A Spreadsheet for Coal Core Canister Desorption

By C.E. Barker[1], T. A. Dallegge[2] and A.C. Clark[1]

[1] U.S. Geological Survey, Denver, Colorado

[2] Former U.S. Geological Survey, now Conoco-Phillips, Houston

For more information, Contact:
Charles E. Barker
U.S. Geological Survey, Denver Federal Center
Sixth Ave and Kipling St., Building 20, MS 977
Denver, CO 80225 USA
voice: (303) 236-5797 ; FAX: (303) 236-3202
Email: barker@usgs.gov

Introduction

This set of instructions is for a spreadsheet that can be used with gas desorption data from coal core canisters. The spreadsheet corrects the measured gas volumes to standard pressure and temperature (STP) conditions and then plots this data to estimate lost gas. The cumulative desorbed gas volume is

added to the lost gas to compute total gas content of the coal core.

The spreadsheet is meant to accompany and work with the USGS canister desorption equipment presented in a Powerpoint® slide presentation (Appendix 2 and 4) on this report.

A critical start to the spreadsheet operation:

The Well Site Desorption Worksheet

WE HAND WRITE ALL DATA ON THE WORKSHEET AND ENTER IT INTO THE SPREADSHEET LATER.

Our well site desorption worksheets are explained in Appendix 1 and 2. Downloadable rtf file format versions of the forms are included in appendix 3.

The worksheets are used for several reasons:

- Although direct entry into the spreadsheet would be most efficient in terms of time, drill rig power generation tends to be unstable and irregular, resulting in many unexpected computer crashes and possible data loss.
- We have found that coalbed methane (CBM) measurements need to be done so quickly that, unless we have a extra person just to do data entry, it is easy to fall behind in the measurements, especially during the critical lost gas period. If the lost gas measurements are not taken on time, an inaccurate gas content estimate may be calculated.
- The raw coal mass, headspace measurements, and calculations are written on the worksheet to maintain a hardcopy record of them. If these measurements were lost, a new core would need to be cut and all of the data re-measured. Re-cutting a core is usually cost prohibitive.

Basic Sheet Operation -1

Project				Cumulative volume @ STP:	107.8
Well ID:		Can no.			
Sample Interval (ft):	From:		To:		
Core Date: (mm/dd/yr)			########		
Time Zero-Coal penetrated (hh:mm) (24 hour clock)			16:09		
Raw coal mass (air-dry): (grams)			1000		
Coal mass (d.a.f.): (grams)			750		
Headspace volume: (cc)			900		

Cumulative volume @ STP:	107.8
cc/gram raw coal:	0.11
cc/gram coal d.a.f.: (excluding lost gas)	0.14
Lost gas estimate (cc) (from lost gas graph)	500
Raw total gas (cc/g)	0.61
DAF total gas (cc/g)	0.81
Raw total gas (SCF/ton)	19.45
DAF total gas (SCF/ton)	25.93
Cuttings correction 25% (SCF/ton)	32.42

Sample Type: Core / Cuttings (selected)

Data Summary: Preliminary (selected) / Final Results

enter data only in shaded areas, copy and paste formulas as needed to calculate more desorption data (columns H through N)

	Date	Time 24 hour Clock	Ambient Temp	Pressure inches	Delta Gas Volume	Internal Canister Temp.	Delta Volume @ STP	Cumulative Volume @ STP	Sq. Root Elapsed Time	ml/gram Ra... Coa...	ml/g d.a.f.	Headspace Correction Cumulative Volume	Cumulative Gas
	(mm/dd/yr)	HH:MM	ºF	Hg	(milliliter)	ºF	(milliliter)	(milliliter)	($Hrs^{1/2}$)	Mas...			
In Can	8/21/2000	18:38	105.0	29.18	0	100.0	0.00	0.00	1.58				
1	8/21/2000	19:12	105.0	29.18	127	100.0	115.08	115.08	1.75	0.12	0.15	107.8	0.004
2							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
3							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
4							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
5							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
6							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Colored cells are for data entry by user.

Basic Sheet Operation -2

Project			
Well ID:		Can no.	
Sample Interval (ft):	From:	To:	
Core Date: (mm/dd/yr)			########
Time Zero-Coal penetrated (hh:mm) (24 hour clock)			16:09
Raw coal mass (air-dry): (grams)			1000
Coal mass (d.a.f.): (grams)			750
Headspace volume: (cc)			900

Cumulative volume @ STP:	107.8
cc/gram raw coal:	0.11
cc/gram coal d.a.f.: (excluding lost gas)	0.14
Lost gas estimate (cc) (from lost gas graph)	500

Raw total gas (cc/g)	0.61
DAF total gas (cc/g)	0.81
Raw total gas (SCF/ton)	19.45
DAF total gas (SCF/ton)	25.93
Cuttings correction 25% (SCF/ton)	32.42

Sample Type: Core / Cuttings (selected)

Data Summary: Preliminary (selected) / Final Results

enter data only in shaded areas, copy and paste formulas as needed to calculate more desorption data (columns H through N)

	Pressure inches Hg	Delta Gas Volume (milliliter)	Internal Canister Temp. °F	Delta Volume @ STP (milliliter)	Cumulative Volume @ STP (milliliter)	Sq. Root Elapsed Time ($Hrs^{1/2}$)	ml/gram Raw Coal Mass	ml/g d.a.f Coal Mass	Headspace Correction Cumulative Volume @ STP (milliliter)	Headspace Correction Cumulative Gas Content (SCF)
In Ca	29.18	0	100.0	0.00	0.00	1.58	0.00	0.00	0.0	0.0
	29.18	127	100.0	115.08	115.08	1.75	0.12	0.15	107.8	0.004
				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
5				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
6				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Unhighlighted cells are used by the spreadsheet program for calculation and are locked against data entry by user.

Basic Sheet Operation -3

Project			Cumulative volume @ STP:	107.8	Raw total gas (cc/g)	0.61
Well ID:		Can no.				
Sample Interval (ft):	From:	To:	cc/gram raw coal:	0.11	DAF total gas (cc/g)	0.81
Core Date: (mm/dd/yr)		#######				
Time Zero-Coal penetrated (hh:mm) (24 hour clock)		16:09	cc/gr			
Raw coal mass (air-dry): (grams)		1000	(ex			
Coal mass (d.a.f.): (grams)		750	Lost gas			
Headspace volume: (cc)		900	(fro			

Sample Type: ○ Core ● Cuttings

Data Summary: ● Preliminary ○ Final Results

Before or during coring prepare enough canisters and related desorption forms to accommodate all coal. This is done ahead of time so that the core pieces can be inserted into a canister as soon as possible to minimize lost gas.

enter data only in shaded areas, copy and paste formulas as needed to calculate more desor

	Date (mm/dd/yr)	Time 24 hour Clock HH:MM	Ambient Temp °F	Pressure inches Hg	Delta Gas Volume (milliliter)	Internal Canister Temp. °F	Delta Volume @ STP (milliliter)	Cumulative Volume @ STP (milliliter)	Sq. Root Elapsed Time (Hrs$^{1/2}$)	ml/gram Raw Coal Mass	ml/g d.a.f Coal Mass	Cumulative Volume @ STP (milliliter)	Cumulative Gas Content (SCF)
In Can	8/21/2000	18:38	105.0	29.18	0	100.0	0.00	0.00	1.58	0.00	0.00	0.0	0.0
1	8/21/2000	19:12	105.0	29.18	127	100.0	115.08	115.08	1.75	0.12	0.15	107.8	0.004
2							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
3							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
4							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
5							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
6							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Before Filling Canister Operations

Step 1. Core or Cuttings samples?
Click radio buttons to indicate whether core or cuttings are being desorbed.

