INFORMATION SYSTEM ON ILLINOIS COAL II: Characterization of Samples In the Illinois Basin Coal Sample Program

Richard D. Harvey
Aravinda Kar
John D. Steele

1986
Final Report to the Coal Research Board
Illinois Department of Energy and Natural Resources through the Center for Research on Sulfur in Coal
Contract 1-5-90190

Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION
Harvey, Richard D.


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ILLINOIS STATE GEOLOGICAL SURVEY
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ABSTRACT

Petrographic, mineralogic, and minor and trace element compositions of the first five samples in the Illinois Basin Coal Sample Program (IBCSP) were determined, and an information system for IBCSP was established on a mainframe computer at the University of Illinois. The information is accessible from remote terminals. Proximate, ultimate and other standard test data were already available on the samples. In addition to these data, the information system includes the name, address, sample number, project title, and results or objectives of each researcher using IBCSP samples. To date 156 uniform splits of the samples have been provided to 48 researchers.

The computerized information system is operational. Persons interested in accessing it from their terminals may arrange to do so by contacting the Illinois State Geological Survey.
EXECUTIVE SUMMARY

Characteristic properties—maceral composition, reflectance of vitrinite, pyrite characterization (including pyrite cleanability index), mineral matter composition, and minor and trace element compositions—were determined on the samples that are part of the Illinois Basin coal sample program (IBCSP). An informational data base comprising these and other data was established on a mainframe computer at the University of Illinois. Other data include the name, address, sample numbers, project title, and objectives or results of each researcher who is using one or more of the IBCSP samples. At this writing 156 uniform splits of the first four samples in the program have been provided to 48 researchers, 34 located in Illinois, the rest in other states and Canada.

Petrographic analyses show that all samples are vitrinite rich (table El). Expressed on a mineral matter corrected basis, the vitrinite content ranges from 62.3 to 85.7 and the total inertinite content from 3.9 to 8.8 volume percent.

Mineral matter is most abundant in sample 4 (table E2) because it is a mine-run product, which contains some shale from the mine roof. A trace of marcasite, an orthorhombic form of FeS$_2$, was detected in samples 1, 2, 3, and 5. This has importance because marcasite is more prone to oxidize than pyrite and marcasite may affect certain chemical processes more readily than pyrite.

Sample 2, from the Colchester (No. 2) Coal, contains relatively high concentrations of arsenic, germanium, and lead in comparison with the average for these elements in previously analyzed samples from the Herrin (No. 6) and Springfield (No. 5) Coal seams. Arsenic and lead are associated with sulfide minerals and germanium with organic matter in previously tested samples.

Other important characteristics of the IBCSP samples are:

<table>
<thead>
<tr>
<th>Sam. no.</th>
<th>Product</th>
<th>Seam</th>
<th>Location</th>
<th>Rank</th>
<th>Ash*</th>
<th>S*</th>
<th>PyS/OrS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prep plant</td>
<td>IL No. 6</td>
<td>W. Central IL</td>
<td>hvCb</td>
<td>10.3</td>
<td>4.3</td>
<td>0.4</td>
</tr>
<tr>
<td>2</td>
<td>Prep plant</td>
<td>IL No. 2</td>
<td>Western IL</td>
<td>hvCb</td>
<td>6.7</td>
<td>3.2</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>Prep plant</td>
<td>80% IL No. 5 20% IL No. 6</td>
<td>Southern IL</td>
<td>hvBb</td>
<td>8.4</td>
<td>2.3</td>
<td>0.9</td>
</tr>
<tr>
<td>4</td>
<td>Mine-run</td>
<td>IL No. 6</td>
<td>Southwestern IL</td>
<td>hvCb</td>
<td>38.1</td>
<td>4.2</td>
<td>1.3</td>
</tr>
<tr>
<td>5</td>
<td>Channel</td>
<td>IL No. 6</td>
<td>Southwestern IL</td>
<td>hvCb</td>
<td>18.0</td>
<td>4.6</td>
<td>1.2</td>
</tr>
</tbody>
</table>

* Weight percent, dry basis.
**Table E1. Maceral and reflectance analyses***

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maceral analysis, vol.%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitrinite</td>
<td>81.8</td>
<td>85.7</td>
<td>81.2</td>
<td>62.3</td>
<td>76.5</td>
</tr>
<tr>
<td>Exinite†</td>
<td>2.5</td>
<td>3.5</td>
<td>3.5</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Resinite</td>
<td>2.7</td>
<td>2.3</td>
<td>1.7</td>
<td>2.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Other liptinite</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>0.1</td>
<td>nil</td>
</tr>
<tr>
<td>Micrinite</td>
<td>1.0</td>
<td>0.7</td>
<td>0.3</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Macrinite &amp; Scl.</td>
<td>0.4</td>
<td>tr</td>
<td>0.2</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Semifusinite</td>
<td>1.9</td>
<td>1.8</td>
<td>5.8</td>
<td>1.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Fusinite</td>
<td>1.2</td>
<td>0.3</td>
<td>0.7</td>
<td>1.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Inertodetrinite</td>
<td>1.1</td>
<td>1.2</td>
<td>1.4</td>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Pyrite</td>
<td>1.1</td>
<td>2.7</td>
<td>1.0</td>
<td>3.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Other minerals</td>
<td>6.2</td>
<td>1.9</td>
<td>4.2</td>
<td>23.9</td>
<td>9.9</td>
</tr>
<tr>
<td>Reflectance of vitrinite (telocollinite) (%)</td>
<td>0.46</td>
<td>0.62</td>
<td>0.74</td>
<td>0.67</td>
<td>0.50</td>
</tr>
<tr>
<td>mean#</td>
<td>0.043</td>
<td>0.050</td>
<td>0.048</td>
<td>0.054</td>
<td>0.034</td>
</tr>
<tr>
<td>std. dev.</td>
<td>0.04</td>
<td>0.05</td>
<td>0.04</td>
<td>0.05</td>
<td>0.03</td>
</tr>
</tbody>
</table>

* Mineral matter corrected according to the ash and sulfur values by the Parr formula. The rounding of decimals causes some columns not to total 100%.
† Sporinite and cutinite are grouped together as exinite.
# Mean of 100 maximum readings, measured under oil.

**Table E2. Mineral composition***

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral matter</td>
<td>13.0</td>
<td>10.0</td>
<td>9.8</td>
<td>43.0</td>
<td>20.9</td>
</tr>
<tr>
<td>(low temperature (140°C) ash residue)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartz</td>
<td>2.6</td>
<td>0.6</td>
<td>1.4</td>
<td>8.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Calcite</td>
<td>0.5</td>
<td>2.7</td>
<td>nil</td>
<td>1.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Pyrite</td>
<td>2.1</td>
<td>4.0</td>
<td>1.8</td>
<td>4.6</td>
<td>4.2</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>3.3</td>
<td>1.0</td>
<td>2.6</td>
<td>6.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Illite</td>
<td>2.4</td>
<td>0.8</td>
<td>2.7</td>
<td>9.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Expandable</td>
<td>2.1</td>
<td>0.9</td>
<td>1.3</td>
<td>12.5</td>
<td>3.4</td>
</tr>
<tr>
<td>Other minerals (detected in minor or trace amounts)†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marc</td>
<td>Marc</td>
<td>Marc</td>
<td>Marc</td>
<td>Plag</td>
<td>Marc</td>
</tr>
<tr>
<td>Anhy</td>
<td>Coq</td>
<td>Szom</td>
<td>Szom</td>
<td>Dol</td>
<td></td>
</tr>
<tr>
<td>Szom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Weight percent of coal sample.
† Anhy - anhydrite (CaSO₄), Coq - Coquimbite (Fe₂(SO₄)₂(OH)₆)
Marc - marcasite (FeS₂), Plag - plagioclase (silicate)
Szom - szomolnokite (Fe₂SO₄·H₂O), Dol - dolomite (CaMg(CO₃)₂)
INTRODUCTION AND BACKGROUND

Much interest has been expressed in the Illinois Basin Coal Sample Program (IBCSP) by researchers being funded by the Illinois Coal Development Board and other coal research groups within and outside Illinois. The program is directed by Dr. Carl W. Kruse, Illinois State Geological Survey. To help the users of the IBCSP and others, this project was initiated with two objectives: 1) determine useful characteristic properties of the samples; and 2) establish a computerized information system (data base) for IBCSP on a computer capable of supporting on-line users at remote terminals. The properties determined are various petrographic, mineralogic, and minor and trace element analyses. These data together with the more standard chemical analyses need to be incorporated in the data base. In addition, the data base should include information about the projects being undertaken by users of the samples. This will promote collaboration among users and help them and others plan future projects using these samples.

