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THE EFFECTS OF MINERALS ON COAL BENEFICIATION PROCESSES

Quarterly Report No. 9 for Period October 1—December 31, 1979

By
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Richard B. Muter
William H. Buttermore
William C. Grady
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David Durham

September 15, 1980

Work Performed Under Contract No. AC22-77ET10559

West Virginia University
College of Mineral and Energy Resources
Morgantown, West Virginia

U. S. DEPARTMENT OF ENERGY

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September 15, 1980

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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OBJECTIVE AND SCOPE

The purpose of this research program is to examine the effect of coal cleaning and preparation on the distribution of mineral materials in coal and the influence of the mineral materials on the coal cleaning operation. The research program will involve the examination of, for coal mineral materials: (1) the natural occurrence and distribution of mineral materials in run-of-mine coal, (2) the changes in these characteristics during cleaning and preparation, (3) the specific effects of coal mineral materials on individual cleaning and preparation processes, and (4) improved methods for controlling their distribution.

In order to accomplish these objectives, samples will be obtained from three commercial coal preparation plants which are: (1) handling coal from major (by volume) coal seams, (2) handling coal most likely to be used in future large scale coal conversion processes (for example, the Bi-Gas process), and (3) using a range of different types of modern cleaning methods. At least one of these plants shall process a coal likely to be used as a feed to a D.O.E.-supported conversion process or similar to a type of coal likely to be used.

SUMMARY OF PROGRESS TO DATE

With the completion of this quarter's work, unit operation pilot scale tests have been completed for froth flotation, tabling and jigging cleaning operations. An assessment and chemical/mineralogical data for these tests are reported herein. Tests for the heavy media cyclone and WEMCO HMS unit are on-going and will be reported in the next quarter.

Also completed during the report period was an in-depth petrographic analysis of the Pocahontas No. 3 coal. Coal macerals by size and gravity were determined as volume percent of the whole coal and are contained in this report. This leaves only the Illinois No. 6 samples for detailed maceral analysis vs. screen/gravity fractions.

Accumulation of XRPD data for coal minerals with Pocahontas No. 3 was continued based on the methodology presented in Quarterly Report No. 8. Standardization equations were developed for the Pocahontas No. 3 and Illinois No. 6 samples and mineralogical trends for these coals and the Pittsburgh seam samples were determined.

DESCRIPTION OF TECHNICAL PROGRESS

Coal Preparation Pilot Plant

Progress in preparation unit tests was achieved during this quarter in froth flotation, tabling and jig pilot scale tests. Coal feeds to these unit operations were prepared to be representative of current practice. A review of this work follows.

Summary of Froth Flotation Work and Recommendations

Data from the flotation tests performed on the Pittsburgh, Pocahontas No. 3, and Illinois No. 6 samples (-50 mesh) suggest that conventional froth flotation can be used to recover a significant amount of the fine-coal plant feed that would be of acceptable quality when compared to the products of the respective preparation plants (see Table 1). The flotation products from the Pittsburgh and Illinois No. 6 seams were both slightly inferior overall to their corresponding cleaning plant outputs, while the Pocahontas No. 3 flotation product was slightly superior overall to the cleaning plant product. It should be noted that the quality of coal in the plant feeds finer than 50 mesh was less than 10 percent. These data were based on dry screening analyses and in all probability the amount of -50 mesh material present in a water cleaning plant would be closer to 10 percent due to both wet screening and mechanical particle degradation inherent in coal cleaning.

Table 2 shows product tonnage and value informaton for froth flotation of the -50 mesh Pittsburgh, Pocahontas No. 3, and Illinois No. 6 coals based on the assumption that 10 percent of the 1000 tons per day plant feed would be finer than 50 mesh. As can be seen in the table, tonnage figures on an annual and 20 year operating life basis represent substantial amounts of fine coal product. The final decision on whether to add flotation to a cleaning circuit;

however, must be based on a variety of factors. The Pocahontas No. 3 sample was being cleaned by flotation at the time of the study and certainly the exceptional value of this high quality metallurgical coal would offset the capital and operating costs of flotation and ancillary operations. The Pittsburgh sample, because of its higher sulfur, would probably be a marginal coal from the viewpoint of economic flotation. Froth flotation for the Illinois No. 6 sample would be an economically doubtful proposition. The higher reagent consumption, the refractory nature of the coal, and lower product value would be inhibitory. Problems would also be expected from the vast amount of clay fines in the Illinois No. 6 coal with respect to their effects on the performance of the flotation cells. The value of the Illinois No. 6 flotation product would probably not offset the costs of flotation, filtration, thermal drying, and materials handling systems for this coal.

Table 1

Comparison of Plant Products with Froth Flotation Products*

	% of Feed Coal 50m	Flotation Yield	Ash %	Sulfur %	BTU
Pittsburgh Seam	6%	-	-	-	-
Plant Product	-	-	8.0	2.70	14,020
Flotation Product	-	75%	8.6	2.85	13,776
Pocahontas #3 Seam	2%	-	-	-	-
Plant Product	-	-	7.0	0.66	14,701
Flotation Product	-	82%	6.5	0.67	14,765
Illinois #6 Seam	4%	-	-	-	-
Plant Product	-	-	12.7	4.42	12,434
Flotation Product	-	61%	13.3	3.49	12,239

*Ash, Sulfur, BTU reported on a dry basis

Table 2

Estimate of Tonnage and Product Value for a 1000 Ton Per Day
Preparation Plant with 10 Percent of the Feed - 50 m

	Tons Per Day	Tons Per Year[1]	20 Year Tonnage	20 Year Value
Pittsburgh Flotation Product	75	18,750	375,000	$ 9,375,000[2]
Pocahontas #3 Flotation Product	82	20,500	410,000	$18,450,000[3]
Illinois #6 Flotation Product	61	15,250	305,000	$ 4,575,000[4]

1) based on 250 working days per year
2) at $25 per ton
3) at $45 per ton
4) at $15 per ton

Table 3

Mineral weight percent values of the feed coals and yields of the froth flotation tests.

	LOW TEMPERATURE ASH wt.%	ILLITE wt.%[1]	KAOLINITE wt.%	QUARTZ wt.%	CALCITE wt.%	DOLOMITE wt.%	SIDERITE wt.%[2]	PYRITE wt.%	FELDSPAR %nc[3]	MUSCOVITE %nc	APATITE %nc	BASSANITE %nc
PITTSBURGH COAL -- District 3												
Feed Coal (-50 mesh)	22.3	28	10	17	25	9	--	11	0	--	0	0
Froth Flotation Product Material	10.7	10	18	17	15	6	--	34	0	--	0	0
Froth Flotation Refuse Material	60.5	32	9	17	28	10	--	4	0	--	0	0
POCAHONTAS NO.3 COAL -- District 7												
Feed Coal (-50 mesh)	16.7	83	24	24	9	--	2	1	0	0	--	1
Froth Flotation Product Material	7.9	57	28	26	7	--	3	4	0	0	--	0
Froth Flotation Refuse Material	55.2	86	22	22	12	--	1	0	0	0	--	2
ILLINOIS NO.6 COAL -- District 10												
Feed Coal (-50 mesh)	37.6	29	14	24	7	--	--	12	--	--	--	--
Froth Flotation Product Material	18.5	37	16	23	6	--	--	17	--	--	--	--
Froth Flotation Refuse Material	65.6	25	13	25	9	--	--	6	--	--	--	--

1 *Mineral values are expressed as weight percent of the low temperature ash.*
2 *The symbol "--" indicates that the mineral was not present in that coal.*
3 *Standard curves were not available for some minerals. These were assigned relative values representing the mineral's contribution to the total X-ray count (percent of net counts).*

Table 4

Mineral values expressed as pounds per short ton of feed coal for the froth flotation tests.