Step 2. Preliminary vs. Final? All measurements start out as preliminary because the ash content and headspace can only be measured after desorption is complete. The analysis is then marked "final"

Project				Cumulative volume @			
Well ID:		Can no.					
Sample Interval (ft):	From:		To:		cc/gram raw		
Core Date: (mm/dd/yr)			########				
Time Zero-Coal penetrated (hh:mm) (24 hour clock)			16:09	cc/gram coal d.a.f.:	0.14	Raw total gas (SCF/ton)	19.45
Raw coal mass (air-dry): (grams)			1000	(excluding lost gas)			
Coal mass (d.a.f.): (grams)			750	Lost gas estimate (cc)	500	DAF total gas (SCF/ton)	25.93
Headspace volume: (cc)			900	(from lost gas graph)			
						Cuttings correction 25% (SCF/ton)	32.42

Sample Type: ○ Core ● Cuttings

Data Summary: ● Preliminary ○ Final Results

enter data only in shaded areas, copy and paste formulas as needed to calculate more desorption data (columns H through N)

	Date	Time 24 hour Clock	Ambient Temp	Pressure inches	Delta Gas Volume	Internal Canister Temp.	Delta Volume @ STP	Cumulative Volume @ STP	Sq. Root Elapsed Time	ml/ R C M			
	(mm/dd/yr)	HH:MM	°F	Hg	(milliliter)	°F	(milliliter)	(milliliter)	($Hrs^{1/2}$)				
In Can	8/21/2000	18:38	105.0	29.18	0	100.0	0.00	0.00	1.58	0			
1	8/21/2000	19:12	105.0	29.18	127	100.0	115.08	115.08	1.75	0			
2							FALSE	FALSE	FALSE	FA			
3							FALSE	FALSE	FALSE	FA			
4							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
5							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
6							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Clicking the cuttings button activates a cuttings correction calculation. The 25% correction is based on a study by Nelson (1998).

Critical Sample and Canister identification Entries

Enter:
1. Canister number.

2. Enter depth interval of core or cutting sample that has been placed in the canister.

Project			
Well ID:		Can no.	
Sample Interval (ft):	From:		To:
Core Date: (mm/dd/yr)			########
Time Zero-Coal penetrated (hh:mm) (24 hour clock)			16:09
Raw coal mass (air-dry): (grams)			1000
Coal mass (d.a.f.): (grams)			750
Headspace volume: (cc)			900

Cumulative volume @ ST			
cc/gram raw co			
cc/gram coal d.a.f.:	0.14	Raw total gas (SCF/ton)	19.45
(excluding lost gas)			
Lost gas estimate (cc)	500	DAF total gas (SCF/ton)	25.93
(from lost gas graph)			
		Cuttings correction 25% (SCF/ton)	32.42

Sample Type: ○ Core ◉ Cuttings

Data Summary: ◉ Preliminary ○ Final Results

enter data only in shaded areas, copy and paste formulas as needed to calculate more desorption data (columns H through N)

	Date	Time 24 hour Clock	Ambient Temp	Pressure inches	Delta Gas Volume	Internal Canister Temp.	Delta Volume @ STP	Cumulative Volume @ STP	Sq. Root Elapsed Time	ml/gram Raw Coal	ml/g d.a.f Coal	Headspace Correction Cumulative Volume @ STP	Headspace Correction Cumulative Gas Content
	(mm/dd/yr)	HH:MM	ºF	Hg	(milliliter)	ºF	(milliliter)	(milliliter)	($Hrs^{1/2}$)	Mass	Mass	(milliliter)	(SCF)
In Can	8/21/2000	18:38	105.0	29.18	0	100.0	0.00	0.00	1.58	0.00	0.00	0.0	0.0
1	8/21/2000	19:12	105.0	29.18	127	100.0	115.08	115.08	1.75	0.12	0.15	107.8	0.004
2							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
3							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
4							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
5							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
6							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Critical Time Entries

First critical entry: time and date that the core was lifted off bottom or the time that the drill cuttings were cut by the bit . The spreadsheet uses 24 hour clock.

Project			Cumulative volume @ STP:		.61
Well ID:	Can no.				
Sample Interval (ft):	From:	To:	cc/gram raw coal: 0.11	DAF total gas (cc/g)	0.81
Core Date: (mm/dd/yr)		########			
Time Zero-Coal penetrated (hh:mm) (24 hour clock)		16:09	cc/gram coal d.a.f.: 0.14	Raw total gas (SCF/ton)	19.45
Raw coal mass (air-dry): (grams)		1000	(excluding lost gas)		
Coal mass (d.a.f.): (grams)		750	Lost gas estimate (cc) 500	DAF total gas (SCF/ton)	25.93
Headspace volume: (cc)		900	(from lost gas graph)		
				Cuttings correction 25% (SCF/ton)	32.42

Sample Type: Core / Cuttings (selected)

Data Summary: Preliminary (selected) / Final Results

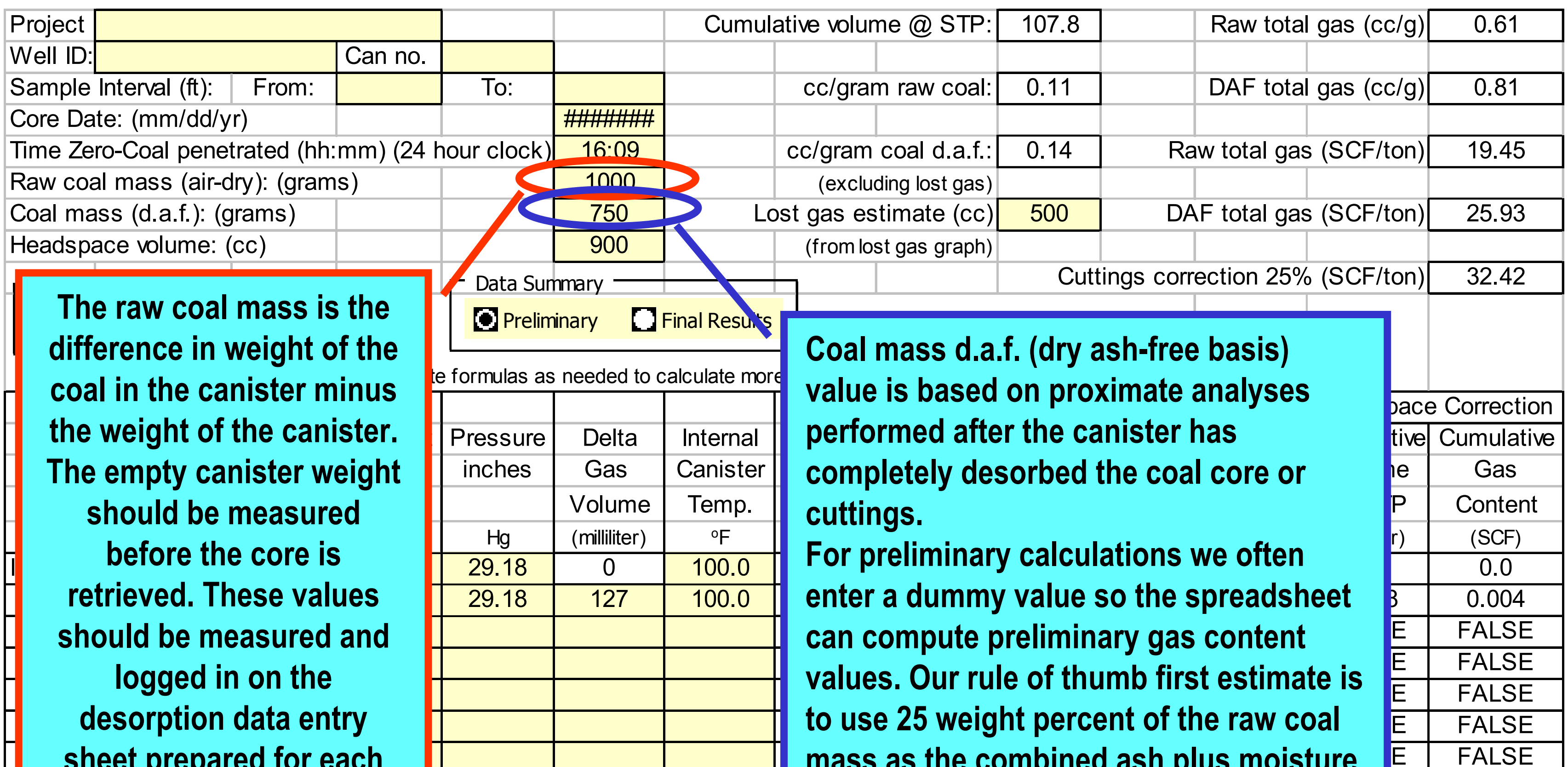
enter data only in shaded areas, copy and paste formulas as needed to calculate more desorption data (columns H through N)

