: 718' to 720' (Summit Coal) in canister Stegeman 6
DENSITIES: COAL (2.34 grams/cc), DARK SHALE (2.41 grams/cc)
sample oven dried at 150 degrees F for 1 day

DRY WEIGHT	lbs.	grams	est. lost gas (cc) =	TIME OF:				elapsed time (off bottom to canistering)
sample weight:	2.1093	956.77	65	off bottom		in canister		6.4 minutes
				10/22/02	12:27	10/22/02	12:34	0.106 hours
								0.325320355 SQRT (hrs)

CONVERSION OF VOLUMES TO STP

RIG MEASUREMENTS			CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 p					CUMULATIVE VOLUMES		SCF/TON (approx)	SCF/TON (approx)			TIME SINCE		
measured cc	measured T (F)	measured P	cubic ft (@rig)	ABS. T (F) (@rig)	psia (@rig)	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP)	without lost gas	with lost gas	TIME OF MEASURE		off bottom	in canister	SQRT hrs. (since off bottom)
6	75	1090	0.00021189	535	14.148	0.000198211	5.61268	0.000198211	5.61268	0.187938339	2.36443657	10/22/02	12:35	0:07:33	0:01:12	0.354729944
4	75	1090	0.00014126	535	14.148	0.00013214	3.74179	0.000330351	9.35447	0.313230565	2.489728796	10/22/02	12:36	0:08:17	0:01:56	0.37155828
4	75	1090	0.00014128	535	14.146	0.00013214	3.74179	0.000462492	13.0963	0.438522791	2.615021022	10/22/02	12:36	0:09:02	0:02:41	0.386014891
5	75	1090	0.00017857	535	14.146	0.000185176	4.67723	0.000627667	17.7735	0.595138073	2.771636304	10/22/02	12:38	0:10:03	0:03:42	0.409267639
6	75	1090	0.00021189	535	14.148	0.000198211	5.61268	0.000825878	23.3862	0.783076412	2.959574643	10/22/02	12:39	0:11:33	0:05:12	0.43874822
9	75	1090	0.00031783	535	14.146	0.000297316	8.41902	0.001123194	31.6052	1.06498392	3.241482151	10/22/02	12:41	0:13:42	0:07:21	0.477842373
5	75	1090	0.00017857	535	14.148	0.000165176	4.67723	0.00126637	36.4824	1.221599203	3.398097434	10/22/02	12:43	0:15:16	0:08:55	0.504424865
4	75	1090	0.00014128	535	14.148	0.00013214	3.74179	0.00142051	40.2242	1.346891428	3.52338966	10/22/02	12:44	0:16:33	0:10:12	0.525198375
5	75	1090	0.00017857	535	14.146	0.000185176	4.67723	0.001585686	44.9015	1.503506711	3.680004942	10/22/02	12:46	0:18:06	0:11:47	0.549747417
5	75	1090	0.00017657	535	14.148	0.000165176	4.67723	0.001750861	49.5787	1.660121993	3.836620224	10/22/02	12:47	0:19:53	0:13:32	0.575663868
14	75	1090	0.00049441	535	14.146	0.000462492	13.0963	0.002213353	62.6749	2.098644784	4.275143015	10/22/02	12:52	0:24:03	0:17:42	0.633113997
5	75	1090	0.00017857	535	14.148	0.000165176	4.67723	0.002378529	67.3522	2.255260066	4.431758297	10/22/02	12:54	0:26:03	0:19:42	0.656913247
3	75	1090	0.00010594	535	14.148	9.91054E-05	2.80634	0.002477634	70.1585	2.349229236	4.525727467	10/22/02	12:56	0:28:03	0:21:42	0.663739717
12	75	1089	0.00042378	535	14.135	0.000396056	11.2151	0.002873692	81.3736	2.724761072	4.901259304	10/22/02	13:06	0:38:03	0:31:42	0.796345821
12	75	1089	0.00042378	535	14.135	0.000396058	11.2151	0.00326975	92.5887	3.100292909	5.27679114	10/22/02	13:14	0:46:03	0:39:42	0.876070773
4	75	1089	0.00014128	535	14.135	0.000132019	3.73836	0.003401769	96.327	3.225470188	5.401968419	10/22/02	13:17	0:49:33	0:43:12	0.906753725
9	75	1089	0.00031783	535	14.135	0.000297043	8.4113	0.003698812	104.738	3.507119065	5.663617297	10/22/02	13:27	0:59:46	0:53:27	0.996331942
8	75	1089	0.00028252	535	14.135	0.000264039	7.47671	0.003962851	112.215	3.757473623	5.933971855	10/22/02	13:34	1:06:33	1:00:12	1.053169819
3	75	1089	0.00010594	535	14.135	9.90144E-05	2.80377	0.004061865	115.019	3.851356562	6.027854814	10/22/02	13:41	1:13:54	1:07:33	1.109804788
18	76	1089	0.00063567	536	14.135	0.000592978	16.7912	0.004654844	131.81	4.413603409	6.59010164	10/22/02	13:54	1:26:03	1:19:42	1.197566978
12	76	1089	0.00042378	536	14.135	0.000395319	11.1941	0.005050162	143.004	4.788434627	6.964932858	10/22/02	14:07	1:39:03	1:32:42	1.284847591 estimate
5	76	1089	0.00017857	538	14.135	0.000164716	4.66423	0.005214879	147.668	4.944614301	7.121112532	10/22/02	14:14	1:46:03	1:39:42	1.32947358
5	76	1089	0.00017657	536	14.135	0.000164716	4.66423	0.005379595	152.333	5.100793975	7.277292206	10/22/02	14:19	1:51:03	1:44:42	1.360453356
15	76	1089	0.00052972	536	14.135	0.000494149	13.9927	0.005873743	166.325	5.569332997	7.745631228	10/22/02	14:37	2:09:03	2:02:42	1.466571967
11	78	1089	0.00038846	536	14.135	0.000362378	10.2613	0.006236119	176.567	5.912928279	8.089426511	10/22/02	14:54	2:26:03	2:19:42	1.560181613
3	77	1088	0.00010594	537	14.122	9.85551E-05	2.79076	0.006334674	179.377	6.006375692	6.182873923	10/22/02	15:19	2:51:03	2:44:42	1.688441096
8	77	1088	0.00028252	537	14.122	0.000262614	7.44202	0.006597488	186.819	6.255568793	8.432067024	10/22/02	15:42	3:14:03	3:07:42	1.7983769
4	77	1088	0.00014126	537	14.122	0.000131407	3.72101	0.006728895	190.54	6.380165343	8.556663575	10/22/02	16:03	3:35:03	3:28:42	1.893189549
- 2	77	1088	-7.063E-05	537	14.122	-8.5703E-05	-1.8605	0.006663191	188.66	6.317867068	8.494365299	10/22/02	16:28	4:00:03	3:53:42	2.000206323
6	77	1088	0.00021189	537	14.122	0.00019711	5.58152	0.006860301	194.261	6.504761694	8.681260125	10/22/02	17:39	5:11:03	5:04:42	2.276876515
4	77	1088	0.00014126	537	14.122	0.000131407	3.72101	0.006991708	197.982	6.629356444	8.805856676	10/22/02	16:12	5:44:03	5:37:42	2.394612008
12	75	1094	0.00042378	535	14.200	0.000397876	11.2666	0.007389584	209.249	7.006614486	9.183112717	10/22/02	22:20	9:52:03	9:45:42	3.14125771
78	75	1093	0.00268392	535	14.187	0.002517579	71.2896	0.009907164	280.539	9.393718757	11.57021699	10/23/02	16:05	27:37:03	27:30:42	5.255235485
35	75	1088	0.00123602	535	14.122	0.001154106	32.6806	0.011061272	313.219	10.48801416	12.66451239	10/24/02	16:48	52:20:03	52:13:42	7.234235735
2	75	1089	7.063E-05	535	14.135	8.80096E-05	1.86918	0.011127281	315.088	10.5506028	12.72710103	10/26/02	22:58	106:30:03	106:23:42	10.3199241
3	75	1089	0.00010594	535	14.135	9.90144E-05	2.80377	0.011226296	317.892	10.64446576	12.82098399	10/27/02	22:19	129:51:03	129:44:42	11.39521098