	COAL REPORTING	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	DOLOMITE	SIDERITE	PYRITE	FELDSPAR	MUSCOVITE	APATITE	BASSANITE
	lb	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*
PITTSBURGH COAL													
Feed Coal[1]	2000	446	125	45	76	112	40	--[4]	49	0	--	0	0
Froth Flotation Product[2]	1500	160	16	29	27	24	10	--	55	0	--	0	0
Froth Flotation Refuse[3]	500	302	97	27	51	85	30	--	12	0	--	0	0
POCAHONTAS NO.3 COAL													
Feed Coal	2000	334	227	66	66	25	--	6	3	0	0	--	3
Froth Flotation Product	1640	130	74	36	34	9	--	4	5	0	0	--	0
Froth Flotation Refuse	360	199	171	44	44	24	--	2	0	0	0	--	4
ILLINOIS NO.6 COAL													
Feed Coal	2000	752	218	105	180	53	--	--	90	--	--	--	--
Froth Flotation Product	1220	226	84	36	52	14	--	--	38	--	--	--	--
Froth Flotation Refuse	780	512	128	67	128	46	--	--	31	--	--	--	--

[1] *Mineral values are expressed as pounds of the mineral in one short ton of feed coal.*

[2] *Mineral values are expressed as pounds of the mineral reporting with the cleaned coal resulting from cleaning one short ton of feed coal.*

[3] *Mineral values are expressed as pounds of the mineral reporting with the refuse resulting from cleaning one short ton of feed coal.*

[4] *The symbol "--" indicates that the mineral was not present in that coal.*

Mineral abundances in the froth flotation feed coal, product coal, and refuse were determined using X-ray powder diffraction (XRPD) analysis. These abundances are reported on a weight percent of the low temperature ash (LTA) basis in Table 3. These same data were recalculated to pounds of the mineral present in a ton of coal, and presented in Table 4. In that table the feed coal data were converted to pounds of mineral matter and the individual minerals present in one short ton of -50 mesh coal. The product and refuse values were proportioned based upon the yields of the tests as shown in the "coal reported" column. Mineral weights were calculated as if one short ton of coal had been processed.

Mineral abundance trends observed in the float-sink tests of these coals, and reported later in this report, were also evident in the froth flotation tests. Because of the inherent errors of the XRPD technique (as reflected in Table 7 of Report No. 8 and Table 16 of this report), care should be exercised in the interpretation of Tables 3 and 4 and other XRPD data in this report. In regard to the trends, illite reported to the refuse, while kaolinite was greatest in the LTA's of the cleaned coal. Quartz was ubiquitous and occurred in similar abundances in the LTA's of the product and the refuse. Calcite was previously reported to be abnormally concentrated in the fines of the Pittsburgh coal, and Table 3 reflects this. Calcite was also concentrated in the flotation refuse of these coals. The concentration of pyrite in the flotation product is an enigma in these coals, and may indicate a complex pyrite-maceral or pyrite-mineral association. The sulfur forms data, however, indicate higher pyrite concentrations in the flotation refuse than the product. All of the above mineral trends, except for pyrite, were observed in the float-sink tests of the +100 mesh fraction of the whole coal as discussed in the Mineralogical Characterization section of this report.

Mineral abundances in the feed coal, product coal, and refuse were determined independently. Summing the product and refuse values in Table 4 indicate good agreement with the feed coal values. Mineral matter values sum with a difference of less than 5% from the feed coal indicating that the variations in the summations of individual minerals result from errors in the XRPD technique, and not through experimental error in the flotation tests.

Cleaning Table Tests

In order to simulate table cleaning of the Illinois No. 6, Pittsburgh, and Pocahontas No. 3 seam coals, batch feeds were mixer agitated and fed across a pilot scale 36" x 24" Deister Table. All samples were 2:1 water/coal slurries fed into a box hopper which provided a constant feed rate to the table. Feedstock size in each test was 3/16" x 100 M, and products were collected and analyzed as reported in Tables 5 and 6. (Preliminary checks had been performed to ensure the table was cleaning properly using ash, sulfur and BTU analyses.)

Table 5 data includes yield, proximate analysis, and total sulfur for each of the samples being studied. Table 7 is included to enable general comparisons of the commercially-derived samples (plant feed vs total clean coal) with the pilot-plant derived data. It is important to remember that Table 7 data represents the full size range of coal processed in each plant as compared to the 3/16" x 100 m size range treated on the table, and is included for general comparison purposes only.

Mineral abundances in the Deister Table feed coal, product coal, and refuse were determined using XRPD. The actual 3/16 inch x 100 mesh feed coal to the table could not be sampled due to sample restrictions. Therefore, the XRPD analyses of the 1/4 inch x 8 mesh, 8 mesh x 28 mesh, and 28 mesh x 100 mesh float-sink fractions were mathematically recombined to establish the mineral abundances in the feed coal. The 1/4 inch x 100 mesh fraction should closely approximate the 3/16 x 100 mesh feed coal. Table 8 presents the mineral abundances as weight percents of the LTA, and in Table 9 these values are presented as pounds of mineral per short ton of feed coal in the same manner as the froth flotation samples.

Mineral abundance trends are indicated by the Deister Table product and refuse samples, and are somewhat different from trends indicated by the float-sink and flotation tests. Illite is moderately concentrated in the

Table 5

PILOT PLANT STUDY

ANALYSIS OF DEISTER TABLE SEPARATION TESTS
3/16" x 100 M FEED COALS

Seam/Sample	Yield (%)	Moisture (%)	Ash (%)[1]	Volatile Matter (%)[1]	Fixed Carbon (%)[1]	BTU[1]	Total Sulfur (%)[1]
Pittsburgh/ Table Feed*	----	---	11.1	37.2	51.7	13,482	2.9
Pittsburgh/ Table Product	85.3	---	5.9	39.1	55.0	14,396	2.3
Pittsburgh/ Table Refuse	14.7	---	41.3	26.3	32.4	8,176	6.4
Pocahontas No. 3/ Table Feed*	----	---	13.0	16.4	70.6	13,538	0.6
Pocahontas No. 3/ Table Product	85.8	---	4.3	17.5	78.2	15,099	0.6
Pocahontas No. 3/ Table Refuse	14.2	---	65.4	10.0	24.6	4,106	0.5
Illinois No. 6/ Table Feed*	----	---	16.7	29.4	53.9	11,468	4.9
Illinois No. 6/ Table Product	86.7	---	9.2	32.3	58.5	12,701	3.9
Illinois No. 6/ Table Refuse	13.3	---	65.6	10.6	23.8	3,430	11.6

[1]Dry Basis.
*Recalculated from products.