ACKNOWLEDGMENTS

This work was sponsored by the Illinois Department of Energy and Natural Resources through the Illinois Coal Development Board. Several ISGS staff members assisted in various tasks: Richard A. Cahill, L. Ray Henderson, Lawrence B. Kohlenberger, Donald J. Lowry, and James J. Miner performed the analyses, and O. Michael Dieter assisted with the computer programming.

PROCEDURES

Petrographic data were determined using the following procedures. A representative split (-20 mesh) of each sample was obtained, mounted in epoxy and polished for determination of reflectance and maceral composition. The methods used followed those described in ASTM (1985): D2797 - for preparation of samples, D2798 - for reflectance measurement, and D2799 - for measurement of maceral composition. The microscopic specimens used for these analyses were also used for pyrite characterization which followed the method of Harvey and DeMaris (1985).

The residue from low temperature ashing (LTA) at about 140°C was used as the best quantitative measure of the total mineral matter content of coal (Harvey et al., 1983). The amount of the various mineral phases in the LTA was determined by quantitative X-ray diffraction methods and the results converted to the whole coal basis.
Figure 1. Elements (with dot pattern) for which analytical data were determined.
Concentrations of the minor and trace elements in the samples were determined by the following analytical methods:

- Optical emission, photographic:
  - Ag, B, Be, Ge, Tl, V.
- Ion selective electrode:
  - F
- Energy dispersive X-ray:
  - Ba, Mo, Sn, Sr, Zr.
- Wave-length dispersive X-ray:
  - Al, Ca, Fe, K, P, Si, Ti.
- Atomic absorption:
  - Cd, Cu, Li, Mg, Ni, Pb, Zn.
- Instrumental neutron activation:
  - As, Br, Ce, Co, Cr, Cs, Dy, Eu, Ga, Hf, La, Lu, Mn, Na, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, U, W, Yb.

These elements together with those determined as part of the ultimate analysis comprise most of the periodic chart (fig. 1). The elements not analyzed either have no stable isotopes (Tc, Pm) or they are of much lesser importance. Bismuth, tellurium, and mercury are of some environmental concern and they, together with some of the other remaining elements, should be considered as part of a future project.

The information system was established on the University of Illinois' Cyber-175 computer, in Urbana. The system provides online menu options so that users can easily obtain the desired data. The system was established in parallel with the existing information system on chemistry of Illinois coals (Harvey, et al. 1985). The two data bases are set up so that investigators at remote facilities can access one or both during a computer session.

**INFORMATION SYSTEM**

The information system was designed to handle two types of data. The first contains the name, address, project title, and results or objectives of the researchers using the samples; the second contains the chemical and other characteristic properties of the samples (fig. 2). These properties are listed in more detail in table 1. The system provides those users who have only a terminal and modem the capability to print data at the ISGS for same day mailing to the user. Those users with a computer and communications software can off-load the data to their own facility.
Figure 2. Design of the IBCSP data base.

Table 1. Chemical, petrographic, and mineralogic data available on the coal samples

<table>
<thead>
<tr>
<th>Standard Chemical Analyses</th>
<th>Minor Elements (reported as oxides)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximate analyses</td>
<td>Si, Al, Fe, Mg, Ca, K, Ti, P</td>
</tr>
<tr>
<td>Ultimate analyses</td>
<td>Trace Elements</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Ag, As, Ba, Be, B, Br, Cd, Ce, Co</td>
</tr>
<tr>
<td>Heating value</td>
<td>Cr, Cs, Cu, Dy, Eu, F, Ga, Ge, Hf</td>
</tr>
<tr>
<td>Free Swelling Index</td>
<td>La, Li, Lu, Mn, Mo, Na, Ni, Pb,Rb</td>
</tr>
<tr>
<td>Gieseler Plasticity</td>
<td>Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb,Th</td>
</tr>
<tr>
<td></td>
<td>Tl, U, V, W, Yb, Zn, Zr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Petrographic Analyses</th>
<th>Mineral Matter Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maceral analysis</td>
<td>Low Temperature Ash</td>
</tr>
<tr>
<td>Reflectance</td>
<td>Pyrite, quartz, calcite, clay</td>
</tr>
<tr>
<td>Pyrite Characterization,</td>
<td>Varieties of clay: kaolinite</td>
</tr>
<tr>
<td>pyrite cleanability index</td>
<td>illite, expandable clay (mixed-</td>
</tr>
<tr>
<td></td>
<td>layered illite/smectite)</td>
</tr>
</tbody>
</table>
User Access

To sign on the computer you must first make telephone connections with the Cyber-175. The telephone number to call depends on the baud rate of your modem:

1-217-333-4000 for 300 baud
1-217-333-4008 for 1200 baud

When telephone connections are established, those using 300 baud need only enter a carriage return <cr>; those using 1200 baud will need to respond to "enter class or help" by entering DNOSA <cr>. The Cyber-175 prompts with "class start", to which you respond with <cr>. On rare occasions all Cyber ports are busy and when this happens, the Cyber gives an opportunity to enter the queue and wait until a port opens. When a port opens, the "READY" prompt is responded to with a <cr>. Don't wait more than 2 or 3 minutes in the queue, but switch off the modem and try again after about 20 minutes. When connection with the Cyber is established, it will prompt for entry of the necessary codes:

You enter*   Note:
SIGNON:      <cr> Do not
PASSWORD:    <cr> enter any
RECOVER/CHARGE:  <cr> spaces

*codes to be provided to users as needed.

You should now be fully logged onto the computer and it prompts for the next entry with a slash, "/".

Data Acquisition Procedure

To start the retrieval program, named IBCSP, enter:

GET, IBCSP/UN=33ISCIC <cr> Note: no spaces are entered
IBCSP <cr>

Further instructions will appear at the terminal screen. A flow chart (fig. 3) summarizes the computer menus and options. The program permits users to read the names of researchers who are using the samples and other related data on the terminal screen, but not the analytical data (fig. 3). However, there is a way to "type" the analytical data to the screen. This can be done by selecting print option 2. This option asks users to give the retrieved file a name--such as the first 6 characters of their institutional name plus a "1" or "2"... This file can then be typed at your screen after you "quit" and get the slash prompt. At that time you enter the sequence given below in item 3.

Sign off the computer by entering "BYE", when prompted with a slash.
Enter name, address, and telephone #

Select your option(s) from the following list:
1 - Standard chemical data
2 - Minor and trace element data
3 - Macerals & reflectance data
4 - Pyrite characterization data
5 - Mineral matter data
6 - Investigators and their projects

How many samples would you like to retrieve?
Enter the sample #s you want data for--

Enter 0 to tabulate all names, sample #s, project, etc.
Enter 17 to see the next page (list of names)
Enter 16 to see the previous page
Enter 18 to see the current page

Would you like to get a hard copy of the Info?
Enter Y for yes, N for no.