DECANISTERED 10/30/02

SAMPLE: 1085' to 1086' (Rowe Coal?) in canister 11
DENSITIES: COAL (1.77 grams/cc), DARK SHALE (2.58 grams/cc)
sample oven dried at 150 degrees F for 1 day

DRY WEIGHT	lbs.	grams		lbs.	grams	moisture weight	est. lost gas (cc) =	TIME OF:				elapsed time (off bottom to canistering)
sample weight:	1.2479	566.02	wet sample weight:	1.2479	566.02	0.0%	42	off bottom		in canister		5.3 minutes
								10/22/02	16:27	10/22/02	16:32	0.088 hours
												0.295803989 SQRT (hrs)

CONVERSION OF VOLUMES TO STP

RIG MEASUREMENTS			CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 p					CUMULATIVE VOLUMES		SCF/TON (approx)	SCF/TON (approx)			TIME SINCE		
measured cc	measured T (F)	measured P	cubic ft (@rig)	ABSOLUTE T (F) (	psia (@rig)	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP)	without lost gas	with lost gas	TIME OF MEASURE		off bottom	in canister	SQRT hrs. (since off bottom)
4	77	1086	0.00014126	537	14.122	0.000131407	3.72101	0.000131407	3.72101	0.210611359	2.587834913	10/22/02	16:33	0:06:22	0:01:07	0.325747005
4	77	1086	0.00014128	537	14.122	0.000131407	3.72101	0.000262814	7.44202	0.421222716	2.798446272	10/22/02	16:34	0:07:20	0:02:05	0.349602949
4	77	1088	0.00014126	537	14.122	0.000131407	3.72101	0.00039422	11.163	0.631834078	3.009057631	10/22/02	16:35	0:08:20	0:03:05	0.372677996
3	77	1088	0.00010594	537	14.122	9.85551E-05	2.79076	0.000492775	13.9538	0.789792597	3.187016151	10/22/02	16:36	0:09:20	0:04:05	0.394405319
4	77	1088	0.00014128	537	14.122	0.000131407	3.72101	0.000624182	17.6748	1.000403956	3.37762751	10/22/02	16:38	0:10:40	0:05:25	0.421637021
7	77	1088	0.0002472	537	14.122	0.000229962	6.51177	0.000854144	24.1866	1.368973835	3.746197389	10/22/02	16:41	0:14:00	0:08:45	0.483045891
3	77	1088	0.00010594	537	14.122	9.65551E-05	2.79076	0.000952699	26.9773	1.526932354	3.904155908	10/22/02	16:42	0:15:14	0:09:59	0.503873882
8	77	1088	0.00028252	537	14.122	0.000262814	7.44202	0.001215513	34.4194	1.948155073	4.325376626	10/22/02	16:47	0:20:02	0:14:47	0.577631194
5	77	1086	0.00017657	537	14.122	0.000164258	4.65126	0.001379771	39.0706	2.211419272	4.588642825	10/22/02	16:51	0:23:30	0:18:15	0.625832778
4	77	1088	0.00014128	537	14.122	0.000131407	3.72101	0.001511178	42.7916	2.422030631	4.799254185	10/22/02	16:54	0:26:30	0:21:15	0.664580068
17	77	1088	0.00060035	537	14.122	0.000558479	15.8143	0.002069657	58.6059	3.317128907	5.694352461	10/22/02	17:03	0:36:10	0:30:55	0.776387647
27	77	1088	0.0009535	537	14.122	0.000886996	25.1168	0.002956653	83.7228	4.736755582	7.115979138	10/22/02	17:37	1:09:30	1:04:15	1.076258953
20	77	1088	0.0007063	537	14.122	0.000657034	18.6051	0.003613687	102.328	5.791812378	8.169035932	10/22/02	18:12	1:44:30	1:39:15	1.319722193