Table 6

PILOT PLANT STUDY

SULFUR ANALYSIS[1] OF DEISTER TABLE TESTS
3/16" x 100 M FEED COALS

Seam Sample	Yield (%)	Total Sulfur	Sulfate Sulfur	Pyritic Sulfur	Total Inorganic Sulfur	Organic Sulfur
Pittsburgh/ Table Feed*	----	2.93	0.03	1.42	1.45	1.48
Pittsburgh/ Table Product	85.3	2.33	0.02	0.72	0.74	1.59
Pittsburgh/ Table Refuse	14.7	6.38	0.12	5.48	5.60	0.78
Pocahontas No. 3/ Table Feed*	---	0.61	0.01	0.10	0.11	0.50
Pocahontas No. 3/ Table Product	85.8	0.63	0.01	0.06	0.07	0.56
Pocahontas No. 3/ Table Refuse	14.2	0.48	0.02	0.35	0.37	0.11
Illinois No. 6/ Table Feed*	-----	4.91	0.26	2.12	2.38	2.53
Illinois No. 6/ Table Product	86.7	3.89	0.21	0.83	1.04	2.85
Illinois No. 6/ Table Refuse	13.3	11.59	0.62	10.51	11.13	0.46

Table 7

REFERENCE DATA
FROM COMMERCIAL PREPARATION PLANTS[1]

Seam/Sample	Moisture	Ash	Volatile Matter	Fixed Carbon	BTU	Total Sulfur
Pittsburgh/ Plant Feed	1.0	13.9	36.5	50.4	13,102	3.01
Pittsburgh/ Plant Product	1.2	8.0	39.5	52.5	14,020	2.70
Pocahontas No. 3/ Plant Feed	1.2	35.0	14.1	50.9	9,949	0.50
Pocahontas No. 3/ Plant Product	0.9	7.0	17.7	75.3	14,701	0.66
Illinois No. 6/ Plant Feed	7.9	28.1	34.9	37.0	10,044	5.10
Illinois No. 6/ Plant Product	8.1	12.7	41.7	45.6	12,434	4.42

[1] Percent, Dry Basis.

refuse for the Pittsburgh and Pocahontas No. 3 3/16 x 100 mesh feed coals, but the refuse from the Illinois No. 6 coal is very low in illite. This is caused by the tendency of the illite in the Illinois No. 6 coal to disintegrate in water producing submicron particles which exit with the wash water. Table 9 shows a deficit of over 70% of the illite. Kaolinite is moderately concentrated in the product, except in the Pocahontas No. 3 samples. In the Pittsburgh and Illinois No. 6 coals the kaolinite is contained within vitrinite, and reports to the product. In the Pocahontas No. 3 sample a great deal of roof and floor rock is included which contains about one half of the total kaolinite in the coal, and this kaolinite reports to the refuse. The flotation tests did not show this tendency because very little of the rock is -50 mesh in size. Quartz reports much differently in the 3/16 x 100 mesh coal than in the -50 mesh. In the Pittsburgh coal quartz is evenly distributed between the cleaned coal material and the refuse. In the Pocahontas No. 3 coal quartz is dominantly enclosed in the roof and floor rock and reports to the refuse. In the Illinois No. 6 coal quartz is disseminated in the coal material, and reports mainly to the product. Calcite reports to the refuse in these three coals tested. Pyrite is largely disseminated in the 3/16 inch x 100 mesh coal, and therefore reports to the product and refuse.

Differences between the feed coal and the sums of the product and refuse in Table 9 are greater for these tests than the flotation tests. This was to be expected because the analyses of the feed coals were calculated from fifteen individual analyses of float-sink fractions.

Table 8

Mineral weight percent values of the feed coals and yields of the Deister Table tests.

	LOW TEMPERATURE ASH wt.%	ILLITE wt.%[1]	KAOLINITE wt.%	QUARTZ wt.%	CALCITE wt.%	DOLOMITE wt.%	SIDERITE wt.%[2]	PYRITE wt.%	FELDSPAR %nc[3]	MUSCOVITE %nc	APATITE %nc	BASSANITE %nc
PITTSBURGH COAL -- District 3												
Feed Coal (¼ inch X 100 mesh)[4]	13.0	27	17	17	8	3	--	22	1	--	1	2
Deister Table Product Material	7.4	13	27	17	10	5	--	24	0	--	0	0
Deister Table Refuse Material	49.0	19	11	18	17	5	--	27	0	--	0	0
POCAHONTAS NO.3 COAL -- District 7												
Feed Coal (¼ inch X 100 mesh)	12.9	27	26	27	4	--	3	2	5	6	--	3
Deister Table Product Material	4.8	29	36	16	5	--	5	2	8	0	--	0
Deister Table Refuse Material	71.0	29	21	37	5	--	1	0	2	0	--	0
ILLINOIS NO.6 COAL -- District 10												
Feed Coal (¼ inch X 100 mesh)	26.3	34	12	22	10	--	--	15	--	--	--	--
Deister Table Product Material	12.1	22	15	24	5	--	--	18	--	--	--	--
Deister Table Refuse Material	78.0	3	7	15	27	--	--	22	--	--	--	--

1 *Mineral values are expressed as weight percent of the low temperature ash.*
2 *The symbol "--" indicates that the mineral was not present in that coal.*
3 *Standard curves were not avaiable for some minerals. These were assigned relative values representing the mineral's contribution to the total X-ray count (percent of net counts).*
4 *The Deister Table feed coal was actually 3/16 inch X 100 mesh, but these were not sampled. The feed coal analyses were calculated from the ¼ inch X 100 mesh float-sink fractions.*

Table 9

Mineral values expressed as pounds per short ton of feed coal for the Deister Table pilot plant tests.

	COAL REPORTING	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	DOLOMITE	SIDERITE	PYRITE	FELDSPAR	MUSCOVITE	APATITE	BASSANITE
	lb	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*
PITTSBURGH COAL													
Feed Coal[1]	2000	260	70	44	44	21	8	--[4]	57	3	--	3	5
Deister Table Product[2]	1706	126	16	34	21	13	6	--	30	0	--	0	0
Deister Table Refuse[3]	294	144	27	16	26	24	7	--	39	0	--	0	0
POCAHONTAS NO.3 COAL													
Feed Coal	2000	258	70	67	70	10	--	8	5	13	15	--	8
Deister Table Product	1716	82	24	30	13	4	--	4	2	7	0	--	0
Deister Table Refuse	284	202	58	42	75	10	--	2	0	4	0	--	0
ILLINOIS NO.6 COAL													
Feed Coal	2000	526	179	63	116	53	--	--	79	--	--	--	--
Deister Table Product	1734	210	46	31	50	10	--	--	38	--	--	--	--
Deister Table Refuse	266	207	6	15	31	56	--	--	46	--	--	--	--

[1] *Mineral values are expressed as pounds of the mineral in one short ton of feed coal.*
[2] *Mineral values are expressed as pounds of the mineral reporting with the cleaned coal resulting from cleaning one short ton of feed coal.*
[3] *Mineral values are expressed as pounds of the mineral reporting with the refuse resulting from cleaning one short ton of feed coal.*
[4] *The symbol "--" indicates that the mineral was not present in that coal.*

Jig Cleaning Tests

Pilot-scale jig cleaning tests were performed for each coal using a McNally-Pittsburg "Baum" type jig. Feed size to the jig was 1" x 3/16" coal sized from the commercial cleaning-plant beltline feedstock. Preliminary testing of the jig had demonstrated the unit was functioning properly when the sample was allowed sufficient time for the refuse bed to form. Large amounts of coarse-sized feed for this test were precluded to sampling so that only a moderate quantity of coal was available for jigging in pilot scale. As with the tabling tests, this required a batch feed rather than a continuous feed.

