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COAL PRECURSORS FOR CARBON MOLECULAR SIEVES (CMS)

Final Report (Appendices A through L)

October 1, 1994
to March 31, 1996

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by

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March 31, 1996

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INTRODUCTION

During the course of this research, much information was gathered. Some of this information was provided by researchers at the Argonne National Laboratory and other information was provided by researchers at Penn State. Additional information was obtained from articles published in open literature. Summaries of information obtained from these sources is included in the appendices. In addition, a large amount of data concerning these coal samples was obtained using the several techniques described in our Final Report. Summaries of the data gathered for each coal sample by us is also included in these appendices.

In addition to the summaries provided in each appendix, much additional information is stored in computerized formats. We have prepared a number of graphs, figures, and partial printouts of the computerized data, which are included in the appendices.

For information concerning the availability of these files, contact:

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FORMAT OF APPENDICES

The data for each coal sample used in this study are included in a separate appendix. Each appendix is separated from other appendices by a colored sheet of paper to facilitate finding information for each of the coal samples.

The information for each coal is presented in the following order:

- Coal Sample Data (Literature)
- Coal Sample Data (Measured)
- Thermogravimetric Data
 - Pyrolysis in Impure Helium (if available)
 - Pyrolysis in Pure Helium
 - Pyrolysis in Artificial Air (Oxidative Pyrolysis)
- Mass Spectroscopy Data
 - Data Collected During Pyrolysis in Helium (Not available for pyrolysis in impure helium)
 - Data Collected During Pyrolysis in Artificial Air

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Quantachrome Gas Sorption Analysis (BET) Using Nitrogen (Raw Whole
Coal Sample):
Sample Information and Isotherms
Multi-Point BET Information
Area-Volume-Pore Size Summary
Plot of Adsorption $Dv(\log r)$ vs Radius (Angstroms)
Quantachrome Gas Sorption Analysis (BET) Using Nitrogen (Activated Whole
Coal Sample):
Sample Information and Isotherms
Multi-Point BET Information
Area-Volume-Pore Size Summary
Plot of Adsorption $Dv(\log r)$ vs Radius (Angstroms)
Plot of FTIR (DRIS) Information (Absorbance vs Wavenumbers)

***** NOTE: All of the values of calculated pore radii shown in the summaries of measured coal data for each coal should be multiplied by 100 (i.e., 0.17 = 17, etc.). This correction results from a change in scale in the plotted data generated by the Quantachrome Autosorb-1 apparatus.

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SUMMARY

This DOE Grant was made by the University Coal Research (UCR) Program administered by the Pittsburgh Energy Technology Center, Pittsburgh, PA. The primary objective of the study was to determine how the physical and chemical properties of coal influence the degree to which a coal may be activated when subject to partial oxidation using air, steam, or carbon dioxide to increase the size and/or number of pores that it contains and to greatly increase its active surface area. Although the original title for this research referred to the use of coal precursors for carbon molecular sieves (CMS), the processes by which CMS may be generated are essentially the same processes used to generate a number of activated carbon materials (ACM). In retrospect, that latter term (ACM) would have been a more inclusive description for this research. CMS contain pores with specific sizes and surface properties that are used for purposes such as separating gas mixtures (e.g., nitrogen and oxygen by pressure swing adsorption, PSA). ACM may be used to store selected gases using adsorption-storage systems. ACM-based adsorption-storage systems will make it possible to store sufficient quantities of natural gas (methane, etc.) at moderate pressure to power automobiles for reasonable distances and to reduce the amount of energy required to transfer gaseous fuels at filling stations. Alternative uses for coal, including its use as a starting material for ACM and CMS, could open new markets and provide employment opportunities in economically depressed areas.

A wide variety of materials have been used as precursors for ACM and CMS (hereafter referred to as ACM/CMS), including agricultural products (coconut, almond, and walnut shells; peach and cherry pits; wood; etc.), synthetic compounds (phenolic resins; Saran; regenerated cellulose; etc.), and even some coals (or the chars derived from them). Most of this previous research seems to be directed towards characterizing the properties of the activated materials themselves, or towards enhancing their properties, rather than towards determining how to select the best possible precursor materials for preparing ACM/CMS. The goal of the research reported here was to determine how the physical and chemical properties of a coal affect the activation process.

A total of twelve standard coal samples were used in this study, including eight coal samples from the Argonne National Laboratory (ANL) Premium Coal Sample suite. Four additional coal samples were obtained from the Department of Energy Coal Sample (DECS) Bank at Penn State. Two of the DECS samples (Illinois #6 and Pittsburgh) came from the same coal seams as ANL samples to determine whether there were any differences from one location to another, or whether differences in the ANL and DECS protocols for sampling, preparation, handling, packaging, etc., might influence the results. The other two coal samples (an anthracite and a lignite-rich coal) provided samples with properties which differed from the available ANL samples.

All of the samples were analyzed by several techniques, including a combined thermogravimetric/mass spectroscopic technique, mercury porosimetry, surface area/porosity determination (BET) using nitrogen sorption, and infrared spectroscopy. In addition, the coal samples were activated using: 1) an artificial air

mixture (80%He:20%O₂); 2) purified helium that had been passed through a bubbler at 18°C (which produced helium gas containing 2% H₂O by weight) and CO₂ gas. The products of the activation experiments were analyzed using nitrogen sorption (BET method). The surface areas generated were compared with a number of coal parameters such as percent volatile matter, reflectivity, maceral content, various chemical ratios, etc.

Raw coal samples had nitrogen sorption surface areas ranging from 4.0 m²/g to 26.7 m²/g, while activated samples had a wide range of surface areas ranging up to 241 m²/g (not corrected for ash content) (up to 294 m²/g corrected for the amount of ash present, assuming the ash does not make a significant contribution to surface area), depending on the activating gases and conditions used during activation. When surface areas were correlated with the % volatile matter (dry ash-free basis), a distinct pattern was noted. At both the low (lignite and subbituminous) and high (anthracite) ends of the "rank" scale, the amount of raw surface area generated was relatively low (27 m²/g for lignite and 72 m²/g for subbituminous coal and 118 m²/g for anthracite) under the activation conditions used. The greatest amounts of surface area (up to 241 m²/g) were generated for high-, medium- and low volatile bituminous coal samples. When some curves (maximum expected surface area "envelopes") were fitted to the data it was noted that four of the coal samples fell well below those curves, i.e., the coal samples had generated much less surface area than might have been anticipated for the % volatile matter they contain.

A number of physical and chemical parameters were considered that might help to explain the deviations from the expected values. Based on this empirical analysis, the second most significant factor (after the % volatile matter) appears to be the maceral composition of each individual coal. Surface area generation appears to be enhanced by the amount of vitrinite present and reduced by the liptinite, inertinite, and/or ash present in the coal.

The results of the analyses performed by us and numerical data for chemical and physical properties obtained from the open literature were recorded in two databases using FoxPro (version 2.6). The combined data was subject to statistical analysis (using Statistical Analysis Software, SAS) to try to determine which coal properties are most useful in predicting whether a specific coal would be a good precursor for the generation of ACM/CMS. The results of our activation study and statistical analyses reveal significant relationships between commonly measured coal parameters and the deviation from the predicted amount of surface area that can be generated for coal of a specific rank.

The primary parameter controlling the generation of surface area (documented in this study for air activation) appears to be coal rank. The greatest amounts of surface area were generated for coal samples of bituminous rank, including high volatile, medium volatile, and low volatile bituminous coal. The results of our statistical analyses reveals that consideration of the % vitrinite present predicts nearly 73% of the variation in deviation from expected BET surface area generated during activation in artificial air ($r^2 = 0.726$ for the nine coal

APPENDIX A

ANL101

Upper Freeport Seam

Coal Sample Data (Literature)

Code#1 **Seam** Upper Freeport **State** PA **Rank** mvb **Sample #** ANL101

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	1.13		
% Ash	13.03	13.18	
% Vol. Matter	27.14	27.45	31.62
% Fixed Carbon	58.70	59.37	68.38

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	13.18		
% Carbon	74.23	85.50	88.08
% Hydrogen	4.08	4.70	4.84
% Nitrogen	1.35	1.55	1.60
% Total Sulfur	2.32		
% Oxygen (diff.)	-1.00	7.51	4.72

Dry % Chlorine 0.00

Dry % Carbon dioxide -1.00

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	1.77	
% Sulfate	0.01	
% Organic	0.54	0.74
% Total	2.32	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	78.99
Inertinite	6.94
Liptinite	0.87

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.99

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.655
Atomic O/C	0.040

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	31.322	30.968
Net, dmmf (MJ/kg)	37.166	

Caking and Mechanical Properties

Gieseler Coal Plastometer

Free-swelling index	8.50	Initial Softening	-1.00 °C
Hardgrove grindability index	-1.00	Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 1 Seam Upper Freeport State PA Rank mvb Sample # ANL101

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	360
Temp. @ Slope = 45 (°C)	443
Peak Temp (°C)	463
Mass Loss (%)	24.96

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	415
Temp. @ Slope = 45 (°C)	430
Peak Temp (°C)	540
Mass Loss (%)	75.62

Particle Size Distribution

<u>Size</u>	<u>Weight %</u>
>35 mesh (>0.5mm)	0.25
35-60 mesh (0.25-0.5mm)	4.58
<60 mesh (<0.25mm)	95.16

FTIR

Peak Intensities:

Aromatics	0.17
Aliphatics	0.46
Aldehydes	0.02
Hydroxyls	0.21
Ratio Aromatics/Aliphatics	0.38

Mercury Porosimetry

Whole Coal (m ² /g)	92.772
>35 Mesh (m ² /g)	-1.000
35 to 60 Mesh (m ² /g)	49.831
<60 Mesh (m ² /g)	90.594

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	4.164
Activated Coal (m ² /g)	235.40
Calculated	
<u>Pore Radius (Å)</u>	<u>Intensity</u>
0.16	0.48
0.35	0.46

Mass Spectroscopy (in He)

<u>Mass; Species</u>	<u>No. Peaks</u>	<u>Peak 1 T°C</u>	<u>Peak 2 T°C</u>	<u>Peak 3 T°C</u>
2 (H ₂)	1	785		
14 (CH ₂ , N)	1	555		
15 (CH ₃)	1	565		
18 (H ₂ O)	1	-1	-1	790
28 (CO, N ₂)	1	530	-1	
44 (CO ₂)	2	-1	525	760

Mass Spectroscopy (in HeO₂)

<u>Mass; Species</u>	<u>No. Peaks</u>	<u>Peak 1 T°C</u>	<u>Peak 2 T°C</u>	<u>Peak 3 T°C</u>
2 (H ₂)	1	575		
14 (CH ₂ , N)	0	-1		
15 (CH ₃)	1	540		
18 (H ₂ O)	1	-1	-1	615
28 (CO, N ₂)	1	595	-1	
44 (CO ₂)	1	-1	610	610

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 83.00 Corrected BET Values: 99.00

**ANL101B UPPER FREEPORT
MEDIUM VOLATILE BITUMINOUS
PYROLYSIS IN IMPURE HELIUM**

**ANL101BR UPPER FREEPORT
MEDIUM VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL101C UPPER FREEPORT
MEDIUM VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL101BR UPPER FREEPORT
MEDIUM VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

ANL101C UPPER FREEPORT
MEDIUM VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE 101

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /169
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 101 VIAL 2075 WHOLE
SUBMITTER: OTTO KOPP

LP 16:07:59 03/10/95
HP 23:30:20 03/10/95
REP 13:05:18 01/31/96

PENETROMETER NUMBER:	14-0353	ADVANCING CONTACT ANGLE:	130.0 deg
PENETROMETER CONSTANT:	10.79 fL/pF	RECEDING CONTACT ANGLE:	130.0 deg
PENETROMETER WEIGHT:	1.0000 g	MERCURY SURFACE TENSION:	485.0 dyn/cm
STEM VOLUME:	0.3920 mL	MERCURY DENSITY:	13.5335 g/mL
MAXIMUM HEAD PRESSURE:	4.4500 psia	SAMPLE WEIGHT:	0.1226 g
PENETROMETER VOLUME:	3.0000 mL	SAMPLE+PEN+Hg WEIGHT:	1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5398 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.7970 mL/g
TOTAL PORE AREA =	92.772 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	4.1962 fm
MEDIAN PORE DIAMETER (AREA) =	0.0046 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0344 fm
STEM VOLUME USED =	25 %

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE 101

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /169
 OPERATOR: CARLA R. SPARKS
 SAMPLE ID: ARGONNE 101 VIAL 2075 WHOLE
 SUBMITTER: OTTO KOPF

LP 16:07:59 03/10/95
 HP 23:30:20 03/10/95
 REP 13:05:18 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
 + intrusion, * extrusion

Date: 03/13/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 101 VIAL 2075
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1063 g P/Po Toler... 3 File Name.. AS531201.RAW
Analysis Time... 506.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-13-95 06:53am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
2.1150e-04	0.0715	1.1418e-01	0.5202	9.3496e-01	3.4459
4.5141e-04	0.0828	1.3880e-01	0.5870	9.0987e-01	3.3443
6.0428e-04	0.0875	1.6380e-01	0.6500	8.8499e-01	3.2295
6.9279e-04	0.0894	1.8883e-01	0.7103	8.6001e-01	3.1025
7.3844e-04	0.0903	2.1344e-01	0.7752	8.3500e-01	2.9831
7.6191e-04	0.0913	2.3861e-01	0.8241	8.0866e-01	3.2098
7.7312e-04	0.0913	2.6377e-01	0.8589	7.8473e-01	3.1326
7.8160e-04	0.0913	2.8704e-01	1.0329	7.5974e-01	3.0433
7.8428e-04	0.0913	3.1345e-01	1.1091	7.3493e-01	2.9341
7.8557e-04	0.0903	3.3867e-01	1.1797	7.0984e-01	2.8382
7.8684e-04	0.0903	3.6370e-01	1.2465	6.8487e-01	2.7404
7.8678e-04	0.0903	3.8873e-01	1.3142	6.5999e-01	2.6359
7.8811e-04	0.0894	4.1368e-01	1.3857	6.3499e-01	2.5221
7.8805e-04	0.0894	4.3867e-01	1.4497	6.0863e-01	2.6613
7.9027e-04	0.0894	4.6362e-01	1.5099	5.8477e-01	2.5814
8.4342e-04	0.0903	4.8862e-01	1.5682	5.5990e-01	2.4817
9.4293e-04	0.0913	5.1372e-01	1.6199	5.3492e-01	2.3782
1.0447e-03	0.0931	5.3882e-01	1.6585	5.0988e-01	2.2832
1.1504e-03	0.0941	5.6368e-01	1.7178	4.8489e-01	2.1825
2.1006e-03	0.1082	5.8870e-01	1.7658	4.5989e-01	2.0837
3.1815e-03	0.1195	6.1082e-01	2.0800	4.3488e-01	1.9784
4.2546e-03	0.1279	6.3837e-01	2.1740	4.0993e-01	1.8711
5.3185e-03	0.1355	6.6342e-01	2.2502	3.8374e-01	1.8993
6.3344e-03	0.1411	6.8847e-01	2.3189	3.5980e-01	1.8137
7.3907e-03	0.1449	7.1338e-01	2.3932	3.3487e-01	1.7131
8.3800e-03	0.1533	7.3841e-01	2.4666	3.0994e-01	1.6115
9.4605e-03	0.1580	7.6337e-01	2.5343	2.8494e-01	1.5052
1.0462e-02	0.1627	7.8835e-01	2.6096	2.6000e-01	1.3960
3.4189e-02	0.2662	8.1332e-01	2.6773	2.3498e-01	1.2888
3.9454e-02	0.2813	8.3850e-01	2.7375	2.1003e-01	1.1863
4.4486e-02	0.2973	8.6352e-01	2.7855	1.8505e-01	1.0790
5.4403e-02	0.3274	8.8869e-01	2.8297	1.5949e-01	1.0263
6.4368e-02	0.3528	9.1336e-01	2.8928	1.3512e-01	0.9182
7.4355e-02	0.3725	9.3348e-01	3.4102	1.1014e-01	0.8034
8.4343e-02	0.3876	9.6290e-01	3.5484	8.5207e-02	0.6849
8.8862e-02	0.4431	9.8792e-01	3.6510	6.0291e-02	0.5588
9.4288e-02	0.4638	9.9940e-01	3.7432	3.5378e-02	0.4233
1.0426e-01	0.4882	9.6064e-01	3.5513	1.3506e-02	0.2794

Date: 03/13/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 101 VIAL 2075
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1063 g P/Po Toler... 3 File Name.. AS531201.RAW
Analysis Time... 506.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-13-95 06:53am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1418e-01	0.5202	1.982E+02
1.6380e-01	0.6500	2.411E+02
2.1344e-01	0.7752	2.801E+02
2.6377e-01	0.8589	3.337E+02
3.1345e-01	1.1091	3.294E+02

Area = 4.164E+00 m²/g

Slope = 7.119E+02

Y - Intercept = 1.243E+02

Correlation Coefficient = 0.9673

C = 6.725E+00

Date: 03/13/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 101 VIAL 2075
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1063 g P/Po Toler... 3 File Name.. AS531201.RAW
Analysis Time... 506.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-13-95 06:53am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	4.164E+00	m ² /g
Langmuir Surface Area.....	1.416E+01	m ² /g
Meso Pore Area.....	3.920E+00	m ² /g
* t-Method Micro Pore Area.....	2.447E-01	m ² /g
* MP-Method Micro Pore Area.....	6.332E+01	m ² /g
DR-Method Micro Pore Area.....	9.420E-01	m ² /g
Cumulative Adsorption Surface Area.....	2.901E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-5.251E-04	cc/g
* MP-Method Micro Pore Volume.....	1.337E-02	cc/g

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 101 VIAL 2075
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A' Corr Factor.. 6.582E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1063 g P/Po Toler... 3 File Name.. AS531201.RAW
Analysis Time... 506.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-13-95 06:53am

Date: 12/23/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT101A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.7 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0180 g P/Po Toler... 3 File Name.. AS581001.RAW
 Analysis Time... 1244.8 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #... 1
 End of Run..... 08-11-95 12:52pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.5161e-05	0.8282	1.1413e-01	71.1618	9.3426e-01	107.7710
1.8585e-05	1.1006	1.3817e-01	72.5792	9.0930e-01	106.7871
1.9744e-05	1.3785	1.6326e-01	73.9355	8.8435e-01	105.8310
2.3272e-05	5.1918	1.8836e-01	75.1862	8.5944e-01	104.7693
3.3021e-05	30.1390	2.1337e-01	76.3646	8.3451e-01	103.7187
4.4270e-05	33.5631	2.3805e-01	77.6209	8.0942e-01	102.7348
5.4444e-05	35.3808	2.6318e-01	79.0828	7.8436e-01	101.7121
6.4719e-05	36.6593	2.8835e-01	80.2779	7.5933e-01	100.7282
7.5048e-05	37.6654	3.1347e-01	81.3563	7.3270e-01	101.0283
8.4101e-05	38.4102	3.3812e-01	82.3902	7.0894e-01	100.3502
1.5541e-04	41.6731	3.6332e-01	83.4074	6.8427e-01	99.4163
2.5763e-04	44.1023	3.8841e-01	84.3746	6.5938e-01	98.4213
3.5813e-04	45.6087	4.1257e-01	85.5642	6.3444e-01	97.4263
4.5846e-04	46.7371	4.3814e-01	86.8705	6.0944e-01	96.4202
5.5474e-04	47.5375	4.6360e-01	87.9711	5.8452e-01	95.3752
6.6891e-04	48.3380	4.8846e-01	89.0050	5.5958e-01	94.2690
7.5740e-04	48.8438	5.1329e-01	89.9944	5.3417e-01	93.3519
8.5874e-04	49.3830	5.3853e-01	90.9616	5.0891e-01	92.8127
9.7779e-04	49.8944	5.6346e-01	91.9177	4.8429e-01	91.8955
1.9966e-03	52.5737	5.8851e-01	92.8683	4.5946e-01	90.8727
2.9869e-03	54.1523	6.1346e-01	93.8021	4.3453e-01	89.8166
4.0735e-03	55.3307	6.3853e-01	94.6581	4.0955e-01	88.7160
5.0973e-03	56.2034	6.6352e-01	95.5420	3.8460e-01	87.6376
6.0431e-03	56.8482	6.8846e-01	96.4480	3.5958e-01	86.5648
7.0124e-03	57.4930	7.1235e-01	97.9433	3.3463e-01	85.4363
8.1717e-03	58.1045	7.3804e-01	99.0661	3.0963e-01	84.3246
9.2934e-03	58.6659	7.6327e-01	100.0611	2.8466e-01	83.1795
1.0144e-02	59.0050	7.8834e-01	100.9894	2.5973e-01	82.0178
3.0670e-02	63.4130	8.1341e-01	101.9066	2.3476e-01	80.8338
3.8823e-02	64.5247	8.3838e-01	102.8016	2.0981e-01	79.6220
4.4258e-02	65.2029	8.6337e-01	103.7076	1.8429e-01	78.6159
5.3957e-02	66.2257	8.8836e-01	104.5859	1.5985e-01	77.3708
6.3998e-02	67.1373	9.1344e-01	105.4586	1.3511e-01	75.9422
7.3850e-02	68.0600	9.3849e-01	106.3146	1.1026e-01	74.3747
8.3933e-02	68.9439	9.6338e-01	107.1595	8.5501e-02	72.6404
8.9375e-02	69.4163	9.8845e-01	107.9711	6.0878e-02	70.5836
9.4436e-02	69.8332	9.9940e-01	110.2001	3.6547e-02	67.9044
1.0419e-01	70.5003	9.5974e-01	108.7160	1.5392e-02	64.1023

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT101A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0180 g P/Po Toler... 3 File Name.. AS581001.RAW
Analysis Time... 1244.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-11-95 12:52pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1413e-01	71.1618	1.449E+00
1.6326e-01	73.9355	2.111E+00
2.1337e-01	76.3646	2.842E+00
2.6318e-01	79.0828	3.614E+00
3.1347e-01	81.3563	4.491E+00

Area = 2.342E+02 m²/g

Slope = 1.522E+01

Y - Intercept = -3.474E-01

Correlation Coefficient = 0.9988

C = -4.280E+01

Date: 12/23/95

Page 3

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT101A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0180 g P/Po Toler... 3 File Name.. AS581001.RAW
Analysis Time... 1244.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-11-95 12:52pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.342E+02	m ² /g
Langmuir Surface Area.....	4.485E+02	m ² /g
Meso Pore Area.....	7.923E+01	m ² /g
• t-Method Micro Pore Area.....	1.550E+02	m ² /g
* MP-Method Micro Pore Area.....	2.619E+02	m ² /g
DR-Method Micro Pore Area.....	7.369E+02	m ² /g
Cumulative Adsorption Surface Area.....	4.028E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	6.495E-02	cc/g
• MP-Method Micro Pore Volume.....	2.054E-01	cc/g

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT101A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0180 g P/Po Toler... 3 File Name.. AS581001.RAW
Analysis Time... 1244.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-11-95 12:52pm

APPENDIX B

ANL202

Wyodak-Anderson Seam

Coal Sample Data (Literature)