48	70	1085	0.00182448	530	14.063	0.001526915	43.2373	0.005140602	145.565	8.239065494	10.81828905	10/22/02	22:26	5:58:30	5:53:15	2.444361312
90	70	1085	0.00317833	530	14.063	0.002987443	84.5946	0.008128045	230.16	13.02718942	15.40439297	10/23/02	16:10	23:42:30	23:37:15	4.869120366
89	85	1085	0.00314302	545	14.063	0.002872939	81.3523	0.011000964	311.512	17.63175376	20.00897731	10/24/02	16:47	46:19:30	46:14:15	6.951618517
0	60	1085	0	540	14.063	0	0	0.011000964	311.512	17.63175376	20.00897731	10/26/02	15:24	94:56:30	94:51:15	9.743801448
2	80	1085	7.063E-05	540	14.083	6.51562E-05	1.84507	0.011066142	313.357	17.73616566	20.11340921	10/27/02	22:22	125:54:30	125:49:15	11.22066626
11	60	1087	0.00038848	540	14.109	0.000359031	10.1666	0.011425173	323.524	18.31161964	20.6888434	10/29/02	22:31	174:03:30	173:56:15	13.19311669

DECANISTERED 10/30/02

SAMPLE: 1144' to 1147' (Riverton Coal) in canister 1

DENSITIES: COAL (1.46 grams/cc), DARK SHALE (2.59 grams/cc)

sample oven dried at 150 degrees F for 1 day

DRY WEIGHT	lbs.	grams		lbs.	grams	moisture weight	est. lost gas (cc) =
sample weight:	1.7827	806.61	wet sample weight:	1.7827	808.61	0.0%	90

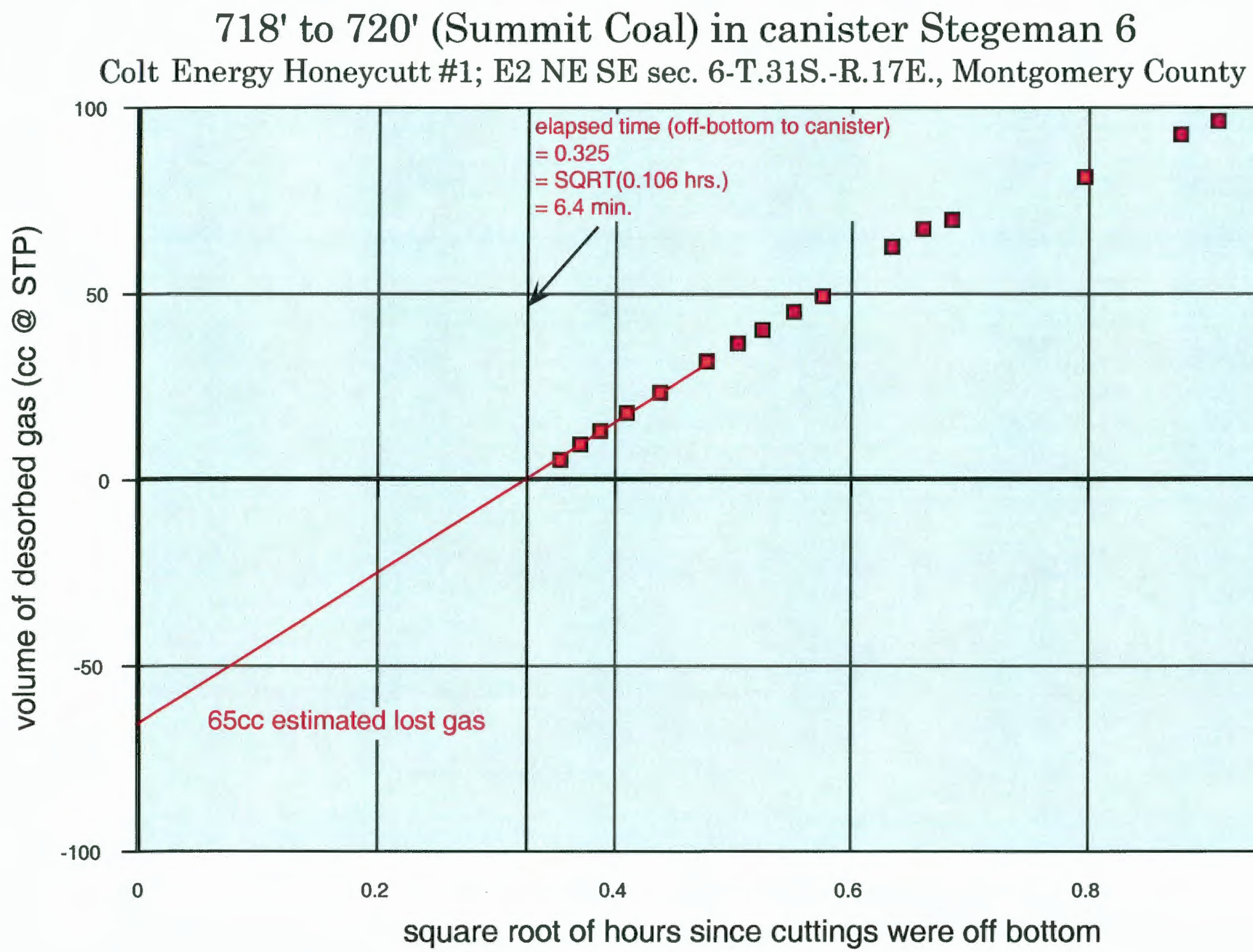
TIME OF: off bottom 10/22/02 16:55; in canister 10/22/02 17:02

elapsed time (off bottom to canistering): 6.8 minutes; 0.114 hours; 0.337474279 SQRT (hrs)