	Date (mm/dd/yr)	Time 24 hour Clock HH:MM	Ambient Temp °F	Pressu inches Hg					q. Root Elapsed Time (Hrs^1/2)	ml/gram Raw Coal Mass	ml/g d.a.f Coal Mass	Headspace Correction Cumulative Volume @ STP (milliliter)	Cumulative Gas Content (SCF)
In Can	8/21/2000	18:38	105.0	29.18					1.58	0.00	0.00	0.0	0.0
1	8/21/2000	19:12	105.0	29.18					1.75	0.12	0.15	107.8	0.004
2									FALSE	FALSE	FALSE	FALSE	FALSE
3							FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Second critical entry: time and date that the core or cuttings are sealed in canister.

Critical Coal Mass, Ash and Moisture Data

--This is done after desorption is finished



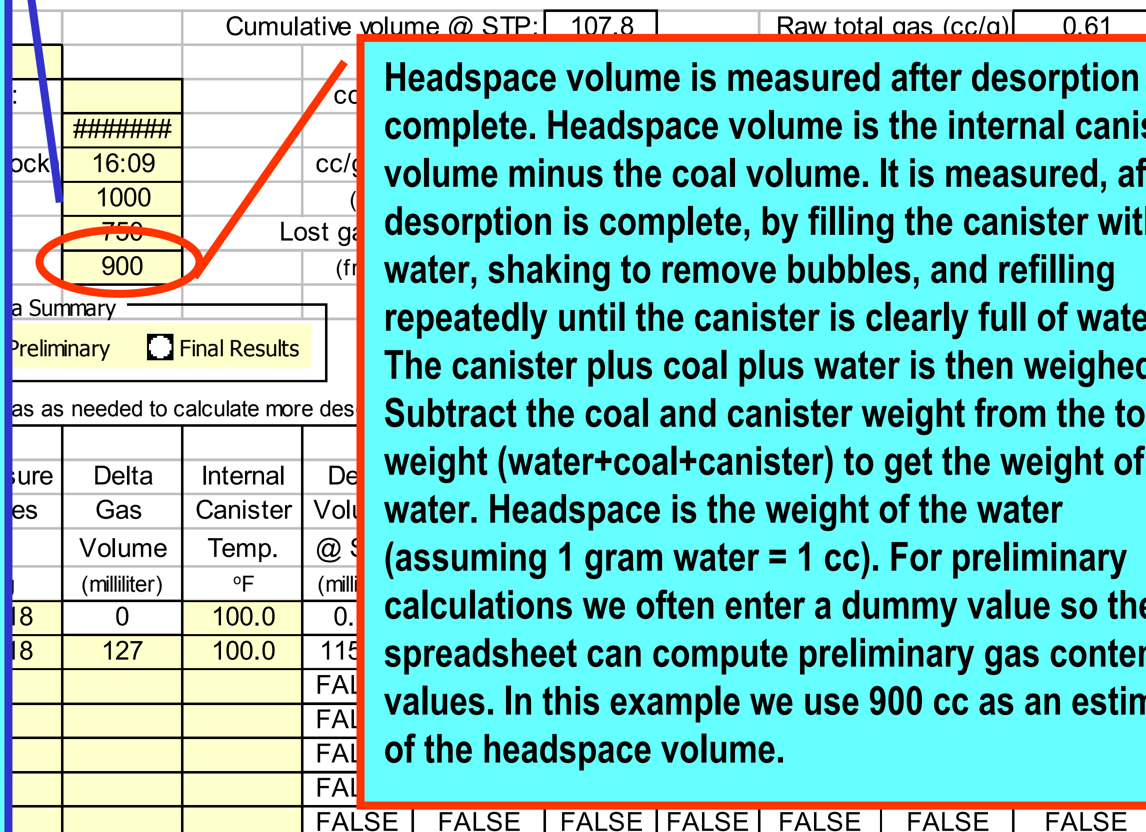
The raw coal mass is the difference in weight of the coal in the canister minus the weight of the canister. The empty canister weight should be measured before the core is retrieved. These values should be measured and logged in on the desorption data entry sheet prepared for each canister.

Coal mass d.a.f. (dry ash-free basis) value is based on proximate analyses performed after the canister has completely desorbed the coal core or cuttings.
For preliminary calculations we often enter a dummy value so the spreadsheet can compute preliminary gas content values. Our rule of thumb first estimate is to use 25 weight percent of the raw coal mass as the combined ash plus moisture value .