Code#2 Seam Wyodak-Anderson State WY Rank sbb Sample #ANL202

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	28.09		
% Ash	6.31	8.77	
% Vol. Matter	32.17	44.73	49.03
% Fixed Carbon	33.43	46.50	50.97

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	8.77		
% Carbon	68.43	75.01	76.04
% Hydrogen	4.88	5.35	5.42
% Nitrogen	1.02	1.12	1.13
% Total Sulfur	0.63		
% Oxygen (diff.)	-1.00	18.02	16.90
Dry % Chlorine 0.03 Dry % Carbon dioxide -1.00			

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	0.17	
% Sulfate	0.03	
% Organic	0.43	0.47
% Total	0.63	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	81.17
Inertinite	10.03
Liptinite	0.00

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.31

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.849
Atomic O/C	0.167

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	27.252	19.597
Net, dmmf (MJ/kg)	30.282	

Caking and Mechanical Properties

Free-swelling index	0.00
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 2 Seam Wyodak-Anderson State WY Rank sbb Sample # ANL202

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	270
Temp. @ Slope = 45 (°C)	385
Peak Temp (°C)	432
Mass Loss (%)	33.87

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	270
Temp. @ Slope = 45 (°C)	315
Peak Temp (°C)	426
Mass Loss (%)	71.07

Particle Size Distribution

<u>Size</u>	<u>Weight %</u>
>35 mesh (>0.5mm)	3.36
35-60 mesh (0.25-0.5mm)	20.10
<60 mesh (<0.25mm)	76.54

FTIR

Peak Intensities:

Aromatics	0.03
Aliphatics	0.28
Aldehydes	0.01
Hydroxyls	0.65

Ratio Aromatics/Aliphatics 0.11

Mercury Porosimetry

Whole Coal (m ² /g)	107.171
>35 Mesh (m ² /g)	89.157
35 to 60 Mesh (m ² /g)	111.356
<60 Mesh (m ² /g)	70.872

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	7.398
Activated Coal (m ² /g)	71.53
<u>Calculated Pore Radius (Å)</u>	<u>Intensity</u>
0.17	0.70
0.35	0.72

Mass Spectroscopy (in He)

<u>Mass; Species</u>	<u>No. Peaks</u>	<u>Peak 1 T°C</u>	<u>Peak 2 T°C</u>	<u>Peak 3 T°C</u>
2 (H ₂)	1	755		
14 (CH ₂ , N)	1	570		
15 (CH ₃)	1	575		
18 (H ₂ O)	2	235	570	-1
28 (CO, N ₂)	2	505	760	
44 (CO ₂)	2	-1	470	660

Mass Spectroscopy (in HeO₂)

<u>Mass; Species</u>	<u>No. Peaks</u>	<u>Peak 1 T°C</u>	<u>Peak 2 T°C</u>	<u>Peak 3 T°C</u>
2 (H ₂)	1	495		
14 (CH ₂ , N)	0	-1		
15 (CH ₃)	1	475		
18 (H ₂ O)	2	185	510	-1
28 (CO, N ₂)	1	490	-1	
44 (CO ₂)	1	-1	495	495

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 79.00 Corrected BET Values: 60.00

**ANL202B WYODAK-ANDERSON
SUB-BITUMINOUS
PYROLYSIS IN IMPURE HELIUM**

**ANL202BR WYODAK-ANDERSON
SUB-BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL202C WYODAK-ANDERSON
SUB-BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL202BR WYODAK-ANDERSON
SUB-BITUMINOUS
PYROLYSIS IN HELIUM

ANL202C WYODAK-ANDERSON
SUB-BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /152
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE COAL 202 VIAL 111 WHOLE
SUBMITTER: OTTO KOPF

LP 15:02:50 02/17/95
HP 21:44:05 02/17/95
REP 13:23:21 01/31/96

PENETROMETER NUMBER: 14-0353	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1151 g
PENETROMETER VOLUME: 15.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fHhg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5157 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.6237 mL/g
TOTAL PORE AREA =	107.171 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	3.3939 fm
MEDIAN PORE DIAMETER (AREA) =	0.0048 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0233 fm
STEM VOLUME USED =	18 % ****

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE 202

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /152
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE COAL 202 VIAL 111 WHOLE
SUBMITTER: OTTO KOPF

LP 15:02:50 02/17/95
HP 21:44:05 02/17/95
REP 13:23:21 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Date: 02/20/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 202(111) WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0858 g P/Po Toler... 3 File Name.. AS521701.RAW
Analysis Time... 514.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-20-95 04:53pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.0999e-04	0.1014	1.1414e-01	1.0956	9.3538e-01	6.0490
2.6986e-04	0.1317	1.3880e-01	1.2028	9.1025e-01	5.8263
4.2256e-04	0.1503	1.6382e-01	1.3065	8.8525e-01	5.6107
5.4256e-04	0.1620	1.8887e-01	1.3998	8.6023e-01	5.4009
6.2792e-04	0.1702	2.1347e-01	1.4872	8.3260e-01	5.6585
6.8581e-04	0.1737	2.3753e-01	1.6970	8.0985e-01	5.5117
7.2168e-04	0.1760	2.6327e-01	1.8112	7.8499e-01	5.3298
7.4629e-04	0.1772	2.8907e-01	1.9207	7.6004e-01	5.1445
7.6347e-04	0.1772	3.1347e-01	2.0291	7.3492e-01	4.9767
7.7199e-04	0.1783	3.3864e-01	2.1270	7.1000e-01	4.7984
7.7713e-04	0.1772	3.6363e-01	2.2284	6.8504e-01	4.6166
7.8090e-04	0.1772	3.8857e-01	2.3298	6.5995e-01	4.4557
7.8454e-04	0.1772	4.1358e-01	2.4231	6.3505e-01	4.2809
7.8571e-04	0.1760	4.3853e-01	2.5221	6.0731e-01	4.4347
7.8812e-04	0.1748	4.6358e-01	2.6177	5.8480e-01	4.2984
8.3374e-04	0.1772	4.8858e-01	2.7121	5.6012e-01	4.1026
9.1918e-04	0.1830	5.1357e-01	2.8065	5.3496e-01	3.9312
1.0180e-03	0.1876	5.3854e-01	2.8951	5.0992e-01	3.7611
1.1253e-03	0.1935	5.6092e-01	3.2879	4.8482e-01	3.6107
1.9788e-03	0.2296	5.8828e-01	3.4289	4.5977e-01	3.4615
3.0574e-03	0.2622	6.1335e-01	3.5583	4.3482e-01	3.3124
4.1607e-03	0.2890	6.3836e-01	3.6818	4.0985e-01	3.1585
5.2095e-03	0.3100	6.6328e-01	3.8089	3.8480e-01	3.0093
6.2818e-03	0.3298	6.8828e-01	3.9301	3.5809e-01	3.0501
7.3382e-03	0.3497	7.1328e-01	4.0641	3.3475e-01	2.9172
8.3927e-03	0.3648	7.3810e-01	4.2063	3.0985e-01	2.7681
9.4518e-03	0.3788	7.6319e-01	4.3345	2.8487e-01	2.6096
1.0445e-02	0.3916	7.8816e-01	4.4744	2.5991e-01	2.4464
3.3748e-02	0.6270	8.1325e-01	4.6002	2.3496e-01	2.2821
3.9367e-02	0.6678	8.3808e-01	4.7471	2.0995e-01	2.1259
4.4371e-02	0.7005	8.6306e-01	4.9021	1.8500e-01	1.9569
5.4253e-02	0.7611	8.8810e-01	5.0536	1.6003e-01	1.7879
6.4207e-02	0.8170	9.0872e-01	5.7214	1.3505e-01	1.6235
7.4217e-02	0.8625	9.3755e-01	5.9744	1.1011e-01	1.4464
8.3936e-02	0.9359	9.6248e-01	6.2168	8.4918e-02	1.2925
8.9239e-02	0.9744	9.8730e-01	6.4918	6.0210e-02	1.1072
9.4245e-02	1.0012	9.9940e-01	6.7203	3.5485e-02	0.8601
1.0416e-01	1.0478	9.6138e-01	6.2879	1.4101e-02	0.5862

Date: 02/20/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 202(111) WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 m² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0858 g P/Po Toler... 3 File Name.. AS521701.RAW
Analysis Time... 514.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-20-95 04:53pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1414e-01	1.0956	9.410E+01
1.6382e-01	1.3065	1.200E+02
2.1347e-01	1.4872	1.460E+02
2.6327e-01	1.8112	1.579E+02
3.1347e-01	2.0291	1.800E+02

Area = 7.398E+00 m²/g

Slope = 4.211E+02

Y - Intercept = 4.965E+01

Correlation Coefficient = 0.9925

C = 9.482E+00

Date: 02/20/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 202(111) WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0858 g P/Po Toler... 3 File Name.. AS521701.RAW
Analysis Time... 514.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-20-95 04:53pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	7.398E+00	m ² /g
Langmuir Surface Area.....	2.355E+01	m ² /g
Meso Pore Area.....	6.856E+00	m ² /g
* t-Method Micro Pore Area.....	5.427E-01	m ² /g
* MP-Method Micro Pore Area.....	3.904E-01	m ² /g
DR-Method Micro Pore Area.....	2.523E+00	m ² /g
Cumulative Adsorption Surface Area.....	4.881E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-8.048E-04	cc/g
* MP-Method Micro Pore Volume.....	8.242E-05	cc/g

Date: 02/20/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 202(111) WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0858 g P/Po Toler... 3 File Name.. AS521701.RAW
Analysis Time... 514.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-20-95 04:53pm

Date: 12/23/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT202A
 Sample Description..... Activated Coal Residue
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area... 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0174 g P/Po Toler... 3 File Name.. AS580103.RAW
 Analysis Time... 914.5 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 08-02-95 12:32pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
9.7213e-06	0.5115	1.1385e-01	17.1207	9.3395e-01	42.8276
1.1845e-05	0.7759	1.3835e-01	17.9540	9.0887e-01	42.0747
1.6280e-05	2.5920	1.6348e-01	18.7184	8.8383e-01	41.3736
2.6861e-05	3.6149	1.8846e-01	19.4598	8.5751e-01	41.6207
3.9167e-05	4.6034	2.1347e-01	20.1897	8.3361e-01	41.0920
4.4200e-05	4.8448	2.3845e-01	20.8793	8.0886e-01	40.3793
5.5620e-05	5.3276	2.6349e-01	21.5632	7.8394e-01	39.5862
6.4567e-05	5.5690	2.8808e-01	22.3908	7.5891e-01	38.8218
7.4849e-05	5.7989	3.1322e-01	23.4540	7.3400e-01	38.0747
8.7739e-05	6.0287	3.3842e-01	24.1897	7.0705e-01	38.1322
1.7050e-04	6.8736	3.6348e-01	24.8621	6.8361e-01	37.5862
2.8388e-04	7.5805	3.8823e-01	25.5115	6.5895e-01	36.8218
3.6745e-04	8.0172	4.1332e-01	26.1667	6.3397e-01	36.0977
4.7901e-04	8.4598	4.3840e-01	26.8161	6.0899e-01	35.3218
5.7012e-04	8.7701	4.6207e-01	27.8966	5.8408e-01	34.5287
6.7643e-04	9.0805	4.8822e-01	28.7241	5.5906e-01	33.7529
7.5849e-04	9.2874	5.1350e-01	29.4483	5.3333e-01	33.2701
8.6225e-04	9.4943	5.3818e-01	30.1149	5.0858e-01	32.8218
9.8749e-04	9.6954	5.6353e-01	30.7874	4.8398e-01	32.1207
1.9822e-03	10.4080	5.8853e-01	31.4713	4.5904e-01	31.3563
3.0323e-03	10.9138	6.1355e-01	32.1322	4.3405e-01	30.5575
4.0390e-03	11.2701	6.3851e-01	32.7759	4.0911e-01	29.7874
5.0845e-03	11.6264	6.6349e-01	33.4195	3.8419e-01	28.9885
6.0310e-03	11.8506	6.8847e-01	34.0345	3.5909e-01	28.2069
7.0412e-03	12.0690	7.1178e-01	35.5747	3.3373e-01	27.7241
8.1390e-03	12.2701	7.3810e-01	36.3851	3.0908e-01	26.9943
9.1086e-03	12.4655	7.6333e-01	37.0920	2.8421e-01	26.2126
1.0153e-02	12.6322	7.8835e-01	37.7644	2.5926e-01	25.4310
3.3144e-02	13.8448	8.1340e-01	38.4368	2.3427e-01	24.6437
3.9036e-02	14.1437	8.3832e-01	39.0747	2.0934e-01	23.8276
4.3984e-02	14.4483	8.6335e-01	39.7586	1.8396e-01	23.1437
5.3908e-02	14.8563	8.8828e-01	40.4023	1.5929e-01	22.3678
6.3963e-02	15.2644	9.1343e-01	41.0402	1.3449e-01	21.5230
7.3963e-02	15.6437	9.3830e-01	41.6724	1.0948e-01	20.6379
8.4016e-02	15.9828	9.6051e-01	43.4828	8.4539e-02	19.7471
8.9161e-02	16.1839	9.8787e-01	44.4425	5.9625e-02	18.7759
9.4147e-02	16.4023	9.9940e-01	45.0805	3.4763e-02	17.6667
1.0401e-01	16.7126	9.5953e-01	43.6034	1.1881e-02	16.2644

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT202A
Sample Description..... Activated Coal Residue
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0174 g P/Po Toler... 3 File Name.. AS580103.RAW
Analysis Time... 914.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-02-95 12:32pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1385e-01	17.1207	6.004E+00
1.6348e-01	18.7184	8.353E+00
2.1347e-01	20.1897	1.076E+01
2.6349e-01	21.5632	1.327E+01
3.1322e-01	23.4540	1.556E+01

Area = 7.153E+01 m²/g

Slope = 4.818E+01

Y - Intercept = 5.027E-01

Correlation Coefficient = 0.9999

C = 9.685E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT202A
Sample Description..... Activated Coal Residue
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0174 g P/Po Toler... 3 File Name.. AS580103.RAW
Analysis Time... 914.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-02-95 12:32pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	7.153E+01	m ² /g
Langmuir Surface Area.....	1.724E+02	m ² /g
Meso Pore Area.....	4.219E+01	m ² /g
* t-Method Micro Pore Area.....	2.935E+01	m ² /g
* MP-Method Micro Pore Area.....	2.762E+02	m ² /g
DR-Method Micro Pore Area.....	1.025E+02	m ² /g
Cumulative Adsorption Surface Area.....	2.850E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	8.700E-03	cc/g
* MP-Method Micro Pore Volume.....	1.031E-01	cc/g

Date: 08/02/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT202A
Sample Description..... Activated Coal Residue
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0174 g P/Po Toler... 3 File Name.. AS580103.RAW
Analysis Time... 914.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-02-95 12:32pm

Adsorption Dv(Log r)

APPENDIX C

ANL301

Illinois #6 Seam

Coal Sample Data (Literature)

Code#3 Seam Illinois #6

State IL

Rank hvB

Sample #ANL301

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	7.97		
% Ash	14.25	15.48	
% Vol. Matter	36.86	40.05	47.39
% Fixed Carbon	40.92	44.47	52.61

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	15.48		
% Carbon	65.65	77.67	80.73
% Hydrogen	4.23	5.00	5.20
% Nitrogen	1.16	1.37	1.43
% Total Sulfur	4.83		
% Oxygen (diff.)	-1.00	13.51	10.11

Dry % Chlorine 0.05

Dry % Carbon dioxide -1.00

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	2.81	
% Sulfate	0.01	
% Organic	2.01	2.38
% Total	4.83	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	71.83
Inertinite	8.45
Liptinite	4.23

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.46

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.768
Atomic O/C	0.094

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	27.796	25.582
Net, dmmf (MJ/kg)	34.180	

Caking and Mechanical Properties

Free-swelling index	-1.00
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 3 Seam Illinois #6

State IL Rank hvBb

Sample # ANL301

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	248
Temp. @ Slope = 45 (°C)	383
Peak Temp (°C)	413
Mass Loss (%)	36.44

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	333
Temp. @ Slope = 45 (°C)	390
Peak Temp (°C)	523
Mass Loss (%)	82.48

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	4.50
35-60 mesh (0.25-0.5mm)	20.80
<60 mesh (<0.25mm)	74.80

FTIR

Peak Intensities:

Aromatics	0.05
Aliphatics	0.28
Aldehydes	0.01
Hydroxyls	0.37

Ratio Aromatics/Aliphatics 0.19

Mercury Porosimetry

Whole Coal (m ² /g)	100.863
>35 Mesh (m ² /g)	136.069
35 to 60 Mesh (m ² /g)	128.633
<60 Mesh (m ² /g)	95.267

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	25.290
Activated Coal (m ² /g)	203.10
Calculated	
Pore Radius (Å)	Intensity
0.21	0.72
0.53	0.79

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	580		
15 (CH ₃)	1	580		
18 (H ₂ O)	2	-1	505	625
28 (CO, N ₂)	2	520	780	
44 (CO ₂)	2	-1	500	765

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	555		
14 (CH ₂ , N)	1	540		
15 (CH ₃)	1	515		
18 (H ₂ O)	1	-1	585	-1
28 (CO, N ₂)	1	575	-1	
44 (CO ₂)	1	-1	575	575

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 111.00

Corrected BET Values: 122.00

**ANL301B ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN IMPURE HELIUM**

**ANL301BR ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL301C ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL301BR ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

ANL301C ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE COALS

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /128
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 301 WHOLE
SUBMITTER: OTTO KOPP

LP 14:27:18 01/13/95
HP 21:27:51 01/13/95
REP 14:11:04 01/31/96

PENETROMETER NUMBER: 14-0484	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1015 g
PENETROMETER VOLUME: 15.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5334 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.6921 mL/g
TOTAL PORE AREA =	100.863 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	10.9853 fm
MEDIAN PORE DIAMETER (AREA) =	0.0053 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0274 fm
STEM VOLUME USED =	18 % ****

SAMPLE DIRECTORY/NUMBER: DATA1 /128
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 301 WHOLE
SUBMITTER: OTTO KOPP

LP 14:27:18 01/13/95
HP 21:27:51 01/13/95
REP 14:11:04 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 301 VIAL 217 WHOLE
 Sample Description..... LARGER SAMPLE THAN PREVIOUS RUN
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0965 g P/Po Toler... 3 File Name.. AS522701.RAW
 Analysis Time... 696.6 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 02-28-95 02:33am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
9.4423e-06	0.1036	1.1364e-01	5.0560	9.3607e-01	21.1554
1.4719e-05	0.1565	1.3784e-01	5.3948	9.1101e-01	20.8249
1.9172e-05	0.2093	1.6257e-01	5.7275	8.8605e-01	20.4756
2.7296e-05	0.3119	1.8767e-01	6.0580	8.5980e-01	20.4394
3.4471e-05	0.3637	2.1277e-01	6.3741	8.3585e-01	20.1181
5.0375e-05	0.4642	2.3775e-01	6.6819	8.1108e-01	19.7648
6.0323e-05	0.5130	2.6321e-01	6.9896	7.8614e-01	19.4041
7.1577e-05	0.5617	2.8617e-01	7.4922	7.6122e-01	19.0363
8.2845e-05	0.6093	3.1243e-01	7.8487	7.3618e-01	18.6622
9.6680e-05	0.6560	3.3768e-01	8.1782	7.1026e-01	18.3876
1.7206e-04	0.8280	3.6270e-01	8.5047	6.8590e-01	18.1326
2.6980e-04	0.9751	3.8766e-01	8.8352	6.6139e-01	17.7430
3.7357e-04	1.0953	4.1253e-01	9.1741	6.3650e-01	17.3233
4.7555e-04	1.1907	4.3751e-01	9.5150	6.1165e-01	16.8902
5.7759e-04	1.2653	4.6249e-01	9.8642	5.8694e-01	16.4228
6.9183e-04	1.3378	4.8746e-01	10.2155	5.7114e-01	15.0280
7.7240e-04	1.3845	5.1236e-01	10.5886	5.4912e-01	13.2104
8.7198e-04	1.4332	5.3724e-01	10.9668	5.1638e-01	12.1316
9.8241e-04	1.4829	5.6218e-01	11.3503	4.8766e-01	11.5409
1.9798e-03	1.7855	5.8706e-01	11.7513	4.6175e-01	11.0829
3.0691e-03	2.0021	6.1188e-01	12.1731	4.3637e-01	10.6705
4.1236e-03	2.1606	6.3410e-01	12.8788	4.1127e-01	10.2788
5.0408e-03	2.2705	6.6123e-01	13.4010	3.8538e-01	10.0166
6.0825e-03	2.3813	6.8629e-01	13.9078	3.6114e-01	9.6549
7.2328e-03	2.4860	7.1121e-01	14.4166	3.3616e-01	9.2850
8.0349e-03	2.5534	7.3598e-01	14.9523	3.1113e-01	8.9233
9.0514e-03	2.6259	7.6075e-01	15.5212	2.8620e-01	8.5585
1.0079e-02	2.6943	7.8575e-01	16.1067	2.6121e-01	8.1886
3.0784e-02	3.4580	8.1042e-01	16.7140	2.3620e-01	7.8238
3.8625e-02	3.6632	8.3527e-01	17.3440	2.1119e-01	7.4601
4.3978e-02	3.7969	8.6012e-01	17.9896	1.8623e-01	7.0953
5.3577e-02	3.9990	8.8517e-01	18.6425	1.6131e-01	6.7171
6.3668e-02	4.1927	9.1000e-01	19.2964	1.3615e-01	6.3627
7.3702e-02	4.3741	9.3542e-01	19.9212	1.1147e-01	5.9534
8.3767e-02	4.5399	9.6040e-01	20.5254	8.6572e-02	5.5233
8.9117e-02	4.6363	9.8149e-01	21.5264	6.1931e-02	5.0425
9.4157e-02	4.7202	9.9940e-01	22.0819	3.7364e-02	4.4746
1.0386e-01	4.8694	9.6241e-01	21.4964	1.7127e-02	3.8010

Date: 02/28/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 301 VIAL 217 WHOLE
Sample Description..... LARGER SAMPLE THAN PREVIOUS RUN
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A' Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0965 g P/Po Toler... 3 File Name.. AS522701.RAW
Analysis Time... 696.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-28-95 02:33am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1364e-01	5.0560	2.029E+01
1.6257e-01	5.7275	2.712E+01
2.1277e-01	6.3741	3.393E+01
2.6321e-01	6.9896	4.089E+01
3.1243e-01	7.8487	4.632E+01

Area = 2.529E+01 m²/g

Slope = 1.322E+02

Y - Intercept = 5.571E+00

Correlation Coefficient = 0.9992

C = 2.472E+01

Date: 02/28/95

Page 3

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 301 VIAL 217 WHOLE
Sample Description..... LARGER SAMPLE THAN PREVIOUS RUN
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0965 g P/Po Toler... 3 File Name.. AS522701.RAW
Analysis Time... 696.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-28-95 02:33am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.529E+01	m ² /g
Langmuir Surface Area.....	7.741E+01	m ² /g
Meso Pore Area.....	2.270E+01	m ² /g
* t-Method Micro Pore Area.....	2.581E+00	m ² /g
* MP-Method Micro Pore Area.....	1.903E+01	m ² /g
DR-Method Micro Pore Area.....	2.204E+01	m ² /g
Cumulative Adsorption Surface Area.....	1.580E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-1.122E-03	cc/g
* MP-Method Micro Pore Volume.....	2.723E-02	cc/g