CONVERSION OF VOLUMES TO STP

RIG MEASUREMENTS			CONVERSION OF RIG MEASUREMENTS TO STP (cubic ft; @60 degrees; @14.7 p					CUMULATIVE VOLUMES		SCF/TON (approx)	SCF/TON (approx)			TIME SINCE		
measured cc	measured T (F)	measured P	cubic ft (@rig)	ABSOLUTE T (F)	(psia (@rig)	cubic ft (@STP)	cc (@STP)	cubic ft (@STP)	cc (@STP)	without lost gas	with lost gas	TIME OF MEASURE		off bottom	in canister	SQRT hrs. (since off bottom)
10	77	1088	0.00035315	537	14.122	0.000328517	9.30253	0.000328517	9.30253	0.366565321	3.934356553	10/22/02	17:04	0:08:48	0:01:56	0.362970643
6	77	1088	0.00021189	537	14.122	0.00019711	5.58152	0.000525827	14.884	0.569704513	4.155495745	10/22/02	17:05	0:09:30	0:02:40	0.397911213
9	77	1088	0.00031783	537	14.122	0.000295665	8.37226	0.000821292	23.2563	0.921413301	4.467204534	10/22/02	17:06	0:10:47	0:03:57	0.423936578
5	77	1088	0.00017657	537	14.122	0.000184258	4.65126	0.000985551	27.9076	1.105695962	4.671467194	10/22/02	17:07	0:11:44	0:04:54	0.442216639
5	77	1088	0.00017657	537	14.122	0.000164258	4.65126	0.001149809	32.5569	1.269976622	4.855769854	10/22/02	17:08	0:12:42	0:05:52	0.460072458
5	77	1088	0.00017657	537	14.122	0.000164258	4.65126	0.001314066	37.2101	1.474261262	5.040052515	10/22/02	17:10	0:14:05	0:07:15	0.484461395
4	77	1088	0.00014128	537	14.122	0.000131407	3.72101	0.001445475	40.9311	1.62166741	5.187478643	10/22/02	17:10	0:14:47	0:07:57	0.496375754
6	77	1088	0.00021189	537	14.122	0.00019711	5.58152	0.001642565	46.5126	1.842826603	5.408617635	10/22/02	17:12	0:16:19	0:09:29	0.521462928
10	77	1088	0.00035315	537	14.122	0.000328517	9.30253	0.001971102	55.8152	2.211391923	5.777183156	10/22/02	17:15	0:19:05	0:12:15	0.563964144
8	77	1088	0.00028252	537	14.122	0.000262814	7.44202	0.002233915	63.2572	2.50624416	6.072035412	10/22/02	17:17	0:21:20	0:14:30	0.596264794
5	77	1088	0.00017657	537	14.122	0.000164258	4.65126	0.002398174	67.9065	2.69052684	6.256318072	10/22/02	17:19	0:23:20	0:16:30	0.623609564
6	77	1088	0.00021189	537	14.122	0.00019711	5.58152	0.002595284	73.49	2.911666032	6.477457265	10/22/02	17:21	0:25:23	0:18:33	0.65042721
9	77	1088	0.00031783	537	14.122	0.000295665	8.37226	0.002890949	81.8623	3.243374621	6.809166053	10/22/02	17:24	0:28:50	0:22:00	0.693221145
6	77	1088	0.00021189	537	14.122	0.00019711	5.58152	0.00308806	87.4438	3.464514013	7.030305245	10/22/02	17:26	0:30:50	0:24:00	0.716860439
10	77	1088	0.00035315	537	14.122	0.000328517	9.30253	0.003418577	96.7463	3.833079334	7.398870566	10/22/02	17:34	0:36:05	0:31:15	0.79669456
6	77	1086	0.00021189	537	14.122	0.00019711	5.58152	0.003813687	102.326	4.054216526	7.620009758	10/22/02	17:36	0:40:05	0:33:15	0.817346656
14	77	1088	0.00049441	537	14.122	0.000459924	13.0235	0.004073611	115.351	4.570209975	8.136001207	10/22/02	17:43	0:47:05	0:40:15	0.865845484
11	77	1088	0.00038848	537	14.122	0.000381369	10.2326	0.004434979	125.584	4.975631627	8.54142306	10/22/02	17:49	0:53:35	0:46:45	0.945016167
15	77	1086	0.00052972	537	14.122	0.000492775	13.9536	0.004927755	139.538	5.528479606	9.09427104	10/22/02	17:59	1:03:05	0:56:15	1.025372561
20	77	1088	0.0007063	537	14.122	0.000657034	18.6051	0.005584789	158.143	6.265610449	9.831401662	10/22/02	18:13	1:17:05	1:10:15	1.133455876
155	70	1094	0.00547379	530	14.200	0.005187718	146.899	0.010772507	305.042	12.0857446	15.65153603	10/22/02	22:30	5:34:05	5:27:15	2.359672764
198	70	1093	0.0069217	530	14.187	0.006553957	165.587	0.017326463	490.629	19.43867126	23.00446249	10/23/02	16:12	23:16:05	23:09:15	4.823697291
170	85	1086	0.00600352	545	14.122	0.00550281	155.822	0.022829273	646.451	25.61230945	29.17810068	10/24/02	16:49	47:53:05	47:46:15	6.919678772
95	60	1089	0.00335491	540	14.135	0.003106425	87.9638	0.025935699	734.414	29.09742823	32.66321946	10/26/02	15:27	94:31:05	94:24:15	9.722039681
110	60	1082	0.00388463	540	14.044	0.003573793	101.198	0.029509492	835.613	33.1068697	36.67268094	10/29/02	22:34	173:38:05	173:31:15	13.17705287
13	60	1087	0.00045909	540	14.109	0.000424309	12.0151	0.029933801	847.628	33.56292462	37.14871606	10/30/02	14:07	189:11:05	189:04:15	13.75444373
4	80	1081	0.00014126	540	14.031	0.000129838	3.67653	0.030063837	851.304	33.72856867	37.29437991	10/31/02	10:53	209:57:05	209:50:15	14.48969941
19	80	1097	0.00067098	540	14.239	0.000625849	17.722	0.030889488	869.026	34.4307329	37.99652413	11/1/02	16:23	241:27:05	241:20:15	15.53870615
51	80	1081	0.00180105	540	14.031	0.001655409	46.8758	0.032344895	915.902	36.28794699	39.85373822	11/4/02	21:49	316:53:05	316:46:15	17.8012562
18	80	1087	0.00063567	540	14.109	0.000587505	16.6362	0.0329324	932.536	36.94707254	40.51266377	11/6/02	13:45	356:49:05	356:42:15	18.88962825
14	80	1081	0.00049441	540	14.031	0.000454426	12.6679	0.033386626	945.406	37.45689601	41.02268725	11/7/02	12:56	380:02:05	379:55:15	19.49447928
20	60	1081	0.0007063	540	14.031	0.00064918	18.3627	0.034036006	963.789	38.16521526	41.7510065	11/9/02	19:00	434:04:05	433:57:15	20.83429998 estimate