Print option:
1. Print at ISGS (for mailing)
2. Print at your facility

Enter 1 to search again  Enter 2 to stop

Figure 3. Flow chart for IBCSP data base. Change of terminal screen indicated by *****
If you are connected to the Cyber with only a terminal and want a printed copy of the selected data then print option 1 is selected. This sends a printed copy to the ISGS and it will be mailed to you the same day. If you are connected to the Cyber with a computer and communications software you may off-load the selected data to your own computer by selecting print option 2. You will then be asked to enter a name for the file. You then quit the program and, after the slash prompt is obtained, do the following:

1. Set up your printer to receive the data.
   The standard chemical and elemental data sets require the printer to print 132 characters per line.

2. Set up your computer so that whatever is typed on your video terminal is echoed to your printer and/or saved on disk.

3. Enter the following (on the Cyber):

   GET, filename <cr>    Note: this is the
   PACK, filename<cr>   filename assigned
   TYPE, filename<cr>   earlier in IBCSP

After the listing is completed and you select the quit option, you may then sign off the computer by entering "BYE".

Service to Users Without Terminals

Persons without terminals can obtain information free of charge by contacting either the Coal Section or the Minerals Engineering Section of the Illinois State Geological Survey (217/344-1481) or the Center for Research on Sulfur in Coal (217/333-9241), both located in Champaign, Illinois.

RESULTS OF ANALYSES

Standard Chemical Analyses

The results of standard chemical analyses were determined for another project by analysts in the Minerals Engineering Section of the ISGS. We set up these results in a special computer file and wrote a program to provide the mean and typical range on an as-received basis (table 2). The ratio of pyritic to organic sulfur varies among the samples in the sample number order: 2 > 4 > 5 > 3 > 1 (see executive summary). The rank of each sample is high volatile C bituminous, except for sample 3 which is high volatile B.

Minor and Trace Elements

The concentration of the minor and trace elements in the samples is given in table 3. Comparison of the results with the average for the main commercial seams in Illinois indicates sample 4 is
Table 2. Statistics for standard chemical results of samples analyzed on an as received basis

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>NO. OF SAMPLES</th>
<th>MEAN</th>
<th>TYPICAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOIS</td>
<td>4</td>
<td>14.1</td>
<td>13.5</td>
</tr>
<tr>
<td>VOL</td>
<td>3</td>
<td>37.4</td>
<td>37.1</td>
</tr>
<tr>
<td>FXC</td>
<td>3</td>
<td>39.6</td>
<td>39.3</td>
</tr>
<tr>
<td>ASH</td>
<td>4</td>
<td>8.9</td>
<td>8.4</td>
</tr>
<tr>
<td>PYS</td>
<td>3</td>
<td>2.43</td>
<td>2.38</td>
</tr>
<tr>
<td>ORS</td>
<td>3</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>TOS</td>
<td>3</td>
<td>3.53</td>
<td>3.48</td>
</tr>
<tr>
<td>CL</td>
<td>2</td>
<td>0.09</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Sample 1

<table>
<thead>
<tr>
<th>NO. OF SAMPLES</th>
<th>MEAN</th>
<th>TYPICAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>5.8</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>58.9</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>O</td>
<td>1</td>
<td>22.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NO. OF SAMPLES</th>
<th>MEAN</th>
<th>TYPICAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOIS</td>
<td>4</td>
<td>13.5</td>
</tr>
<tr>
<td>VOL</td>
<td>3</td>
<td>36.7</td>
</tr>
<tr>
<td>FXC</td>
<td>3</td>
<td>43.8</td>
</tr>
<tr>
<td>ASH</td>
<td>4</td>
<td>5.9</td>
</tr>
<tr>
<td>PYS</td>
<td>3</td>
<td>1.83</td>
</tr>
<tr>
<td>ORS</td>
<td>1</td>
<td>0.73</td>
</tr>
<tr>
<td>TOS</td>
<td>3</td>
<td>0.20</td>
</tr>
<tr>
<td>CL</td>
<td>3</td>
<td>2.70</td>
</tr>
</tbody>
</table>

Sample 2

<table>
<thead>
<tr>
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Sample 5

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<td>4.9</td>
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<tr>
<td>C</td>
<td>2</td>
<td>56.7</td>
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<td>O</td>
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10
notably rich in SiO₂, MgO, Na₂O, F, and Rb. The reason for these high values is the relatively high abundance of mineral matter in this mine-run sample. It should also be noted that sample 2 contains a relatively high amount of As, Ge, and Pb in comparison with the average for Illinois (table 3). Germanium is probably associated with the organic matter in the sample, while As and Pb are probably associated together in grains of pyrite.

Petrographic Analyses

The results of maceral and reflectance analyses of the samples are given in table 4. On a mineral free basis, all are distinctly rich in vitrinite (85.3 to 89.9 vol. %). On this basis, sample 5 is most enriched in inertinite group macerals (10.0 vol. %). The mean maximum reflectance of the samples ranges from 0.46 to 0.74 percent, sample 1 being the lowest and sample 3 the highest. The reflectance results are consistent with the rank of the coals as noted above. Note: the format of table 4, as well as the remaining ones, is essentially the same as the format of the tabulated data that is printed from IBCSP.

The results of pyrite characerization are given in table 5, which comprises quantitative data on the mean size and maceral/mineral association of pyrite grains and the pyrite cleanability index (PCI) for each sample (Harvey and DeMaris, 1985). The mean diameter of pyrite ranges from 4.2 μm (sample 3) to 8.72 μm (sample 4). The results also show a wide range of PCI values for these two samples: 0.25 to 2.19. This index is very much a function of particle size due to increased liberation of pyrite during fine grinding. However, as all the reported values were determined on -20 mesh samples, they can be used to compare the samples one to the other. The PCI data indicate a higher percentage of the pyrite in sample 4 can be cleaned (removed) from this sample than from sample 3 without further grinding. This is consistent with the fact that sample 3 is a product from a preparation plant while sample 4 is a mine-run product. The high PCI for sample 4 is due to the large percentages of free pyrite and pyritic coal in this sample as compared to the others. Sample 5 tested to have the highest index (2.96).

Mineralogic Analyses

The results of mineral analyses are given in table 6. The mine-run sample (sample 4) contains the highest amount of mineral matter (43%). Kaolinite is the predominant clay mineral in samples 1, 2, and 5; and both kaolinite and illite are about equal in abundance in sample 3. The expandable clay mineral, also known as mixed-layered illite/smectite, is most abundant in sample 4.

SAMPLE USERS

The name, address, sample number, project title, and results or objectives of the research work of each of the investigators of IBCSP samples are given in the appendix.
REFERENCES

ASTM, 1985, Annual book of ASTM standards; section 5, v. 05.05; gaseous fuels; coal and coke: ASTM, Philadelphia, PA, p. 213-520.


### Table 3. Minor and trace elements

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* Calculated from data on channel samples from the Herrin (No. 6) and Springfield (No. 5) Coals (Harvey, et al., 1983).
Table 4. Maceral and reflectance (mean, standard deviation for vitrinite) data

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<th>Lab. No.</th>
<th>Sample Collected By MDS</th>
<th>Date</th>
<th>Project</th>
<th>Description</th>
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<td>7-10-83</td>
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**Data Set:** C22542.A2P  
**Volume Percent**

<table>
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<td><strong>Resinite</strong></td>
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<td>2.9</td>
</tr>
<tr>
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<td>nil</td>
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<tr>
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<td>1.1</td>
</tr>
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<td><strong>Macrinite/Sclerotinite</strong></td>
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<td>0.4</td>
<td>0.4</td>
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<tr>
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<td>2.1</td>
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<td><strong>Pustinite</strong></td>
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<td>1.3</td>
</tr>
<tr>
<td><strong>Total Inertinite</strong></td>
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</table>