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 301 VIAL 217 WHOLE
Sample Description..... LARGER SAMPLE THAN PREVIOUS RUN
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0965 g P/Po Toler... 3 File Name.. AS522701.RAW
Analysis Time... 696.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-28-95 02:33am

Adsorption Dv(Log r)

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT301A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 15 2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0151 g P/Po Toler... 3 File Name.. AS572601.RAW
 Analysis Time... 935.5 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 07-27-95 04:23pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.1859e-05	1.3064	1.1445e-01	60.4178	9.3159e-01	98.5544
1.4052e-05	1.6379	1.3859e-01	61.6777	9.0914e-01	97.8913
1.6300e-05	14.7679	1.6324e-01	63.1233	8.8424e-01	97.0026
2.4478e-05	19.6220	1.8853e-01	64.4629	8.5940e-01	96.0013
3.4264e-05	23.7599	2.1365e-01	65.6300	8.3447e-01	94.9934
4.4276e-05	25.6432	2.3874e-01	66.7507	8.0935e-01	93.9854
5.4431e-05	27.1950	2.6377e-01	67.8050	7.8440e-01	92.9509
6.4715e-05	28.7268	2.8879e-01	68.8462	7.5933e-01	91.9363
7.5018e-05	29.6286	3.1320e-01	70.2851	7.3183e-01	92.1286
8.7928e-05	30.5172	3.3831e-01	71.4456	7.0898e-01	91.5252
1.5535e-04	33.6207	3.6345e-01	72.4801	6.8428e-01	90.5637
2.5997e-04	35.8422	3.8860e-01	73.4615	6.5934e-01	89.5756
3.5797e-04	37.2878	4.1369e-01	74.4297	6.3438e-01	88.5610
4.6715e-04	38.3024	4.3842e-01	75.3714	6.0942e-01	87.5133
5.6739e-04	39.1048	4.6411e-01	76.3263	5.8515e-01	86.1339
6.6866e-04	39.7347	4.8929e-01	77.2215	5.6049e-01	84.3767
7.6471e-04	40.2122	5.1379e-01	78.2692	5.3496e-01	82.9178
8.7479e-04	40.6897	5.3776e-01	79.7082	5.0881e-01	82.4337
9.9399e-04	41.1538	5.6339e-01	80.8753	4.8436e-01	81.4655
2.0238e-03	43.5875	5.8863e-01	81.8568	4.5941e-01	80.3979
3.0194e-03	45.0796	6.1369e-01	82.8382	4.3446e-01	79.2905
4.1100e-03	46.1737	6.3865e-01	83.7865	4.0952e-01	78.1300
5.0283e-03	46.9231	6.6368e-01	84.7480	3.8453e-01	76.9828
6.1779e-03	47.6194	6.8866e-01	85.7162	3.5956e-01	75.8157
7.2886e-03	48.2825	7.1368e-01	86.6711	3.3456e-01	74.6485
8.1208e-03	48.6605	7.3876e-01	87.5928	3.0961e-01	73.4814
9.0604e-03	49.1114	7.6369e-01	88.5146	2.8406e-01	72.7188
1.0233e-02	49.5225	7.8872e-01	89.4231	2.5953e-01	71.5849
3.1904e-02	53.5875	8.1077e-01	91.8568	2.3466e-01	70.3515
3.9362e-02	54.5093	8.3817e-01	93.1698	2.0974e-01	69.0782
4.4633e-02	55.0862	8.6346e-01	94.2507	1.8478e-01	67.7719
5.4326e-02	55.9748	8.8852e-01	95.2918	1.5987e-01	66.4125
6.4222e-02	56.9231	9.1347e-01	96.3594	1.3496e-01	64.9469
7.4345e-02	57.7321	9.3852e-01	97.3276	1.1006e-01	63.3952
8.4387e-02	58.4682	9.6359e-01	98.3289	8.5282e-02	61.7042
8.9666e-02	58.8859	9.8852e-01	99.2971	6.0533e-02	59.7347
9.4695e-02	59.2241	9.9940e-01	100.0796	3.5929e-02	57.2613
1.0444e-01	59.8276	9.6017e-01	98.1897	1.3977e-02	53.4881

Date: 12/23/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT301A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0151 g P/Po Toler... 3 File Name.. AS572601.RAW
Analysis Time... 935.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-27-95 04:23pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1445e-01	60.4178	1.712E+00
1.6324e-01	63.1233	2.473E+00
2.1365e-01	65.6300	3.312E+00
2.6377e-01	67.8050	4.228E+00
3.1320e-01	70.2851	5.191E+00

Area = 2.031E+02 m²/g

Slope = 1.750E+01

Y - Intercept = -3.557E-01

Correlation Coefficient = 0.9990

C = -4.819E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT301A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0151 g P/Po Toler... 3 File Name.. AS572601.RAW
Analysis Time... 935.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-27-95 04:23pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.031E+02	m ² /g
Langmuir Surface Area.....	4.044E+02	m ² /g
Meso Pore Area.....	7.527E+01	m ² /g
* t-Method Micro Pore Area.....	1.279E+02	m ² /g
* MP-Method Micro Pore Area.....	3.980E+02	m ² /g
DR-Method Micro Pore Area.....	4.304E+02	m ² /g
Cumulative Adsorption Surface Area.....	3.947E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	5.312E-02	cc/g
* MP-Method Micro Pore Volume.....	2.134E-01	cc/g

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT301A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0151 g P/Po Toler... 3 File Name.. AS572601.RAW
Analysis Time... 935.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-27-95 04:23pm

2.4 BIO-RAD

APPENDIX D

ANL401

Pittsburgh Seam

Coal Sample Data (Literature)

Code#4 Seam Pittsburgh

State PA

Rank hvA

Sample #ANL401

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	1.65		
% Ash	9.10	9.25	
% Vol. Matter	37.20	37.82	41.67
% Fixed Carbon	52.05	52.93	58.33

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	9.25		
% Carbon	75.50	83.20	84.95
% Hydrogen	4.83	5.32	5.43
% Nitrogen	1.49	1.64	1.68
% Total Sulfur	2.19		
% Oxygen (diff.)	-1.00	8.83	6.90

Dry % Chlorine 0.11

Dry % Carbon dioxide -1.00

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	1.37	
% Sulfate	0.01	
% Organic	0.81	0.89
% Total	2.19	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	77.18
Inertinite	7.26
Liptinite	6.36

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.72

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.762
Atomic O/C	0.061

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	31.698	31.175
Net, dmmf (MJ/kg)	35.669	

Caking and Mechanical Properties

Gieseler Coal Plastometer

Free-swelling index	2.00	Initial Softening	-1.00 °C
Hardgrove grindability index	-1.00	Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 4 Seam Pittsburgh

State PA Rank hvAb

Sample # ANL401

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	316
Temp. @ Slope = 45 (°C)	393
Peak Temp (°C)	448
Mass Loss (%)	35.15

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	369
Temp. @ Slope = 45 (°C)	405
Peak Temp (°C)	525
Mass Loss (%)	90.58

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	4.91
35-60 mesh (0.25-0.5mm)	14.70
<60 mesh (<0.25mm)	80.31

FTIR

Peak Intensities:

Aromatics	0.11
Aliphatics	0.39
Aldehydes	0.02
Hydroxyls	0.30

Ratio Aromatics/Aliphatics 0.28

Mercury Porosimetry

Whole Coal (m ² /g)	75.053
>35 Mesh (m ² /g)	51.133
35 to 60 Mesh (m ² /g)	88.517
<60 Mesh (m ² /g)	56.273

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	4.504
Activated Coal (m ² /g)	233.00
Calculated Pore Radius (Å)	Intensity
0.20	1.27
0.53	0.66

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	580		
15 (CH ₃)	1	560		
18 (H ₂ O)	2	245	565	-1
28 (CO, N ₂)	1	510	-1	
44 (CO ₂)	2	-1	505	745

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	515		
15 (CH ₃)	0	-1		
18 (H ₂ O)	2	400	575	-1
28 (CO, N ₂)	1	575	-1	
44 (CO ₂)	1	-1	580	580

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 92.00 Corrected BET Values: 83.00

**ANL401B PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL401C PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL401B PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

ANL401C PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /180
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 401 VIAL 175 WHOLE
SUBMITTER: OTTO KOPF

LP 13:34:21 03/24/95
HP 19:58:29 03/24/95
REP 14:28:50 01/31/96

PENETROMETER NUMBER: 14-0226	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1340 g
PENETROMETER VOLUME: 3.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5350 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.6819 mL/g
TOTAL PORE AREA =	75.053 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	9.0241 fm
MEDIAN PORE DIAMETER (AREA) =	0.0046 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0363 fm
STEM VOLUME USED =	23 % ****

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE 401

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /180
 OPERATOR: CARLA R. SPARKS
 SAMPLE ID: ARGONNE 401 VIAL 175 WHOLE
 SUBMITTER: OTTO KOPF

LP 13:34:21 03/24/95
 HP 19:58:29 03/24/95
 REP 14:28:50 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
 + intrusion, * extrusion

Date: 03/19/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 401
Sample Description..... VIAL 175 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area... 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0981 g P/Po Toler... 3 File Name.. AS531801.RAW
Analysis Time... 510.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-19-95 04:05am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
2.5722e-04	0.0724	1.1474e-01	0.4139	9.3442e-01	2.9918
5.0834e-04	0.0795	1.3936e-01	0.4587	9.0937e-01	2.8940
6.5483e-04	0.0815	1.6437e-01	0.5107	8.8193e-01	3.1916
7.3472e-04	0.0826	1.8930e-01	0.5566	8.5910e-01	3.1305
7.7305e-04	0.0815	2.1431e-01	0.6004	8.3433e-01	3.0408
7.9586e-04	0.0815	2.3905e-01	0.6361	8.0939e-01	2.9368
8.0838e-04	0.0805	2.6311e-01	0.8532	7.8432e-01	2.8440
8.1234e-04	0.0785	2.8978e-01	0.9337	7.5933e-01	2.7401
8.1325e-04	0.0785	3.1402e-01	0.9684	7.3430e-01	2.6514
8.1617e-04	0.0765	3.3944e-01	1.0255	7.0942e-01	2.5454
8.1734e-04	0.0754	3.6439e-01	1.0744	6.8170e-01	2.7288
8.1721e-04	0.0734	3.8913e-01	1.1244	6.5926e-01	2.6544
8.1675e-04	0.0703	4.1415e-01	1.1764	6.3437e-01	2.5545
8.1820e-04	0.0714	4.3911e-01	1.2283	6.0933e-01	2.4618
8.1839e-04	0.0724	4.6413e-01	1.2742	5.8424e-01	2.3711
8.5681e-04	0.0703	4.8899e-01	1.3293	5.5943e-01	2.2610
9.5462e-04	0.0714	5.1409e-01	1.3731	5.3449e-01	2.1386
1.0574e-03	0.0714	5.3912e-01	1.4190	5.0934e-01	2.0449
1.1601e-03	0.0724	5.6096e-01	1.7819	4.8430e-01	1.9521
2.1268e-03	0.0826	5.8896e-01	1.8532	4.5793e-01	2.0499
3.2110e-03	0.0907	6.1418e-01	1.8899	4.3424e-01	1.9745
4.2743e-03	0.0958	6.3906e-01	1.9388	4.0934e-01	1.8736
5.3320e-03	0.0999	6.6404e-01	1.9867	3.8436e-01	1.7727
6.3997e-03	0.1040	6.8887e-01	2.0449	3.5932e-01	1.6728
7.3417e-03	0.1101	7.1391e-01	2.1009	3.3432e-01	1.5657
8.4690e-03	0.1142	7.3886e-01	2.1560	3.0938e-01	1.4638
9.4356e-03	0.1162	7.6397e-01	2.2039	2.8440e-01	1.3609
1.0519e-02	0.1182	7.8882e-01	2.2650	2.5947e-01	1.2559
3.4702e-02	0.2100	8.1389e-01	2.3211	2.3442e-01	1.1539
3.9908e-02	0.2273	8.3871e-01	2.3853	2.0901e-01	1.1284
4.4923e-02	0.2355	8.5915e-01	2.9123	1.8442e-01	1.0285
5.4857e-02	0.2548	8.8887e-01	2.9715	1.5955e-01	0.9174
6.4788e-02	0.2732	9.1388e-01	3.0265	1.3458e-01	0.8073
7.4763e-02	0.2946	9.3877e-01	3.0856	1.0958e-01	0.6983
8.4378e-02	0.3507	9.6365e-01	3.1621	8.4603e-02	0.5851
8.9707e-02	0.3772	9.8864e-01	3.2324	5.9633e-02	0.4659
9.4858e-02	0.3772	9.9940e-01	3.2936	3.4689e-02	0.3384
1.0476e-01	0.3935	9.6025e-01	3.0938	1.3345e-02	0.2090

Date: 03/19/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 401
Sample Description..... VIAL 175 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0981 g P/Po Toler... 3 File Name.. AS531801.RAW
Analysis Time... 510.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-19-95 04:05am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1474e-01	0.4139	2.506E+02
1.6437e-01	0.5107	3.082E+02
2.1431e-01	0.6004	3.635E+02
2.6311e-01	0.8532	3.348E+02
3.1402e-01	0.9684	3.782E+02

Area = 4.504E+00 m²/g

Slope = 5.676E+02

Y - Intercept = 2.055E+02

Correlation Coefficient = 0.8834

C = 3.762E+00

Date: 03/19/95

Page 3

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 401
Sample Description..... VIAL 175 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0981 g P/Po Toler... 3 File Name.. AS531801.RAW
Analysis Time... 510.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-19-95 04:05am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	4.504E+00	m ² /g
Langmuir Surface Area.....	1.348E+01	m ² /g
Meso Pore Area.....	3.606E+00	m ² /g
* t-Method Micro Pore Area.....	8.988E-01	m ² /g
* MP-Method Micro Pore Area.....	4.071E+02	m ² /g
DR-Method Micro Pore Area.....	6.061E-01	m ² /g
Cumulative Adsorption Surface Area.....	2.772E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-5.294E-04	cc/g
* MP-Method Micro Pore Volume.....	8.617E-02	cc/g

Date: 03/19/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 401
Sample Description..... VIAL 175 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0981 g P/Po Toler... 3 File Name.. AS531801.RAW
Analysis Time... 510.4 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-19-95 04:05am

Date: 12/23/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT401A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0153 g P/Po Toler... 3 File Name.. AS581102.RAW
Analysis Time... 1047.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-14-95 08:51am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.0796e-05	1.2745	1.1409e-01	69.3268	9.3438e-01	108.7386
1.2960e-05	1.5948	1.3823e-01	70.8758	9.0766e-01	109.0131
1.5197e-05	18.3007	1.6327e-01	72.3856	8.8393e-01	108.2810
2.4537e-05	24.3203	1.8834e-01	73.8039	8.5922e-01	107.3203
3.4323e-05	27.7582	2.1337e-01	75.1503	8.3436e-01	106.2549
4.3094e-05	30.2288	2.3844e-01	76.4379	8.0938e-01	105.1634
5.4552e-05	32.0523	2.6351e-01	77.6601	7.8436e-01	104.1111
6.3533e-05	33.2549	2.8810e-01	79.4118	7.5942e-01	103.0457
7.3847e-05	34.1438	3.1341e-01	80.6863	7.3235e-01	102.9281
8.4225e-05	35.0131	3.3816e-01	81.8366	7.0897e-01	102.2222
1.5302e-04	38.3595	3.6328e-01	83.0000	6.8430e-01	101.2288
2.6180e-04	41.0261	3.8837e-01	84.0980	6.5937e-01	100.1569
3.5718e-04	42.4379	4.1345e-01	85.1830	6.3438e-01	99.0915
4.6151e-04	43.6732	4.3936e-01	86.2549	6.0940e-01	97.9673
5.5908e-04	44.5033	4.6333e-01	87.2288	5.8445e-01	96.8693
6.7450e-04	45.3137	4.8841e-01	88.2418	5.5954e-01	95.6993
7.5651e-04	45.7974	5.1190e-01	90.1242	5.3450e-01	94.5425
8.6966e-04	46.4641	5.3829e-01	91.4183	5.0785e-01	94.2288
9.7601e-04	46.9542	5.6348e-01	92.5294	4.8411e-01	93.4052
2.0022e-03	49.9477	5.8863e-01	93.6078	4.5936e-01	92.3268
3.0103e-03	51.7255	6.1357e-01	94.6340	4.3447e-01	91.1634
4.0073e-03	52.9020	6.3861e-01	95.6667	4.0949e-01	90.0065
5.0863e-03	54.0000	6.6361e-01	96.6340	3.8453e-01	88.8170
6.0585e-03	54.7255	6.8862e-01	97.6340	3.5953e-01	87.6405
7.1532e-03	55.4771	7.1364e-01	98.5752	3.3458e-01	86.3856
7.9914e-03	55.9608	7.3861e-01	99.5163	3.0964e-01	85.1569
8.9938e-03	56.5098	7.6359e-01	100.4575	2.8465e-01	83.8824
1.0051e-02	57.0196	7.8870e-01	101.4183	2.5918e-01	82.8431
3.0994e-02	61.3529	8.1089e-01	103.6471	2.3465e-01	81.6405
3.8649e-02	62.4510	8.3809e-01	104.9608	2.0977e-01	80.2876
4.3974e-02	63.1373	8.6334e-01	106.0588	1.8491e-01	78.8693
5.3717e-02	64.1765	8.8839e-01	107.1307	1.6002e-01	77.3595
6.3754e-02	65.1438	9.1342e-01	108.1634	1.3514e-01	75.7647
7.3841e-02	66.0327	9.3840e-01	109.1307	1.1026e-01	74.0654
8.3874e-02	66.8105	9.6341e-01	110.1242	8.5340e-02	72.1895
8.9388e-02	67.2876	9.8845e-01	111.0784	6.0635e-02	70.0196
9.4414e-02	67.7124	9.9940e-01	111.8366	3.6144e-02	67.2745
1.0401e-01	68.5033	9.6013e-01	109.8235	1.4628e-02	63.2810

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT401A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0153 g P/Po Toler... 3 File Name.. AS581102.RAW
Analysis Time... 1047.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-14-95 08:51am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1409e-01	69.3268	1.486E+00
1.6327e-01	72.3856	2.157E+00
2.1337e-01	75.1503	2.888E+00
2.6351e-01	77.6601	3.686E+00
3.1341e-01	80.6863	4.527E+00

Area = 2.330E+02 m²/g

Slope = 1.526E+01

Y - Intercept = -3.088E-01

Correlation Coefficient = 0.9991

C = -4.841E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT401A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A' Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0153 g P/Po Toler... 3 File Name.. AS581102.RAW
Analysis Time... 1047.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-14-95 08:51am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.330E+02	m ² /g
Langmuir Surface Area.....	4.565E+02	m ² /g
Meso Pore Area.....	8.352E+01	m ² /g
* t-Method Micro Pore Area.....	1.495E+02	m ² /g
* MP-Method Micro Pore Area.....	3.607E+02	m ² /g
DR-Method Micro Pore Area.....	5.034E+02	m ² /g
Cumulative Adsorption Surface Area.....	4.365E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	6.191E-02	cc/g
* MP-Method Micro Pore Volume.....	2.253E-01	cc/g

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT401A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corl Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0153 g P/Po Toler... 3 File Name.. AS581102.RAW
Analysis Time... 1047.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-14-95 08:51am

Adsorption Dv(Loz r)

APPENDIX E

ANL501

Pocahontas #3 Seam

Coal Sample Data (Literature)

Code#5 Seam Pocahontas #3 State VA Rank lvb Sample #ANL501

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	0.65		
% Ash	4.74	4.77	
% Vol. Matter	18.48	18.60	19.53
% Fixed Carbon	76.13	76.63	80.47

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	4.77		
% Carbon	86.71	91.05	91.81
% Hydrogen	4.23	4.44	4.48
% Nitrogen	1.27	1.33	1.34
% Total Sulfur	0.66		
% Oxygen (diff.)	-1.00	2.47	1.66

Dry % Chlorine 0.19

Dry % Carbon dioxide -1.00

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	0.15	
% Sulfate	0.03	
% Organic	0.48	0.50
% Total	0.66	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	84.73
Inertinite	9.25
Liptinite	0.95

Reflectance Data

Vitrinite(%):

Mean-max Ro: 1.42

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.581
Atomic O/C	0.014

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	34.943	34.715
Net, dmmf (MJ/kg)	36.999	

Caking and Mechanical Properties

Free-swelling index	8.00
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 5 Seam Pocahontas #3

State VA Rank lvb

Sample # ANL501

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	395
Temp. @ Slope = 45 (°C)	470
Peak Temp (°C)	490
Mass Loss (%)	21.38

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	424
Temp. @ Slope = 45 (°C)	468
Peak Temp (°C)	595
Mass Loss (%)	93.48

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	1.79
35-60 mesh (0.25-0.5mm)	13.04
<60 mesh (<0.25mm)	85.17

FTIR

Peak Intensities:

Aromatics	0.24
Aliphatics	0.37
Aldehydes	0.03
Hydroxyls	0.12

Ratio Aromatics/Aliphatics 0.66

Mercury Porosimetry

Whole Coal (m ² /g)	116.133
>35 Mesh (m ² /g)	-1.000
35 to 60 Mesh (m ² /g)	71.079
<60 Mesh (m ² /g)	106.264

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	2.572
Activated Coal (m ² /g)	241.00
Calculated Pore Radius (Å)	Intensity
0.20	0.53
0.47	0.51

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	785		
14 (CH ₂ , N)	1	575		
15 (CH ₃)	1	580		
18 (H ₂ O)	1	-1	-1	815
28 (CO, N ₂)	1	545	-1	
44 (CO ₂)	2	-1	535	710

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	590		
14 (CH ₂ , N)	1	660		
15 (CH ₃)	1	555		
18 (H ₂ O)	1	-1	-1	660
28 (CO, N ₂)	1	635	-1	
44 (CO ₂)	1	-1	-1	-1

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 121.00 Corrected BET Values: 102.00

**ANL501B POCAHONTAS #3
LOW VOLATILE BITUMINOUS
PYROLYSIS IN IMPURE HELIUM**

**ANL501BR POCAHONTAS #3
LOW VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL501C POCAHONTAS #3
LOW VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL501BR POCAHONTAS #3
LOW VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

ANL501C POCAHONTAS #3
LOW VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /137
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE COAL 501 WHOLE
SUBMITTER: OTTO KOPF

LP 17:04:38 02/03/95
HP 23:11:47 02/03/95
REP 14:44:08 01/31/96

PENETROMETER NUMBER: 14-0377	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1060 g
PENETROMETER VOLUME: 15.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5254 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.8253 mL/g
TOTAL PORE AREA =	116.133 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	7.9238 fm
MEDIAN PORE DIAMETER (AREA) =	0.0046 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0284 fm
STEM VOLUME USED =	22 % ****

SAMPLE DIRECTORY/NUMBER: DATA1 /137
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE COAL 501 WHOLE
SUBMITTER: OTTO KOPP