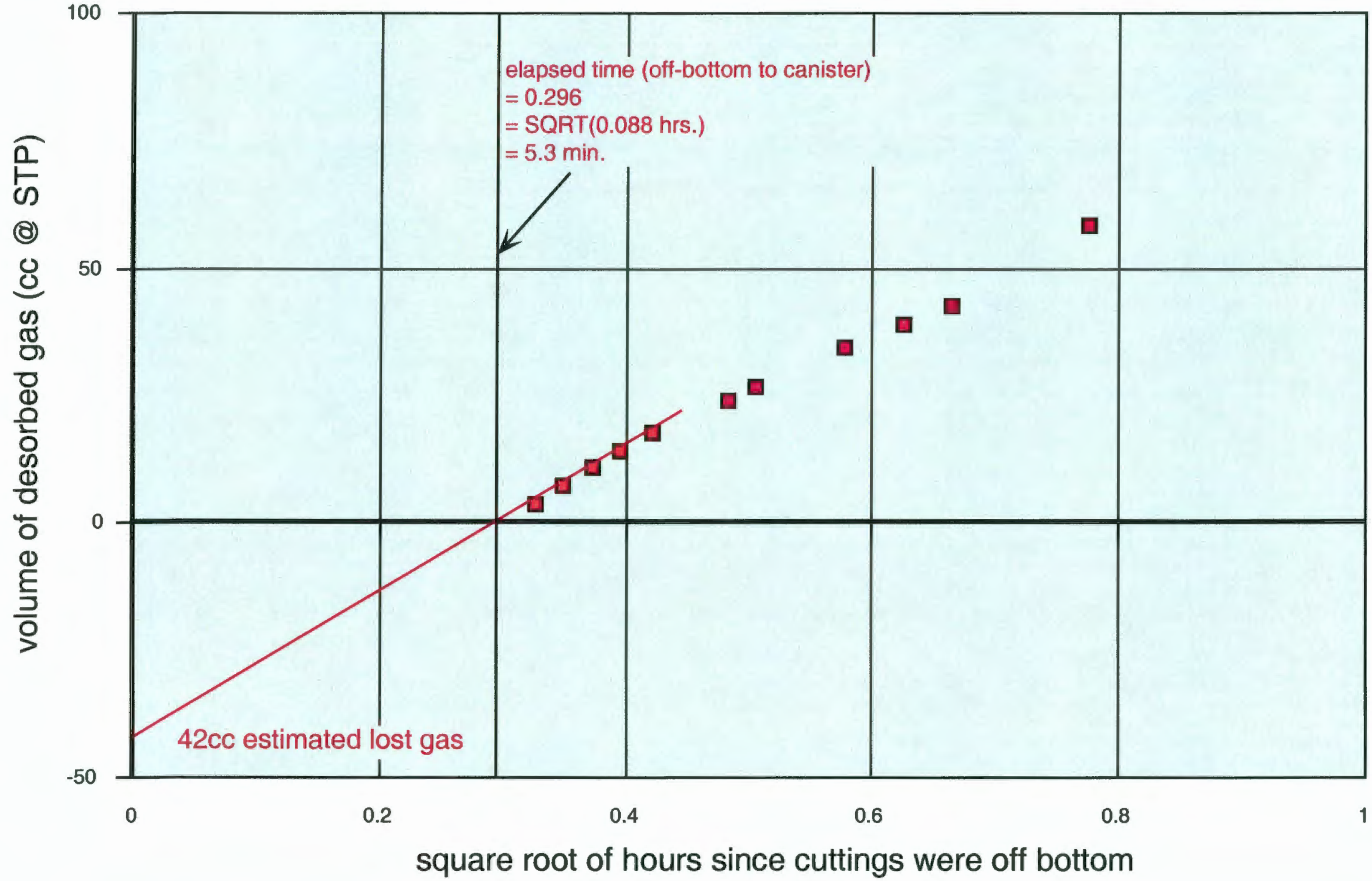
DECANISTERED 11/07 (slightly early due to need for canister), so estimate of final gas is made on prior desorption rates



718' to 720' (Summit Coal) in canister Stegeman 6
Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County
elapsed time (off-bottom to canister)
= 0.325
= SQRT(0.106 hrs.)
= 6.4 min.
65cc estimated lost gas
volume of desorbed gas (cc @ STP)
square root of hours since cuttings were off bottom
100
50
0
-50
-100
0
0.2
0.4
0.6
0.8
1