Coal was fed to the jig which was operated in normal fashion for approximately 8 minutes, and the clean coal was collected as it came off the unit, dried, and analyzed (see Tables 10 and 11). The entire bed was also collected, dried, and analyzed. It should be noted that because of the test sample constraints, the refuse bed never became thick enough to remove all of the clean coal fraction. Therefore, this test is more representative of jigging at a lower gravity than industry would normally use. As a result, the clean coal is a cleaner fraction than would be expected, and the refuse contains more middlings than would be profitable in a commercial preparation plant.

Mineral abundances in the Baum Jig feed coal, product coal, and refuse were determined using XRPD. The actual 1 inch x 3/16 inch feed coal to the jig could not be sampled due to sample restrictions. Therefore, the XRPD analyses of the 1 inch x 1/4 inch float-sink fractions were mathematically recombined to approximate the analyses of the feed coals. Table 12 presents the mineral abundances as weight percents of the LTA, and in Table 13 these values are presented as pounds of mineral per short ton of feed coal in the same manner as the froth flotation samples.

Mineral abundance trends observed by jig cleaning are the same as those produced by the Deister table even though a larger coal size was cleaned, and a different process was used.

Table 10

PILOT PLANT STUDY

ANALYSIS OF MCNALLY PITTSBURG BAUM JIG TESTS
1" x 3/16" FEED COALS

Seam/Sample	Yield (%)	Moisture (%)	Ash (%)[1]	Volatile Matter (%)[1]	Fixed Carbon (%)[1]	BTU[1]	Total Sulfur (%)[1]
Pittsburgh/ Jig Feed*	----	---	13.3	37.3	49.4	13,201	3.02
Pittsburgh/ Jig Product	70.9	---	7.7	39.3	53.0	14,148	2.45
Pittsburgh/ Jig Bed	29.1	---	27.0	32.5	40.5	10,891	4.40
Pocahontas No. 3/ Jig Feed*	----	---	39.0	12.7	48.3	9,024	0.42
Pocahontas No. 3/ Jig Product	48.4	---	6.1	16.6	77.3	14,784	0.55
Pocahontas No. 3/ Jig Bed	51.6	---	69.9	9.0	21.1	3,621	0.29
Illinois No. 6/ Jig Feed*	----	---	18.2	38.1	43.8	11,335	4.95
Illinois No. 6/ Jig Product	63.1	---	8.5	42.7	48.8	12,893	3.80
Illinois No. 6/ Jig Bed	36.9	---	34.8	30.0	35.2	8,672	6.92

[1] Dry Basis.
*Recalculated from products.

Table 11

PILOT PLANT STUDY

SULFUR ANALYSIS[1] OF MCNALLY PITTSBURG BAUM JIG TESTS
1" x 3/16" FEED COALS

Seam/Sample	Yield (%)	Total Sulfur	Sulfate Sulfur	Pyritic Sulfur	Total Inorganic Sulfur	Organic Sulfur
Pittsburgh/ Jig Feed	----	3.01	0.06	1.50	1.56	1.45
Pittsburgh/ Jig Product	70.9	2.45	0.03	0.87	0.90	1.54
Pittsburgh/ Jig Bed	29.1	4.40	0.12	3.04	3.16	1.24
Pocahontas No. 3/ Jig Feed	----	0.42	0.02	0.15	0.17	0.25
Pocahontas No. 3 Jig Product	48.4	0.55	0.02	0.09	0.11	0.44
Pocahontas No. 3 Jig Bed	51.6	0.29	0.02	0.20	0.22	0.07
Illinois No. 6 Jig Feed	----	4.96	0.28	2.21	2.49	2.47
Illinois No. 6 Jig Product	63.1	3.85	0.20	0.74	0.94	2.91
Illinois No. 6 Jig Bed	36.9	6.87	0.43	4.71	5.14	1.73

1 Percent, Dry Basis.

Table 12

Mineral weight percent values of the feed coals and yields of the Baum Jig tests.

	LOW TEMPERATURE ASH	ILLITE	KAOLINITE	QUARTZ	CALCITE	DOLOMITE	SIDERITE	PYRITE	FELDSPAR	MUSCOVITE	APATITE	BASSANITE
	wt.%	*wt.%*[1]	*wt.%*	*wt.%*	*wt.%*	*wt.%*	*wt.%*[2]	*wt.%*	*%nc*[3]	*%nc*	*%nc*	*%nc*
PITTSBURGH COAL -- District 3												
Feed Coal (1 inch X ¼ inch)[4]	16.0	30	17	19	6	2	--	18	5	--	1	2
Baum Jig Product Material	9.4	21	22	19	9	5	--	21	0	--	0	0
Baum Jig Refuse Material	31.6	28	11	21	12	5	--	22	0	--	0	0
POCAHONTAS NO.3 COAL -- District 7												
Feed Coal (1 inch X ¼ inch)	45.3	33	29	13	4	--	7	0	6	12	--	4
Baum Jig Product Material	6.9	30	36	13	6	--	6	2	8	0	--	0
Baum Jig Refuse Material	74.2	31	21	26	2	--	1	0	3	0	--	2
ILLINOIS NO.6 COAL -- District 10												
Feed Coal (1 inch X ¼ inch)	33.8	36	10	24	4	--	--	17	--	--	--	--
Baum Jig Product Material	11.3	3	13	24	5	--	--	19	--	--	--	--
Baum Jig Refuse Material	41.5	0	7	24	5	--	--	24	--	--	--	--

1 *Mineral values are expressed as weight percent of the low temperature ash.*
2 *The symbol "--" indicates that the mineral was not present in that coal.*
3 *Standard curves were not available for some minerals. These were assigned relative values representing the mineral's contribution to the total X-ray count.*
4 *The "Baum" Jig feed coal was actually 1 inch X 3/16 inch, but these were not sampled. The feed coal analyses were calculated from the 1 inch X ¼ inch float-sink fractions.*

Table 13

Mineral values expressed as pounds per short ton of feed coal for the Baum Jig pilot plant tests.

	COAL REPORTING	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	DOLOMITE	SIDERITE	PYRITE	FELDSPAR	MUSCOVITE	APATITE	BASSANITE
	lb	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*
PITTSBURGH COAL													
Feed Coal[1]	2000	320	96	54	61	19	6	--[4]	58	16	--	3	6
Baum Jig Product[2]	1418	133	28	29	25	12	7	--	28	0	--	0	0
Baum Jig Refuse[3]	582	184	37	15	28	16	7	--	29	0	--	0	0
POCAHONTAS NO.3 COAL													
Feed Coal	2000	906	299	263	118	36	--	63	0	54	109	--	36
Baum Jig Product	968	67	20	24	9	4	--	4	1	5	0	--	0
Baum Jig Refuse	1032	766	237	161	199	15	--	8	0	23	0	--	15
ILLINOIS NO.6 COAL													
Feed Coal	2000	676	243	68	162	27	--	--	115	--	--	--	--
Baum Jig Product	1262	143	4	19	34	7	--	--	27	--	--	--	--
Baum Jig Refuse	738	306	0	21	74	15	--	--	74	--	--	--	--

1 *Mineral values are expressed as pounds of the mineral in one short ton of feed coal.*
2 *Mineral values are expressed as pounds of the mineral reporting with the cleaned coal resulting from cleaning one short ton of feed coal.*
3 *Mineral values are expressed as pounds of the mineral reporting with the refuse resulting from cleaning one short ton of feed coal.*
4 *The symbol "--" indicates that the mineral was not present in that coal.*

Differences between the feed coal analyses and the product and refuse sums of the values in Table 13 are small, except for the Illinois No. 6 coal. In that coal, large amounts of illite were dispersed and removed with the wash water.