Headspace Calculation

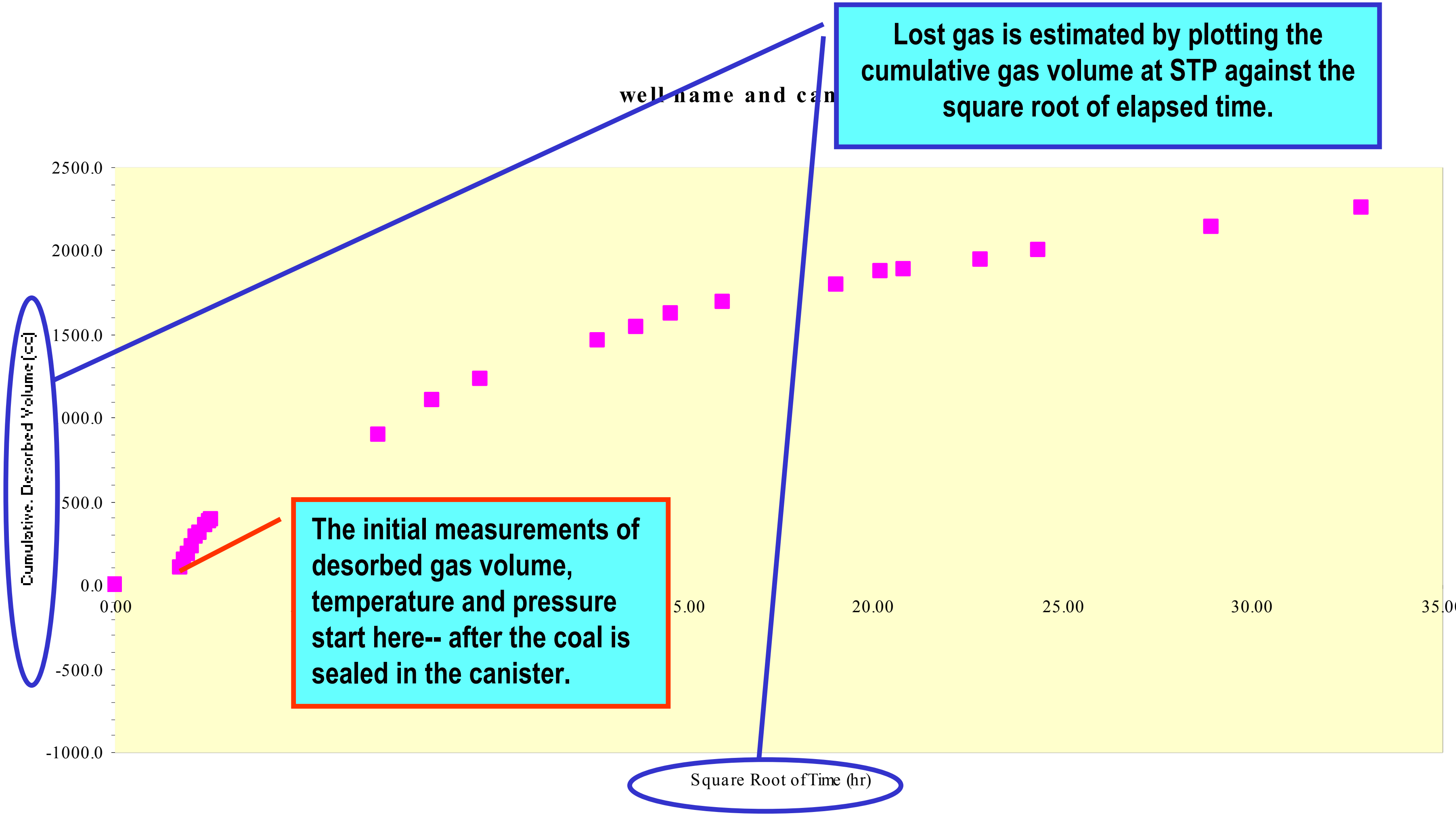
Before desorption is complete an estimate of headspace can be made by computing the volume of the canister from its internal working length (that could be filled with sample) and internal diameter. Then subtract the estimated volume of core computed from the core diameter and its length (usually about 30 cm (12 in) in 36 cm (14 in) long canisters). The difference is the estimated head space.

Example: a 7.5 cm (3 in) internal diameter by 36 cm (14 in) long USGS can with pressure plug installed still has about 33 cm (13 in) of free space and a volume of 1460 cc. A common core size is 6.6 cm (2.6 in) and a 30 cm (12 in) piece of this has a volume of 995 cc. The estimated headspace = 465 cc.



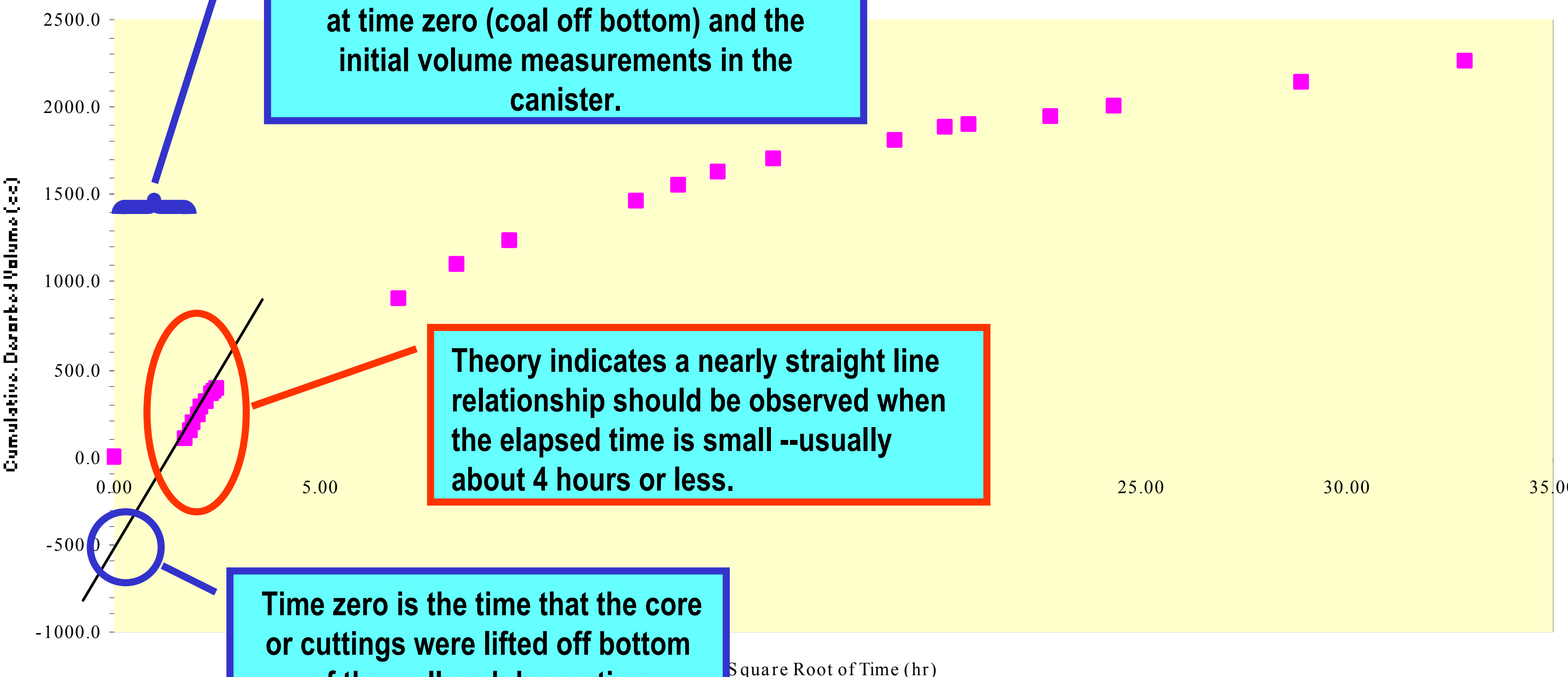
Headspace volume is measured after desorption is complete. Headspace volume is the internal canister volume minus the coal volume. It is measured, after desorption is complete, by filling the canister with water, shaking to remove bubbles, and refilling repeatedly until the canister is clearly full of water. The canister plus coal plus water is then weighed. Subtract the coal and canister weight from the total weight (water+coal+canister) to get the weight of the water. Headspace is the weight of the water (assuming 1 gram water = 1 cc). For preliminary calculations we often enter a dummy value so the spreadsheet can compute preliminary gas content values. In this example we use 900 cc as an estimate of the headspace volume.

Graphical Analysis of Lost Gas-1



This graph is located on page 2 of the spreadsheet file

Graphical Analysis of Lost Gas-2



Definition of Lost Gas

Lost gas is the volume of gas lost between when the sample commences desorption at time zero (coal off bottom) and the initial volume measurements in the canister.