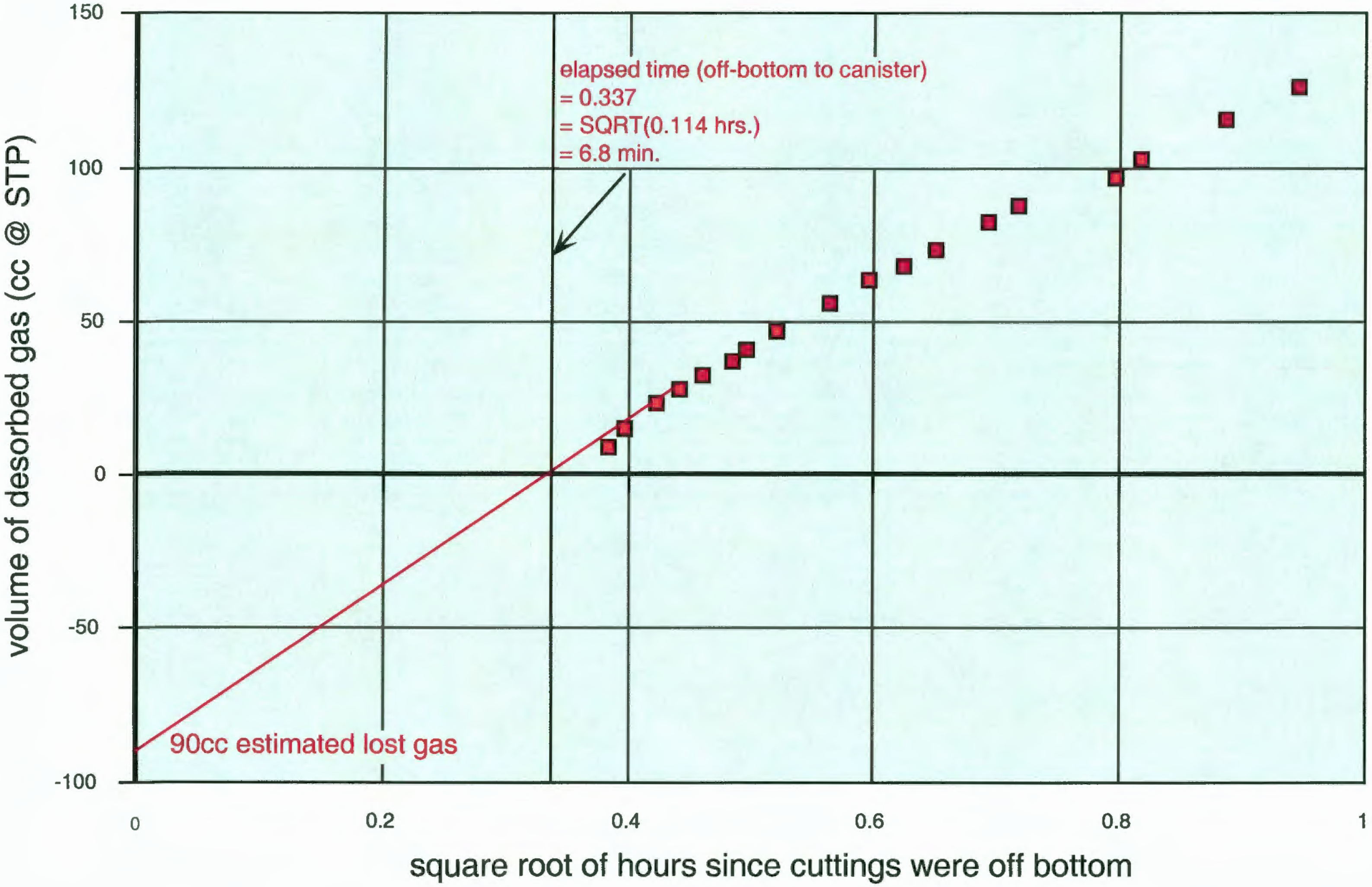
1085' to 1086' (Rowe Coal?) in canister 11

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County



1144' to 1147' (Riverton Coal) in canister 1

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County



Desorption Characteristics of Cuttings Samples

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County, KS

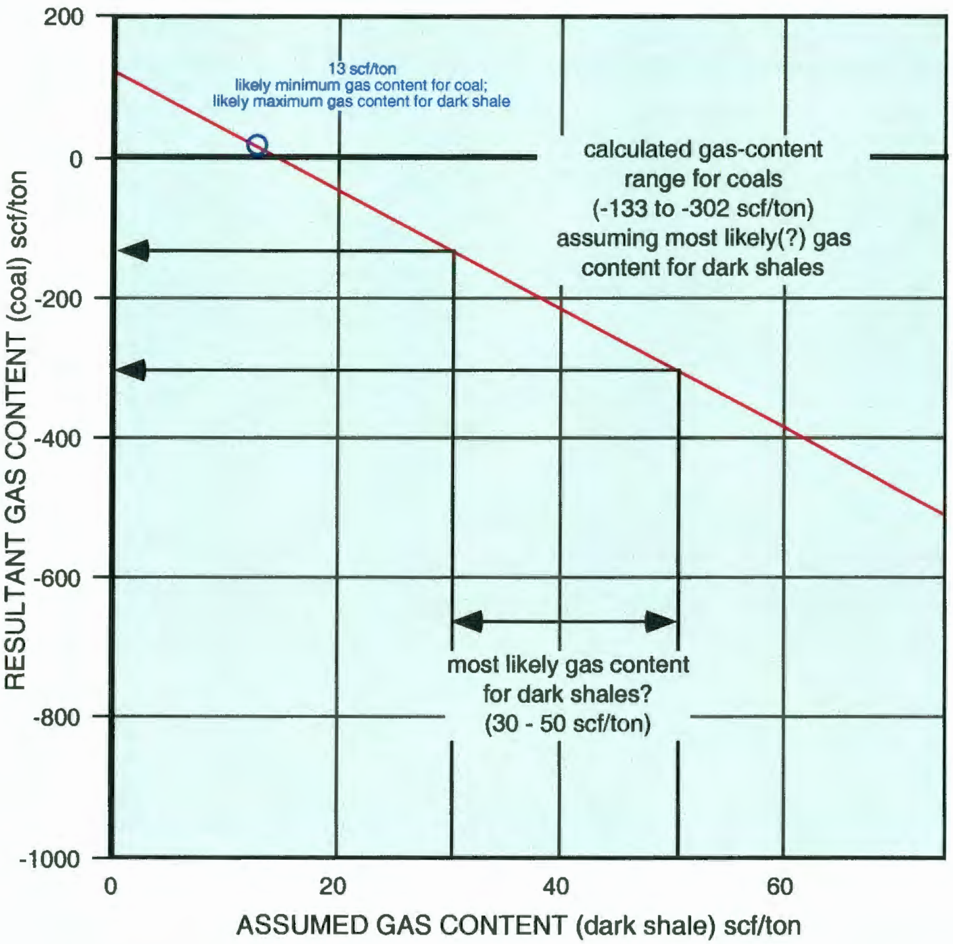
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Summit coal from 718-720'

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

total gas desorbed = 383 ccs
$\text{weight}_{dark\ shale}$ = 855.66 grams
weight_{coal} = 101.11 grams

TOTAL DRY WEIGHT OF SAMPLE = 1279.54 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 322.77 grams (25.2%)
$\text{weight}_{dark\ shale}$ = 855.66 grams (66.9%)
weight_{coal} = 101.11 grams (7.9%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930	917.11	7.56% / 66.46% / 25.97%
>0.0661	212.58	9.93% / 67.30% / 22.78%
>0.0460	106.62	6.32% / 69.73% / 23.95%
>0.0331	26.99	9.38% / 65.93% / 24.69%
<0.0331	17.24	8.30% / 67.35% / 24.35%
	1279.54 TOTAL	