Petrographic Analysis

Maceral analyses of the District 7 Pocahontas No. 3 feed coal, cleaned coal, refuse, float-sink fractions, and the -100 mesh feed coal fraction are reported and interpreted in this section. Macerals identified in this coal are listed in Table 14 with their volume-percent abundances in the sample fractions. Petrographic mineral matter is included in Table 14, and the mineral species identified optically in the Pocahontas No. 3 coal are included in Table 17.

The Pocahontas No. 3 coal in District 7 is of low volatile bituminous (lvb) rank, and because of rank-related factors, has a maceral composition considerably different from that of the high volatile B bituminous (hvAb) Pittsburgh coal reported in previous reports of this series. High inertinite and low exinite abundances shown in Table 14 are aspects of these compositional differences. Table 15 includes minimum and maximum maceral values for these samples, and shows the higher inertinite and lower exinite values when compared to Table 4 of Quarterly Report No. 5, showing similar values for the Pittsburgh coal. Examination of Table 14 reveals that semifusinite and fusinite are the predominant inertinite macerals. Semifusinite is the major inertinite maceral in all size fractions, but fusinite is increasingly abundant in the finer coal sizes. An important trend in the maceral composition of the float-sink fractions was the shift of the maximum inertinite content from the 1.40 float specific gravity fraction in the +1 inch coal to the 1.60 float fractions of the finer coal sizes. Because fusinite has a greater specific gravity[1] (1.5 gm/cm^3) than semifusinite (1.35-1.45 gm/cm^3), this shift was primarily caused by the increased fusinite in the finer coals. Another contributing factor was the increased specific gravity of fusinite particles caused by mineralizations in the cell lumens.

The absence of exinite macerals in these samples was an aspect of the coal's rank. Coals of lvb rank have been devolatilized to the extent that exinite maceral reflectance has increased to match that of the vitrinite matrix in which it was enclosed.[2] Devolatilization of the Pocahontas No. 3 coal produced exinite macerals which were undetectable by normal coal petrographic procedures.

Devolatilization similarly deleted some vitrinite macerals common in bituminous coals (Table 5 of Quarterly Report No. 3) such as telinite and desmocollinite from the analyses of these samples.

With collinite being the only vitrinite maceral present, the vitrinite content of these samples paralleled the contents of the Pittsburgh coal samples in both abundance and size and specific gravity trends. Specifically, vitrinite content of the whole coal decreases as specific gravity of the fraction is increased.

Petrography of the Pocahontas No. 3 coal also revealed a feature of these samples undetectable using other methods of analysis. This lvb coal contained a small amount (3-5% in the feed coal) of a hvAb coal from another location. The hvAb coal was recognized by the much lower reflectance of its vitrinite and exinite macerals. This "contaminant" coal was generally diluted in the float-sink fraction, but tended to concentrate in the finer coal sizes. The effects of minerals included with the "contaminant" coal, especially in certain float-sink fractions, is undetermined to date.

Table 14

Petrographic analyses of the District 7 Pocahontas No. 3 coal float-sink fractions and head samples presented as volume percent of the whole coal.

	+1 inch					1 X ¼ inch					¼ inch X 8 mesh				
	1.30F	1.40F	1.60F	1.80F	1.80S	1.30F	1.40F	1.60F	1.80F	1.80S	1.30F	1.40F	1.60F	1.80F	1.80S
VITRINITE	82%	60%	52%	54%	8%	79%	52%	54%	58%	7%	86%	53%	51%	52%	5%
Telinite	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Collinite	82	60	51	53	8	79	52	54	58	6	86	53	50	52	5
EXINITE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INERTINITE	18	38	31	9	2	20	43	43	14	2	13	42	37	24	3
Fusinite	4	8	8	2	1	3	8	9	5	1	3	11	14	10	1
Pyrofusinite	1	5	6	1	0	2	5	8	4	1	1	7	11	10	1
Degradofusinite	3	3	2	1	0	2	3	2	1	0	2	4	3	1	0
Semifusinite	12	21	17	5	1	13	26	14	6	0	6	24	17	8	1
Pyrosemifusinite	2	3	4	0	0	2	4	2	1	0	1	5	5	2	1
Degradosemifusinite	10	19	13	5	1	12	23	12	5	0	6	19	12	6	0
Macrinite	0	2	2	1	0	0	1	2	2	1	0	1	3	2	1
Micrinite	0	2	1	0	0	2	3	1	0	0	2	3	1	0	0
Inertodetrinite	3	5	3	1	1	2	4	3	2	1	2	4	2	3	1
MINERAL MATTER	0	3	18	37	90	1	5	17	28	91	1	4	12	24	91

Table 14

(continued)

	8 X 28 mesh					28 X 100 mesh								
	1.30F	1.40F	1.60F	1.80F	1.80S	1.30F	1.40F	1.60F	1.80F	1.80S	-100 mesh fraction	Feed coal head	Cleaned coal head	Refuse head
VITRINITE	89%	53%	47%	42%	5%	89%	60%	41%	37%	9%	77%	52%	81%	11%
Telinite	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Collinite	89	52	46	42	5	89	60	41	37	9	81	84	82	70
EXINITE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INERTINITE	9	38	43	30	4	10	37	51	40	7	18	10	17	5
Fusinite	1	8	14	16	1	0	4	15	16	3	3	4	4	1
Pyrofusinite	0	6	10	15	1	0	3	9	16	3	3	3	3	1
Degradofusinite	1	2	3	2	0	0	2	5	4	1	1	1	1	0
Semifusinite	6	25	24	9	1	7	28	33	13	1	7	4	11	1
Pyrosemifusinite	1	4	6	3	0	0	3	7	3	1	1	1	2	1
Degradosemifusinite	6	21	18	5	0	7	24	26	10	1	6	3	9	1
Macrinite	0	1	3	4	1	0	0	2	6	1	1	1	0	2
Micrinite	1	2	1	0	0	2	3	1	0	0	1	0	1	0
Inertodetrinite	1	3	2	1	1	1	2	1	2	1	6	1	2	0
MINERAL MA TER	1	9	10	28	92	1	3	8	23	84	5	39	2	84

Table 15

Macerals present in the District 7 Pocahontas No. 3 coal samples with their minimum and maximum observed values.

GROUP MACERAL Maceral submaceral	Minimum	Maximum
VITRINITE	5% (44%)*	89% (91%)*
Collinite**	5%	89%
EXINITE	0%	0%
INERTINITE	2% (9%)*	51% (56%)*
Fusinite	1%	16%
pyrofusinite	0%	16%
degradofusinite	0%	5%
Semifusinite	0%	33%
pyrosemifusinite	0%	7%
degradosemifusinite	0%	26%
Macrinite	0%	6%
Micrinite	0%	3%
Inertodetrinite	0%	6%
MINERAL MATTER	0%	92%

* Values in parentheses are values of the maceral group recalculated to a mineral-matter-free basis.
** Collinite was the only Vitrinite maceral present in 2% or greater.

X-Ray Powder Diffraction

In Quarterly Report No. 8 of this series, XRPD standardization equations were developed which allowed quantitative weight-percent determinations of minerals in the low temperature ash (LTA) of the District 3 Pittsburgh coal. During this report period, similar standardization equations were developed for the District 7 Pocahontas No. 3 coal and the District 10 Illinois No. 6 coal. Though some minerals were added or deleted, the procedures established in Appendix B of Report No. 8 were followed to produce the XRPD standardization equations presented in Table 16. Minerals for which XRPD standard curves could not be developed as well as minerals detected using other analytical techniques are listed in Tables 17 and 18 for the Pocahontas No. 3 and Illinois No. 6 coals respectively.