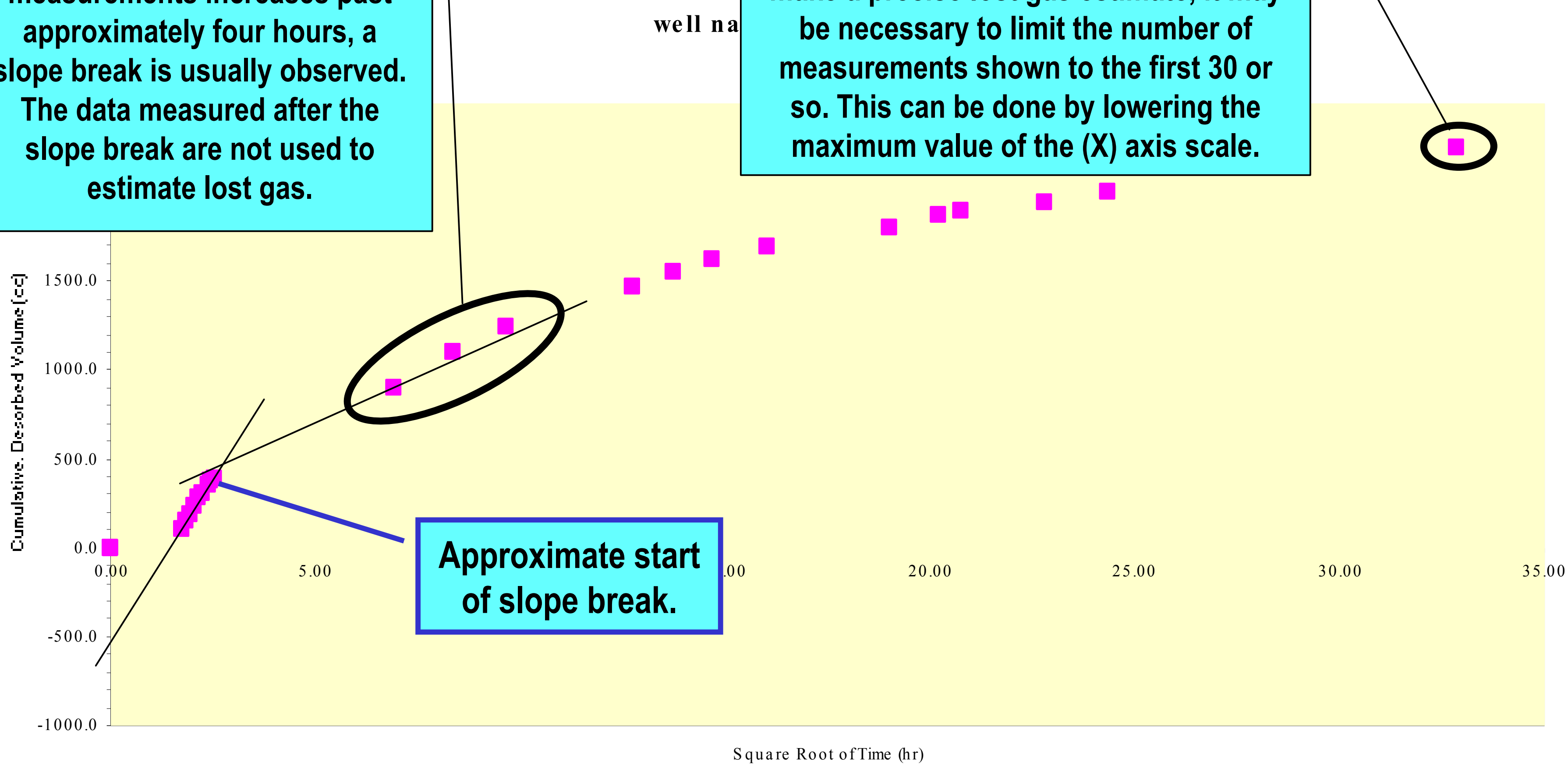
Theory indicates a nearly straight line relationship should be observed when the elapsed time is small --usually about 4 hours or less.

Time zero is the time that the core or cuttings were lifted off bottom of the well and desorption commenced.

Graphical Analysis of Lost Gas-3

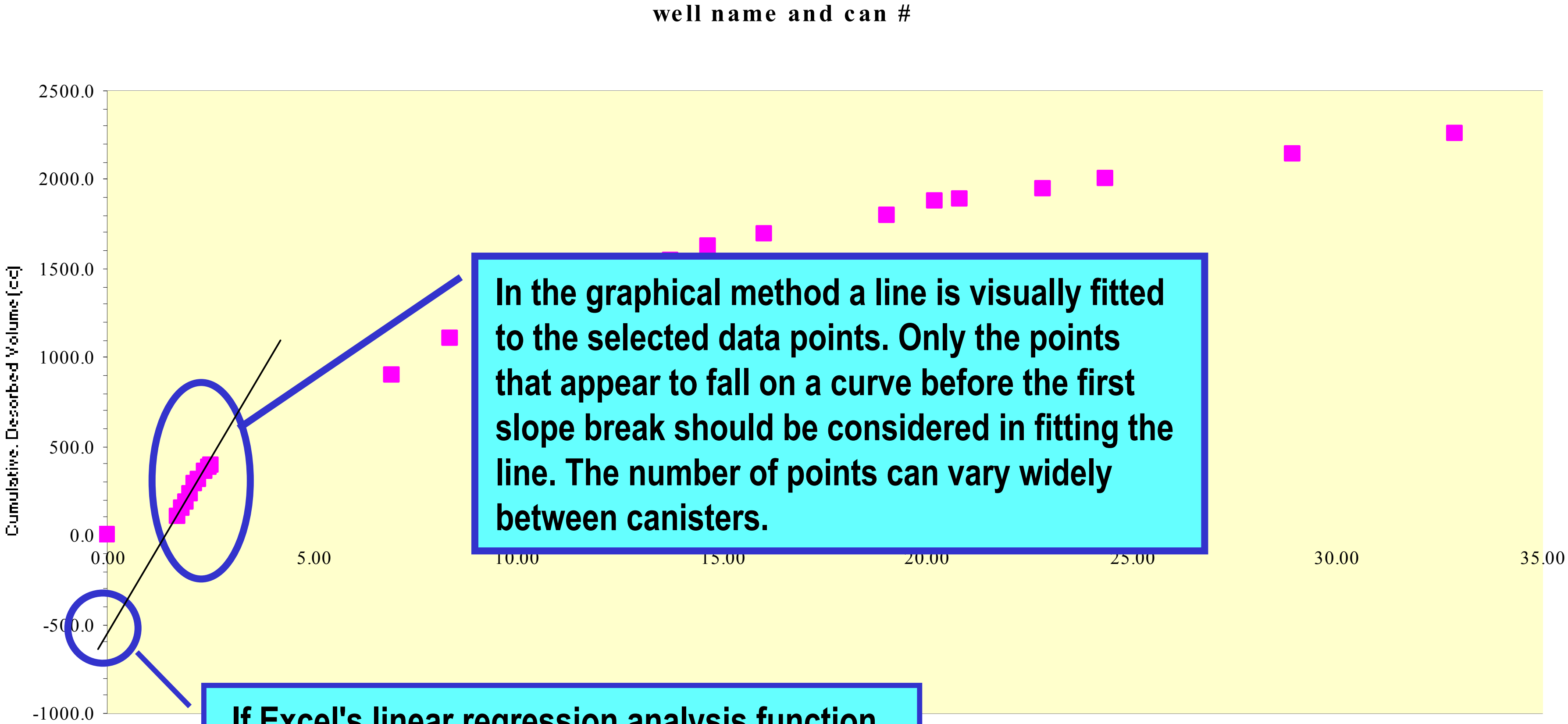
As elapsed time of the measurements increases past approximately four hours, a slope break is usually observed. The data measured after the slope break are not used to estimate lost gas.

The spreadsheet automatically displays up to the first hundred measurements. To make a precise lost gas estimate, it may be necessary to limit the number of measurements shown to the first 30 or so. This can be done by lowering the maximum value of the (X) axis scale.



Approximate start of slope break.

Graphical Analysis of Lost Gas-4



In the graphical method a line is visually fitted to the selected data points. Only the points that appear to fall on a curve before the first slope break should be considered in fitting the line. The number of points can vary widely between canisters.