**Reflectance, Vitrinite (Teblocollinite):** 0.46% (Mean of 100 Maximum Standard Deviation: 0.043% Readings Under Oil)

**Ash:** 10.9%  
**Total Sulfur:** 4.19% (Dry Basis)

**Analyst:** J.J.M.  
**Date of Analysis:** 12-31-85  
**Project:** IBCSP  
**Description:** Macrinite = 0.2%, Sclerotinite = 0.2% (As Measured)

**Data Set:** C22543.A2P  
**Volume Percent**

<table>
<thead>
<tr>
<th>MACERAL/MINERAL</th>
<th>Measured</th>
<th>Corrected</th>
<th>Mineral Free</th>
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<tbody>
<tr>
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<td>3.6</td>
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<td>2.3</td>
<td>2.4</td>
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<tr>
<td><strong>Total Liptinite</strong></td>
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<td><strong>Micrinite</strong></td>
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<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Macrinite/Sclerotinite</strong></td>
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<td>tr</td>
<td>tr</td>
</tr>
<tr>
<td><strong>Semifusinite</strong></td>
<td>1.8</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Pustinite</strong></td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Total Inertinite</strong></td>
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<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Total Inertinite</strong></td>
<td>4.0</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td><strong>Pyrite</strong></td>
<td>2.7</td>
<td>2.7</td>
<td>N</td>
</tr>
<tr>
<td><strong>Other Minerals</strong></td>
<td>0.6</td>
<td>1.9</td>
<td>N</td>
</tr>
<tr>
<td><strong>Calcite Observed (Y or N)</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

**Reflectance, Vitrinite (Teblocollinite):** 0.62% (Mean of 100 Maximum Standard Deviation: 0.050% Readings Under Oil)

**Ash:** 6.8%  
**Total Sulfur:** 3.17% (Dry Basis)

**Analyst:** J.J.M.  
**Date of Analysis:** 01-03-86  
**Project:** IBCSP  
**Description:** Both Macrinite and Sclerotinite were observed in trace amounts.
<table>
<thead>
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<th>Location:</th>
<th>Sample Collected By:</th>
<th>Sample Type:</th>
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<td>IBCSP-3</td>
<td>SEE NOTE</td>
<td>SOUTHERN ILLINOIS</td>
<td>MDS, 11-08-83</td>
<td>RUN OF PREPARATION PLANT</td>
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**Note:** 80% SPRINGFIELD (NO.5) AND 20% HERRIN (NO.6) SEAMS

**Data Set:** C22544.A2P

### Table 4. (Continued)

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<th>Measured</th>
<th>Mineral Corrected</th>
<th>Free</th>
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<td><strong>Exinite</strong></td>
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<td>3.6</td>
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<td><strong>Resinite</strong></td>
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<tr>
<td><strong>Other Liptinite</strong></td>
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</tr>
<tr>
<td><strong>Total Liptinite</strong></td>
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<td>5.2</td>
<td>5.5</td>
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<td>0.3</td>
</tr>
<tr>
<td><strong>Macrinite/Sclerotinite</strong></td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Semiausinite</strong></td>
<td>6.0</td>
<td>5.8</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Fusinite</strong></td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Inertodetrinite</strong></td>
<td>1.5</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total Inertinite</strong></td>
<td>8.7</td>
<td>8.4</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Pyrite</strong></td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td><strong>Other Minerals</strong></td>
<td>0.3</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td><strong>Calcite Observed (Y or N)</strong></td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other Sulfides Observed (Y or N)</strong></td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Count:</strong></td>
<td>1000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reflectance, Vitrinite (Telecollinite):** 0.74% (Mean of 100 Maximum Standards Deviation: 0.048% Readings Under Oil)

**Ash:** 8.4%

**Total Sulfur:** 2.19% (Dry Basis)

**Analyst:** JJM, **Date of Analysis:** 01-05-86, **Project:** IBCSP

**Description:** No Sclerotinite was observed

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Seam:</th>
<th>Location:</th>
<th>Sample Collected By:</th>
<th>Sample Type:</th>
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</thead>
<tbody>
<tr>
<td>IBCSP-4</td>
<td>HERRIN (NO.6)</td>
<td>SOUTHWESTERN ILLINOIS</td>
<td>JMB, 12-15-83</td>
<td>RUN OF MINE</td>
</tr>
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</table>

**Data Set:** C22545.A2P

### Table 4. (Continued)

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<tr>
<th>Maceral/Mineral</th>
<th>Measured</th>
<th>Mineral Corrected</th>
<th>Free</th>
</tr>
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<tr>
<td><strong>Total Vitrinite</strong></td>
<td>65.2</td>
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<td><strong>Resinite</strong></td>
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<tr>
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<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total Liptinite</strong></td>
<td>4.7</td>
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<tr>
<td><strong>Micrinite</strong></td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Macrinite/Sclerotinite</strong></td>
<td>0.6</td>
<td>0.6</td>
<td>0.8</td>
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<tr>
<td><strong>Semiausinite</strong></td>
<td>1.9</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Fusinite</strong></td>
<td>1.9</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Inertodetrinite</strong></td>
<td>1.1</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total Inertinite</strong></td>
<td>6.5</td>
<td>6.2</td>
<td>8.5</td>
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<tr>
<td><strong>Pyrite</strong></td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td><strong>Other Minerals</strong></td>
<td>20.6</td>
<td>23.9</td>
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<tr>
<td><strong>Calcite Observed (Y or N)</strong></td>
<td>Y</td>
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<td></td>
</tr>
<tr>
<td><strong>Other Sulfides Observed (Y or N)</strong></td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Count:</strong></td>
<td>1000</td>
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<td></td>
</tr>
</tbody>
</table>

**Reflectance, Vitrinite (Telecollinite):** 0.67% (Mean of 100 Maximum Standards Deviation: 0.054% Readings Under Oil)

**Ash:** 38.1%

**Total Sulfur:** 3.91% (Dry Basis)

**Analyst:** J JM, **Date of Analysis:** 04-19-85, **Project:** IBCSP

**Description:** Sclerotinite=0.2% (as measured); Other Liptinite=Fluorinite
Table 4. (Continued)

<table>
<thead>
<tr>
<th>MACERAL/MINERAL</th>
<th>MEASURED</th>
<th>CORRECTED</th>
<th>FREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXINITE</td>
<td>2.4</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>RESINITE</td>
<td>0.8</td>
<td>0.7</td>
<td>0.8</td>
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<tr>
<td>OTHER LIPTINITE</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
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<tr>
<td>TOTAL LIPTINITE</td>
<td>3.2</td>
<td>3.0</td>
<td>3.4</td>
</tr>
<tr>
<td>MIRGINITE</td>
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<td>0.9</td>
<td>1.1</td>
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<tr>
<td>MACRINITE/SCLEROTINITE</td>
<td>1.2</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>SEMIFUSINITE</td>
<td>3.6</td>
<td>3.4</td>
<td>3.8</td>
</tr>
<tr>
<td>FUSINITE</td>
<td>2.8</td>
<td>2.6</td>
<td>3.0</td>
</tr>
<tr>
<td>INERTODETRINITE</td>
<td>0.8</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>TOTAL INERTINITE</td>
<td>9.4</td>
<td>8.8</td>
<td>10.0</td>
</tr>
<tr>
<td>PYRITE</td>
<td>1.8</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>OTHER MINERALS</td>
<td>3.8</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>CALCITE OBSERVED (Y OR N)</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER SULFIDES OBSERVED (Y OR N)</td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL COUNT:</td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFLECTANCE, VITRINITE (TELOCOLLINITE): 0.50 % (MEAN OF 100 MAXIMUM
STANDARD DEVIATION: 0.034 % READINGS UNDER OIL)

ASH: 17.8%
TOTAL SULFUR: 4.27% (DRY BASIS)
ANALYST: JHM, DATE OF ANALYSIS: 08-13-86, PROJECT: IBCSP
DESCRIPTION: MACRINITE = 0.6%, SCLEROTINITE = 0.6% (AS MEASURED)
Table 5. Pyrite characterization and pyrite cleanability index