Desorption Characteristics of Cuttings Samples

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County, KS

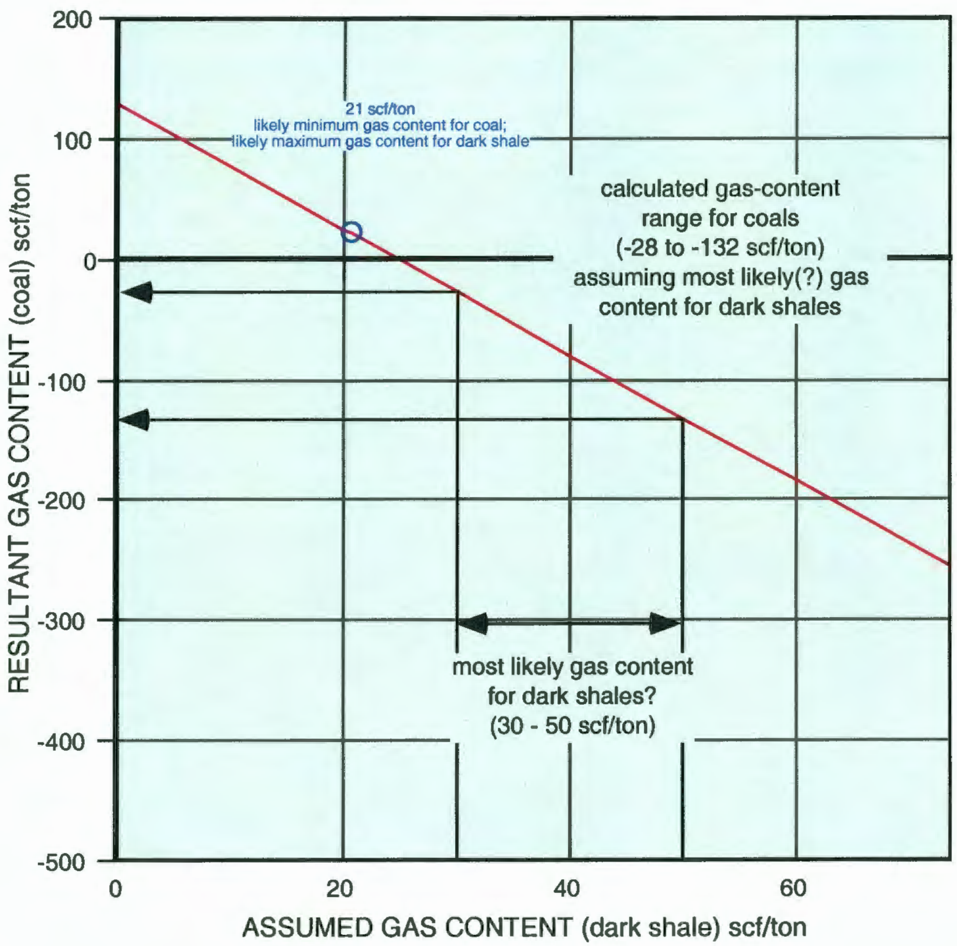
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Rowe(?) coal from 1085-1086'

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

total gas desorbed = 366 ccs
$\text{weight}_{dark\ shale}$ = 474.84 grams
weight_{coal} = 91.18 grams

TOTAL DRY WEIGHT OF SAMPLE = 729.41 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 163.39 grams (22.4%)
$\text{weight}_{dark\ shale}$ = 474.84 grams (65.1%)
weight_{coal} = 91.18 grams (12.5%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930	451.88	10.45% / 64.19% / 25.36%
>0.0661	129.08	18.31% / 63.38% / 18.31%
>0.0460	100.96	15.04% / 69.19% / 15.77%
>0.0331	31.68	9.58% / 71.05% / 19.38%
<0.0331	15.82	13.34% / 66.95% / 19.70%
	729.41 TOTAL	



Desorption Characteristics of Cuttings Samples

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County, KS

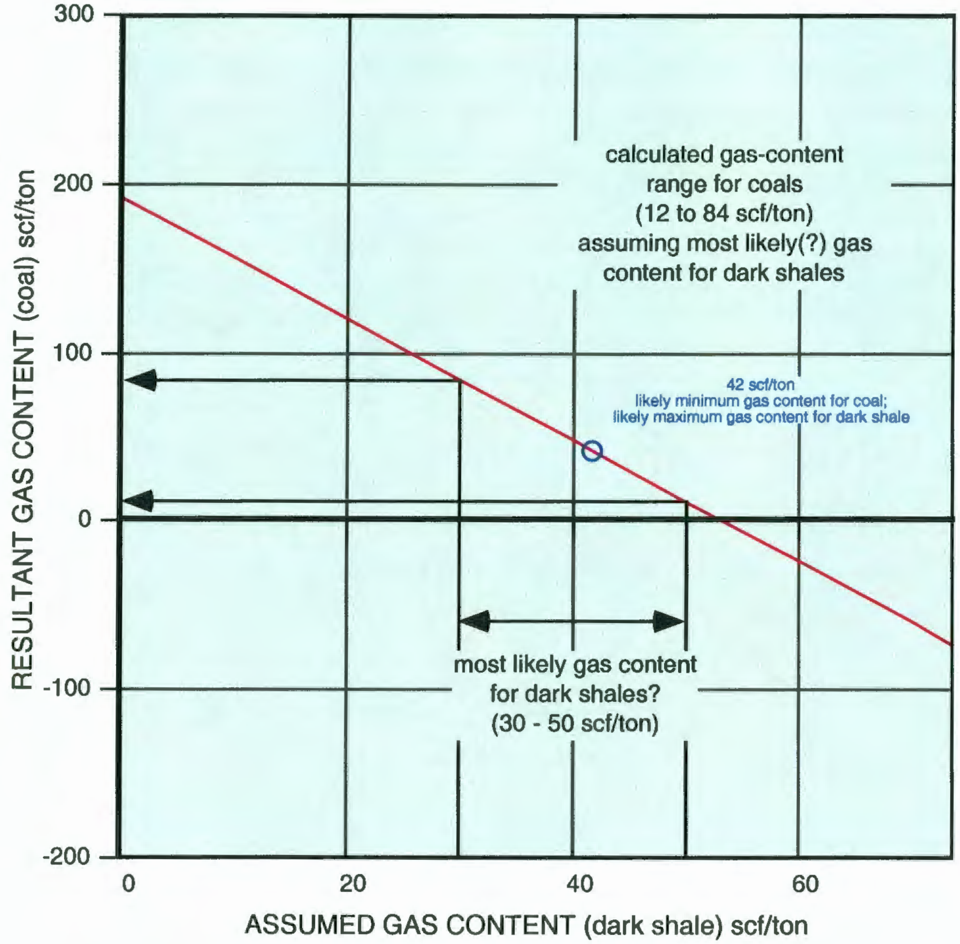
LITHOLOGIC COMPONENT SENSITIVITY ANALYSIS for calculation of gas content of Riverton coal from 1144-1147'