If Excel's linear regression analysis function is used. The lost gas is equal to the negative of the y-intercept of the regression equation fitted to the line.

Enter Lost Gas Estimate into Spreadsheet

Project		Cumulative volume @ STP:	107.8
Well ID:	Can no.		
		cc/gram raw coal:	0.11
		cc/gram coal d.a.f.: (excluding lost gas)	0.14
		Lost gas estimate (cc) (from lost gas graph)	500

Raw total gas (cc/g)	0.61
DAF total gas (cc/g)	0.81
Raw total gas (SCF/ton)	19.45
DAF total gas (SCF/ton)	25.93
Cuttings correction 25% (SCF/ton)	32.42

l Results

ulate more desorption data (columns H through N)

ternal anister Temp. °F	Delta Volume @ STP (milliliter)	Cumulative Volume @ STP (milliliter)	Sq. Root Elapsed Time ($Hrs^{1/2}$)	ml/gram Raw Coal Mass	ml/g d.a.f Coal Mass	Headspace Correction: Cumulative Volume @ STP (milliliter)	Headspace Correction: Cumulative Gas Content (SCF)
00.0	0.00	0.00	1.58	0.00			
00.0	115.08	115.08	1.75	0.12			
	FALSE	FALSE	FALSE	FALS			
	FALSE	FALSE	FALSE	FALS			
	FALSE	FALSE	FALSE	FALS			
	FALSE	FALSE	FALSE	FALS			
	FALSE	FALSE	FALSE	FALS			

Discussion

Some programs automate the lost gas estimation process by using a macro to automatically insert the negative of the Y-intercept calculated by the EXCEL regression function.

However, in practice we've found that this automation can produce significant errors because the number of measurements that fall along a line segment can vary widely. An automated regression macro that considers a fixed number of points may choose a line that is not a good fit because some of the points are on different line segments. We think it important for the operator to examine the results from each canister, choose the number of data points under consideration, and hand fit a line or apply regression analysis. Therefore, our method does not necessary include a regression macro.

Enter the estimated lost gas. The lost gas estimate is made graphically or using regression analysis on page 2 of the spreadsheet (appendix 4).

Spreadsheet Computes Cumulative Desorbed Gas Corrected to STP and Total Gas

Project	
Well ID:	
Can no.	

Cumulative volume @ STP:	107.8
cc/gram raw coal:	0.11
cc/gram coal d.a.f.: (excluding lost gas)	0.14
Lost gas estimate (cc) (from lost gas graph)	500

Raw total gas (cc/g)	0.61
DAF total gas (cc/g)	0.81
Raw total gas (SCF/ton)	19.45
DAF total gas (SCF/ton)	25.93
Cuttings correction 25% (SCF/ton)	32.42

Final Results

Headspace Correction	
Cumulative Volume @ STP (milliliter)	Cumulative Gas Content (SCF)
0.0	0.0
107.8	0.004
FALSE	FALSE
FALSE	FALSE
FALSE	FALSE
FALSE	FALSE
FALSE	FALSE

Final Results:

Cumulative volume at STP is the sum of the measured gas volume corrected to STP.

cc/ gram raw coal is the cumulative gas volume at STP divided by the raw coal mass

cc/ gram coal d.a.f. is the cumulative gas volume at STP divided by the d.a.f. coal mass

Raw total gas is the cumulative volume plus the lost gas volume divided by raw coal mass

DAF total gas is the total gas corrected to d.a.f. coal mass These total gas values are given in metric units (cc/g) and English units (SCF/Ton)

If the sample is cuttings, a correction of 25% is arbitrarily added.

Appendix 1A: The Well Site Desorption Worksheet: Before the core reaches the surface

Company:________________ Well name________________________CORE CAN#____________________
Location:________________________________ Can Sample interval_____________________________
API: Mud logger Co and logger names

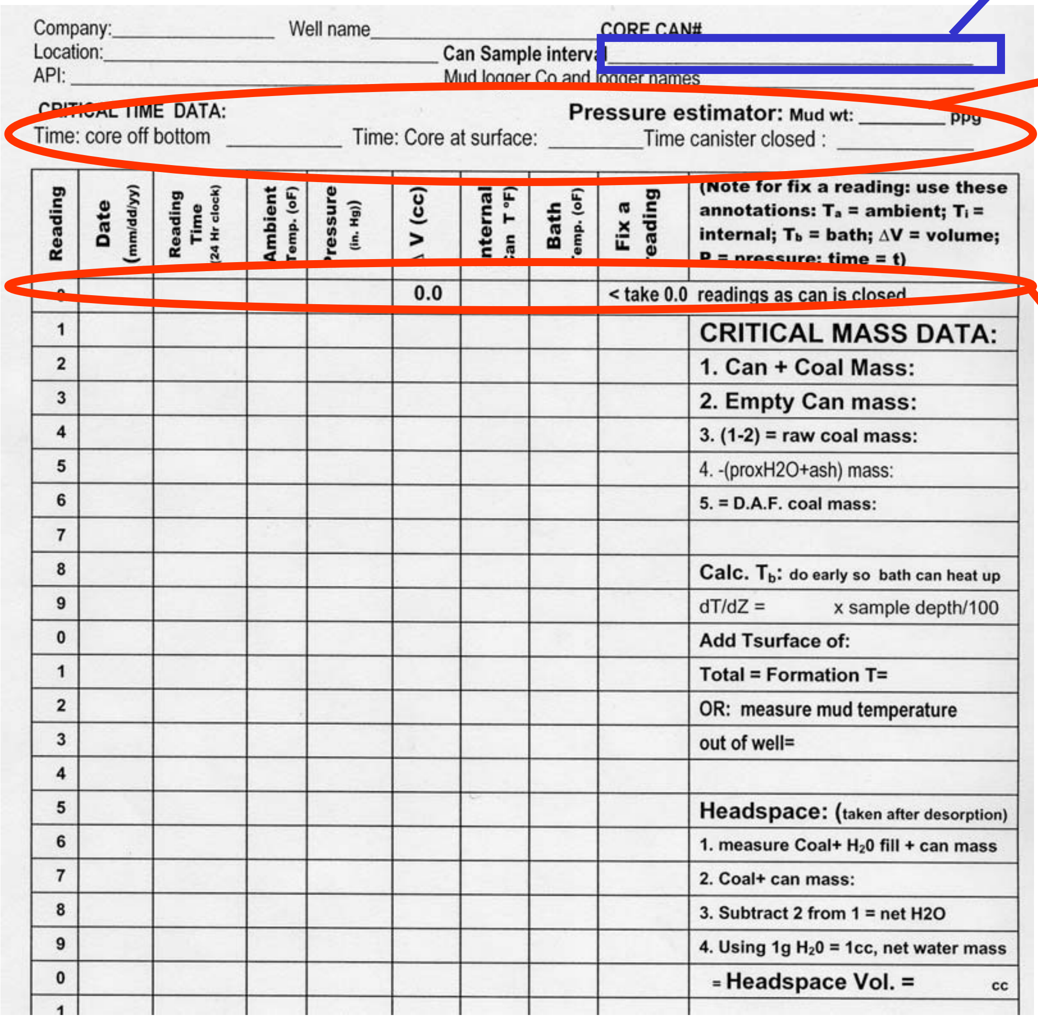
CRITICAL TIME DATA: **Pressure estimator:** Mud wt: ________ ppg
Time: core off bottom __________ Time: Core at surface: _________Time canister closed : __________