The Pocahontas No. 3 coal contained 14 minerals, of which 6 could be quantitatively determined with standard curves established for this coal. As is further described in Appendix B of the Report No. 8, the standardization equations were produced through linear regression analysis of plots of mineral abundances verses X-ray peak intensity. The mineral abundances were calculated using normative methods from the elemental analyses of the ash. X-ray peak intensities were expressed as a percent-of-net counts which represents that quantitative peak's contribution to the net intensity produced by all minerals in the sample. The standardization equations were calculated as linear regression equations as presented in Table 16. All plots were linear, and the R^2 values indicated the "goodness-of-fit" of the regression line to the data. Greater R^2 values indicate a better fit, and therefore, more accurate equations. The detectable limits and errors presented in Table 16 were extrapolated visually from the plots.

Fourteen-angstrom clays and dolomite were not present in enough samples to allow quantification. Orthoclase (feldspar), muscovite, and bassanite could not be quantified using normative methods, and therefore, standard curves

Table 16

Standardization equations for X-ray powder diffraction analysis of minerals in the District 7 Pocahontas No.3 coal and the District 10 Illinois No.6 coal.

POCAHONTAS NO.3 COAL

Linear Regression Equation		R^2	*Detectable Limit*	*Error**
ILLITE *(wt.%)*	= 11.6(%nc†)-13.1	0.54	10%	±40%
KAOLINITE *(wt.%)*	= 0.74(%nc)+16.0	0.73	16%	±20%
QUARTZ *(wt.%)*	= 0.80(%nc)-19.4	0.58	8%	±20%
CALCITE *(wt.%)*	= 0.45(%nc)+0.7	0.92	1%	±3%
SIDERITE *(wt.%)*	= 1.19(%nc)-2.9	0.74	1%	±3%
PYRITE *(wt.%)*	= 1.19(%nc)+0.3	0.68	1%	±2%

ILLINOIS #6 COAL

Linear Regression Equation		*R*	*Detectable Limit*	*Error**
CALCITE *(wt.%)*	= 0.53(%nc)+3	0.82	3%	±3%
PYRITE *(wt.%)*	= 1.15(%nc)+2	0.88	10%	±5%

* The error given is the range on either side of the regression equation containing 90% of the samples.

† %nc = Percent-of-net-counts (see text).

Table 17
MINERALS OF THE DISTRICT 7 POCAHONTAS NO.3 COAL.
Symbols indicate the analytical procedures available for each mineral, and whether the procedure can be used for quantification or identification.

	X-Ray Powder Diffraction	*Infrared Spectroscopy*	*Normative Calculations*	*Optical Petrography*	*Scanning Electron Microscopy*	*Formulae*
14 Å CLAYS	I					variable
ILLITE	Q		Q	I	I	variable
KAOLINITE	Q	Q	Q	I	I	$Al_4(Si_4O_{10})(OH)_8$
QUARTZ	Q	I	Q	I	I	SiO_2
ORTHOCLASE	I					$K(AlSi_3O_8)$
MUSCOVITE	I			I	I	$KAl_4(AlSi_3O_{10})(OH)_2$
CARBONATES	I	Q		I	I	variable
CALCITE	Q	I	Q	I	I	$CaCO_3$
DOLOMITE	I	I		I		$CaMg(CO_3)_2$
SIDERITE	Q		Q	I	I	$FeCO_3$
BASSANITE	I	I				$CaSO_4 \cdot \frac{1}{2}H_2O$
IRON DISULFIDES	Q		Q	I	I	FeS_2
PYRITE				I		FeS_2
MARCASITE				I		FeS_2
HEMATITE				I	I	Fe_2O_3
RUTILE				I	I	TiO_2
PYROLYTIC CARBON				I		C
COKE				I		variable

Q = Quantitative determinations (±3-40%)

I = Identification only possible

Table 18

MINERALS OF THE DISTRICT 10 ILLINOIS NO.6 COAL.
Symbols indicate the analytical procedures available for each mineral, and whether the procedure can be used for quantification or identification.

	X-Ray Powder Diffraction	*Infrared Spectroscopy*	*Normative Calculations*	*Optical Petrography*	*Scanning Electron Microscopy*	*Formulae*
ILLITE	Q*		Q	I	I	variable
KAOLINITE	Q*	Q	Q	I	I	$Al_4(Si_4O_{10})(OH)_8$
QUARTZ	Q*		Q	I	I	SiO_2
MUSCOVITE				I	I	$KAl_4(AlSi_3O_{10})(OH)_2$
CARBONATES	I	Q		I	I	variable
CALCITE	Q	I	Q	I	I	$CaCO_3$
SIDERITE	I			I	I	$FeCO_3$
IRON DISULFIDES	Q		Q	I	I	FeS_2
PYRITE				I		FeS_2
MARCASITE				I		FeS_2
SPHALERITE				I	I	ZnS
RUTILE				I	I	TiO_2

Q = Quantitative determinations (±3-40%)

I = Identification only possible

* Illite was determined quantitatively using the standardization equation established for the Pocahontas No.3 coal, and kaolinite and quartz were determined from Pittsburgh coal equations.

Table 19

Mineralogic analysis of the District 3 Pittsburgh coal float-sink fractions and head samples. Mineral values were obtained by X-ray Powder Diffraction, and are expressed as weight-percent of the low temperature ash.

Sample Number	Size Fraction	Specific Gravity Fraction	ILLITE wt.%[1]	KAOLINITE wt.%	QUARTZ wt.%	CALCITE wt.%	DOLOMITE wt.%	PYRITE wt.%	FELDSPAR %nc[2]	APATITE %nc	BASSANITE %nc
780037	*+1 inch*	*1.30 Float*	21	23	16	2	3	20	1	4	10
780038	*+1 inch*	*1.40 Float*	19	15	17	2	3	27	2	1	14
780039	*+1 inch*	*1.60 Float*	38	8	17	14	10	8	1	4	0
780040	*+1 inch*	*1.80 Float*	50	6	24	6	4	1	0	5	0
780041	*+1 inch*	*1.80 Sink*	35	10	20	9	3	18	1	2	0
780012	*1 X ¼ inch*	*1.30 Float*	27	29	17	2	2	17	1	1	4
780013	*1 X ¼ inch*	*1.40 Float*	26	19	18	4	2	24	2	1	4
780014	*1 X ¼ inch*	*1.60 Float*	26	11	19	1	3	28	2	2	9
780015	*1 X ¼ inch*	*1.80 Float*	34	7	19	9	6	22	1	2	0
780016	*1 X ¼ inch*	*1.80 Sink*	33	10	21	9	2	14	9	1	0
780017	*¼ inch X 8 mesh*	*1.30 Float*	26	28	15	4	3	18	1	1	3
780018	*¼ inch X 8 mesh*	*1.40 Float*	28	20	18	6	2	24	1	1	0
780019	*¼ inch X 8 mesh*	*1.60 Float*	25	12	19	6	2	33	2	1	0
780020	*¼ inch X 8 mesh*	*1.80 Float*	25	7	18	11	4	28	2	1	4
780021	*¼ inch X 8 mesh*	*1.80 Sink*	37	9	20	9	2	20	1	1	0