LP 17:04:38 02/03/95
HP 23:11:47 02/03/95
REP 14:44:08 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... AS512703
Sample Description..... LARGER SAMPLE OF 501 FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1006 g P/Po Toler... 3 File Name.. AS520301.RAW
Analysis Time... 572.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-04-95 15:46pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
4.2019e-04	0.0666	1.2131e-01	0.3131	9.2529e-01	2.1829
7.9012e-04	0.0726	1.4583e-01	0.3479	9.0027e-01	2.1312
9.9559e-04	0.0736	1.7070e-01	0.3807	8.7526e-01	2.0795
1.0971e-03	0.0746	1.9568e-01	0.4105	8.5031e-01	2.0229
1.1498e-03	0.0736	2.1984e-01	0.4851	8.2541e-01	1.9652
1.1740e-03	0.0736	2.4538e-01	0.5338	7.9757e-01	2.0865
1.1855e-03	0.0726	2.7029e-01	0.5726	7.7515e-01	2.0537
1.1931e-03	0.0676	2.9526e-01	0.6074	7.5038e-01	1.9901
1.1951e-03	0.0666	3.2031e-01	0.6372	7.2534e-01	1.9334
1.1969e-03	0.0706	3.4520e-01	0.6759	7.0039e-01	1.8688
1.1967e-03	0.0716	3.6982e-01	0.7972	6.7537e-01	1.8131
1.1968e-03	0.0696	3.9517e-01	0.8410	6.5043e-01	1.7505
1.1966e-03	0.0676	4.2023e-01	0.8708	6.2547e-01	1.6899
1.1966e-03	0.0706	4.4476e-01	0.9066	5.9941e-01	1.7744
1.1986e-03	0.0686	4.6973e-01	0.9404	5.7547e-01	1.7187
1.2005e-03	0.0636	4.9338e-01	1.0835	5.5047e-01	1.6571
1.2025e-03	0.0666	5.1950e-01	1.1233	5.2545e-01	1.5964
1.2062e-03	0.0646	5.4582e-01	1.1680	5.0043e-01	1.5318
1.2343e-03	0.0636	5.6962e-01	1.2048	4.7551e-01	1.4761
2.1680e-03	0.0696	5.9512e-01	1.2455	4.5055e-01	1.4115
3.2376e-03	0.0755	6.2026e-01	1.2823	4.2559e-01	1.3549
4.3136e-03	0.0805	6.4486e-01	1.3151	4.0004e-01	1.3976
5.3466e-03	0.0835	6.6993e-01	1.3469	3.7576e-01	1.3330
6.3961e-03	0.0865	6.9488e-01	1.3857	3.5082e-01	1.2704
7.4595e-03	0.0885	7.1991e-01	1.4264	3.2582e-01	1.2008
8.4936e-03	0.0905	7.4280e-01	1.6272	3.0087e-01	1.1322
9.5753e-03	0.0924	7.6964e-01	1.6899	2.7598e-01	1.0586
1.0518e-02	0.0964	7.9474e-01	1.7346	2.5103e-01	0.9891
4.1294e-02	0.1670	8.1971e-01	1.7783	2.2613e-01	0.9175
4.6781e-02	0.1779	8.4480e-01	1.8201	2.0077e-01	0.8718
5.1756e-02	0.1879	8.6978e-01	1.8638	1.7613e-01	0.8191
6.1669e-02	0.2048	8.9477e-01	1.9026	1.5121e-01	0.7475
7.1573e-02	0.2227	9.1982e-01	1.9433	1.2627e-01	0.6769
8.1555e-02	0.2346	9.4468e-01	1.9841	1.0132e-01	0.5984
9.1502e-02	0.2455	9.6969e-01	2.0288	7.6371e-02	0.5229
9.6470e-02	0.2545	9.9478e-01	2.0696	5.1425e-02	0.4423
1.0109e-01	0.2833	9.9940e-01	2.3479	1.9524e-02	0.3211
1.1132e-01	0.3012	9.5101e-01	2.2416	7.4244e-03	0.2674

Date: 02/04/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... AS512703
Sample Description..... LARGER SAMPLE OF 501 FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1006 g P/Po Toler... 3 File Name.. AS520301.RAW
Analysis Time... 572.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-04-95 15:46pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.2131e-01	0.3131	3.528E+02
1.7070e-01	0.3807	4.326E+02
2.1984e-01	0.4851	4.648E+02
2.7029e-01	0.5726	5.176E+02
3.2031e-01	0.6372	5.918E+02

Area = 2.572E+00 m²/g

Slope = 1.132E+03

Y - Intercept = 2.224E+02

Correlation Coefficient = 0.9916

C = 6.088E+00

Date: 02/04/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... AS512703
Sample Description..... LARGER SAMPLE OF 501 FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1006 g P/Po Toler... 3 File Name.. AS520301.RAW
Analysis Time... 572.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-04-95 15:46pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.572E+00	m ² /g
Langmuir Surface Area.....	9.232E+00	m ² /g
Meso Pore Area.....	2.376E+00	m ² /g
* t-Method Micro Pore Area.....	1.957E-01	m ² /g
* MP-Method Micro Pore Area.....	7.588E+01	m ² /g
DR-Method Micro Pore Area.....	4.794E-01	m ² /g
Cumulative Adsorption Surface Area.....	1.875E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-2.928E-04	cc/g
* MP-Method Micro Pore Volume.....	1.649E-02	cc/g

Date: 02/04/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... AS512703
Sample Description..... LARGER SAMPLE OF 501 FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 $\text{\AA}^2$ Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1006 g P/Po Toler... 3 File Name.. AS520301.RAW
Analysis Time... 572.8 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-04-95 15:46pm

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT501C
Sample Description..... Activated Coal Residue (Whole)
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS572102.RAW
Analysis Time... 38.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-22-95 12:10pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
7.6961e-06	5.4528	1.1410e-01	72.1195	9.3360e-01	112.5626
7.6947e-06	5.7739	1.3804e-01	73.6159	9.0899e-01	111.6313
1.5182e-05	18.5228	1.6313e-01	75.1124	8.8400e-01	110.6551
2.4527e-05	26.0694	1.8787e-01	76.7052	8.5897e-01	109.7303
3.4314e-05	29.7945	2.1307e-01	78.1760	8.3401e-01	108.6834
4.3102e-05	32.5369	2.3818e-01	79.5183	8.0910e-01	107.6044
5.3282e-05	34.3417	2.6325e-01	80.7964	7.8411e-01	106.5896
6.4834e-05	35.8317	2.8831e-01	82.0295	7.5806e-01	106.5125
7.3880e-05	36.7052	3.1301e-01	83.3783	7.3384e-01	105.7161
8.6834e-05	37.8613	3.3801e-01	84.8491	7.0897e-01	104.7463
1.5569e-04	41.1368	3.6306e-01	86.0565	6.8401e-01	103.7251
2.5286e-04	43.5324	3.8814e-01	87.2126	6.5912e-01	102.6975
3.6250e-04	45.1252	4.1319e-01	88.3558	6.3413e-01	101.6635
4.6812e-04	46.3198	4.3808e-01	89.4348	6.0919e-01	100.5845
5.6322e-04	47.1163	4.6374e-01	90.5331	5.8330e-01	99.9358
6.7248e-04	47.9255	4.8888e-01	91.5800	5.5879e-01	99.1715
7.7382e-04	48.5292	5.1279e-01	92.9672	5.3413e-01	98.1567
8.5735e-04	48.9981	5.3777e-01	94.2710	5.0920e-01	97.0906
9.6503e-04	49.4798	5.6318e-01	95.4143	4.8417e-01	95.9987
2.0082e-03	52.4534	5.8820e-01	96.4868	4.5920e-01	94.9004
2.9876e-03	54.2068	6.1326e-01	97.5594	4.3420e-01	93.7829
3.9914e-03	55.3821	6.3829e-01	98.6256	4.0928e-01	92.6140
5.0506e-03	56.4804	6.6327e-01	99.6660	3.8430e-01	91.4644
6.0380e-03	57.2062	6.8830e-01	100.6615	3.5864e-01	90.6037
7.1238e-03	57.9640	7.1328e-01	101.6378	3.3405e-01	89.6146
8.1672e-03	58.6641	7.3834e-01	102.6076	3.0926e-01	88.4907
9.2449e-03	59.3256	7.6334e-01	103.5581	2.8438e-01	87.2768
1.0116e-02	59.7495	7.8652e-01	105.3950	2.5946e-01	86.0244
3.0820e-02	64.0655	8.1292e-01	106.6089	2.3445e-01	84.7527
3.8503e-02	65.1766	8.3819e-01	107.6365	2.0955e-01	83.4297
4.3858e-02	65.8703	8.6321e-01	108.6320	1.8466e-01	82.0552
5.3550e-02	66.9236	8.8821e-01	109.6146	1.5977e-01	80.5780
6.3642e-02	67.8870	9.1324e-01	110.5267	1.3463e-01	79.1779
7.3706e-02	68.7797	9.3820e-01	111.4708	1.0993e-01	77.5851
8.3600e-02	69.6468	9.6328e-01	112.3956	8.5110e-02	75.7803
8.9202e-02	70.2119	9.8832e-01	113.2755	6.0450e-02	73.6288
9.4292e-02	70.6872	9.9940e-01	113.9563	3.5999e-02	70.8414
1.0403e-01	71.4065	9.5733e-01	113.1663	1.4555e-02	66.8272

Date: 12/23/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT501C
Sample Description..... Activated Coal Residue (Whole)
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS572102.RAW
Analysis Time... 38.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-22-95 12:10pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1410e-01	72.1195	1.429E+00
1.6313e-01	75.1124	2.076E+00
2.1307e-01	78.1760	2.771E+00
2.6325e-01	80.7964	3.538E+00
3.1301e-01	83.3783	4.372E+00

Area = 2.410E+02 m²/g

Slope = 1.476E+01

Y - Intercept = -3.111E-01

Correlation Coefficient = 0.9988

C = -4.645E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT501C
Sample Description..... Activated Coal Residue (Whole)
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS572102.RAW
Analysis Time... 38.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-22-95 12:10pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.410E+02	m ² /g
Langmuir Surface Area.....	4.683E+02	m ² /g
Meso Pore Area.....	8.356E+01	m ² /g
* t-Method Micro Pore Area.....	1.575E+02	m ² /g
DR-Method Micro Pore Area.....	4.233E+02	m ² /g
Cumulative Adsorption Surface Area.....	4.360E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT501C
Sample Description..... Activated Coal Residue (Whole)
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS572102.RAW
Analysis Time... 38.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 07-22-95 12:10pm

Adsorption $Dv(\log r)$

X-AXIS SCALE UNIT..... Angstroms x 10E3

Y-AXIS SCALE UNIT..... cc/g x 10E-1

APPENDIX F

ANL601

Blind Canyon Seam

Coal Sample Data (Literature)

Code#6 **Seam Blind Canyon** **State UT** **Rank hvB** **Sample #ANL601**

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	4.63		
% Ash	4.49	4.71	
% Vol. Matter	43.72	45.84	48.11
% Fixed Carbon	47.16	49.45	51.89

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	4.71		
% Carbon	76.89	80.69	81.32
% Hydrogen	5.49	5.76	5.81
% Nitrogen	1.50	1.57	1.59
% Total Sulfur	0.62		
% Oxygen (diff.)	-1.00	11.58	10.88

Dry % Chlorine 0.03

Dry % Carbon dioxide -1.00

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	0.24	
% Sulfate	0.03	
% Organic	0.35	0.37
% Total	0.62	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	82.91
Inertinite	7.62
Liptinite	4.77

Reflectance Data

Vitrinite (%):

Mean-max Ro: 0.50

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.851
Atomic O/C	0.100

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	32.387	30.887
Net, dmmf (MJ/kg)	34.255	

Caking and Mechanical Properties

Free-swelling index	1.50
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 6 Seam Blind Canyon

State UT Rank hvBb Sample # ANL601

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	165
Temp. @ Slope = 45 (°C)	388
Peak Temp (°C)	433
Mass Loss (%)	41.39

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	323
Temp. @ Slope = 45 (°C)	395
Peak Temp (°C)	516
Mass Loss (%)	90.67

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	2.08
35-60 mesh (0.25-0.5mm)	22.56
<60 mesh (<0.25mm)	75.36

FTIR

Peak Intensities:

Aromatics	0.08
Aliphatics	0.43
Aldehydes	0.01
Hydroxyls	0.43
Ratio Aromatics/Aliphatics	0.18

Mercury Porosimetry

Whole Coal (m ² /g)	132.245
>35 Mesh (m ² /g)	64.162
35 to 60 Mesh (m ² /g)	116.880
<60 Mesh (m ² /g)	58.742

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	4.005
Activated Coal (m ² /g)	175.50
Calculated	
Pore Radius (Å)	Intensity
0.23	1.02
0.60	0.38

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	805		
14 (CH ₂ , N)	1	580		
15 (CH ₃)	1	575		
18 (H ₂ O)	2	260	-1	780
28 (CO, N ₂)	1	525	-1	
44 (CO ₂)	2	-1	505	745

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	625		
14 (CH ₂ , N)	0	-1		
15 (CH ₃)	1	610		
18 (H ₂ O)	2	290	-1	660
28 (CO, N ₂)	1	670	-1	
44 (CO ₂)	1	-1	-1	-1

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 108.00 Corrected BET Values: 75.00

**ANL601B BLIND CANYON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN IMPURE HELIUM**

**ANL601BR BLIND CANYON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL601C BLIND CANYON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL601BR BLIND CANYON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

ANL601C BLIND CANYON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE COALS

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /131
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE COAL 601 WHOLE
SUBMITTER: OTTO KOPF

LP 14:44:17 01/20/95
HP 21:48:58 01/20/95
REP 15:01:26 01/31/96

PENETROMETER NUMBER: 14-0377	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1009 g
PENETROMETER VOLUME: 15.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5334 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.7971 mL/g
TOTAL PORE AREA =	132.245 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	12.3044 fm
MEDIAN PORE DIAMETER (AREA) =	0.0047 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0241 fm
STEM VOLUME USED =	21 % ****

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE COALS

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /131
 OPERATOR: CARLA R. SPARKS
 SAMPLE ID: ARGONNE COAL 601 WHOLE
 SUBMITTER: OTTO KOPF

LP 14:44:17 01/20/95
 HP 21:48:58 01/20/95
 REP 15:01:26 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
 + intrusion, * extrusion

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 601 WHOLE
 Sample Description..... LARGER SAMPLE FOR REPEAT
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.1051 g P/Po Toler... 3 File Name.. AS521301.RAW
 Analysis Time... 493.6 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 02-14-95 08:31pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
2.9680e-04	0.0571	1.1390e-01	0.4491	9.3505e-01	3.5718
5.1802e-04	0.0628	1.3868e-01	0.5071	9.0995e-01	3.4520
6.3962e-04	0.0657	1.6368e-01	0.5633	8.8494e-01	3.3187
7.0598e-04	0.0666	1.8868e-01	0.6099	8.5856e-01	3.4805
7.4052e-04	0.0676	2.1305e-01	0.7326	8.3467e-01	3.3892
7.6034e-04	0.0666	2.3842e-01	0.7935	8.0984e-01	3.2702
7.6912e-04	0.0666	2.6348e-01	0.8554	7.8489e-01	3.1503
7.7657e-04	0.0666	2.8847e-01	0.9029	7.5982e-01	3.0324
7.8363e-04	0.0657	3.1389e-01	0.9619	7.3263e-01	3.1332
7.8470e-04	0.0647	3.3877e-01	1.0219	7.0958e-01	3.0466
7.8484e-04	0.0618	3.6239e-01	1.1827	6.8469e-01	2.9439
7.8472e-04	0.0628	3.8840e-01	1.2617	6.5975e-01	2.8354
7.8594e-04	0.0628	4.1348e-01	1.3254	6.3478e-01	2.7231
7.8588e-04	0.0618	4.3844e-01	1.3939	6.0978e-01	2.6070
7.8823e-04	0.0637	4.6349e-01	1.4529	5.8289e-01	2.6736
8.4850e-04	0.0618	4.8847e-01	1.5100	5.5979e-01	2.5585
9.4152e-04	0.0628	5.1337e-01	1.5775	5.3485e-01	2.4301
1.0458e-03	0.0637	5.3840e-01	1.6299	5.0984e-01	2.3130
1.1512e-03	0.0647	5.6254e-01	1.7650	4.8480e-01	2.2046
2.1207e-03	0.0752	5.8772e-01	1.9286	4.5978e-01	2.0942
3.2022e-03	0.0837	6.1320e-01	2.0076	4.3346e-01	2.1123
4.2357e-03	0.0904	6.3821e-01	2.0856	4.0976e-01	2.0114
5.2778e-03	0.0961	6.6323e-01	2.1656	3.8473e-01	1.9068
6.3358e-03	0.1037	6.8820e-01	2.2388	3.5971e-01	1.7954
7.3769e-03	0.1085	7.1328e-01	2.3035	3.3473e-01	1.6851
8.4229e-03	0.1132	7.3829e-01	2.3625	3.0980e-01	1.5728
9.4897e-03	0.1170	7.6320e-01	2.4301	2.8479e-01	1.4643
1.0499e-02	0.1199	7.8564e-01	2.7488	2.5950e-01	1.4282
3.3814e-02	0.2065	8.1296e-01	2.8573	2.3480e-01	1.3168
3.8963e-02	0.2312	8.3800e-01	2.9505	2.0986e-01	1.2008
4.4027e-02	0.2474	8.6304e-01	3.0362	1.8493e-01	1.0837
5.3948e-02	0.2788	8.8804e-01	3.1199	1.5997e-01	0.9667
6.3995e-02	0.3026	9.1301e-01	3.2055	1.3503e-01	0.8430
7.3962e-02	0.3254	9.3796e-01	3.2940	1.0981e-01	0.7422
8.3984e-02	0.3473	9.6303e-01	3.3758	8.4992e-02	0.6327
8.9041e-02	0.3549	9.8483e-01	3.7755	6.0029e-02	0.5052
9.3720e-02	0.3911	9.9940e-01	3.9029	3.5139e-02	0.3701
1.0393e-01	0.4196	9.6064e-01	3.6927	1.3713e-02	0.2265

Date: 02/14/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 601 WHOLE
Sample Description..... LARGER SAMPLE FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1051 g P/Po Toler... 3 File Name.. AS521301.RAW
Analysis Time... 493.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-14-95 08:31pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1390e-01	0.4491	2.290E+02
1.6368e-01	0.5633	2.780E+02
2.1305e-01	0.7326	2.957E+02
2.6348e-01	0.8554	3.346E+02
3.1389e-01	0.9619	3.805E+02

Area = 4.005E+00 m²/g

Slope = 7.198E+02

Y - Intercept = 1.498E+02

Correlation Coefficient = 0.9917

C = 5.805E+00

Date: 02/14/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 601 WHOLE
Sample Description..... LARGER SAMPLE FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1051 g P/Po Toler... 3 File Name.. AS521301.RAW
Analysis Time... 493.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-14-95 08:31pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	4.005E+00	m ² /g
Langmuir Surface Area.....	1.534E+01	m ² /g
Meso Pore Area.....	4.005E+00	m ² /g
* t-Method Micro Pore Area.....	0.000E+00	m ² /g
* MP-Method Micro Pore Area.....	1.693E+03	m ² /g
DR-Method Micro Pore Area.....	6.942E-01	m ² /g
Cumulative Adsorption Surface Area.....	3.106E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	0.000E+00	cc/g
* MP-Method Micro Pore Volume.....	3.573E-01	cc/g

Date: 02/14/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 601 WHOLE
Sample Description..... LARGER SAMPLE FOR REPEAT
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1051 g P/Po Toler... 3 File Name.. AS521301.RAW
Analysis Time... 493.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-14-95 08:31pm

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT601A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.583E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0152 g P/Po Toler... 3 File Name.. AS581602.RAW
Analysis Time... 1038.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-17-95 08:57am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.1886e-05	0.9539	1.1407e-01	49.6118	9.3312e-01	90.1053
1.4087e-05	1.2632	1.3837e-01	50.9605	9.0897e-01	89.2566
1.5207e-05	8.3158	1.6333e-01	52.3092	8.8409e-01	88.2368
2.4567e-05	13.0592	1.8837e-01	53.6118	8.5921e-01	87.1842
3.3126e-05	15.5592	2.1308e-01	55.0066	8.3425e-01	86.1316
4.5671e-05	17.7171	2.3837e-01	56.3553	8.0923e-01	85.0658
5.3349e-05	18.9276	2.6343e-01	57.5658	7.8230e-01	85.0132
6.3612e-05	19.8289	2.8851e-01	58.7368	7.5890e-01	84.3092
7.6510e-05	20.7105	3.1352e-01	59.8487	7.3412e-01	83.3289
8.3054e-05	21.2961	3.3814e-01	61.1250	7.0928e-01	82.2368
1.6103e-04	24.0592	3.6301e-01	62.4737	6.8427e-01	81.1447
2.5972e-04	25.9671	3.8825e-01	63.6184	6.5931e-01	80.0592
3.6041e-04	27.1645	4.1340e-01	64.7434	6.3433e-01	78.9539
4.5731e-04	28.2961	4.3930e-01	65.8158	6.0938e-01	77.8289
5.6158e-04	29.0789	4.6324e-01	66.8158	5.8363e-01	77.3026
6.6590e-04	29.9671	4.8829e-01	67.8092	5.5924e-01	76.2763
7.7904e-04	30.7171	5.1373e-01	68.8750	5.3438e-01	75.1842
8.8300e-04	31.1579	5.3867e-01	69.8947	5.0937e-01	74.0329
9.8422e-04	31.6118	5.6203e-01	71.6776	4.8442e-01	72.9079
1.9632e-03	34.1513	5.8818e-01	72.9803	4.5941e-01	71.7632
2.9577e-03	35.4211	6.1346e-01	74.1053	4.3439e-01	70.6118
3.9911e-03	36.3882	6.3846e-01	75.1842	4.0943e-01	69.5000
5.0710e-03	37.2961	6.6352e-01	76.2500	3.8364e-01	68.7434
6.0495e-03	37.9211	6.8855e-01	77.2895	3.5917e-01	67.7961
7.1401e-03	38.5724	7.1355e-01	78.3487	3.3440e-01	66.6382
7.9702e-03	38.9803	7.3848e-01	79.3816	3.0954e-01	65.4671
9.0083e-03	39.4211	7.6360e-01	80.3816	2.8455e-01	64.2368
1.0073e-02	39.8355	7.8844e-01	81.4079	2.5966e-01	62.9605
3.1870e-02	42.9079	8.1343e-01	82.4013	2.3468e-01	61.6974
3.8775e-02	43.7303	8.3663e-01	84.3026	2.0968e-01	60.4145
4.4012e-02	44.3158	8.6295e-01	85.6447	1.8476e-01	59.0855
5.3815e-02	45.1645	8.8819e-01	86.7500	1.5970e-01	57.7829
6.3884e-02	45.9671	9.1327e-01	87.8553	1.3487e-01	56.3882
7.3954e-02	46.7171	9.3827e-01	88.9737	1.1000e-01	54.9013
8.3968e-02	47.4342	9.6329e-01	90.0724	8.5125e-02	53.2829
8.9232e-02	47.8553	9.8832e-01	91.1316	6.0354e-02	51.4605
9.4085e-02	48.3026	9.9940e-01	92.0197	3.5771e-02	49.2105
1.0397e-01	48.9803	9.5996e-01	90.0526	1.3931e-02	46.1382