<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>SEAM: HERRIN (NO. 6)</th>
<th>ANALYSIS DATE: 04/18/86</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBCSP-1</td>
<td>LOCATION: WEST CENTRAL ILLINOIS</td>
<td>PARTICLE SIZE: -20 MESH</td>
</tr>
</tbody>
</table>

SAMPLE TYPE: RUN OF PREPARATION PLANT

RESULTS FOR PYRITIC GRAINS

<table>
<thead>
<tr>
<th>PARTICLE TYPE</th>
<th>NO. OF GRAINS</th>
<th>MEAN DIAMETER (µm)</th>
<th>% DIAmETER</th>
<th>% DIAMETER (V.I.T BASIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITRITE</td>
<td>225</td>
<td>5.00</td>
<td>38.36</td>
<td>56.25</td>
</tr>
<tr>
<td>INERTITE</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TRIMACERITE</td>
<td>175</td>
<td>5.00</td>
<td>29.83</td>
<td>43.75</td>
</tr>
<tr>
<td>CARBOMINERITE</td>
<td>48</td>
<td>8.94</td>
<td>14.63</td>
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</tr>
<tr>
<td>PYRITIC COAL</td>
<td>23</td>
<td>13.83</td>
<td>10.85</td>
<td></td>
</tr>
<tr>
<td>FREE PYRITE</td>
<td>29</td>
<td>6.40</td>
<td>6.33</td>
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<tr>
<td>TOTAL</td>
<td>500</td>
<td>5.87</td>
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PYRITE CLEANABILITY INDEX: 0.47

<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>SEAM: COLCHESTER (NO. 2)</th>
<th>ANALYSIS DATE: 04/21/86</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBCSP-2</td>
<td>LOCATION: WESTERN ILLINOIS</td>
<td>PARTICLE SIZE: -20 MESH</td>
</tr>
</tbody>
</table>

SAMPLE TYPE: RUN OF PREPARATION PLANT

RESULTS FOR PYRITIC GRAINS

<table>
<thead>
<tr>
<th>PARTICLE TYPE</th>
<th>NO. OF GRAINS</th>
<th>MEAN DIAMETER (µm)</th>
<th>% DIAmETER</th>
<th>% DIAMETER (V.I.T BASIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITRITE</td>
<td>197</td>
<td>4.50</td>
<td>34.77</td>
<td>54.18</td>
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<tr>
<td>INERTITE</td>
<td>1</td>
<td>2.41</td>
<td>0.09</td>
<td>0.14</td>
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<tr>
<td>TRIMACERITE</td>
<td>160</td>
<td>4.67</td>
<td>29.31</td>
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<tr>
<td>CARBOMINERITE</td>
<td>97</td>
<td>6.46</td>
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<tr>
<td>PYRITIC COAL</td>
<td>17</td>
<td>11.34</td>
<td>17.56</td>
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<td>3.36</td>
<td>3.69</td>
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<td>TOTAL</td>
<td>500</td>
<td>5.10</td>
<td>100.0</td>
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</tr>
</tbody>
</table>

PYRITE CLEANABILITY INDEX: 0.56

*THE COMPOSITION OF PYRITE BEARING PARTICLES ARE DISTINGUISHED AS FOLLOWS: VITRITE = >95% VITRINITE; INERTITE = >95% INERTINITE; TRIMACERITE = >95% OF 2 OR 3 DIFFERENT GROUP MACERALS; CARBOMINERITE = 5-20% PYRITE OR 20-60% CLAY, QUARTZ, AND CALCITE; PYRITIC COAL = 20-95% PYRITE; FREE PYRITE = >95% PYRITE (LIBERATED). NOTE: TRACES OF PYRITE IN LIPTITE (IF ANY) IS ADDED TO VITRITE.

ISGS
Table 5. (Continued)

<table>
<thead>
<tr>
<th>SAMPLE NO. IBCSP-3</th>
<th>SEAM: SEE NOTE</th>
<th>LAB NO: C22544.P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION: SOUTHERN ILLINOIS</td>
<td>ANALYSIS DATE: 04/22/86</td>
<td></td>
</tr>
<tr>
<td>SAMPLE TYPE: RUN OF PREPARATION PLANT</td>
<td>PARTICLE SIZE: -20 MESH</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: 80% SPRINGFIELD (NO.5) AND 20% HERRIN (NO.6) SEAMS

RESULTS FOR PYRITIC GRAINS

<table>
<thead>
<tr>
<th>PARTICLE TYPE</th>
<th>NO. OF GRAINS</th>
<th>MEAN DIAMETER (µm)</th>
<th>% DIAMETER</th>
<th>% DIAMETER (V,I,T BASIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITRITE</td>
<td>222</td>
<td>4.15</td>
<td>42.99</td>
<td>53.67</td>
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<tr>
<td>INERTITE</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TRIMACERITE</td>
<td>193</td>
<td>4.12</td>
<td>37.10</td>
<td>46.33</td>
</tr>
<tr>
<td>CARBOMINERITE</td>
<td>71</td>
<td>4.99</td>
<td>16.53</td>
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</tr>
<tr>
<td>PYRITIC COAL</td>
<td>1</td>
<td>4.82</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>FREE PYRITE</td>
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<td>5.19</td>
<td>3.16</td>
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<td>TOTAL</td>
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<td>100.0</td>
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PYRITE CLEANABILITY INDEX: 0.25

<table>
<thead>
<tr>
<th>SAMPLE NO. IBCSP-4</th>
<th>SEAM: HERRIN (NO. 6)</th>
<th>LAB NO: C22545.JJM</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION: SOUTHWESTERN ILLINOIS</td>
<td>ANALYSIS DATE: 04/22/86</td>
<td></td>
</tr>
<tr>
<td>SAMPLE TYPE: RUN OF MINE</td>
<td>PARTICLE SIZE: -20 MESH</td>
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RESULTS FOR PYRITIC GRAINS

<table>
<thead>
<tr>
<th>PARTICLE TYPE</th>
<th>NO. OF GRAINS</th>
<th>MEAN DIAMETER (µm)</th>
<th>% DIAMETER</th>
<th>% DIAMETER (V,I,T BASIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITRITE</td>
<td>86</td>
<td>5.86</td>
<td>8.25</td>
<td>26.32</td>
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<tr>
<td>INERTITE</td>
<td>4</td>
<td>4.82</td>
<td>0.32</td>
<td>1.01</td>
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<tr>
<td>TRIMACERITE</td>
<td>193</td>
<td>7.21</td>
<td>22.77</td>
<td>72.67</td>
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<td>CARBOMINERITE</td>
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<td>9.77</td>
<td>26.71</td>
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<tr>
<td>PYRITIC COAL</td>
<td>39</td>
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<td>211</td>
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<td>TOTAL</td>
<td>700</td>
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PYRITE CLEANABILITY INDEX: 2.19

<table>
<thead>
<tr>
<th>SAMPLE NO. IBCSP-5</th>
<th>SEAM: HERRIN (NO.6)</th>
<th>LAB NO: C25189.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION: SOUTHWESTERN ILLINOIS</td>
<td>ANALYSIS DATE: 8-15-86</td>
<td></td>
</tr>
<tr>
<td>SAMPLE TYPE: CHANNEL</td>
<td>PARTICLE SIZE: -20 MESH</td>
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</tr>
</tbody>
</table>