Reading	Date (mm/dd/yy)	Reading Time (24 Hr clock)	Ambient Temp. (oF)	Pressure (in. Hg)	Δ V (cc)	Internal Can T °F	Bath Temp. (oF)	Fix a reading	(Note for fix a reading: use these annotations: T_a = ambient; T_i = internal; T_b = bath; ΔV = volume; P = pressure; time = t)
0					0.0			< take 0.0	readings as can is closed
1									**CRITICAL MASS DATA:**
2									1. Can + Coal Mass:
3									2. Empty Can mass:
4									3. (1-2) = raw coal mass:
5									4. -(proxH2O+ash) mass:
6									5. = D.A.F. coal mass:
7									
8									Calc. T_b: do early so bath can heat up
9									dT/dZ = x sample depth/100
0									Add Tsurface of:
1									Total = Formation T=
2									OR: measure mud temperature
3									out of well=
4									
5									Headspace: (taken after desorption)
6									1. measure Coal+ H_20 fill + can mass
7									2. Coal+ can mass:
8									3. Subtract 2 from 1 = net H2O
9									4. Using 1g H_20 = 1cc, net water mass
0									= Headspace Vol. = cc
1									

1. Long before the core reaches the surface, prepare enough forms and canisters to cover the expected core footage.
2. Weigh the empty canister with pressure plug and quick connect installed. We write that weight on this form and on the canister itself with a felt tip marker.

The coalbed in-situ temperature needs to be calculated, if not available from drill stem test (DST), drilling mud temperature or other data.
The coalbed in-situ temperature is used as the water bath temperature. It is thought that lost gas estimates are more accurate if the desorption is done at coalbed in-situ temperature.

Appendix 1B: The Well Site Desorption Worksheet: During Coring



Company:________________ Well name________________ CORE CAN#

Location:____________________________ Can Sample interval____________________

API: ____________________________ Mud logger Co and logger names____________

CRITICAL TIME DATA: Pressure estimator: Mud wt: ________ ppg

Time: core off bottom __________ Time: Core at surface: _________Time canister closed : __________

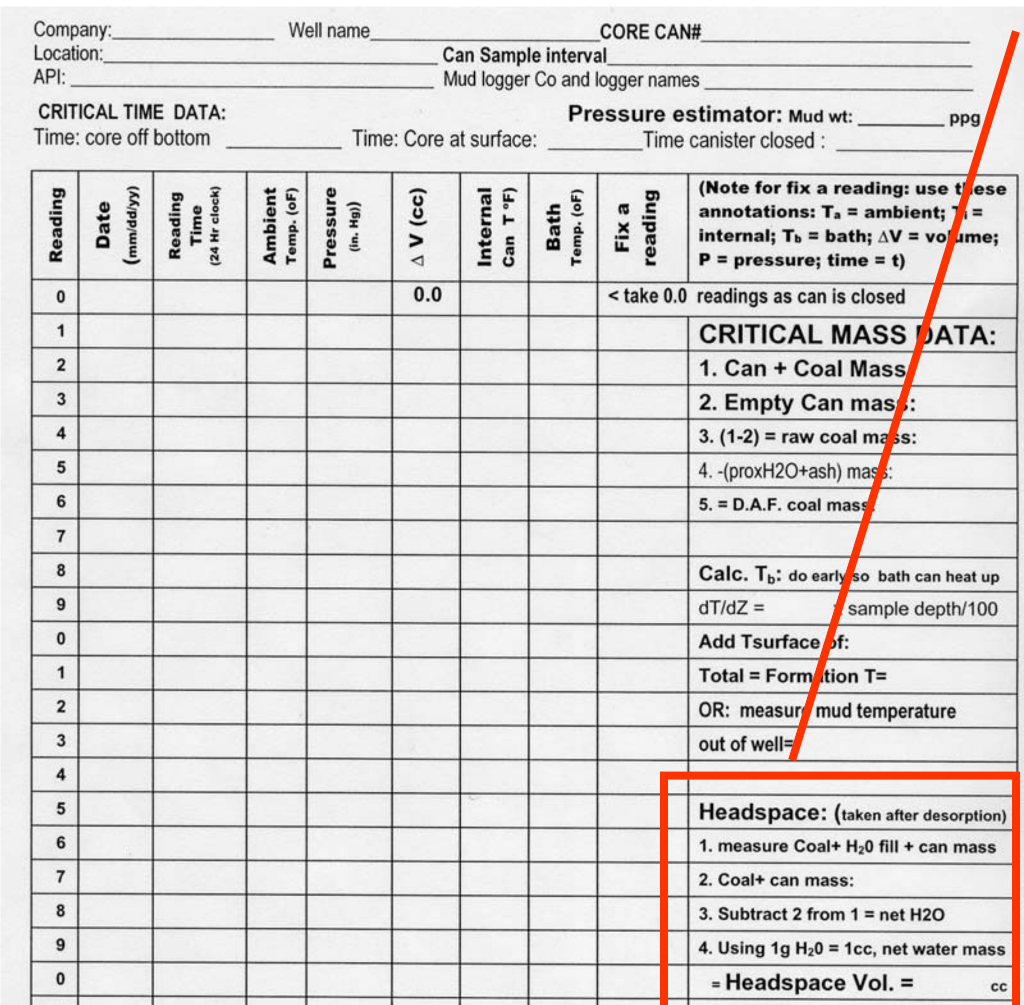
Reading	Date (mm/dd/yy)	Reading Time (24 Hr clock)	Ambient Temp. (oF)	Pressure (in. Hg)	ΔV (cc)	Internal Can T °F	Bath Temp. (oF)	Fix a reading	(Note for fix a reading: use these annotations: T_a = ambient; T_i = internal; T_b = bath; ΔV = volume; P = pressure; time = t)
0					0.0			< take 0.0	readings as can is closed
1									CRITICAL MASS DATA:
2									1. Can + Coal Mass:
3									2. Empty Can mass:
4									3. (1-2) = raw coal mass:
5									4. -(proxH_2O+ash) mass:
6									5. = D.A.F. coal mass:
7									
8									Calc. T_b: do early so bath can heat up
9									dT/dZ = x sample depth/100
0									Add Tsurface of:
1									Total = Formation T=
2									OR: measure mud temperature
3									out of well=
4									
5									Headspace: (taken after desorption)
6									1. measure Coal+ H_20 fill + can mass
7									2. Coal+ can mass:
8									3. Subtract 2 from 1 = net H_2O
9									4. Using 1g H_20 = 1cc, net water mass
0									= Headspace Vol. = cc
1									

Enter the sample footage as the can is loaded into the canister.

Enter the critical times of core off bottom, core at surface (used in Smith and Williams lost gas method) and core in canister.

If time and personnel availability allow, take the initial readings of canister conditions when measured gas volume = 0

Appendix 1C: The Well Site Desorption Worksheet: Headspace Calculation



Company:__________ Well name__________CORE CAN#__________
Location:__________ Can Sample interval__________
API: __________ Mud logger Co and logger names __________