Date: 12/23/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT601A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0152 g P/Po Toler... 3 File Name.. AS581602.RAW
Analysis Time... 1038.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-17-95 08:57am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1407e-01	49.6118	2.076E+00
1.6333e-01	52.3092	2.986E+00
2.1308e-01	55.0066	3.939E+00
2.6343e-01	57.5658	4.971E+00
3.1352e-01	59.8487	6.106E+00

Area = 1.755E+02 m²/g

Slope = 2.013E+01

Y - Intercept = -2.818E-01

Correlation Coefficient = 0.9991

C = -7.043E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT601A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0152 g P/Po Toler... 3 File Name.. AS581602.RAW
Analysis Time... 1038.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-17-95 08:57am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	1.755E+02	m ² /g
Langmuir Surface Area.....	3.681E+02	m ² /g
Meso Pore Area.....	7.607E+01	m ² /g
* t-Method Micro Pore Area.....	9.940E+01	m ² /g
* MP-Method Micro Pore Area.....	3.696E+02	m ² /g
DR-Method Micro Pore Area.....	3.572E+02	m ² /g
Cumulative Adsorption Surface Area.....	4.345E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	3.841E-02	cc/g
* MP-Method Micro Pore Volume.....	1.928E-01	cc/g

Date: 08/17/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT601A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0152 g P/Po Toler... 3 File Name.. AS581602.RAW
Analysis Time... 1038.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-17-95 08:57am

Adsorption Dv(Loz r)

APPENDIX G

ANL701

Lewiston-Stockton Seam

Coal Sample Data (Literature)

Code#7 Seam Lewiston-Stockton State WV Rank hvA Sample #ANL701

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	2.42		
% Ash	19.36	19.84	
% Vol. Matter	29.44	30.17	37.64
% Fixed Carbon	48.78	49.99	62.36

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	19.84		
% Carbon	66.20	82.58	85.47
% Hydrogen	4.21	5.25	5.44
% Nitrogen	1.25	1.56	1.61
% Total Sulfur	0.71		
% Oxygen (diff.)	-1.00	9.83	6.68
Dry % Chlorine 0.10 Dry % Carbon dioxide -1.00			

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	0.16	
% Sulfate	0.03	
% Organic	0.52	0.65
% Total	0.71	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	58.55
Inertinite	12.03
Liptinite	9.62

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.77

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.758
Atomic O/C	0.059

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	27.468	26.803
Net, dmmf (MJ/kg)	35.462	

Caking and Mechanical Properties

Free-swelling index	3.50
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 7 Seam Lewiston-Stockton State WV Rank hvAb Sample # ANL701

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	330
Temp. @ Slope = 45 (°C)	410
Peak Temp (°C)	439
Mass Loss (%)	30.09

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	366
Temp. @ Slope = 45 (°C)	415
Peak Temp (°C)	517
Mass Loss (%)	78.19

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	3.72
35-60 mesh (0.25-0.5mm)	22.06
<60 mesh (<0.25mm)	74.18

FTIR

Peak Intensities:	
Aromatics	0.12
Aliphatics	0.36
Aldehydes	0.02
Hydroxyls	0.28
Ratio Aromatics/Aliphatics	0.34

Mercury Porosimetry

Whole Coal (m ² /g)	67.342
>35 Mesh (m ² /g)	34.216
35 to 60 Mesh (m ² /g)	66.500
<60 Mesh (m ² /g)	32.108

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	4.662
Activated Coal (m ² /g)	167.80
Calculated	
Pore Radius (Å)	Intensity
0.20	0.92
0.47	0.33

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	565		
15 (CH ₃)	1	575		
18 (H ₂ O)	2	245	-1	660
28 (CO, N ₂)	1	505	-1	
44 (CO ₂)	2	-1	505	735

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	515		
15 (CH ₃)	0	-1		
18 (H ₂ O)	1	-1	575	-1
28 (CO, N ₂)	1	570	-1	
44 (CO ₂)	1	-1	565	565

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 18.00 Corrected BET Values: 41.00

**ANL701B LEWISTON-STOCKTON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**ANL701C LEWISTON-STOCKTON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

ANL701B LEWISTON-STOCKTON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

ANL701C LEWISTON-STOCKTON
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE 701

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /188
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 701 VIAL 125 WHOLE
SUBMITTER: OTTO KOPP

LP 15:36:37 04/17/95
HP 22:33:08 04/17/95
REP 15:25:40 01/31/96

PENETROMETER NUMBER:	14-0353	ADVANCING CONTACT ANGLE:	130.0 deg
PENETROMETER CONSTANT:	10.79 fL/pF	RECEDING CONTACT ANGLE:	130.0 deg
PENETROMETER WEIGHT:	1.0000 g	MERCURY SURFACE TENSION:	485.0 dyn/cm
STEM VOLUME:	0.3920 mL	MERCURY DENSITY:	13.5335 g/mL
MAXIMUM HEAD PRESSURE:	4.4500 psia	SAMPLE WEIGHT:	0.1534 g
PENETROMETER VOLUME:	3.0000 mL	SAMPLE+PEN+Hg WEIGHT:	1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5382 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.6701 mL/g
TOTAL PORE AREA =	67.342 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	11.4687 fm
MEDIAN PORE DIAMETER (AREA) =	0.0043 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0398 fm
STEM VOLUME USED =	26 %

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /188
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 701 VIAL 125 WHOLE
SUBMITTER: OTTO KOPP

LP 15:36:37 04/17/95
HP 22:33:08 04/17/95
REP 15:25:40 01/31/95

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Date: 03/27/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 701 VIAL 125
 Sample Description..... WHOLE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS532601.RAW
 Analysis Time... 515.2 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 03-27-95 09:22pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.2697e-04	0.0662	1.1427e-01	0.6046	9.3309e-01	3.6823
3.1515e-04	0.0838	1.3888e-01	0.6723	9.0922e-01	3.5969
4.7813e-04	0.0938	1.6382e-01	0.7423	8.8423e-01	3.5008
5.9756e-04	0.1000	1.8886e-01	0.8085	8.5931e-01	3.3954
6.7502e-04	0.1031	2.1383e-01	0.8731	8.3428e-01	3.3015
7.2335e-04	0.1046	2.3779e-01	0.9862	8.0928e-01	3.2000
7.5390e-04	0.1062	2.6362e-01	1.0669	7.8434e-01	3.0985
7.7301e-04	0.1062	2.8864e-01	1.1369	7.5678e-01	3.1777
7.8443e-04	0.1062	3.1333e-01	1.2069	7.3417e-01	3.0985
7.9198e-04	0.1062	3.3897e-01	1.2777	7.0926e-01	3.0054
7.9592e-04	0.1062	3.6399e-01	1.3477	6.8428e-01	2.9092
7.9847e-04	0.1054	3.8849e-01	1.4169	6.5929e-01	2.8169
8.0480e-04	0.1054	4.1381e-01	1.4862	6.3432e-01	2.7146
8.0602e-04	0.1046	4.3883e-01	1.5523	6.0929e-01	2.6246
8.0839e-04	0.1046	4.6377e-01	1.6254	5.8437e-01	2.5285
8.4277e-04	0.1046	4.8875e-01	1.6908	5.5784e-01	2.5269
9.2772e-04	0.1069	5.1222e-01	1.8708	5.3436e-01	2.4331
1.0314e-03	0.1100	5.3862e-01	1.9569	5.0934e-01	2.3346
1.1363e-03	0.1123	5.6369e-01	2.0308	4.8433e-01	2.2354
2.0099e-03	0.1315	5.8862e-01	2.1092	4.5938e-01	2.1338
3.0863e-03	0.1485	6.1362e-01	2.1823	4.3431e-01	2.0323
4.1713e-03	0.1615	6.3860e-01	2.2562	4.0929e-01	1.9377
5.2498e-03	0.1731	6.6360e-01	2.3331	3.8435e-01	1.8400
6.3386e-03	0.1823	6.8849e-01	2.4162	3.5932e-01	1.7400
7.3727e-03	0.1900	7.1361e-01	2.4846	3.3374e-01	1.7200
8.4203e-03	0.1962	7.3850e-01	2.5662	3.0939e-01	1.6215
9.4590e-03	0.2046	7.6356e-01	2.6369	2.8442e-01	1.5192
1.0468e-02	0.2100	7.8597e-01	2.8931	2.5943e-01	1.4177
3.4077e-02	0.3400	8.1328e-01	2.9954	2.3448e-01	1.3154
3.9542e-02	0.3608	8.3832e-01	3.0938	2.0946e-01	1.2185
4.4504e-02	0.3769	8.6338e-01	3.1754	1.8450e-01	1.1138
5.4451e-02	0.4085	8.8831e-01	3.2692	1.5953e-01	1.0115
6.4345e-02	0.4431	9.1314e-01	3.3677	1.3457e-01	0.9054
7.4365e-02	0.4723	9.3823e-01	3.4569	1.0933e-01	0.8238
8.4383e-02	0.5008	9.6333e-01	3.5569	8.4654e-02	0.7146
8.9195e-02	0.5354	9.8824e-01	3.6554	5.9739e-02	0.5985
9.4366e-02	0.5500	9.9940e-01	3.7477	3.4842e-02	0.4646
1.0426e-01	0.5777	9.6030e-01	3.5569	1.3413e-02	0.3269

Date: 03/27/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 701 VIAL 125
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A' Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS532601.RAW
Analysis Time... 515.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-27-95 09:22pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1427e-01	0.6046	1.707E+02
1.6382e-01	0.7423	2.112E+02
2.1383e-01	0.8731	2.493E+02
2.6362e-01	1.0669	2.685E+02
3.1333e-01	1.2069	3.025E+02

Area = 4.662E+00 m²/g

Slope = 6.444E+02

Y - Intercept = 1.027E+02

Correlation Coefficient = 0.9934

C = 7.276E+00

Date: 03/27/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 701 VIAL 125
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS532601.RAW
Analysis Time... 515.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-27-95 09:22pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	4.662E+00	m ² /g
Langmuir Surface Area.....	1.476E+01	m ² /g
Meso Pore Area.....	4.092E+00	m ² /g
* t-Method Micro Pore Area.....	5.703E-01	m ² /g
* MP-Method Micro Pore Area.....	5.574E+01	m ² /g
DR-Method Micro Pore Area.....	1.305E+00	m ² /g
Cumulative Adsorption Surface Area.....	3.220E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-4.651E-04	cc/g
* MP-Method Micro Pore Volume.....	1.179E-02	cc/g

Date: 03/27/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE 701 VIAL 125
Sample Description..... WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS532601.RAW
Analysis Time... 515.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-27-95 09:22pm

Adsorption Dv(Loz r)

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT701A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0165 g P/Po Toler... 3 File Name.. AS581401.RAW
 Analysis Time... 900.2 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 08-15-95 07:01pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.2970e-05	0.8848	1.1453e-01	48.7394	9.3430e-01	81.9939
1.5194e-05	1.1818	1.3860e-01	49.9455	9.0940e-01	81.1576
1.5195e-05	9.5030	1.6314e-01	51.3091	8.8441e-01	80.2849
2.4526e-05	14.2061	1.8848e-01	52.5515	8.5950e-01	79.3576
3.4316e-05	17.0970	2.1363e-01	53.6545	8.3449e-01	78.4667
4.4346e-05	18.8121	2.3875e-01	54.6848	8.0797e-01	78.9636
5.3260e-05	19.9333	2.6375e-01	55.6727	7.8414e-01	78.3030
6.3524e-05	21.0485	2.8881e-01	56.5939	7.5934e-01	77.4727
7.5135e-05	21.8667	3.1332e-01	57.6606	7.3443e-01	76.5576
8.8102e-05	22.6788	3.3812e-01	58.8545	7.0951e-01	75.6061
1.5954e-04	25.2182	3.6356e-01	59.8242	6.8448e-01	74.6364
2.6438e-04	26.9939	3.8864e-01	60.6788	6.5955e-01	73.6849
3.5986e-04	28.1030	4.1371e-01	61.5091	6.3450e-01	72.7394
4.6678e-04	29.0061	4.3859e-01	62.3333	6.0842e-01	72.7030
5.5803e-04	29.5879	4.6413e-01	63.1576	5.8443e-01	71.8606
6.6856e-04	30.1818	4.8910e-01	64.0121	5.5972e-01	70.7879
7.6608e-04	30.6242	5.1270e-01	65.4485	5.3466e-01	69.7273
8.8165e-04	31.0545	5.3855e-01	66.4848	5.0963e-01	68.6909
9.5613e-04	31.3455	5.6384e-01	67.3818	4.8462e-01	67.6485
1.9593e-03	33.4303	5.8892e-01	68.2182	4.5952e-01	66.6424
3.0505e-03	34.8242	6.1389e-01	69.0182	4.3385e-01	65.9454
4.1187e-03	35.7939	6.3892e-01	69.8242	4.0913e-01	65.2788
5.0454e-03	36.4606	6.6394e-01	70.5879	3.8445e-01	64.3455
6.1742e-03	37.0909	6.8887e-01	71.3697	3.5952e-01	63.3212
7.1810e-03	37.6909	7.1390e-01	72.1212	3.3458e-01	62.2485
8.0506e-03	38.0545	7.3891e-01	72.9030	3.0966e-01	61.1879
9.0877e-03	38.4242	7.6312e-01	74.0061	2.8469e-01	60.0606
1.0134e-02	38.8182	7.8778e-01	75.4182	2.5973e-01	58.9333
3.2093e-02	42.4424	8.1348e-01	76.4121	2.3476e-01	57.7939
3.9456e-02	43.2727	8.3865e-01	77.3030	2.0931e-01	56.8727
4.4683e-02	43.8121	8.6376e-01	78.1333	1.8474e-01	55.7697
5.4419e-02	44.6364	8.8880e-01	78.9030	1.5993e-01	54.5091
6.4300e-02	45.4788	9.1383e-01	79.6545	1.3507e-01	53.1576
7.4361e-02	46.2667	9.3880e-01	80.4061	1.1019e-01	51.6848
8.4450e-02	46.9455	9.6383e-01	81.1697	8.5344e-02	50.0970
8.9730e-02	47.2970	9.8858e-01	81.9879	6.0636e-02	48.2545
9.4715e-02	47.6242	9.9940e-01	84.1152	3.6087e-02	45.9394
1.0453e-01	48.1939	9.5976e-01	82.8424	1.4133e-02	42.5879

Date: 12/23/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT701A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0165 g P/Po Toler... 3 File Name.. AS581401.RAW
Analysis Time... 900.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-15-95 07:01pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1453e-01	48.7394	2.123E+00
1.6314e-01	51.3091	3.040E+00
2.1363e-01	53.6545	4.051E+00
2.6375e-01	55.6727	5.148E+00
3.1332e-01	57.6606	6.332E+00

Area = 1.678E+02 m²/g

Slope = 2.113E+01

Y - Intercept = -3.757E-01

Correlation Coefficient = 0.9989

C = -5.524E+01

Date: 12/23/95

Page 3

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT701A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0165 g P/Po Toler... 3 File Name.. AS581401.RAW
Analysis Time... 900.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-15-95 07:01pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	1.678E+02	m ² /g
Langmuir Surface Area.....	3.367E+02	m ² /g
Meso Pore Area.....	6.565E+01	m ² /g
* t-Method Micro Pore Area.....	1.022E+02	m ² /g
* MP-Method Micro Pore Area.....	3.786E+02	m ² /g
DR-Method Micro Pore Area.....	3.436E+02	m ² /g
Cumulative Adsorption Surface Area.....	3.458E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	4.049E-02	cc/g
* MP-Method Micro Pore Volume.....	1.827E-01	cc/g

Date: 08/15/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT701A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0165 g P/Po Toler... 3 File Name.. AS581401.RAW
Analysis Time... 900.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-15-95 07:01pm

2.4-BIO-RAD

APPENDIX H

ANL801

Beulah-Zap Seam

Coal Sample Data (Literature)

Code#8 Seam Beulah-Zap

State ND

Rank lig

Sample #ANL801

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	32.24		
% Ash	6.59	9.72	
% Vol. Matter	30.45	44.94	49.78
% Fixed Carbon	30.72	45.34	50.22

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	9.72		
% Carbon	65.85	72.94	74.05
% Hydrogen	4.36	4.83	4.90
% Nitrogen	1.04	1.15	1.17
% Total Sulfur	0.80		
% Oxygen (diff.)	-1.00	20.34	19.13

Dry % Chlorine 0.04

Dry % Carbon dioxide -1.00

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	0.14	
% Sulfate	0.03	
% Organic	0.63	0.70
% Total	0.80	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	-1.00
Inertinite	-1.00
Liptinite	-1.00

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.28

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.789
Atomic O/C	0.194

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	25.586	17.337
Net, dmmf (MJ/kg)	28.770	

Caking and Mechanical Properties

Free-swelling index	-1.00
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code # 8 Seam Beulah-Zap

State ND Rank lig

Sample # ANL801

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	139
Temp. @ Slope = 45 (°C)	400
Peak Temp (°C)	425
Mass Loss (%)	28.80

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	124
Temp. @ Slope = 45 (°C)	315
Peak Temp (°C)	405
Mass Loss (%)	64.03

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	7.96
35-60 mesh (0.25-0.5mm)	27.82
<60 mesh (<0.25mm)	64.22

FTIR

Peak Intensities:

Aromatics	0.03
Aliphatics	0.20
Aldehydes	0.01
Hydroxyls	0.69

Ratio Aromatics/Aliphatics 0.16

Mercury Porosimetry

Whole Coal (m ² /g)	74.806
>35 Mesh (m ² /g)	58.973
35 to 60 Mesh (m ² /g)	86.229
<60 Mesh (m ² /g)	42.174

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	5.374
Activated Coal (m ² /g)	27.33

Calculated Pore Radius (Å)	Intensity
0.16	0.99
0.33	0.75

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	565		
15 (CH ₃)	1	571		
18 (H ₂ O)	2	230	570	-1
28 (CO, N ₂)	2	505	740	
44 (CO ₂)	2	-1	455	700

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	0	-1		
15 (CH ₃)	1	445		
18 (H ₂ O)	2	175	490	-1
28 (CO, N ₂)	1	470	-1	
44 (CO ₂)	1	-1	480	480

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 122.00 Corrected BET Values: 105.00

**ANL801B BEULAH ZAP
LIGNITE
PYROLYSIS IN IMPURE HELIUM**

**ANL801BR BEULAH ZAP
LIGNITE
PYROLYSIS IN PURE HELIUM**

**ANL801C BEULAH ZAP
LIGNITE
PYROLYSIS IN ARTIFICIAL AIR**

ANL801BR BEULAH-ZAP
LIGNITE
PYROLYSIS IN HELIUM

ANL801C BEULAH-ZAP
LIGNITE
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR ARGONNE 801

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /161
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 801 VIAL 206 WHOLE
SUBMITTER: OTTO KOPP

LP 15:30:17 02/24/95
HP 22:57:56 02/24/95
REF 15:49:52 01/31/96

PENETROMETER NUMBER:	14-0353	ADVANCING CONTACT ANGLE:	130.0 deg
PENETROMETER CONSTANT:	10.79 fL/pF	RECEDING CONTACT ANGLE:	130.0 deg
PENETROMETER WEIGHT:	1.0000 g	MERCURY SURFACE TENSION:	485.0 dyn/cm
STEM VOLUME:	0.3920 mL	MERCURY DENSITY:	13.5335 g/mL
MAXIMUM HEAD PRESSURE:	4.4500 psia	SAMPLE WEIGHT:	0.1484 g
PENETROMETER VOLUME:	3.0000 mL	SAMPLE+PEN+Hg WEIGHT:	1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5398 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.5615 mL/g
TOTAL PORE AREA =	74.806 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	4.3679 fm
MEDIAN PORE DIAMETER (AREA) =	0.0052 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0300 fm
STEM VOLUME USED =	21 % ****

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /161
OPERATOR: CARLA R. SPARKS
SAMPLE ID: ARGONNE 801 VIAL 206 WHOLE
SUBMITTER: OTTO KOPP

LP 15:30:17 02/24/95
HP 22:57:56 02/24/95
REP 15:49:52 01/31/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Date: 02/27/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 801 VIAL 206 WHOLE
 Sample Description.....
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0793 g P/Po Toler... 3 File Name.. AS522401.RAW
 Analysis Time... 499.1 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 02-27-95 12:27pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
3.4761e-04	0.0693	1.1403e-01	0.5560	9.3278e-01	4.3482
5.6646e-04	0.0731	1.3878e-01	0.6203	9.0977e-01	4.2436
6.7948e-04	0.0744	1.6353e-01	0.7451	8.8471e-01	4.1251
7.3604e-04	0.0744	1.8831e-01	0.8245	8.5985e-01	3.9788
7.6312e-04	0.0744	2.1339e-01	0.9014	8.3486e-01	3.8187
7.7783e-04	0.0719	2.3852e-01	0.9544	8.0889e-01	3.9788
7.8511e-04	0.0706	2.6294e-01	1.0956	7.8467e-01	3.8603
7.8758e-04	0.0693	2.8904e-01	1.1863	7.5972e-01	3.7355
7.8857e-04	0.0605	3.1339e-01	1.2595	7.3466e-01	3.6157
7.8971e-04	0.0630	3.3849e-01	1.3338	7.0885e-01	3.5867
7.8975e-04	0.0643	3.6357e-01	1.3931	6.8440e-01	3.5830
7.9080e-04	0.0618	3.8859e-01	1.4574	6.5968e-01	3.4531
7.9106e-04	0.0681	4.1352e-01	1.5179	6.3464e-01	3.3333
7.9098e-04	0.0668	4.3751e-01	1.7158	6.0963e-01	3.2186
7.9086e-04	0.0643	4.6335e-01	1.8129	5.8430e-01	3.1367
8.4735e-04	0.0605	4.8846e-01	1.8848	5.5934e-01	3.1341
9.4653e-04	0.0605	5.1335e-01	1.9692	5.3471e-01	3.0055
1.0554e-03	0.0618	5.3838e-01	2.0398	5.0965e-01	2.8933
1.1574e-03	0.0618	5.6349e-01	2.0978	4.8469e-01	2.7572
2.1417e-03	0.0731	5.8846e-01	2.1571	4.5973e-01	2.6261
3.1953e-03	0.0832	6.1184e-01	2.4332	4.3425e-01	2.6147
4.2487e-03	0.0908	6.3818e-01	2.5353	4.0963e-01	2.4975
5.2883e-03	0.0958	6.6328e-01	2.6286	3.8471e-01	2.3701
6.3472e-03	0.1034	6.8827e-01	2.7244	3.5976e-01	2.2403
7.3652e-03	0.1097	7.1322e-01	2.8089	3.3468e-01	2.1104
8.3970e-03	0.1147	7.3840e-01	2.8795	3.0916e-01	2.0499
9.4534e-03	0.1185	7.6327e-01	2.9425	2.8467e-01	1.9428
1.0560e-02	0.1223	7.8629e-01	3.2791	2.5977e-01	1.8003
3.3848e-02	0.2799	8.1312e-01	3.3812	2.3478e-01	1.6578
3.9161e-02	0.3013	8.3798e-01	3.4909	2.0983e-01	1.5179
4.4167e-02	0.3215	8.6310e-01	3.5867	1.8484e-01	1.3754
5.4096e-02	0.3555	8.8823e-01	3.6624	1.5953e-01	1.2746
6.4099e-02	0.3858	9.1317e-01	3.7494	1.3488e-01	1.1309
7.4054e-02	0.4160	9.3592e-01	4.1213	1.0997e-01	0.9808
8.4011e-02	0.4513	9.6268e-01	4.2726	8.4980e-02	0.8308
8.9007e-02	0.4892	9.8790e-01	4.4075	6.0005e-02	0.6745
9.4067e-02	0.5030	9.9940e-01	4.5071	3.5087e-02	0.4955
1.0400e-01	0.5308	9.6078e-01	4.2209	1.3320e-02	0.3089