NOTE: 3-TON CHANNEL EXCLUSIVE OF 6 " @ TOP & BOTTOM; N - SEALED AT MINE BY ARGONNE NATIONAL LABORATORY

RESULTS FOR PYRITE GRAINS

<table>
<thead>
<tr>
<th>PARTICLE TYPE</th>
<th>NO. OF GRAINS</th>
<th>MEAN DIAMETER (µm)</th>
<th>% DIAMETER</th>
<th>% DIAMETER (V,I,T BASIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITRITE</td>
<td>123</td>
<td>4.25</td>
<td>13.96</td>
<td>55.33</td>
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<tr>
<td>INERTITE</td>
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<td>14.46</td>
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<tr>
<td>TRIMACERITE</td>
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<td>4.48</td>
<td>10.88</td>
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<tr>
<td>CARBOMINERITE</td>
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<td>3.93</td>
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<tr>
<td>PYRITIC COAL</td>
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<td>17.98</td>
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<td>FREE PYRITE</td>
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<td>7.42</td>
<td>40.60</td>
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PYRITE CLEANABILITY INDEX: 2.96
### Table 6. Mineral analyses of coal samples

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<thead>
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<th>SAMPLE NO.</th>
<th>SEAM:</th>
<th>SAMPLE TYPE:</th>
<th>LOCATION:</th>
<th>LAB. NO.:</th>
<th>COLLECTED BY:</th>
<th>DATE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBCSP-1</td>
<td>HERRIN (NO. 6)</td>
<td>RUN OF PREPARATION PLANT</td>
<td>WEST CENTRAL ILLINOIS</td>
<td>C22542</td>
<td>MDS</td>
<td>6-15-83</td>
</tr>
<tr>
<td>SAMPLE NO.</td>
<td>COLCHESTER (NO. 2)</td>
<td>RUN OF PREPARATION PLANT</td>
<td>WESTERN ILLINOIS</td>
<td>C22543</td>
<td>MDS</td>
<td>7-10-83</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>RESULTS (WEIGHT % BY LOW TEMP. ASHING)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORGANIC MATTER: 87.0</td>
</tr>
<tr>
<td>MINERAL MATTER: 13.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MINERAL COMPOSITION ( % OF SAMPLE BY X-RAY DIFFRACTION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUARTZ: 2.6</td>
</tr>
<tr>
<td>CALCITE: 0.5</td>
</tr>
<tr>
<td>PYRITE: 2.1</td>
</tr>
<tr>
<td>CLAY: 7.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIETIES OF CLAY MINERALS ( % OF SAMPLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAOLINITE: 3.3</td>
</tr>
<tr>
<td>ILLITE: 2.4</td>
</tr>
<tr>
<td>EXPANDABLE: 2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER MINERALS DETECTED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINOR - MARCASITE &amp; SZOMOLNOKITE</td>
</tr>
<tr>
<td>TRACE - ANHYDRITE &amp; COQUIMBITE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANALYST:</th>
<th>DATE OF ANALYSIS:</th>
<th>PROJECT:</th>
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<tbody>
<tr>
<td>DJL</td>
<td>04-15-86</td>
<td>IBCSP</td>
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### Table 6. Mineral analyses of coal samples

<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>SEAM:</th>
<th>SAMPLE TYPE:</th>
<th>LOCATION:</th>
<th>LAB. NO.:</th>
<th>COLLECTED BY:</th>
<th>DATE:</th>
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<tbody>
<tr>
<td>IBCSP-2</td>
<td>COLCHESTER (NO. 2)</td>
<td>RUN OF PREPARATION PLANT</td>
<td>WESTERN ILLINOIS</td>
<td>C22543</td>
<td>MDS,</td>
<td>7-10-83</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESULTS (WEIGHT % BY LOW TEMP. ASHING)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORGANIC MATTER: 90.0</td>
</tr>
<tr>
<td>MINERAL MATTER: 10.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MINERAL COMPOSITION ( % OF SAMPLE BY X-RAY DIFFRACTION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUARTZ: 0.6</td>
</tr>
<tr>
<td>CALCITE: 2.7</td>
</tr>
<tr>
<td>PYRITE: 4.0</td>
</tr>
<tr>
<td>CLAY: 2.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIETIES OF CLAY MINERALS ( % OF SAMPLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAOLINITE: 1.0</td>
</tr>
<tr>
<td>ILLITE: 0.8</td>
</tr>
<tr>
<td>EXPANDABLE: 0.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER MINERALS DETECTED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINOR - MARCASITE &amp; COQUIMBITE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANALYST:</th>
<th>DATE OF ANALYSIS:</th>
<th>PROJECT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJL</td>
<td>04-15-86</td>
<td>IBCSP</td>
</tr>
<tr>
<td>Sample No.</td>
<td>Seam:</td>
<td>Lab. No.</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
<tr>
<td>IBCSP-3</td>
<td>SEE NOTE</td>
<td>C22544</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Type:</th>
<th>Results (Weight % by Low Temp. Ashing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run of Preparation Plant</td>
<td></td>
</tr>
</tbody>
</table>

**Organic Matter:** 90.2
**Mineral Matter:** 9.8

**Mineral Composition (% of Sample by X-ray Diffraction):**
- **Quartz:** 1.4
- **Calcite:** NIL
- **Pyrite:** 1.8 (By Chemistry)
- **Pyrite:** 1.4 (By X-ray Diff.)
- **Clay:** 6.6 (By Difference)

**Varieties of Clay Minerals (% of Sample):**
- **Kaolinite:** 2.6
- **Illite:** 2.7
- **Expansible:** 1.3

**Other Minerals Detected:** Minor - Marcasite, Trace - Szomolnokite

**Analyst:** DJL, Date of Analysis: 04-15-86, Project: IBCSP

---

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Seam:</th>
<th>Lab. No.</th>
<th>Location:</th>
<th>Sample Type:</th>
<th>Results (Weight % by Low Temp. Ashing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBCSP-4</td>
<td>Herrin (No. 6)</td>
<td>C22545</td>
<td>SOUTHWESTERN ILLINOIS</td>
<td>Run of Mine</td>
<td></td>
</tr>
</tbody>
</table>

**Organic Matter:** 57.0
**Mineral Matter:** 43.0

**Mineral Composition (% of Sample by X-ray Diffraction):**
- **Quartz:** 8.0
- **Calcite:** 1.6
- **Pyrite:** 4.6 (By Chemistry)
- **Pyrite:** 3.1 (By X-ray Diff.)
- **Clay:** 28.8 (By Difference)

**Varieties of Clay Minerals (% of Sample):**
- **Kaolinite:** 6.4
- **Illite:** 9.9
- **Expansible:** 12.5

**Other Minerals Detected:** Minor - Szomolnokite, Trace - Plagioclase

**Analyst:** DJL, Date of Analysis: 04-15-86, Project: IBCSP
Table 6. (Continued)

<table>
<thead>
<tr>
<th>SAMPLE NO.</th>
<th>IBCSP-5</th>
<th>SEAM: HERRIN (NO.6)</th>
<th>LAB. NO.</th>
<th>C25189</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION</td>
<td>SOUTHERN ILLINOIS</td>
<td>COLLECTED BY RDH 12-03-83</td>
<td>SAMPLE TYPE: CHANNEL OF SEAM; IMPURITIES &gt;3/8&quot; PRESENT IN THE SEAM</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: 3-TON CHANNEL EXCLUSIVE OF 6" AT TOP & BOTTOM; N-SEALED BY ARGONNE NATIONAL LABORATORY

RESULTS (WEIGHT % BY LOW TEMP. ASHING)

- ORGANIC MATTER: 79.1
- MINERAL MATTER: 20.9

MINERAL COMPOSITION (% OF SAMPLE BY X-RAY DIFFRACTION)

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUARTZ</td>
<td>4.0</td>
</tr>
<tr>
<td>CALCITE</td>
<td>2.7</td>
</tr>
<tr>
<td>PYRITE</td>
<td>4.2</td>
</tr>
<tr>
<td>PYRITE (BY CHEMISTRY)</td>
<td>3.0</td>
</tr>
<tr>
<td>CLAY (BY DIFFERENCE)</td>
<td>10.0</td>
</tr>
</tbody>
</table>

MINERAL COMPOSITION ( % OF SAMPLE BY X-RAY DIFFRACTION)