[1] *Weight percent of the low temperature ash.*

[2] *Standard curves were not available, and therefore these minerals are expressed as percent of the net counts on all minerals.*

Table 19
(continued)

Sample Number	Size Fraction	Specific Gravity Fraction	ILLITE wt.%[1]	KAOLINITE wt.%	QUARTZ wt.%	CALCITE wt.%	DOLOMITE wt.%	PYRITE wt.%	FELDSPAR %nc[2]	APATITE %nc	BASSANITE %nc
780023	*8 X 28 mesh*	*1.30 Float*	20	28	16	4	3	24	1	1	3
780024	*8 X 28 mesh*	*1.40 Float*	19	16	18	4	3	36	3	2	0
780025	*8 X 28 mesh*	*1.60 Float*	16	11	18	6	2	43	2	2	0
780026	*8 X 28 mesh*	*1.80 Float*	23	7	17	13	5	25	2	9	0
780027	*8 X 28 mesh*	*1.80 Sink*	27	7	18	14	2	24	2	3	0
780028	*28 X 100 mesh*	*1.30 Float*	29	21	16	3	5	12	1	1	12
780029	*28 X 100 mesh*	*1.40 Float*	25	25	17	3	3	13	1	1	2
780030	*28 X 100 mesh*	*1.60 Float*	11	13	18	5	2	28	2	2	9
780031	*28 X 100 mesh*	*1.80 Float*	8	9	15	11	4	23	2	2	26
780032	*28 X 100 mesh*	*1.80 Sink*	33	6	14	25	4	16	1	1	0
780022	*-100 mesh feed coal fraction*		29	10	18	1	5	8	1	1	26
780036	*Cleaned coal head sample*		31	19	19	6	2	20	1	2	0
780043	*Feed coal head sample*		25	12	17	5	2	28	1	2	8
780035	*Refuse head sample*		20	8	19	10	2	23	0	2	15

[1] *Weight percent of the low temperature ash.*

[2] *Standard curves were not available, and therefore these minerals are expressed as percent of the net counts on all minerals.*

could not be developed.

In the Illinois No. 6 coal samples, 10 minerals were detected (Table 18), but standardization equations could only be developed for calcite and pyrite. Illite, kaolinite, and quartz produced strong, usable, peaks on the diffractograms, but the range from minimum to maximum percent-of-net-counts of each mineral was too narrow to allow linear regression to be applied accurately. Therefore, in calculating mineral abundances in the Illinois No. 6 coal the illite standardization equation established for the Pocahontas No. 3 coal was adopted, and the kaolinite and quartz equations for the Pittsburgh coal were used. These equations were applied because the Pocahontas No. 3 samples provided the only illite standard curve, and because the abundances of kaolinite and quartz in the Pittsburgh coal most paralleled abundances in the Illinois No. 6 coal.

Using the standardization equations developed in Report No. 8 for the Pittsburgh coal, and in this report for the Pocahontas No. 3 and Illinois No. 6 coals, all raw XRPD mineral data (percent-of-net-counts) were recalculated to weight-percent values of the LTA, and tabulated.

The XRPD mineralogic analyses of the Pittsburgh coal and its fractions are presented in Table 19 as weight percents of the LTA. Percent-of-net-count values for feldspar, apatite, and bassanite were included for relative trend interpretations only. In this coal illite, kaolinite, quartz, and pyrite were the quantitatively important minerals in the LTA. Calcite, however, was a predominate mineral in the 1.80 float and 1.80 sink fractions of the finer coal sizes. Other mineral trends in the float-sink fractions are apparent in Table 19, but care must be exercised in these interpretations because of the large expected analytical errors for some minerals (Table 7 of Report No. 8). A very tenuous trend of greater illite in the LTA of the higher specific gravity fractions was interpreted. Kaolinite constituted a greater proportion of the LTA in the lower specific gravity fractions, especially in the fine sizes.

Quartz appeared in these samples as being distributed equally in all LTA's. Pyrite was present in its greatest proportion in the LTA's of the middle gravity fractions (1.60 float), and this trend was accentuated in the finer coal sizes. Bassanite occurred in the lower specific gravity (very low ash) coal fractions. Apatite displayed a size-related trend, and appeared most abundant in the +1 inch coal size.

The XRPD mineralogic analyses of the Pocahontas No. 3 coal and its fractions are presented in Table 20 as weight-percents of the LTA. Percent-of-net count values for feldspar (specifically orthoclase), bassanite, and muscovite were included for relative trend interpretation only. Illite, kaolinite, and quartz were the quantitatively important minerals in this coal, though siderite, pyrite, feldspar, and calcite were important in certain size and specific gravity fractions. Illite constituted a proportionally greater amount of the LTA's of the higher specific gravity fractions. Kaolinite displayed an opposite trend, being proportionally greater in the LTA's of the lower specific gravity fractions. Quartz content increased proportionally to the specific gravity of the coal, but generally showed a relative decrease in the 1.80 sink fractions. In the 8 mesh and larger coal sizes, siderite displayed a distinct trend to be proportionally greatest in the LTA of the 1.30 float fractions. Pyrite and feldspar displayed similar trends in the + 1/4 inch and + 28 mesh coal, respectively.

The XRPD mineralogic analyses of the Illinois No. 6 coal and its fractions are presented in Table 21. The weight-percent of the LTA values are presented for illite, kaolinite, quartz, calcite, and pyrite, but the sporadic occurrence of siderite allowed only presence-absence information to be tabulated. Illite, kaolinite, quartz, and pyrite were the quantitatively important minerals, but calcite occurred in significant amounts in the LTA's of the finest coal fractions. Illite and quartz appeared to be equally distributed in the LTA's of all fractions of this coal. Kaolinite constituted a larger proportion of the LTA of the lower

Table 20

Mineralogic analyses of the District 7 Pocahontas No.3 coal float-sink fractions and head samples. Mineral values were obtained by X-ray Powder Diffraction, and are expressed as weight-percent of the low temperature ash.

Sample Number	Size Fraction	Specific Gravity Fraction	ILLITE *wt.%*[1]	KAOLINITE *wt.%*	QUARTZ *wt.%*	CALCITE *wt.%*	SIDERITE *wt.%*	PYRITE *wt.%*	FELDSPAR *%nc*[2]	BASSANITE *%nc*	MUSCOVITE *%nc*
780050	*+1 inch*	*1.30 Float*	9	35	10	4	14	10	19	6	3
780051	*+1 inch*	*1.40 Float*	25	33	13	5	7	3	8	2	5
780052	*+1 inch*	*1.60 Float*	27	28	27	7	0	1	2	2	6
780053	*+1 inch*	*1.80 Float*	26	18	50	1	0	0	2	0	4
780054	*+1 inch*	*1.80 Sink*	34	21	35	2	1	0	2	1	5
780055	*1 X ¼ inch*	*1.30 Float*	5	39	10	4	19	7	18	2	6
780056	*1 X ¼ inch*	*1.40 Float*	24	33	13	4	5	2	10	2	7
780057	*1 X ¼ inch*	*1.60 Float*	27	26	30	6	0	2	2	2	6
780058	*1 X ¼ inch*	*1.80 Float*	25	22	40	4	0	2	2	0	6
780059	*1 X ¼ inch*	*1.80 Sink*	35	29	10	4	8	0	6	5	13
780067	*¼ inch X 8 mesh*	*1.30 Float*	8	44	10	3	10	0	15	11	8
780068	*¼ inch X 8 mesh*	*1.40 Float*	23	34	18	2	4	3	9	1	6
780069	*¼ inch X 8 mesh*	*1.60 Float*	24	27	23	5	5	2	5	3	6
780070	*¼ inch X 8 mesh*	*1.80 Float*	30	24	27	8	0	1	1	3	5
780071	*¼ inch X 8 mesh*	*1.80 Sink*	30	20	34	2	1	2	3	3	6