Date: 02/27/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 801 VIAL 206 WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0793 g P/Po Toler... 3 File Name.. AS522401.RAW
Analysis Time... 499.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-27-95 12:27pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1403e-01	0.5560	1.852E+02
1.6353e-01	0.7451	2.099E+02
2.1339e-01	0.9014	2.408E+02
2.6294e-01	1.0956	2.605E+02
3.1339e-01	1.2595	2.900E+02

Area = 5.374E+00 m²/g

Slope = 5.221E+02

Y - Intercept = 1.258E+02

Correlation Coefficient = 0.9984

C = 5.149E+00

Date: 02/27/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 801 VIAL 206 WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0793 g P/Po Toler... 3 File Name.. AS522401.RAW
Analysis Time... 499.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-27-95 12:27pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	5.374E+00	m²/g
Langmuir Surface Area.....	1.841E+01	m²/g
Meso Pore Area.....	4.866E+00	m²/g
* t-Method Micro Pore Area.....	5.079E-01	m²/g
* MP-Method Micro Pore Area.....	7.451E+02	m²/g
DR-Method Micro Pore Area.....	6.616E-01	m²/g
Cumulative Adsorption Surface Area.....	3.898E+00	m²/g
Cumulative Desorption Surface Area.....	-6.923E+15	m²/g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-7.499E-04	cc/g
* MP-Method Micro Pore Volume.....	1.573E-01	cc/g

Date: 02/27/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ARGONNE COAL 801 VIAL 206 WHOLE
Sample Description.....
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 $\text{\AA}^2$ Corr Factor.. $6.580\text{E-}05$ Molec Wgt.. 28.0134
Sample Weight... 0.0793 g P/Po Toler... 3 File Name.. AS522401.RAW
Analysis Time... 499.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 02-27-95 12:27pm

Adsorption $D_v(\text{Log } r)$

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT801A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0164 g P/Po Toler... 3 File Name.. AS580701.RAW
 Analysis Time... 553.1 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 08-08-95 12:11pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
3.8005e-05	0.2256	1.1439e-01	3.0427	9.3376e-01	18.9451
1.0609e-04	0.4451	1.3897e-01	3.4512	9.0874e-01	18.3293
3.1927e-04	0.5793	1.6397e-01	3.8537	8.8382e-01	17.7256
5.4522e-04	0.6341	1.8891e-01	4.2256	8.5876e-01	17.1220
6.7948e-04	0.6585	2.1396e-01	4.5976	8.3378e-01	16.5305
7.4484e-04	0.6646	2.3895e-01	4.9451	8.0872e-01	15.9878
7.7809e-04	0.6707	2.6343e-01	5.7500	7.8266e-01	16.5732
7.9847e-04	0.6707	2.8883e-01	6.2195	7.5857e-01	16.1829
8.0855e-04	0.6646	3.1387e-01	6.6037	7.3371e-01	15.6585
8.1484e-04	0.6585	3.3887e-01	6.9695	7.0882e-01	15.0488
8.1761e-04	0.6463	3.6360e-01	7.2988	6.8381e-01	14.5061
8.1854e-04	0.6524	3.8867e-01	7.6463	6.5879e-01	14.0061
8.2147e-04	0.6402	4.1281e-01	8.6098	6.3278e-01	14.3659
8.2533e-04	0.6280	4.3931e-01	9.1707	6.0862e-01	13.9817
8.3170e-04	0.6159	4.6347e-01	9.5671	5.8380e-01	13.4573
8.6623e-04	0.6098	4.8881e-01	9.9695	5.5884e-01	12.9085
9.6465e-04	0.6098	5.1370e-01	10.3537	5.3384e-01	12.3537
1.0859e-03	0.6037	5.3888e-01	10.7195	5.0885e-01	11.7805
1.1733e-03	0.6037	5.6392e-01	11.0732	4.8384e-01	11.2256
2.1379e-03	0.6524	5.8884e-01	11.4146	4.5800e-01	11.3232
3.2172e-03	0.6951	6.1388e-01	11.7439	4.3373e-01	10.8537
4.2517e-03	0.7256	6.3885e-01	12.0732	4.0884e-01	10.2927
5.3386e-03	0.7500	6.6346e-01	12.6098	3.8385e-01	9.7561
6.3307e-03	0.7683	6.8751e-01	13.8110	3.5889e-01	9.1951
7.4368e-03	0.7927	7.1340e-01	14.4451	3.3387e-01	8.6280
8.4760e-03	0.8049	7.3862e-01	14.8841	3.0896e-01	8.0732
9.4143e-03	0.8171	7.6370e-01	15.2744	2.8395e-01	7.5244
1.0464e-02	0.8476	7.8874e-01	15.6402	2.5857e-01	7.1524
3.4496e-02	1.4207	8.1371e-01	16.0000	2.3382e-01	6.7439
3.9731e-02	1.5183	8.3871e-01	16.3780	2.0903e-01	6.1951
4.4729e-02	1.6159	8.6366e-01	16.7256	1.8406e-01	5.6159
5.4615e-02	1.7866	8.8865e-01	17.0366	1.5908e-01	5.0427
6.4553e-02	1.9512	9.1373e-01	17.3659	1.3415e-01	4.4451
7.4542e-02	2.1220	9.3872e-01	17.7195	1.0922e-01	3.8232
8.4509e-02	2.2805	9.6364e-01	18.0183	8.4301e-02	3.2195
8.9528e-02	2.3659	9.8487e-01	20.0366	5.9358e-02	2.5976
9.4295e-02	2.6220	9.9940e-01	20.6402	3.4446e-02	1.9573
1.0438e-01	2.8537	9.5924e-01	19.5488	1.1184e-02	1.2500

Date: 08/08/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT801A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0164 g P/Po Toler... 3 File Name.. AS580701.RAW
Analysis Time... 553.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-08-95 12:11pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1439e-01	3.0427	3.397E+01
1.6397e-01	3.8537	4.072E+01
2.1396e-01	4.5976	4.737E+01
2.6343e-01	5.7500	4.977E+01
3.1387e-01	6.6037	5.543E+01

Area = 2.733E+01 m²/g

Slope = 1.043E+02

Y - Intercept = 2.315E+01

Correlation Coefficient = 0.9890

C = 5.504E+00

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT801A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0164 g P/Po Toler... 3 File Name.. AS580701.RAW
Analysis Time... 553.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-08-95 12:11pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.733E+01	m ² /g
Langmuir Surface Area.....	8.339E+01	m ² /g
Meso Pore Area.....	2.214E+01	m ² /g
* t-Method Micro Pore Area.....	5.191E+00	m ² /g
* MP-Method Micro Pore Area.....	4.105E+02	m ² /g
DR-Method Micro Pore Area.....	4.865E+00	m ² /g
Cumulative Adsorption Surface Area.....	1.885E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-2.577E-03	cc/g
• MP-Method Micro Pore Volume.....	8.649E-02	cc/g

Date: 08/08/95

Page 10

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACT801A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0164 g P/Po Toler... 3 File Name.. AS580701.RAW
Analysis Time... 553.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-08-95 12:11pm

Adsorption $D_v(\log r)$

APPENDIX I
DECS-2
Illinois #6 Seam

Coal Sample Data (Literature)

Code#9 Seam Illinois #6

State IL

Rank hvC

Sample # DECS-2

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	10.43		
% Ash	14.47	16.16	
% Vol. Matter	34.16	38.14	45.49
% Fixed Carbon	40.93	45.70	54.51

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	16.16		
% Carbon	65.49	78.11	81.80
% Hydrogen	4.56	5.44	5.70
% Nitrogen	1.11	1.32	1.39
% Total Sulfur	4.52		
% Oxygen (diff.)	8.16	9.73	11.12
Dry % Chlorine	0.12	Dry % Carbon dioxide	0.66

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	2.27	
% Sulfate	0.01	
% Organic	2.24	2.67
% Total	4.52	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	72.91
Inertinite	4.19
Liptinite	6.70

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.52

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.808
Atomic O/C	0.087

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	27.631	24.749
Net, dmmf (MJ/kg)	32.704	

Caking and Mechanical Properties

Free-swelling index	3.50
Hardgrove grindability index	57.80

Gieseler Coal Plastometer

Initial Softening	385.00 °C
Maximum fluidity	411.00 °C

Coal Sample Data (Measured)

Code # 9 Seam Illinois #6

State IL Rank hvCb Sample # DECS-2

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	308
Temp. @ Slope = 45 (°C)	690
Peak Temp (°C)	415
Mass Loss (%)	33.89

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	342
Temp. @ Slope = 45 (°C)	395
Peak Temp (°C)	529
Mass Loss (%)	79.97

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	39.35
35-60 mesh (0.25-0.5mm)	25.23
<60 mesh (<0.25mm)	35.42

FTIR

Peak Intensities:

Aromatics	0.03
Aliphatics	0.16
Aldehydes	0.01
Hydroxyls	0.30
Ratio Aromatics/Aliphatics	0.21

Mercury Porosimetry

Whole Coal (m ² /g)	102.446
>35 Mesh (m ² /g)	78.728
35 to 60 Mesh (m ² /g)	112.503
<60 Mesh (m ² /g)	73.537

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	26.720
Activated Coal (m ² /g)	179.70
Calculated Pore Radius (Å)	Intensity
0.22	0.12
0.42	1.90

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	580		
15 (CH ₃)	1	575		
18 (H ₂ O)	2	220	-1	635
28 (CO, N ₂)	2	505	775	
44 (CO ₂)	2	-1	485	770

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	560		
14 (CH ₂ , N)	1	530		
15 (CH ₃)	1	525		
18 (H ₂ O)	2	200	590	-1
28 (CO, N ₂)	1	580	-1	
44 (CO ₂)	2	-1	580	580

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 61.00 Corrected BET Values: 73.00

**DECS2B ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN IMPURE HELIUM**

**DECS2BR ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**DECS2C ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

DECS2BR ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

DECS2C ILLINOIS #6
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR DECS-2

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /165
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-2 COAL BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPP

LP 16:14:37 03/03/95
HF 23:12:42 03/03/95
REF 10:57:34 02/11/96

FENETROMETER NUMBER: 14-0353	ADVANCING CONTACT ANGLE: 130.0 deg
FENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
FENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1450 g
FENETROMETER VOLUME: 3.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5414 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.7010 mL/g
TOTAL PORE AREA =	102.446 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	32.3685 fm
MEDIAN PORE DIAMETER (AREA) =	0.0050 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0274 fm
STEM VOLUME USED =	26 %

MERCURY INTRUSION PORE ANALYSIS FOR DECS-2

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /165
 OPERATOR: CARLA R. SPARKS
 SAMPLE ID: DECS-2 COAL BAG 1 OF 4 WHOLE
 SUBMITTER: OTTO KOPP

LP 16:14:37 03/03/95
 HP 23:12:42 03/03/95
 REP 10:57:34 02/11/96

CUMULATIVE INTRUSION vs DIAMETER
 + intrusion, * extrusion

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-2
 Sample Description..... BAG 1 of 4 WHOLE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area... 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.1038 g P/Po Toler... 3 File Name.. AS530602.RAW
 Analysis Time... 851.1 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 03-07-95 10:60am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.2549e-05	0.0963	1.1349e-01	5.4378	9.3597e-01	21.3939
1.8022e-05	0.1445	1.3733e-01	5.7885	9.1082e-01	21.0731
2.3743e-05	0.1927	1.6203e-01	6.1449	8.8393e-01	21.0481
2.8443e-05	0.2399	1.8717e-01	6.4878	8.6058e-01	20.7774
3.4421e-05	0.2871	2.1229e-01	6.8279	8.3591e-01	20.4576
4.7824e-05	0.3805	2.3734e-01	7.1592	8.1084e-01	20.1339
5.5224e-05	0.4267	2.6177e-01	7.5773	7.8605e-01	19.7929
6.3931e-05	0.4720	2.8719e-01	7.9222	7.6094e-01	19.4615
7.3915e-05	0.5173	3.1214e-01	8.2670	7.3601e-01	19.1205
8.3923e-05	0.5606	3.3708e-01	8.6061	7.1104e-01	18.7728
1.5925e-04	0.7649	3.6204e-01	8.9519	6.8398e-01	18.6234
2.6315e-04	0.9720	3.8705e-01	9.2949	6.6096e-01	18.2979
3.5925e-04	1.1136	4.1192e-01	9.6474	6.3627e-01	17.9183
4.6126e-04	1.2321	4.3687e-01	10.0039	6.1144e-01	17.5214
5.5833e-04	1.3236	4.6179e-01	10.3728	5.8671e-01	17.0985
6.7131e-04	1.4141	4.8677e-01	10.7369	5.7208e-01	15.7152
7.7456e-04	1.4844	5.1157e-01	11.1174	5.4947e-01	13.9572
8.9117e-04	1.5538	5.3652e-01	11.5085	5.1667e-01	13.0421
9.7669e-04	1.5981	5.6130e-01	11.9131	4.8832e-01	12.4044
1.9802e-03	1.9410	5.8404e-01	12.5335	4.6212e-01	11.9073
3.0383e-03	2.1809	6.1087e-01	13.0142	4.3666e-01	11.4642
3.9925e-03	2.3331	6.3592e-01	13.4717	4.1143e-01	11.0490
5.0734e-03	2.4824	6.6067e-01	13.9534	3.8638e-01	10.6444
6.0115e-03	2.5884	6.8547e-01	14.4620	3.6135e-01	10.2495
7.0854e-03	2.6963	7.1036e-01	14.9716	3.3623e-01	9.8651
8.1443e-03	2.7965	7.3510e-01	15.5168	3.1126e-01	9.4914
8.9820e-03	2.8648	7.6002e-01	16.0736	2.8541e-01	9.2062
1.0285e-02	2.9679	7.8482e-01	16.6545	2.6116e-01	8.8469
3.0126e-02	3.7020	8.0969e-01	17.2421	2.3627e-01	8.4751
3.8090e-02	3.9351	8.3452e-01	17.8499	2.1130e-01	8.0984
4.3597e-02	4.0834	8.5624e-01	18.7756	1.8632e-01	7.7199
5.3218e-02	4.2934	8.8402e-01	19.4557	1.6140e-01	7.3317
6.3274e-02	4.5034	9.0942e-01	20.0809	1.3647e-01	6.9338
7.3306e-02	4.6970	9.3455e-01	20.6897	1.1161e-01	6.5186
8.3386e-02	4.8781	9.5969e-01	21.2716	8.6821e-02	6.0765
8.8527e-02	5.0053	9.8485e-01	21.8370	6.2138e-02	5.5891
9.3861e-02	5.1074	9.9940e-01	22.2705	3.7638e-02	5.0149
1.0349e-01	5.2741	9.6231e-01	21.7262	1.7799e-02	4.3522

Date: 03/08/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-2
Sample Description..... BAG 1 of 4 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1038 g P/Po Toler... 3 File Name.. AS530602.RAW
Analysis Time... 851.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-07-95 10:60am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1349e-01	5.4378	1.884E+01
1.6203e-01	6.1449	2.518E+01
2.1229e-01	6.8279	3.158E+01
2.6177e-01	7.5773	3.744E+01
3.1214e-01	8.2670	4.392E+01

Area = 2.672E+01 m²/g

Slope = 1.256E+02

Y - Intercept = 4.721E+00

Correlation Coefficient = 0.9999

C = 2.760E+01

Date: 03/08/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-2
Sample Description..... BAG 1 of 4 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1038 g P/Po Toler... 3 File Name.. AS530602.RAW
Analysis Time... 851.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-07-95 10:60am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.672E+01	m²/g
Langmuir Surface Area.....	8.002E+01	m²/g
Meso Pore Area.....	2.329E+01	m²/g
* t-Method Micro Pore Area.....	3.438E+00	m²/g
* MP-Method Micro Pore Area.....	2.296E+01	m²/g
DR-Method Micro Pore Area.....	2.685E+01	m²/g
Cumulative Adsorption Surface Area.....	1.638E+01	m²/g
Cumulative Desorption Surface Area.....	-6.923E+15	m²/g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-9.111E-04	cc/g
* MP-Method Micro Pore Volume.....	3.271E-02	cc/g

Date: 03/08/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-2
Sample Description..... BAG 1 of 4 WHOLE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 $\text{\AA}^2$ Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1038 g P/Po Toler... 3 File Name.. AS530602.RAW
Analysis Time... 851.1 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-07-95 10:60am

Adsorption $D_v(\text{Log } r)$

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD2A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS581701.RAW
 Analysis Time... 936.5 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 08-18-95 04:40pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
9.7524e-06	3.4936	1.1458e-01	53.3205	9.3422e-01	87.7051
1.0806e-05	3.8141	1.3864e-01	54.5256	9.0922e-01	86.7051
1.5202e-05	12.3718	1.6370e-01	55.6987	8.8414e-01	85.7692
2.4534e-05	17.3782	1.8872e-01	56.7500	8.5912e-01	84.8590
3.5566e-05	20.7628	2.1377e-01	57.7885	8.2972e-01	86.3590
4.3086e-05	22.2885	2.3849e-01	59.1154	8.0869e-01	85.7949
5.4550e-05	24.0897	2.6371e-01	60.1859	7.8413e-01	84.8654
6.4813e-05	24.9808	2.8874e-01	61.1474	7.5916e-01	83.8654
7.3876e-05	25.8590	3.1383e-01	62.0833	7.3413e-01	82.8718
8.5531e-05	26.7244	3.3742e-01	63.6282	7.0919e-01	81.9423
1.5831e-04	29.4423	3.6320e-01	64.8077	6.8414e-01	80.9551
2.6574e-04	31.3333	3.8842e-01	65.7821	6.5917e-01	79.9487
3.6518e-04	32.5128	4.1349e-01	66.7244	6.3424e-01	78.9679
4.6423e-04	33.3205	4.3830e-01	67.6410	6.0919e-01	78.0321
5.7613e-04	34.0833	4.6414e-01	68.5513	5.8455e-01	76.9359
6.6339e-04	34.5385	4.8944e-01	69.4487	5.6014e-01	75.4423
7.6855e-04	35.0000	5.1433e-01	70.2692	5.3303e-01	75.3590
8.7387e-04	35.4615	5.3865e-01	71.1474	5.0901e-01	74.5641
9.6106e-04	35.7692	5.6350e-01	71.9744	4.8432e-01	73.5128
2.0221e-03	38.0513	5.8860e-01	72.8269	4.5939e-01	72.4167
2.9796e-03	39.2372	6.1360e-01	73.6795	4.3437e-01	71.3141
4.0778e-03	40.3013	6.3860e-01	74.4872	4.0935e-01	70.2436
5.0502e-03	41.0128	6.6356e-01	75.3397	3.8432e-01	69.1410
6.1594e-03	41.6667	6.8856e-01	76.1667	3.5943e-01	68.0385
7.2468e-03	42.2500	7.1356e-01	77.0064	3.3446e-01	66.9423
8.0466e-03	42.6218	7.3848e-01	77.8077	3.0954e-01	65.8654
9.0626e-03	43.0192	7.5812e-01	81.0641	2.8456e-01	64.7115
1.0198e-02	43.3974	7.8779e-01	82.4231	2.5964e-01	63.5769
3.2085e-02	47.1026	8.1319e-01	83.4551	2.3466e-01	62.4487
3.9433e-02	47.9295	8.3830e-01	84.4167	2.0967e-01	61.2692
4.4697e-02	48.4487	8.6340e-01	85.3526	1.8475e-01	60.0833
5.4476e-02	49.2885	8.8836e-01	86.2821	1.5979e-01	58.8269
6.4522e-02	50.0641	9.1337e-01	87.1795	1.3495e-01	57.5000
7.4514e-02	50.7692	9.3835e-01	88.0641	1.0970e-01	56.3974
8.4584e-02	51.3782	9.6337e-01	89.0000	8.5160e-02	54.8590
8.9818e-02	51.7564	9.8832e-01	89.8974	6.0460e-02	53.0256
9.4835e-02	52.0705	9.9940e-01	90.6026	3.5916e-02	50.6923
1.0445e-01	52.7051	9.5988e-01	88.7372	1.3863e-02	47.2179

Date: 12/23/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD2A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS581701.RAW
Analysis Time... 936.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-18-95 04:40pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1458e-01	53.3205	1.942E+00
1.6370e-01	55.6987	2.812E+00
2.1377e-01	57.7885	3.764E+00
2.6371e-01	60.1859	4.761E+00
3.1383e-01	62.0833	5.894E+00

Area = 1.797E+02 m²/g

Slope = 1.977E+01

Y - Intercept = -3.945E-01

Correlation Coefficient = 0.9989

C = -4.911E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD2A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS581701.RAW
Analysis Time... 936.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-18-95 04:40pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	1.797E+02	m ² /g
Langmuir Surface Area.....	3.652E+02	m ² /g
Meso Pore Area.....	6.939E+01	m ² /g
* t-Method Micro Pore Area.....	1.103E+02	m ² /g
* MP-Method Micro Pore Area.....	6.606E+02	m ² /g
DR-Method Micro Pore Area.....	3.163E+02	m ² /g
Cumulative Adsorption Surface Area.....	3.623E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	4.601E-02	cc/g
* MP-Method Micro Pore Volume.....	2.376E-01	cc/g

Date: 08/18/95

Page 10

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD2A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0156 g P/Po Toler... 3 File Name.. AS581701.RAW
Analysis Time... 936.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-18-95 04:40pm

APPENDIX J

DECS-21

Lykens Valley #2 Seam

Coal Sample Data (Literature)

Code#10 Seam Lykens Valley #2 State PA Rank an Sample # DECS-21

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	3.99		
% Ash	10.71	11.15	
% Vol. Matter	4.33	4.51	5.08
% Fixed Carbon	80.97	84.34	94.92

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	11.15		
% Carbon	80.26	90.33	91.53
% Hydrogen	3.56	4.01	4.06
% Nitrogen	0.71	0.80	0.81
% Total Sulfur	0.50		
% Oxygen (diff.)	3.82	4.30	3.60

Dry % Chlorine 0.04

Dry % Carbon dioxide 0.05

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	0.06	
% Sulfate	0.00	
% Organic	0.43	0.48
% Total	0.50	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	77.39
Inertinite	11.46
Liptinite	0.00

Reflectance Data

Vitrinite(%):