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUARTZ</td>
<td>4.0</td>
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<tr>
<td>CALCITE</td>
<td>2.7</td>
</tr>
<tr>
<td>PYRITE</td>
<td>4.2</td>
</tr>
<tr>
<td>PYRITE (BY CHEMISTRY)</td>
<td>3.0</td>
</tr>
<tr>
<td>CLAY (BY DIFFERENCE)</td>
<td>10.0</td>
</tr>
</tbody>
</table>

VARIETIES OF CLAY MINERALS (% OF SAMPLE)

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAOLINITE</td>
<td>4.1</td>
</tr>
<tr>
<td>ILLITE</td>
<td>2.5</td>
</tr>
<tr>
<td>EXPANDABLE</td>
<td>3.4</td>
</tr>
</tbody>
</table>

OTHER MINERALS DETECTED: MINOR - MARCASITE
TRACE - DOLOMITE

ANALYST: DJL, DATE OF ANALYSIS: 07-30-86, PROJECT: IBSCP
### Appendix. Investigators of samples from the Illinois Basin Coal Sample Program

**ALBAL, RAJ**  
ISGS, CHAMPAIGN, IL 61820

**SAMPLE #**  
**DATE (MM/DD/YR)**  
01180800 71984

**PROJECT TITLE:**  
LOW TEMPERATURE CHARRING.  
CONTACT: M. STEPHENSON OR D. RAPP AT ISGS, CHAMPAIGN, IL

**ATHERTON, LINDA**  
EPRI, 3412 HILLVIEW AVE, PALO ALTO, CA 94303

**SAMPLE #**  
**DATE (MM/DD/YR)**  
01181200 082885

**PROJECT TITLE:**  
MICROBIALLY INDUCED SPONTANEOUS COMBUSTION

**ATWOOD, J**  
CHEMISTRY, UNIV. ALABAMA, UNIVERSITY, AL 35486

**SAMPLE #**  
**DATE (MM/DD/YR)**  
02160407 082885  
03160407 082885  
04030613 082885 ONE 1 LB BAG

**PROJECT TITLE:**  
LIQUEFACTION UNDER AMBIENT CONDITIONS

**BRADEN, H.**  
POLYBAC CORP., 954 MARCON BLVD, ALLENTOWN, PA 18103

**SAMPLE #**  
**DATE (MM/DD/YR)**  
01 102284 1 LB BAG  
02 102284 1 LB BAG  
03 102284 1 LB BAG  
04 102284 1 LB BAG

**PROJECT TITLE:**  
DESULFURIZATION WITH BACTERIA.  

**NOTE:** ILLINOIS COAL WAS NEVER USED. THEY USED SOME PENNSYLVANIA COAL ACQUIRED THROUGH PENN. STATE UNIV.  
CONTACT: C. S. MCDOWELL, POLYBAC CORP. AT THE ABOVE ADDRESS.

**BRUCHNER, A.**  
UNIVERSAL OIL PROD., 10 UOP PLAZA, DES PLAINES, IL 60016

**SAMPLE #**  
**DATE (MM/DD/YR)**  
01180700 032284  
03160600 032284  
04030300 032884 ONE 20 LB BAG

**PROJECT TITLE:**  
BRUCHNER HAS MOVED FROM UOP; NO ONE ELSE NAMED.
CHEMICAL CHARACTERIZATION OF ILLINOIS COAL

RESULTS: LOW TEMPERATURE AIR OXIDATION OF COALS IN THE IBSCP RENDER THEM LESS SOLUBLE IN PYRIDINE, THF AND OTHER SOLVENTS. THE PYRIDINE SOLUBLE, TOLUENE INSOLUBLE FRACTIONS (TIPS) BECOME PARTIALLY INSOLUBLE UPON OXIDATION. CHANGES IN FT-IR SPECTRA, SOLVENT SWELLING, GPC TRACES OF SOLUBLE FRACTIONS. PHENOL OH CONTENT AND ELEMENTAL ANALYSES ARE CONSISTENT WITH THE VIEW THAT THE PYRIDINE SOLUBLE FRACTION OF THESE COALS IS A PHENOL RICH MATERIAL WHICH IS HYDROGEN BONDED TO THE INSOLUBLE COAL RESIDUE AND WITHIN ITSELF.

ELEMENTAL S, SO4; TRANSFORMATION OF PYRITE TO S & SO4; CL, BR, F, P

OBJECTIVES: ATTEMPT WILL BE MADE TO DEVISE A NEW SULFUR FRACTIONATION PROCEDURE FOR COAL AND ITS PYROLYTIC PRODUCTS - NAMELY CHAR. AND POSSIBLY OTHER TREATMENTS SUCH AS EXPLOSIVE SHATTERING TECHNIQUE, SUPER CRITICAL EXTRACTION ETC.

EFFICIENCY OF SULFUR REMOVAL BY MICROBIAL DESULFURIZATION.

NOT YET AVAILABLE
CLARKSON, R. UNIV. OF ILL., NOYES LAB, URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)
01180101 09/23/83 URBANA, IL
02160201 09/23/83
03160101 09/23/83

PROJECT TITLE:
EPR & ENDOR STUDIES OF RADICALS IN COAL AND COAL LITHOTYPES

COLEMAN, D. ISGS, CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)
01180405 06/17/84
02160514 05/08/85
03160402 05/08/85
04030610 05/08/85

PROJECT TITLE:
BEHAVIOR OF SULFUR DURING DESULFURIZATION.

DEBARR, J ISGS, 615 F. PEABODY DR, CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)
01180413 07/16/85
03160409 07/16/85

PROJECT TITLE:
CHAR DESULFURIZATION & COAL DEAGGLOMERATION USING THERMAL GRAVIMETRIC AND MICRO-DILATOMETER ANALYSES

OBJECTIVES: DETERMINATION OF DEVOLATILIZATION AND SWELLING CHARACTERISTICS USING TGA AND TMA EQUIPMENT, AND THE REACTIVITY OF CHARS PRODUCED FROM THESE SAMPLES

DEBRUNNER, P. G. UNIV. OF ILL, 331 LOOMIS LAB, URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)
01180104 09/23/83
01181406 01/07/86
02160204 09/23/83
03160104 09/23/83

PROJECT TITLE:
The desulfurization of Illinois coal by in-situ preparation of iron catalysts.

RESULTS: (1) THE ASIM ASSAY FOR PYRITE IS NOT RELIABLE.
(2) PYRITE OXIDATION TO SOME FORM OF IRON OXIDE IS A SERIOUS PROBLEM IN COALS THAT ARE NOT STORED UNDER STRICTLY ANAEROBIC CONDITIONS. (3) IN THE SAMPLES OF THE ILLINOIS COAL BANK, SPECIFICALLY THE FRACTION OF IRON OXIDES INCREASES SUBSTANTIALLY AT THE EXPENSE OF PYRITE OVER THE LAST TWO YEARS.
DUGAN, P. OHIO STATE UNIV., 484 W. 12TH AVE., COLUMBUS, OH 43210

SAMPLE # DATE(MM/DD/YR)

02160307 010786
03160307 010786

PROJECT TITLE:
ENERGY DISPERSIVE X-RAY FOR PYRITE AND METALS

DUTY, R. CHEMISTRY DEPT, ILL. STATE UNIV., NORMAL, IL 61761

SAMPLE # DATE(MM/DD/YR)