[1] *Weight percent of the low temperature ash.*

[2] *Standard curves were not available, and therefore these minerals are expressed as percent of the net counts on all minerals.*

Table 20

(continued)

Sample Number	Size Fraction	Specific Gravity Fraction	ILLITE wt.%[1]	KAOLINITE wt.%	QUARTZ wt.%	CALCITE wt.%	SIDERITE wt.%	PYRITE wt.%	FELDSPAR %nc[2]	BASSANITE %nc	MUSCOVITE %nc
780072	*8 X 28 mesh*	*1.30 Float*	18	45	10	3	6	4	10	5	10
780073	*8 X 28 mesh*	*1.40 Float*	26	29	26	3	2	2	6	0	7
780074	*8 X 28 mesh*	*1.60 Float*	23	31	21	2	6	2	6	2	7
780075	*8 X 28 mesh*	*1.80 Float*	24	24	28	5	6	3	2	3	5
780076	*8 X 28 mesh*	*1.80 Sink*	31	21	32	5	1	1	3	2	5
780099	*28 X 100 mesh*	*1.30 Float*	29	41	10	5	4	7	6	0	9
780100	*28 X 100 mesh*	*1.40 Float*	26	35	12	4	1	4	9	0	8
780101	*28 X 100 mesh*	*1.60 Float*	27	34	21	2	2	2	5	0	7
780102	*28 X 100 mesh*	*1.80 Float*	23	25	25	4	4	3	6	2	7
780103	*28 X 100 mesh*	*1.80 Sink*	37	19	19	17	1	2	3	1	1
780060	*-100 mesh feed coal fraction*		38	24	17	11	2	1	3	2	3
780049	*Cleaned coal head sample*		40	22	26	2	1	0	2	2	4
780090	*Feed coal head sample*		32	28	21	6	2	2	4	0	4
790164	*Refuse head sample*		31	21	34	2	1	0	2	2	8

[1] *Weight percent of the low temperature ash.*

[2] *Standard curves were not available, and therefore these minerals are expressed as percent of the net count on all minerals.*

Table 21

Mineralogic analysis of the District 10 Illinois No.6 Coal float-sink fractions and head samples. Mineral values were obtained by X-ray Powder Diffraction, and are expressed as weight-percent of the low temperature ash.

Sample Number	Size Fraction	Specific Gravity Fraction	ILLITE *wt.%*[1]	KAOLINITE *wt.%*	QUARTZ *wt.%*	CALCITE *wt.%*	PYRITE *wt.%*	SIDERITE [2]
790149	*+1 inch*	*1.30 Float*	40	16	22	6	19	-
790150	*+1 inch*	*1.40 Float*	21	12	25	6	14	-
790151	*+1 inch*	*1.60 Float*	4	10	22	5	35	-
790152	*+1 inch*	*1.80 Float*	21	10	20	6	30	P
790153	*+1 inch*	*1.80 Sink*	37	9	26	4	13	-
790154	*1 X ¼ inch*	*1.30 Float*	33	16	22	5	21	-
790155	*1 X ¼ inch*	*1.40 Float*	39	13	24	5	19	-
790156	*1 X ¼ inch*	*1.60 Float*	19	12	22	7	25	-
790157	*1 X ¼ inch*	*1.80 Float*	24	11	21	7	30	-
790158	*1 X ¼ inch*	*1.80 Sink*	37	9	25	4	15	-
790159	*¼ inch X 8 mesh*	*1.30 Float*	25	13	23	5	23	-
790160	*¼ inch X 8 mesh*	*1.40 Float*	8	12	24	5	20	-
790161	*¼ inch X 8 mesh*	*1.60 Float*	22	14	22	6	24	-
790162	*¼ inch X 8 mesh*	*1.80 Float*	24	14	21	8	25	-
790163	*¼ inch X 8 mesh*	*1.80 Sink*	48	10	24	7	16	P

[1] *Weight percent of the low temperature ash.*

[2] *"-" indicates the mineral was not detected, and "P" indicates the mineral was present.*

Table 21

(continued)

Sample Number	Size Fraction	Specific Gravity Fraction	ILLITE wt.%[1]	KAOLINITE wt.%	QUARTZ wt.%	CALCITE wt.%	PYRITE wt.%	SIDERITE[2]
790166	*8 X 28 mesh*	*1.30 Float*	43	18	22	4	21	-
790168	*8 X 28 mesh*	*1.40 Float*	30	14	24	5	17	-
790167	*8 X 28 mesh*	*1.60 Float*	33	14	23	9	14	-
790169	*8 X 28 mesh*	*1.80 Float*	33	14	22	8	17	-
790170	*8 X 28 mesh*	*1.80 Sink*	23	9	21	16	12	-
790171	*28 X 100 mesh*	*1.30 Float*	44	18	22	6	16	-
790172	*28 X 100 mesh*	*1.40 Float*	41	15	22	10	11	-
790173	*28 X 100 mesh*	*1.60 Float*	40	15	24	6	11	-
790174	*28 X 100 mesh*	*1.80 Float*	40	15	24	8	11	-
790175	*28 X 100 mesh*	*1.80 Sink*	30	10	19	21	11	-
790176	*-100 mesh feed coal fraction*		29	14	24	7	12	-
790165	*Cleaned coal head sample*		24	12	21	14	16	-
790047	*Feed coal head sample*		0	9	22	10	20	-
790419	*Refuse head sample*		41	10	25	6	12	P
800039	*Black-water slurry fines*		0	9	27	5	7	P

[1] *Weight percent of the low temperature ash.*

[2] *"-" indicates the mineral was not detected, and "P" indicates the mineral was present.*

specific gravity coals. Pyrite, in the larger coal sizes, was greatest in the LTA's of the middle gravity fractions, but in the finer size coals was greatest in the LTA's of the 1.30 float fractions.

Though the previous discussions concentrated on distributions of minerals in the LTA's of the size and specific gravity fractions of three specific coals, some generalizations are possible which should aid in interpreting the preparation plant and pilot plant cleaning of these coals. Illite and quartz constitute the majority of all LTA's whether of cleaned coals or refuse. Some minerals display the property of being highly separated into either the cleaned coal or the refuse, especially when fine coal sizes are cleaned. Calcite and kaolinite are prime examples in that kaolinite is greatest in the LTA's of the cleaned coal, and calcite is greatest in the LTA's of the refuse. Minerals such as apatite and siderite are most effectively separated into the cleaned coal and refuse only when large coal sizes are cleaned.

Mineral abundance distributions in these float-sink cleaning tests can be better explained when the weight-percent of the LTA values are recalculated into weights of each mineral, in each fraction, resulting from one ton of coal cleaned, This type of analysis will allow a realistic interpretation of the distribution of minerals in the size and specific gravity fractions.

<u>References Cited</u>

1. Stach, E., Mackowsky, M.-Th., Teichmuller, M., Taylor, G. H., Chandra, D., and Teichmuller, R., Stachs Textbook of Coal Petrology, Gebruder Borntraeger, Berlin, 1975, pp. 98-100.

2. ibid, pp. 200-202.

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