Mean-max Ro: 5.19

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.511
Atomic O/C	0.024

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	30.896	29.664
Net, dmmf (MJ/kg)	34.483	

Caking and Mechanical Properties

Free-swelling index	0.00
Hardgrove grindability index	31.60

Gieseler Coal Plastometer

Initial Softening	-1.00 °C
Maximum fluidity	-1.00 °C

Coal Sample Data (Measured)

Code #10 Seam Lykens Valley

State PA Rank an

Sample # DECS-21

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	596
Temp. @ Slope = 45 (°C)	-1
Peak Temp (°C)	750
Mass Loss (%)	3.83

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	534
Temp. @ Slope = 45 (°C)	550
Peak Temp (°C)	620
Mass Loss (%)	90.06

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	45.19
35-60 mesh (0.25-0.5mm)	19.99
<60 mesh (<0.25mm)	34.82

FTIR

Peak Intensities:

Aromatics	0.02
Aliphatics	0.01
Aldehydes	0.00
Hydroxyls	0.02

Ratio Aromatics/Aliphatics 1.44

Mercury Porosimetry

Whole Coal (m ² /g)	66.687
>35 Mesh (m ² /g)	49.801
35 to 60 Mesh (m ² /g)	82.884
<60 Mesh (m ² /g)	42.414

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	8.874
Activated Coal (m ² /g)	117.90

Calculated Pore Radius (Å)	Intensity
0.16	0.91
0.35	0.81

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	865		
14 (CH ₂ , N)	1	695		
15 (CH ₃)	1	690		
18 (H ₂ O)	1	-1	-1	900
28 (CO, N ₂)	0	-1	-1	
44 (CO ₂)	1	-1	-1	760

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	1	655		
14 (CH ₂ , N)	0	-1		
15 (CH ₃)	1	635		
18 (H ₂ O)	1	-1	-1	740
28 (CO, N ₂)	1	665	-1	
44 (CO ₂)	1	-1	-1	-1

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 122.00

Corrected BET Values: 105.00

**DECS21B LYKENS VALLEY #2
ANTHRACITE
PYROLYSIS IN IMPURE HELIUM**

**DECS21BR LYKENS VALLEY #2
ANTHRACITE
PYROLYSIS IN PURE HELIUM**

**DECS21C LYKENS VALLEY #2
ANTHRACITE
PYROLYSIS IN ARTIFICIAL AIR**

DECS21BR LYKENS VALLEY #2
ANTHRACITE
PYROLYSIS IN HELIUM

DECS21C LYKENS VALLEY #2
ANTHRACITE
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR DECS-21

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /167
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-21 COAL BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPF

LP 15:33:32 03/08/95
HP 22:46:29 03/08/95
REP 11:19:21 02/11/96

PENETROMETER NUMBER: 14-0226	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1548 g
PENETROMETER VOLUME: 3.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5430 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.5924 mL/g
TOTAL PORE AREA =	66.687 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	26.5445 fm
MEDIAN PORE DIAMETER (AREA) =	0.0045 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0355 fm
STEM VOLUME USED =	23 % ****

MERCURY INTRUSION PORE ANALYSIS FOR DECS-21

AUTOPORE II 9220 V3.01

PAGE 4

SAMPLE DIRECTORY/NUMBER: DATA1 /167
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-21 COAL BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPP

LP 15:33:32 03/08/95
HP 22:46:29 03/08/95
REP 11:19:21 02/11/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Date: 03/10/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-21
Sample Description..... WHOLE BAG 1of4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS530902.RAW
Analysis Time... 809.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-10-95 08:11am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
4.4689e-05	0.0746	1.1325e-01	1.2354	9.3493e-01	6.5131
1.1613e-04	0.1046	1.3798e-01	1.3731	9.0984e-01	6.3938
2.0018e-04	0.1300	1.6259e-01	1.5115	8.8485e-01	6.2608
2.8760e-04	0.1508	1.8769e-01	1.6508	8.5980e-01	6.1277
3.6988e-04	0.1669	2.1279e-01	1.7838	8.3313e-01	6.1900
4.3958e-04	0.1808	2.3724e-01	1.9669	8.0958e-01	6.0938
5.3147e-04	0.1892	2.6327e-01	2.1100	7.8473e-01	5.9685
5.4860e-04	0.2000	2.8839e-01	2.2454	7.5980e-01	5.8462
5.8892e-04	0.2077	3.1303e-01	2.3792	7.3494e-01	5.7054
6.1958e-04	0.2138	3.3764e-01	2.5185	7.0785e-01	5.7315
6.4887e-04	0.2192	3.6286e-01	2.6462	6.8463e-01	5.6200
6.6358e-04	0.2238	3.8784e-01	2.7692	6.5971e-01	5.5023
6.9047e-04	0.2277	4.1251e-01	2.9231	6.3484e-01	5.3692
7.0875e-04	0.2300	4.3719e-01	3.1300	6.0990e-01	5.2277
7.2213e-04	0.2323	4.6259e-01	3.2800	5.8481e-01	5.0938
7.8220e-04	0.2385	4.8763e-01	3.4200	5.5857e-01	5.0723
8.4589e-04	0.2469	5.1270e-01	3.5562	5.3477e-01	4.9469
9.4237e-04	0.2562	5.3763e-01	3.6946	5.0987e-01	4.8085
1.0390e-03	0.2662	5.6269e-01	3.8254	4.8485e-01	4.6715
2.0266e-03	0.3038	5.8782e-01	3.9477	4.5984e-01	4.5354
3.0539e-03	0.3454	6.1261e-01	4.0762	4.3483e-01	4.4008
4.0145e-03	0.3715	6.3587e-01	4.3377	4.0938e-01	4.2962
5.0500e-03	0.3985	6.6240e-01	4.4985	3.8473e-01	4.2062
6.0577e-03	0.4254	6.8754e-01	4.6385	3.5990e-01	4.0700
7.1408e-03	0.4508	7.1259e-01	4.7715	3.3492e-01	3.9323
8.1923e-03	0.4777	7.3743e-01	4.9192	3.0999e-01	3.7938
9.1779e-03	0.5038	7.6258e-01	5.0554	2.8501e-01	3.6485
1.0195e-02	0.5292	7.8760e-01	5.1885	2.6001e-01	3.5031
3.3059e-02	0.6900	8.1250e-01	5.3292	2.3488e-01	3.3746
3.8629e-02	0.7331	8.3614e-01	5.6485	2.0993e-01	3.2677
4.3611e-02	0.7685	8.6215e-01	5.8108	1.8516e-01	3.1146
5.3472e-02	0.8277	8.8739e-01	5.9492	1.6017e-01	2.9615
6.3373e-02	0.8977	9.1237e-01	6.0938	1.3523e-01	2.8062
7.3442e-02	0.9608	9.3730e-01	6.2408	1.1024e-01	2.6477
8.3407e-02	1.0215	9.6236e-01	6.3854	8.5304e-02	2.4908
8.8567e-02	1.0592	9.8744e-01	6.5162	6.0317e-02	2.3300
9.3530e-02	1.0985	9.9940e-01	6.6438	3.5463e-02	2.1523
1.0344e-01	1.1538	9.5961e-01	6.6292	1.4065e-02	1.9762

Date: 03/10/95

Page 2

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-21
Sample Description..... WHOLE BAG 1of4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS530902.RAW
Analysis Time... 809.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-10-95 08:11am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1325e-01	1.2354	8.272E+01
1.6259e-01	1.5115	1.028E+02
2.1279e-01	1.7838	1.212E+02
2.6327e-01	2.1100	1.355E+02
3.1303e-01	2.3792	1.532E+02

Area = 8.874E+00 m²/g

Slope = 3.473E+02

Y - Intercept = 4.512E+01

Correlation Coefficient = 0.9982

C = 8.697E+00

Date: 03/10/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-21
Sample Description..... WHOLE BAG 1of4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS530902.RAW
Analysis Time... 809.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-10-95 08:11am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	8.874E+00	m ² /g
Langmuir Surface Area.....	2.654E+01	m ² /g
Meso Pore Area.....	7.373E+00	m ² /g
* t-Method Micro Pore Area.....	1.501E+00	m ² /g
DR-Method Micro Pore Area.....	3.616E+00	m ² /g
Cumulative Adsorption Surface Area.....	5.865E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

Date: 03/10/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-21
Sample Description..... WHOLE BAG 1of4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1300 g P/Po Toler... 3 File Name.. AS530902.RAW
Analysis Time... 809.0 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-10-95 08:11am

Adsorption Dv(Loz r)

Date: 12/23/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD21A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt... 28.0134
Sample Weight... 0.0171 g P/Po Toler... 3 File Name.. AS580901.RAW
Analysis Time... 759.7 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-10-95 15:47pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.8553e-05	0.5673	1.1404e-01	33.4795	9.3388e-01	58.1403
2.2057e-05	0.8480	1.3852e-01	34.5029	9.0886e-01	57.5088
2.3238e-05	1.1345	1.6356e-01	35.4503	8.8403e-01	56.8187
2.8049e-05	6.5673	1.8859e-01	36.2982	8.5896e-01	56.1813
3.5424e-05	8.5380	2.1367e-01	37.0994	8.3393e-01	55.5322
4.7958e-05	10.2047	2.3872e-01	37.8012	8.0902e-01	54.9006
5.5592e-05	11.0292	2.6362e-01	38.5497	7.8091e-01	55.5556
6.5816e-05	11.8421	2.8835e-01	39.6784	7.5867e-01	55.1871
7.4800e-05	12.3743	3.1362e-01	40.4035	7.3391e-01	54.5789
8.5128e-05	12.8947	3.3871e-01	41.0994	7.0897e-01	53.9357
1.5743e-04	15.1520	3.6370e-01	41.7193	6.8401e-01	53.2573
2.5791e-04	16.6842	3.8850e-01	42.3041	6.5909e-01	52.5789
3.5917e-04	17.5906	4.1360e-01	42.8947	6.3402e-01	51.9181
4.6801e-04	18.3275	4.3732e-01	44.0292	6.0902e-01	51.2690
5.7663e-04	18.8655	4.6379e-01	44.8304	5.8266e-01	51.2865
6.7616e-04	19.2690	4.8918e-01	45.4737	5.5896e-01	50.7427
7.9490e-04	19.6608	5.1395e-01	46.0526	5.3411e-01	50.0585
8.7273e-04	19.9181	5.3833e-01	46.6374	5.0913e-01	49.3509
9.7599e-04	20.1930	5.6365e-01	47.1988	4.8416e-01	48.6023
1.9872e-03	21.7485	5.8864e-01	47.7602	4.5916e-01	47.8363
3.0266e-03	22.7544	6.1370e-01	48.2749	4.3417e-01	47.1170
4.0406e-03	23.4094	6.3875e-01	48.7836	4.0914e-01	46.3801
5.0947e-03	23.9883	6.6370e-01	49.2749	3.8417e-01	45.6140
6.0152e-03	24.3743	6.8862e-01	49.8187	3.5913e-01	44.8772
7.0563e-03	24.7310	7.1124e-01	51.3216	3.3358e-01	44.5146
8.0121e-03	25.0936	7.3816e-01	52.1170	3.0917e-01	43.8363
9.1626e-03	25.4035	7.6339e-01	52.7778	2.8427e-01	43.0351
1.0316e-02	25.6784	7.8850e-01	53.3567	2.5937e-01	42.1871
3.2472e-02	28.5906	8.1344e-01	53.9474	2.3446e-01	41.3041
3.9340e-02	29.1871	8.3856e-01	54.4561	2.0944e-01	40.3977
4.4509e-02	29.5906	8.6351e-01	55.0117	1.8450e-01	39.4386
5.4265e-02	30.2456	8.8849e-01	55.5497	1.5963e-01	38.4327
6.4257e-02	30.8363	9.1343e-01	56.0994	1.3446e-01	37.4795
7.4304e-02	31.4035	9.3849e-01	56.6433	1.0972e-01	36.4152
8.4320e-02	31.9123	9.6345e-01	57.1871	8.4901e-02	35.1696
8.9515e-02	32.1871	9.8838e-01	57.7544	6.0189e-02	33.6725
9.4547e-02	32.4269	9.9940e-01	59.6901	3.5529e-02	31.8012
1.0433e-01	32.8655	9.5914e-01	58.7134	1.3048e-02	29.0351

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD21A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0171 g P/Po Toler... 3 File Name.. AS580901.RAW
Analysis Time... 759.7 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-10-95 15:47pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1404e-01	33.4795	3.076E+00
1.6356e-01	35.4503	4.413E+00
2.1367e-01	37.0994	5.861E+00
2.6362e-01	38.5497	7.430E+00
3.1362e-01	40.4035	9.048E+00

Area = 1.179E+02 m²/g

Slope = 2.997E+01

Y - Intercept = -4.391E-01

Correlation Coefficient = 0.9993

C = -6.726E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD21A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0171 g P/Po Toler... 3 File Name.. AS580901.RAW
Analysis Time... 759.7 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-10-95 15:47pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	1.179E+02	m ² /g
Langmuir Surface Area.....	2.379E+02	m ² /g
Meso Pore Area.....	4.917E+01	m ² /g
* t-Method Micro Pore Area.....	6.875E+01	m ² /g
* MP-Method Micro Pore Area.....	3.123E+02	m ² /g
DR-Method Micro Pore Area.....	2.645E+02	m ² /g
Cumulative Adsorption Surface Area.....	2.610E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	2.530E-02	cc/g
* MP-Method Micro Pore Volume.....	1.380E-01	cc/g

Date: 08/10/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD21A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A' Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0171 g P/Po Toler... 3 File Name.. AS580901.RAW
Analysis Time... 759.7 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-10-95 15:47pm

Adsorption $D_v(\log r)$

APPENDIX K
DECS-22
Upper Kittanning Seam

Coal Sample Data (Literature)

Code#11 Seam Upper Kittanning State PA Rank hvA Sample # DECS-22

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	0.91		
% Ash	23.06	23.27	
% Vol. Matter	30.17	30.45	39.68
% Fixed Carbon	45.86	46.28	60.32

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	23.27		
% Carbon	64.89	84.57	87.77
% Hydrogen	4.48	5.84	6.06
% Nitrogen	1.36	1.77	1.84
% Total Sulfur	1.71		
% Oxygen (diff.)	4.29	5.59	4.33

Dry % Chlorine 0.14

Dry % Carbon dioxide 0.36

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	1.15	
% Sulfate	0.03	
% Organic	0.53	0.69
% Total	1.71	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	22.24
Inertinite	29.91
Liptinite	24.54

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.77

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.779
Atomic O/C	0.026

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	27.412	27.163
Net, dmmf (MJ/kg)	35.983	

Caking and Mechanical Properties

Free-swelling index	1.00
Hardgrove grindability index	31.00

Gieseler Coal Plastometer

Initial Softening	416.00 °C
Maximum fluidity	444.00 °C

Coal Sample Data (Measured)

Code #11 Seam Upper Kittanning State PA Rank hvAb Sample # DECS-22

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	324
Temp. @ Slope = 45 (°C)	418
Peak Temp (°C)	455
Mass Loss (%)	30.79

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	382
Temp. @ Slope = 45 (°C)	420
Peak Temp (°C)	533
Mass Loss (%)	76.43

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	46.28
35-60 mesh (0.25-0.5mm)	22.00
<60 mesh (<0.25mm)	31.71

FTIR

Peak Intensities:

Aromatics	0.02
Aliphatics	0.09
Aldehydes	0.00
Hydroxyls	0.02

Ratio Aromatics/Aliphatics 0.23

Mercury Porosimetry

Whole Coal (m ² /g)	61.017
>35 Mesh (m ² /g)	29.369
35 to 60 Mesh (m ² /g)	71.613
<60 Mesh (m ² /g)	37.991

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	2.744
Activated Coal (m ² /g)	145.50
Calculated Pore Radius (Å)	Intensity
0.19	1.10
0.53	0.74

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	570		
15 (CH ₃)	1	565		
18 (H ₂ O)	1	-1	-1	765
28 (CO, N ₂)	1	525	-1	
44 (CO ₂)	2	-1	515	785

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	515		
15 (CH ₃)	0	-1		
18 (H ₂ O)	2	395	580	-1
28 (CO, N ₂)	1	580	-1	
44 (CO ₂)	1	-1	585	585

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 0.00 Corrected BET Values: 29.00

**DECS22B UPPER KITTANNING
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**DECS22C UPPER KITTANNING
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

DECS22B UPPER KITTANNING
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

DECS22C UPPER KITTANNING HIGH VOLATILE BITUMINOUS PYROLYSIS IN ARTIFICIAL AIR

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /184
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-22 BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPF

LP 14:32:02 04/10/95
HP 21:15:54 04/10/95
REP 11:43:45 02/11/96

PENETROMETER NUMBER:	14-0353	ADVANCING CONTACT ANGLE:	130.0 deg
PENETROMETER CONSTANT:	10.79 fL/pF	RECEDING CONTACT ANGLE:	130.0 deg
PENETROMETER WEIGHT:	1.0000 g	MERCURY SURFACE TENSION:	485.0 dyn/cm
STEM VOLUME:	0.3920 mL	MERCURY DENSITY:	13.5335 g/mL
MAXIMUM HEAD PRESSURE:	4.4500 psia	SAMPLE WEIGHT:	0.1699 g
PENETROMETER VOLUME:	3.0000 mL	SAMPLE+PEN+Hg WEIGHT:	1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5334 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.6775 mL/g
TOTAL PORE AREA =	61.017 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	27.0675 fm
MEDIAN PORE DIAMETER (AREA) =	0.0045 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0444 fm
STEM VOLUME USED =	29 %

SAMPLE DIRECTORY/NUMBER: DATA1 /184
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-22 BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPF

LP 14:32:02 04/10/95
HP 21:15:54 04/10/95
REP 11:43:45 02/11/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-22
 Sample Description..... BAG 1 OF 4
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.1213 g P/Po Toler... 3 File Name.. AS532201.RAW
 Analysis Time... 509.6 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 03-25-95 01:43am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
3.8286e-04	0.0412	1.3911e-01	0.3223	9.0892e-01	2.2028
6.0639e-04	0.0429	1.6381e-01	0.4114	8.8300e-01	2.3586
7.0885e-04	0.0429	1.8897e-01	0.4592	8.5893e-01	2.2918
7.6083e-04	0.0429	2.1396e-01	0.4971	8.3387e-01	2.2234
7.8742e-04	0.0420	2.3864e-01	0.5342	8.0898e-01	2.1459
7.9787e-04	0.0420	2.6372e-01	0.5746	7.8390e-01	2.0684
8.0193e-04	0.0412	2.8880e-01	0.6117	7.5892e-01	1.9984
8.0710e-04	0.0404	3.1355e-01	0.6488	7.3301e-01	2.1311
8.1139e-04	0.0338	3.3784e-01	0.7857	7.0885e-01	2.0725
8.1258e-04	0.0354	3.6369e-01	0.8409	6.8398e-01	1.9909
8.1406e-04	0.0379	3.8874e-01	0.8912	6.5898e-01	1.9143
8.1427e-04	0.0396	4.1369e-01	0.9373	6.3393e-01	1.8442
8.1374e-04	0.0346	4.3869e-01	0.9860	6.0890e-01	1.7716
8.1391e-04	0.0363	4.6377e-01	1.0148	5.8396e-01	1.6983
8.5794e-04	0.0330	4.8867e-01	1.0618	5.5703e-01	1.7840
9.5007e-04	0.0330	5.1351e-01	1.1105	5.3394e-01	1.7255
1.0586e-03	0.0330	5.3858e-01	1.1542	5.0897e-01	1.6554
1.1642e-03	0.0330	5.6362e-01	1.1929	4.8398e-01	1.5804
2.1586e-03	0.0371	5.8857e-01	1.2341	4.5892e-01	1.5054
3.2274e-03	0.0412	6.1146e-01	1.4518	4.3408e-01	1.4147
4.2810e-03	0.0437	6.3832e-01	1.5194	4.0891e-01	1.3454
5.3287e-03	0.0462	6.6346e-01	1.5705	3.8396e-01	1.2696
6.3987e-03	0.0478	6.8844e-01	1.6158	3.5800e-01	1.2762
7.4037e-03	0.0511	7.1352e-01	1.6603	3.3393e-01	1.2036
8.4627e-03	0.0528	7.3836e-01	1.7098	3.0901e-01	1.1278
9.5148e-03	0.0536	7.6361e-01	1.7345	2.8406e-01	1.0462
1.0488e-02	0.0544	7.8844e-01	1.7667	2.5908e-01	0.9687
3.4417e-02	0.1336	8.1344e-01	1.8013	2.3414e-01	0.8871
3.9605e-02	0.1467	8.3848e-01	1.8335	2.0908e-01	0.8087
4.4585e-02	0.1558	8.6324e-01	1.8862	1.8358e-01	0.7733
5.4522e-02	0.1723	8.8639e-01	2.2036	1.5912e-01	0.6966
6.4306e-02	0.2020	9.1305e-01	2.2737	1.3424e-01	0.6076
7.4418e-02	0.2259	9.3823e-01	2.3248	1.0924e-01	0.5210
8.4415e-02	0.2440	9.6324e-01	2.3833	8.4269e-02	0.4328
8.9428e-02	0.2506	9.8821e-01	2.4369	5.9275e-02	0.3495
9.4409e-02	0.2556	9.9940e-01	2.4798	3.4386e-02	0.2531
1.0434e-01	0.2704	9.5964e-01	2.3487	1.2944e-02	0.1575
1.1433e-01	0.2852	9.3409e-01	2.2679		

Date: 03/25/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-22
Sample Description..... BAG 1 OF 4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 5.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1213 g P/Po Toler... 3 File Name.. AS532201.RAW
Analysis Time... 509.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-25-95 01:43am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1433e-01	0.2852	3.621E+02
1.6381e-01	0.4114	3.810E+02
2.1396e-01	0.4971	4.381E+02
2.6372e-01	0.5746	4.987E+02
3.1355e-01	0.6488	5.633E+02

Area = 2.744E+00 m²/g

Slope = 1.044E+03

Y - Intercept = 2.254E+02

Correlation Coefficient = 0.9861

C = 5.631E+00

Date: 03/25/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-22
Sample Description..... BAG 1 OF 4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1213 g P/Po Toler... 3 File Name.. AS532201.RAW
Analysis Time... 509.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-25-95 01:43am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	2.744E+00	m ² /g
Langmuir Surface Area.....	1.114E+01	m ² /g
Meso Pore Area.....	2.744E+00	m ² /g
* t-Method Micro Pore Area.....	0.000E+00	m ² /g
* MP-Method Micro Pore Area.....	1.310E+02	m ² /g
DR-Method Micro Pore Area.....	2.578E-01	m ² /g
Cumulative Adsorption Surface Area.....	2.081E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	0.000E+00	cc/g
* MP-Method Micro Pore Volume.....	2.770E-02	cc/g

Date: 03/25/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-22
Sample Description..... BAG 1 OF 4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1213 g P/Po Toler... 3 File Name.. AS532201.RAW
Analysis Time... 509.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-25-95 01:43am