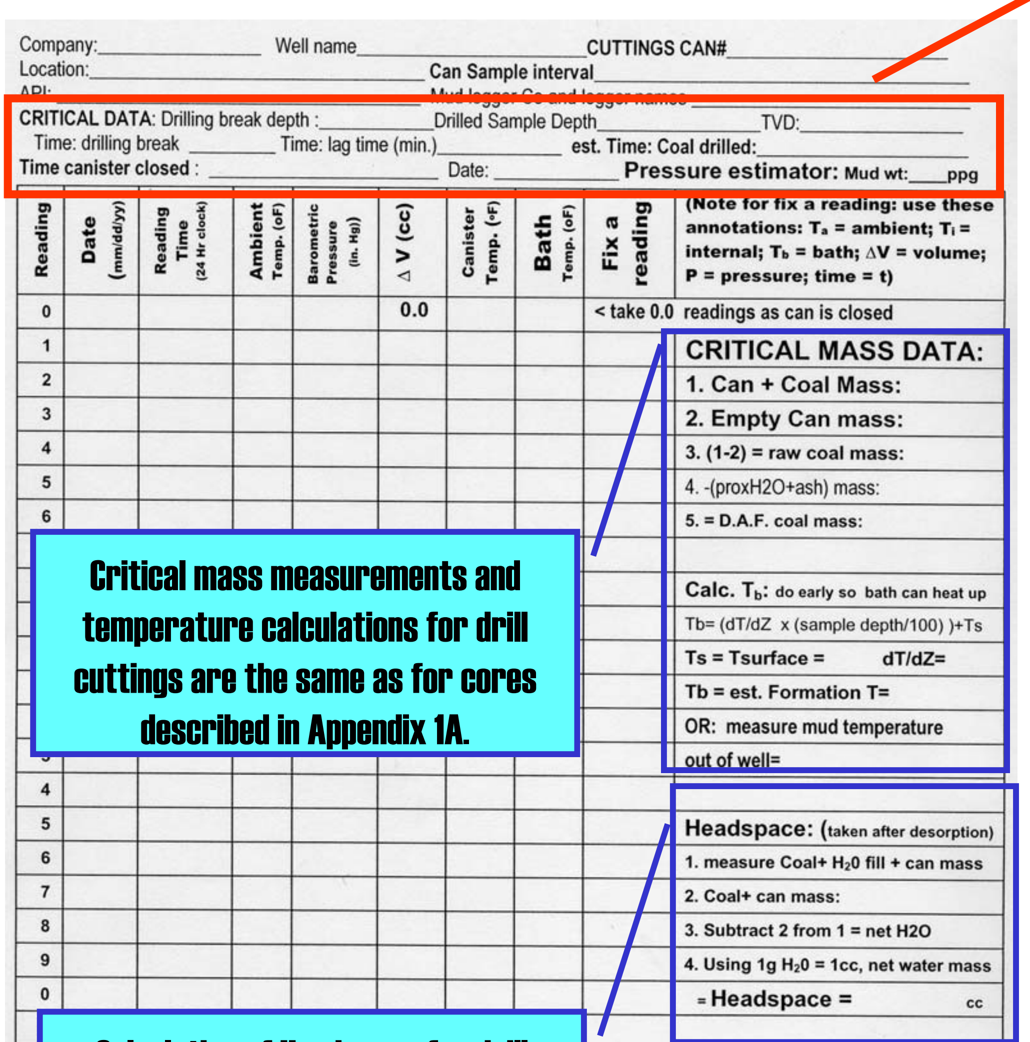
CRITICAL TIME DATA: Pressure estimator: Mud wt: ________ ppg
Time: core off bottom ________ Time: Core at surface: ________Time canister closed : ________

Reading	Date (mm/dd/yy)	Reading Time (24 Hr clock)	Ambient Temp. (oF)	Pressure (in. Hg)	Δ V (cc)	Internal Can T °F	Bath Temp. (oF)	Fix a reading	(Note for fix a reading: use these annotations: T_a = ambient; T_i = internal; T_b = bath; ΔV = volume; P = pressure; time = t)
0					0.0			< take 0.0	readings as can is closed
1									CRITICAL MASS DATA:
2									1. Can + Coal Mass:
3									2. Empty Can mass:
4									3. (1-2) = raw coal mass:
5									4. -(proxH2O+ash) mass:
6									5. = D.A.F. coal mass
7									
8									Calc. T_b: do early so bath can heat up
9									dT/dZ = × sample depth/100
0									Add Tsurface of:
1									Total = Formation T=
2									OR: measure mud temperature
3									out of well=
4									
5									Headspace: (taken after desorption)
6									1. measure Coal+ H_2O fill + can mass
7									2. Coal+ can mass:
8									3. Subtract 2 from 1 = net H2O
9									4. Using 1g H_2O = 1cc, net water mass
0									= Headspace Vol. = cc
1									

Headspace volume is measured after desorption is complete. Headspace volume is the internal canister volume minus the coal volume. It is measured after desorption is complete, by removing the quick connect , filling the canister with water, shaking to remove bubbles, refilling with water and shaking again. The cycle is repeated until the canister is clearly full of water. The canister plus coal plus water is then weighed. Subtract the coal and canister weight from the total weight (water+coal+canister) to get the weight of the water. Headspace is the weight of the water (assuming 1 gram water = 1 cc).

NOTE: Headspace calculation for drill cuttings uses the same method described here.

Appendix 2: The Well Site Desorption Data Worksheet: Drill Cuttings



Company:________________ Well name______________________CUTTINGS CAN#____________________

Location:________________________________ Can Sample interval____________________________

CRITICAL DATA: Drilling break depth :___________Drilled Sample Depth_______________TVD:_______________

Time: drilling break ________ Time: lag time (min.)___________ est. Time: Coal drilled:_______________

Time canister closed : ______________________ Date: ____________ Pressure estimator: Mud wt:____ppg

Reading	Date (mm/dd/yy)	Reading Time (24 Hr clock)	Ambient Temp. (oF)	Barometric Pressure (in. Hg)	Δ V (cc)	Canister Temp. (oF)	Bath Temp. (oF)	Fix a reading	(Note for fix a reading: use these annotations: T_a = ambient; T_i = internal; T_b = bath; ΔV = volume; P = pressure; time = t)
0					0.0			< take 0.0	readings as can is closed
1									
2									
3									
4									
5									
6									
4									
5									
6									
7									
8									
9									
0									

CRITICAL MASS DATA:
1. Can + Coal Mass:
2. Empty Can mass:
3. (1-2) = raw coal mass:
4. -(proxH2O+ash) mass:
5. = D.A.F. coal mass:

Calc. T_b: do early so bath can heat up
Tb= (dT/dZ x (sample depth/100))+Ts
Ts = Tsurface = dT/dZ=
Tb = est. Formation T=
OR: measure mud temperature out of well=

Headspace: (taken after desorption)
1. measure Coal+ H_2O fill + can mass
2. Coal+ can mass:
3. Subtract 2 from 1 = net H2O
4. Using 1g H_2O = 1cc, net water mass = Headspace = cc

Critical mass measurements and temperature calculations for drill cuttings are the same as for cores described in Appendix 1A.

Calculation of Headspace for drill cuttings is the same as for cores.

The major difference between using drill cuttings over core is determining the time the samples are cut by the drill bit. Another difference is assessment of sample depth. The major problem with cuttings is the grinding of the sample enhances lost gas and it is not easy to separate unrelaled carbonaneceous rock that mixes with the coal in the well bore. However, for cuttings, all of the other functions on the work sheet are the same as those discussed for cores.

Measurement of time off bottom and sample depth

Method 1. Initial time of drilling break is noted on geolograph = time of coal cuttings off bottom. Depth duration of the drilling break = coal sample interval.

Method 2. The shale shaker is watched. When a coal is detected on the shaker, the time is noted. The time off bottom is the time on shaker minus the lag time. Lag time measurement is usually monitored by the well mud loggers. It can also be measured using carbide added to the mudstream or calculated using pump strokes, pump volume and the net well volume available to move the cuttings to the surface. After drilling, The coal sample depth interval in the canister is most accurately measured from geophysical logs.

References

Nelson, C.R., 1998, Advances in coalbed reservoir gas in place analysis: Gas Research Institute Gas Tips, Winter 1997/1998 v. 4, no. 1 p. 14-19.

Smith, D.M. and Williams, F.L., 1984, Diffusion models for gas production from coals: Fuel, v. 63, p. 251-255.