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

total gas desorbed = 1054 ccs
$\text{weight}_{dark\ shale}$ = 632.94 grams
weight_{coal} = 175.67 grams

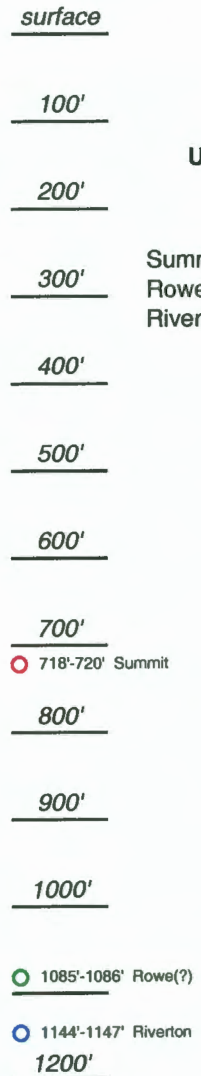
TOTAL DRY WEIGHT OF SAMPLE = 830.50 grams
$\text{weight}_{light\text{-}colored\ lithologies}$ = 21.89 grams (2.6%)
$\text{weight}_{dark\ shale}$ = 632.94 grams (76.2%)
weight_{coal} = 175.67 grams (21.2%)

sieve size	*grams*	*% coal / % dark shale / % light-colored liths*
>0.0930	492.28	18.60% / 79.80% / 1.60%
>0.0661	185.00	27.63% / 68.74% / 3.63%
>0.0460	108.06	22.20% / 73.60% / 4.20%
>0.0331	31.06	19.01% / 73.96% / 7.03%
<0.0331	14.10	21.86% / 74.02% / 4.12%
	830.50 TOTAL	



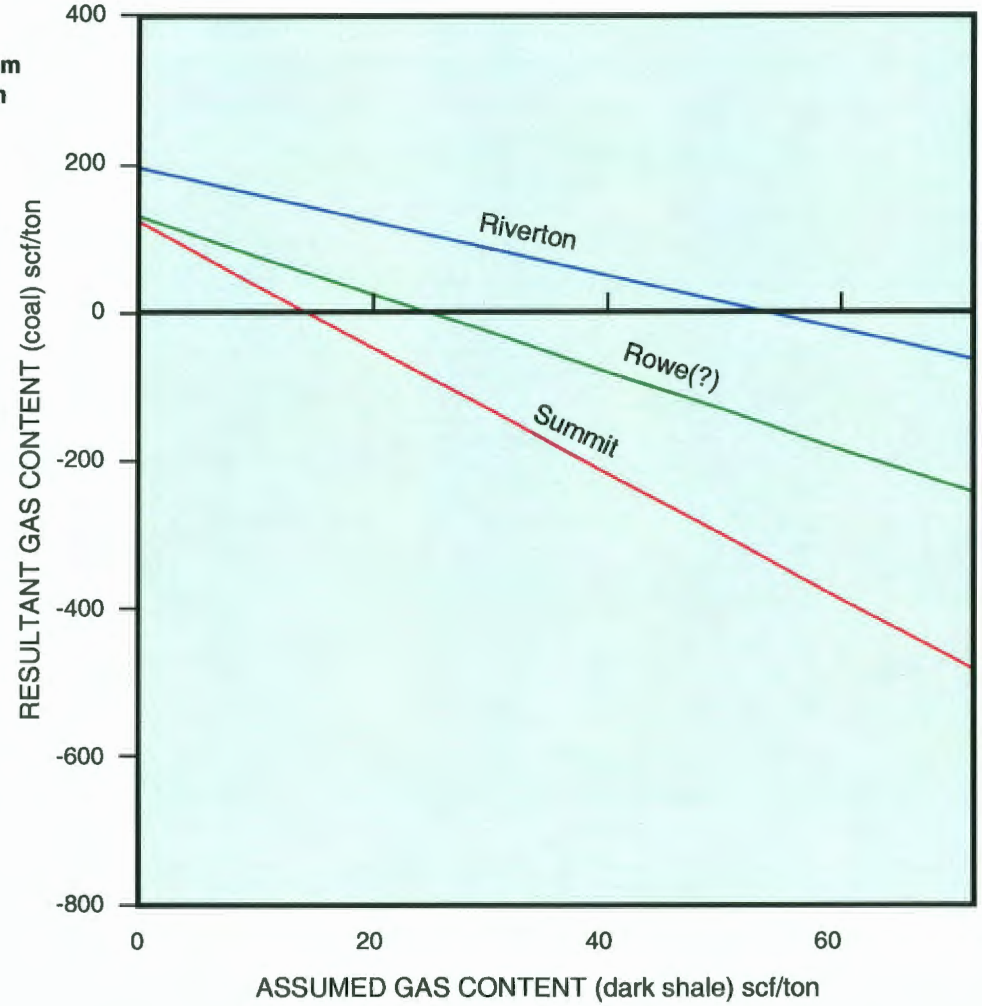
Desorption Characteristics of Cuttings Samples

Colt Energy Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., 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
Summit	8%	95.9	121.3	12.8
Rowe(?)	13%	112.8	128.4	20.7
Riverton	21%	181.3	192.2	41.8



Desorption Characteristics of Cuttings Samples (ie., coal & dark shale)

Honeycutt #1; E2 NE SE sec. 6-T.31S.-R.17E., Montgomery County, KS