Date: 12/23/95

Page 1

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD22A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0163 g P/Po Toler... 3 File Name.. AS581501.RAW
 Analysis Time... 832.5 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 08-16-95 15:57pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
1.2976e-05	0.8957	1.1433e-01	42.1104	9.3407e-01	71.4172
1.4083e-05	1.1902	1.3851e-01	43.2515	9.0583e-01	72.0061
1.6336e-05	6.8896	1.6350e-01	44.3436	8.8362e-01	71.5337
2.4545e-05	10.7485	1.8856e-01	45.3497	8.5891e-01	70.7669
3.4318e-05	13.0920	2.1357e-01	46.3006	8.3398e-01	69.9939
4.5635e-05	14.8221	2.3865e-01	47.1902	8.0907e-01	69.1534
5.5818e-05	15.9632	2.6366e-01	48.0368	7.8412e-01	68.3190
6.6087e-05	16.8037	2.8867e-01	48.8528	7.5908e-01	67.4785
7.5151e-05	17.3558	3.1297e-01	49.9939	7.3405e-01	66.6074
8.4225e-05	18.1779	3.3851e-01	50.9448	7.0913e-01	65.7914
1.5558e-04	20.5153	3.6329e-01	51.7730	6.8288e-01	66.0491
2.5791e-04	22.3190	3.8847e-01	52.5460	6.5890e-01	65.4172
3.6873e-04	23.4356	4.1352e-01	53.3006	6.3403e-01	64.6442
4.7277e-04	24.1840	4.3860e-01	54.0552	6.0915e-01	63.7669
5.7153e-04	24.7423	4.6446e-01	54.8159	5.8434e-01	62.8405
6.7706e-04	25.3129	4.8686e-01	56.2086	5.5946e-01	61.7914
7.8341e-04	25.7301	5.1326e-01	57.2025	5.3438e-01	60.7730
8.6282e-04	26.0061	5.3844e-01	58.0245	5.0930e-01	59.8098
9.5885e-04	26.2945	5.6342e-01	58.8159	4.8423e-01	58.8896
1.9877e-03	28.2883	5.8862e-01	59.5828	4.5764e-01	58.7117
3.0373e-03	29.4172	6.1369e-01	60.3251	4.3387e-01	58.0307
3.9945e-03	30.1840	6.3874e-01	61.0429	4.0916e-01	57.1288
5.0408e-03	30.8896	6.6361e-01	61.8037	3.8419e-01	56.1840
6.2385e-03	31.4908	6.8866e-01	62.5215	3.5925e-01	55.2515
6.9996e-03	31.8773	7.1367e-01	63.2331	3.3426e-01	54.2515
8.1206e-03	32.2883	7.3869e-01	63.9141	3.0935e-01	53.2699
9.1483e-03	32.6135	7.6364e-01	64.6135	2.8433e-01	52.2761
1.0160e-02	32.9693	7.8852e-01	65.3252	2.5941e-01	51.2577
3.2293e-02	36.3681	8.1038e-01	67.4356	2.3448e-01	50.2025
3.9412e-02	37.0920	8.3806e-01	68.4724	2.0950e-01	49.1472
4.4636e-02	37.5337	8.6336e-01	69.2945	1.8458e-01	48.0368
5.4315e-02	38.3190	8.8845e-01	70.0798	1.5963e-01	46.8650
6.4393e-02	39.0184	9.1344e-01	70.8037	1.3426e-01	45.8344
7.4388e-02	39.6442	9.3836e-01	71.6196	1.0975e-01	44.5828
8.4386e-02	40.2270	9.6339e-01	72.3865	8.5026e-02	43.1104
8.9610e-02	40.5521	9.8841e-01	73.1840	6.0303e-02	41.3988
9.4609e-02	40.8712	9.9940e-01	73.8098	3.5710e-02	39.2147
1.0417e-01	41.5644	9.5965e-01	72.2638	1.3499e-02	35.9939

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD22A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0163 g P/Po Toler... 3 File Name.. AS581501.RAW
Analysis Time... 832.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-16-95 15:57pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1433e-01	42.1104	2.453E+00
1.6350e-01	44.3436	3.527E+00
2.1357e-01	46.3006	4.693E+00
2.6366e-01	48.0368	5.964E+00
3.1297e-01	49.9939	7.291E+00

Area = 1.455E+02 m²/g

Slope = 2.435E+01

Y - Intercept = -4.161E-01

Correlation Coefficient = 0.9991

C = -5.752E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD22A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 .Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0163 g P/Po Toler... 3 File Name.. AS581501.RAW
Analysis Time... 832.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-16-95 15:57pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	1.455E+02	m ² /g
Langmuir Surface Area.....	2.972E+02	m ² /g
Meso Pore Area.....	5.993E+01	m ² /g
* t-Method Micro Pore Area.....	8.557E+01	m ² /g
* MP-Method Micro Pore Area.....	7.352E+02	m ² /g
DR-Method Micro Pore Area.....	2.918E+02	m ² /g
Cumulative Adsorption Surface Area.....	3.250E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	3.326E-02	cc/g
* MP-Method Micro Pore Volume.....	2.313E-01	cc/g

Date: 08/16/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD22A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 $\text{\AA}^2$ Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0163 g P/Po Toler... 3 File Name.. AS581501.RAW
Analysis Time... 832.5 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-16-95 15:57pm

Adsorption $D_v(\text{Log } r)$

APPENDIX L
DECS-23
Pittsburgh Seam

Coal Sample Data (Literature)

Code#12 Seam Pittsburgh Seam State PA Rank hV A Sample # DECS-23

Proximate Analysis

	<u>as rec'd</u>	<u>dry</u>	<u>daf</u>
% Moisture	2.00		
% Ash	9.25	9.44	
% Vol. Matter	38.63	39.42	43.53
% Fixed Carbon	50.12	51.14	56.47

Ultimate Analysis

	<u>dry</u>	<u>daf</u>	<u>dmmf (Parr)</u>
% Ash	9.44		
% Carbon	74.21	81.95	84.64
% Hydrogen	5.10	5.63	5.82
% Nitrogen	1.35	1.49	1.54
% Total Sulfur	3.87		
% Oxygen (diff.)	6.03	6.66	8.00
Dry % Chlorine 0.10 Dry % Carbon dioxide 0.12			

Sulfur Forms

	<u>dry</u>	<u>daf</u>
% Pyrite	2.23	
% Sulfate	0.01	
% Organic	1.63	1.80
% Total	3.87	

Maceral Composition

(Corrected for Ash Content)

Vitrinite	71.57
Inertinite	12.68
Liptinite	6.34

Reflectance Data

Vitrinite(%):

Mean-max Ro: 0.73

Atomic Ratios

	<u>mod. Parr</u>
Atomic H/C	0.813
Atomic O/C	0.061

Calorific Value

	<u>dry</u>	<u>as rec'd moist</u>
MM-containing (MJ/kg)	31.664	31.031
Net, dmmf (MJ/kg)	34.322	

Caking and Mechanical Properties

Free-swelling index	7.50
Hardgrove grindability index	-1.00

Gieseler Coal Plastometer

Initial Softening	373.00 °C
Maximum fluidity	428.00 °C

Coal Sample Data (Measured)

Code #12 Seam Pittsburgh

State PA Rank hvAb Sample # DECS-23

Thermogravimetry

He Pyrolysis

Temp. @ 1% Mass Loss (°C)	283
Temp. @ Slope = 45 (°C)	390
Peak Temp (°C)	442
Mass Loss (%)	36.66

HeO₂ Pyrolysis

Temp. @ 1% Mass Loss (°C)	365
Temp. @ Slope = 45 (°C)	405
Peak Temp (°C)	516
Mass Loss (%)	91.30

Particle Size Distribution

Size	Weight %
>35 mesh (>0.5mm)	39.12
35-60 mesh (0.25-0.5mm)	23.56
<60 mesh (<0.25mm)	37.32

FTIR

Peak Intensities:

Aromatics	0.07
Aliphatics	0.21
Aldehydes	0.01
Hydroxyls	0.23

Ratio Aromatics/Aliphatics 0.34

Mercury Porosimetry

Whole Coal (m ² /g)	89.725
>35 Mesh (m ² /g)	43.720
35 to 60 Mesh (m ² /g)	61.488
<60 Mesh (m ² /g)	40.622

Nitrogen Adsorption (BET)

Fresh Coal (m ² /g)	4.086
Activated Coal (m ² /g)	188.30
Calculated Pore Radius (Å)	Intensity
0.17	1.29
0.42	0.62

Mass Spectroscopy (in He)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	571		
15 (CH ₃)	1	555		
18 (H ₂ O)	2	275	-1	720
28 (CO, N ₂)	1	515	-1	
44 (CO ₂)	3	385	510	770

Mass Spectroscopy (in HeO₂)

Mass; Species	No. Peaks	Peak 1 T°C	Peak 2 T°C	Peak 3 T°C
2 (H ₂)	0	-1		
14 (CH ₂ , N)	1	515		
15 (CH ₃)	0	-1		
18 (H ₂ O)	2	385	565	-1
28 (CO, N ₂)	1	570	-1	
44 (CO ₂)	2	-1	570	570

Deviations from "Expected Surface Areas" (m²/g) (Transformed)

Raw BET Values: 56.00 Corrected BET Values: 41.00

**DECS23B PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN PURE HELIUM**

**DECS23C PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR**

DECS23B PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN HELIUM

DECS23C PITTSBURGH
HIGH VOLATILE BITUMINOUS
PYROLYSIS IN ARTIFICIAL AIR

MERCURY INTRUSION PORE ANALYSIS FOR DECS-23

AUTOPORE II 9220 V3.01

PAGE 1

SAMPLE DIRECTORY/NUMBER: DATA1 /192
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-23 BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPP

LP 12:54:07 04/21/95
HP 19:21:09 04/21/95
REP 12:47:17 02/11/96

PENETROMETER NUMBER: 14-0353	ADVANCING CONTACT ANGLE: 130.0 deg
PENETROMETER CONSTANT: 10.79 fL/pF	RECEDING CONTACT ANGLE: 130.0 deg
PENETROMETER WEIGHT: 1.0000 g	MERCURY SURFACE TENSION: 485.0 dyn/cm
STEM VOLUME: 0.3920 mL	MERCURY DENSITY: 13.5335 g/mL
MAXIMUM HEAD PRESSURE: 4.4500 psia	SAMPLE WEIGHT: 0.1308 g
PENETROMETER VOLUME: 3.0000 mL	SAMPLE+PEN+Hg WEIGHT: 1.0000 g

LOW PRESSURE:

EVACUATION PRESSURE: 50 fmHg
EVACUATION TIME: 5 min
MERCURY FILLING PRESSURE: 0.5350 psia
EQUILIBRATION TIME: 60 sec

HIGH PRESSURE:

EQUILIBRATION TIME: 120 sec

INTRUSION DATA SUMMARY

TOTAL INTRUSION VOLUME =	0.7258 mL/g
TOTAL PORE AREA =	89.725 sq-m/g
MEDIAN PORE DIAMETER (VOLUME) =	22.8941 fm
MEDIAN PORE DIAMETER (AREA) =	0.0046 fm
AVERAGE PORE DIAMETER (4V/A) =	0.0324 fm
STEM VOLUME USED =	24 % ****

SAMPLE DIRECTORY/NUMBER: DATA1 /192
OPERATOR: CARLA R. SPARKS
SAMPLE ID: DECS-23 BAG 1 OF 4 WHOLE
SUBMITTER: OTTO KOPF

LP 12:54:07 04/21/95
HP 19:21:09 04/21/95
REP 12:47:17 02/11/96

CUMULATIVE INTRUSION vs DIAMETER
+ intrusion, * extrusion

Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-23 WHOLE
 Sample Description..... BAG 1 OF 4
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.1129 g P/Po Toler... 3 File Name.. AS532801.RAW
 Analysis Time... 512.6 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 03-29-95 08:62am

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
3.3051e-04	0.0514	1.1445e-01	0.3543	9.3425e-01	2.8698
5.6532e-04	0.0549	1.3866e-01	0.4526	9.0920e-01	2.7741
6.8885e-04	0.0549	1.6394e-01	0.5155	8.8427e-01	2.6608
7.4943e-04	0.0549	1.8891e-01	0.5731	8.5776e-01	2.8769
7.7975e-04	0.0540	2.1390e-01	0.6271	8.3401e-01	2.8007
7.9368e-04	0.0540	2.3862e-01	0.6794	8.0903e-01	2.7192
8.0134e-04	0.0531	2.6373e-01	0.7272	7.8412e-01	2.6315
8.0464e-04	0.0478	2.8879e-01	0.7653	7.5918e-01	2.5350
8.0603e-04	0.0469	3.1247e-01	0.8964	7.3418e-01	2.4482
8.0523e-04	0.0523	3.3830e-01	0.9973	7.0921e-01	2.3472
8.0573e-04	0.0487	3.6378e-01	1.0620	6.8150e-01	2.4827
8.0661e-04	0.0514	3.8886e-01	1.1187	6.5895e-01	2.4234
8.0733e-04	0.0461	4.1373e-01	1.1842	6.3414e-01	2.3410
8.0682e-04	0.0496	4.3880e-01	1.2400	6.0913e-01	2.2471
8.0672e-04	0.0505	4.6373e-01	1.3003	5.8416e-01	2.1568
8.5281e-04	0.0461	4.8882e-01	1.3614	5.5924e-01	2.0593
9.5229e-04	0.0461	5.1382e-01	1.4048	5.3422e-01	1.9655
1.0533e-03	0.0469	5.3869e-01	1.4641	5.0920e-01	1.8760
1.1566e-03	0.0469	5.6374e-01	1.5093	4.8420e-01	1.7812
2.1306e-03	0.0540	5.8873e-01	1.5527	4.5842e-01	1.8388
3.2059e-03	0.0593	6.1370e-01	1.5961	4.3416e-01	1.7547
4.2658e-03	0.0629	6.3609e-01	1.8601	4.0911e-01	1.6678
5.3196e-03	0.0655	6.6349e-01	1.9318	3.8418e-01	1.5757
6.3666e-03	0.0700	6.8832e-01	2.0142	3.5917e-01	1.4863
7.4231e-03	0.0735	7.1345e-01	2.0815	3.3424e-01	1.3880
8.4644e-03	0.0753	7.3846e-01	2.1479	3.0929e-01	1.2958
9.5183e-03	0.0779	7.6355e-01	2.2011	2.8431e-01	1.1993
1.0493e-02	0.0788	7.8849e-01	2.2578	2.5883e-01	1.1470
3.4533e-02	0.1701	8.1357e-01	2.3047	2.3420e-01	1.0912
3.9771e-02	0.1789	8.3864e-01	2.3428	2.0937e-01	0.9956
4.4611e-02	0.2028	8.6344e-01	2.4004	1.8441e-01	0.8946
5.4659e-02	0.2338	8.8837e-01	2.4570	1.5947e-01	0.7945
6.4600e-02	0.2586	9.0998e-01	2.8060	1.3450e-01	0.6944
7.4592e-02	0.2826	9.3803e-01	2.8973	1.0957e-01	0.5899
8.4582e-02	0.3065	9.6316e-01	2.9841	8.4575e-02	0.4863
8.9592e-02	0.3153	9.8818e-01	3.0611	5.9657e-02	0.3818
9.4572e-02	0.3233	9.9940e-01	3.1320	3.4712e-02	0.2675
1.0450e-01	0.3366	9.5982e-01	2.9663	1.3180e-02	0.1532

Date: 03/29/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-23 WHOLE
Sample Description..... BAG 1 OF 4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1129 g P/Po Toler... 3 File Name.. AS532801.RAW
Analysis Time... 512.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-29-95 08:62am

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1445e-01	0.3543	2.919E+02
1.6394e-01	0.5155	3.044E+02
2.1390e-01	0.6271	3.472E+02
2.6373e-01	0.7272	3.941E+02
3.1247e-01	0.8964	4.057E+02

Area = 4.086E+00 m²/g

Slope = 6.405E+02

Y - Intercept = 2.118E+02

Correlation Coefficient = 0.9797

C = 4.024E+00

Date: 03/29/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-23 WHOLE
Sample Description..... BAG 1 OF 4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1129 g P/Po Toler... 3 File Name.. AS532801.RAW
Analysis Time... 512.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-29-95 08:62am

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	4.086E+00	m ² /g
Langmuir Surface Area.....	1.338E+01	m ² /g
Meso Pore Area.....	3.416E+00	m ² /g
* t-Method Micro Pore Area.....	6.700E-01	m ² /g
* MP-Method Micro Pore Area.....	1.366E+02	m ² /g
DR-Method Micro Pore Area.....	4.044E-01	m ² /g
Cumulative Adsorption Surface Area.....	2.546E+00	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	-5.182E-04	cc/g
* MP-Method Micro Pore Volume.....	2.888E-02	cc/g

Date: 03/29/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... DECS-23 WHOLE
Sample Description..... BAG 1 OF 4
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.1129 g P/Po Toler... 3 File Name.. AS532801.RAW
Analysis Time... 512.6 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 03-29-95 08:62am

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD23A
 Sample Description..... ACTIVATED COAL RESIDUE
 Comments.....
 Gas Type..... Nitrogen
 Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
 Sample Weight... 0.0160 g P/Po Toler... 3 File Name.. AS581802.RAW
 Analysis Time... 947.2 min Equil Time... 2 Operator...
 Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
 End of Run..... 08-21-95 04:40pm

ISOTHERM

P/Po	Volume cc/g STP	P/Po	Volume cc/g STP	P/Po	Volume cc/g STP
8.7033e-06	4.7250	1.1412e-01	55.0562	9.3387e-01	91.3312
9.7392e-06	5.0375	1.3809e-01	56.4750	9.0897e-01	90.4375
1.5176e-05	13.1812	1.6335e-01	57.7875	8.8410e-01	89.4750
2.4490e-05	18.4375	1.8850e-01	58.9625	8.5904e-01	88.5437
3.4243e-05	20.8813	2.1353e-01	60.0875	8.3415e-01	87.5812
4.4286e-05	23.2937	2.3853e-01	61.1625	8.0721e-01	87.5375
5.5710e-05	24.7812	2.6301e-01	62.5687	7.8374e-01	86.8937
6.4726e-05	25.6562	2.8844e-01	63.7937	7.5905e-01	85.9687
7.5045e-05	26.8125	3.1356e-01	64.8438	7.3411e-01	84.9937
8.4092e-05	27.3875	3.3860e-01	65.8500	7.0907e-01	84.0687
1.5803e-04	30.3625	3.6329e-01	66.8000	6.8410e-01	83.1125
2.5883e-04	32.2562	3.8841e-01	67.7625	6.5916e-01	82.1250
3.5919e-04	33.4375	4.1351e-01	68.7312	6.3250e-01	81.9187
4.6355e-04	34.4437	4.3936e-01	69.6500	6.0879e-01	81.2187
5.7649e-04	35.2062	4.6254e-01	71.3187	5.8414e-01	80.2500
6.5851e-04	35.6625	4.8832e-01	72.3687	5.5929e-01	79.1687
7.7918e-04	36.2687	5.1346e-01	73.3625	5.3426e-01	78.0812
8.9057e-04	36.7125	5.3846e-01	74.3125	5.0924e-01	76.9937
9.7274e-04	37.0062	5.6349e-01	75.2750	4.8423e-01	75.9250
2.0210e-03	39.3187	5.8845e-01	76.2125	4.5926e-01	74.8688
3.0478e-03	40.7062	6.1344e-01	77.1437	4.3431e-01	73.8187
4.0720e-03	41.7125	6.3847e-01	78.0500	4.0893e-01	72.9313
5.0343e-03	42.4312	6.6344e-01	78.9250	3.8381e-01	72.2750
6.1409e-03	43.1000	6.8847e-01	79.8063	3.5919e-01	71.2625
7.2330e-03	43.7500	7.1341e-01	80.6750	3.3433e-01	70.1625
8.0532e-03	44.1562	7.3846e-01	81.5312	3.0939e-01	69.0562
9.1266e-03	44.5875	7.6195e-01	83.3438	2.8444e-01	67.8812
1.0193e-02	44.9750	7.8789e-01	84.5125	2.5953e-01	66.7000
3.1557e-02	48.5812	8.1324e-01	85.5000	2.3451e-01	65.5125
3.8766e-02	49.4750	8.3821e-01	86.4250	2.0957e-01	64.3125
4.4063e-02	50.0687	8.6327e-01	87.3375	1.8462e-01	63.0312
5.3826e-02	50.9187	8.8827e-01	88.2250	1.5974e-01	61.6812
6.3885e-02	51.7187	9.1328e-01	89.1312	1.3451e-01	60.4250
7.3968e-02	52.4812	9.3826e-01	90.0062	1.0982e-01	58.9875
8.4001e-02	53.1687	9.6324e-01	90.8250	8.5033e-02	57.3312
8.9273e-02	53.5500	9.8814e-01	91.7562	6.0268e-02	55.4125
9.4298e-02	53.8875	9.9940e-01	92.9062	3.5695e-02	53.0125
1.0411e-01	54.4875	9.5894e-01	92.1062	1.4122e-02	49.5437

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD23A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 Å² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0160 g P/Po Toler... 3 File Name.. AS581802.RAW
Analysis Time... 947.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-21-95 04:40pm

MULTI-POINT BET

P/Po	Volume cc/g STP	1/[W((Po/P)-1)]
1.1412e-01	55.0562	1.872E+00
1.6335e-01	57.7875	2.703E+00
2.1353e-01	60.0875	3.615E+00
2.6301e-01	62.5687	4.564E+00
3.1356e-01	64.8438	5.636E+00

Area = 1.883E+02 m²/g

Slope = 1.884E+01

Y - Intercept = -3.435E-01

Correlation Coefficient = 0.9990

C = -5.383E+01

Date: 12/23/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD23A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A² Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0160 g P/Po Toler... 3 File Name.. AS581802.RAW
Analysis Time... 947.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-21-95 04:40pm

AREA-VOLUME-PORE SIZE SUMMARY

SURFACE AREA DATA

Multi-Point BET.....	1.883E+02	m ² /g
Langmuir Surface Area.....	3.762E+02	m ² /g
Meso Pore Area.....	7.090E+01	m ² /g
* t-Method Micro Pore Area.....	1.174E+02	m ² /g
* MP-Method Micro Pore Area.....	5.949E+02	m ² /g
DR-Method Micro Pore Area.....	3.119E+02	m ² /g
Cumulative Adsorption Surface Area.....	3.972E+01	m ² /g
Cumulative Desorption Surface Area.....	-6.923E+15	m ² /g

PORE VOLUME DATA

* t-Method Micro Pore Volume.....	4.813E-02	cc/g
* MP-Method Micro Pore Volume.....	2.334E-01	cc/g

Date: 08/21/95

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Quantachrome Corporation
Quantachrome Autosorb Automated Gas Sorption System Report
Micropore Version 2.42

Sample ID..... ACTD23A
Sample Description..... ACTIVATED COAL RESIDUE
Comments.....
Gas Type..... Nitrogen
Cross-Sec Area.. 16.2 A' Corr Factor.. 6.580E-05 Molec Wgt.. 28.0134
Sample Weight... 0.0160 g P/Po Toler... 3 File Name.. AS581802.RAW
Analysis Time... 947.2 min Equil Time... 2 Operator...
Outgas Time..... 0.0 hrs Outgas Temp.. 0 °C Station #.. 1
End of Run..... 08-21-95 04:40pm

Adsorption Dv(Loz r)