03160107 092385
03160108 092385
03160109 092385

PROJECT TITLE:
ORG. S. REACTIONS, CARBOXYLATION & PROTCAPROTIC SOLVENTS

EHRLINGER, HANK ISGS, CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01181600 062383
01181500 062383
01180900 071784 USED BY MIKE BUCKENTIN FOR STEM WORK
01171600 062383
01171500 062383
02151515 070683
02151600 070683
02161500 070683
02161616 070683
03151400 072683
03151500 072683
03151600 072683
03161400 072683
03161500 072683
03161600 072683
04030606 072683 2-1 LB BAGS 6,7
04050300 070683 1-20 LB BAG
04050102 072683 14-1 LB BAGS 2-15
04050102 072683 12-1 LB BAGS 2-7,10-12,14-16
04010200 072683 2-20 LB BAGS 2,3
04010102 072683 11-1 LB BAGS 2,3,4,7,8,9,10,13,14,15,16
04030102 072683 11-1 LB BAGS 2,3,4,7,8,9,10,13,14,15,16
04030606 072683 1-1 LB BAG

PROJECT TITLE:
FINE COAL CLEANING BY AGGREGATE FLOTATION

OBJECTIVES: DEVELOP AND OPTIMIZE THE ISGS AGGREGATE FLOTATION PROCESS FOR CLEANING SULFUR AND ASH FROM FINELY CRUSHED COAL.
FROST, J. K. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)
01180407 061784
01180408 061784
04030605 061784 1-1 LB BAG

PROJECT TITLE:
SECONDARY REFERENCE STANDARDS FOR THE ANALYTICAL CHEMISTRY SECTION.

OBJECTIVE: COAL BANK SAMPLES #1 AND #4 HAVE BEEN ADOPTED FOR USE AS SECONDARY REFERENCE SAMPLES. THEY WILL BE REPEATEDLY ANALYSED OVER A LONG PERIOD OF TIME FOR MAJOR, MINOR AND TRACE ELEMENTS.

GIDASPOW, D. CHEM. ENG. DEPT., RM. 105PH, IIT CENTER, CHICAGO, IL 60616

SAMPLE # DATE(MM/DD/YR)
04081000 031886
04081500 031886

PROJECT TITLE:
DESULFURIZATION OF ILLINOIS COAL IN AN ELECTROFLUIDIZED BED.

RESULTS: AN EXPERIMENT WAS DONE WITH ILLINOIS #2 COAL OF 75 MICRON AVERAGE PARTICLE SIZE HAVING 5.2% PYRITES. WITH 12000 VOLTS IN AN ELECTROFLUIDISED BED THEY WERE ABLE TO REDUCE PYRITES TO 3.33% IN THE FIRST RUN.

GOECKNER, N. A. WESTERN IL UNIV., CURRENTS HALL 438A, MACOMB, IL 61455

SAMPLE # DATE(MM/DD/YR)
01180411 010985
02160508 010985

PROJECT TITLE:
THE CATALYTIC CONVERSION OF ILLINOIS COAL TO LIQUID PRODUCTS.

GRAFF, R. CHEM. ENG. DEPT., CITY COLLEGE, NEW YORK, NY 10031

SAMPLE # DATE(MM/DD/YR)
01180301 092184
01180311 092184
01180313 092184
01180314 092184
03160308 092184
03160311 092184
03160313 092184

PROJECT TITLE:
STEAM PRETREATMENT OF COAL.
HACKLEY, K. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE (MM/DD/yr)

01180402 120385
01180403 120385
01180404 120385
01180410 120385
01180416 120385
03160401 120385
03160403 030885
03160412 030885

PROJECT TITLE:

BEHAVIOR OF SULFUR DURING DESULFURIZATION (ISOTOPE)

HAGY, JOHN DRAINSWERKE INC., 801 SWEET GUM RD., PITTSBURGH, PA 15243

SAMPLE # DATE (MM/DD/yr)

04030700 1-20 LB BAG

PROJECT TITLE:

STIRRED BALL MILL GRINDING TESTS
NOTE: THEY MANUFACTURE MACHINES USED TO GRIND COAL.

HOWELL, WAYNE CHEMICAL ENG. DEPT., 125 RAL, UNIV. OF ILL. URBANA 61801

SAMPLE # DATE (MM/DD/yr)

031186 1-20 LB BAG

PROJECT TITLE:

STUDY OF ATTRITION IN FLUIDIZED BED PYROLYSIS

HUGHES, R. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE (MM/DD/yr)

01180305 042584
02160314 042584
04070109 042584 1-1 LB BAG

PROJECT TITLE:

CARBON MONOXIDE/ETHANOL DESULFURIZATION.

OBJECTIVE: IDENTIFY THE AFFECTS OF MINERAL IMPURITES ON THE DESULFURIZATION PROCESS.
IGNASIUK, DR. B.  INTERIM HIGH PRESSURE FAC , 1901 5TH ST., NISKU, ALB., CANADA

SAMPLE #  DATE (MM/DD/YR)

011120600  052086  A  20 LB BAG
011120500  052086  A  20 LB BAG

PROJECT TITLE:

NOT YET AVAILABLE

JEPSON, W. P.  UNIV. OF ILL., 207 ROGER ADAMS LAB., URBANA, IL 61801

SAMPLE #  DATE (MM/DD/YR)

03161000  030885

PROJECT TITLE:

SPRAYING OF COAL/DIL AND COAL/WATER SLIMES

JERGER, D.  IGT, 3424 S. STATE ST., CHICAGO, IL 60616

SAMPLE #  DATE (MM/DD/YR)

01180107  092383
01180108  092383
01180109  092383

PROJECT TITLE:

DESULFURIZATION OF COAL IN ELECTROFLUIDIZED BED.
CONTACT: DR. D. GIDASPOW: CHEM. ENG., IIT CENTER, CHICAGO, IL 60616

JOHNSON, W.  UNIV. OF VICTORIA, VICTORIA, BC (CANADA)

SAMPLE #  DATE (MM/DD/YR)

011180316  092184
02160509  050885
03160315  092084

KRIER, H  UNIV. OF ILL., 214 MECH. ENG. BLDG., URBANA, IL 61801

SAMPLE #  DATE (MM/DD/YR)

011140900  110185  B-20LB. BAGS 09-16 (200 LBS)
03130000  092185  400 LBS.

PROJECT TITLE:

STUDIES OF SO2 REMOVAL DURING PULVERIZED COAL COMBUSTION BY INJECTING LIMESTONE.
OBJECTIVE: DETERMINE OPTIMUM MIXTURE RATIOS, MIXING TIMES, PARTICLE SIZES AND TEMPERATURE FOR THE CAPTURE OF SULFUR OXIDES THROUGH LIMESTONE INJECTION.

KWANG, E. C.  ROCKWELL INT. CORP. 1049 BOX 1085, THOUSAND OAKS, CA 91360

SAMPLE #  DATE (MM/DD/YR)

011101401  100285

PROJECT TITLE: CHEMICAL-STRUCTURAL CHARACTER. USING NAOH/ETHANOL/H2O REACTIONS
NOTE: CONTACT DR. K. CHUNG AT ROCKWELL.
MILLER, K.  
ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE #  DATE (MM/DD/YR)

04031301  010786  10 LB. SAMPLE, 1-9 BAGS.

PROJECT TITLE:
MICROBIAL DESULFURIZATION OF COAL.

MIRZA, IGBAL  
ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE #  DATE (MM/DD/YR)

01181300  062685

PROJECT TITLE:
FLUIDIZED BED PYROLYSIS & CHAR DESULFURIZATION

MUCHMORE, C.  
SOUTHERN IL UNIV., CHEM. ENG., CARBONDALE, IL 62901

SAMPLE #  DATE (MM/DD/YR)

01130000  041885  400 LBS.
01170100  081283  14-20 LB. BAGS 01-14
02150300  081283  12-20 LB. BAGS 03-14
03150200  072683  12-20 LB. BAGS 02-13

PROJECT TITLE:
SUPERCRITICAL EXTRACTION OF SULFUR

NARAYAN, D. R.  
PURDUE UNIV., POTTER BLDG, WEST LAFAYETTE, IN 47907

SAMPLE #  DATE (MM/DD/YR)

01180308  111484  A 20 LB BAG
01120800  052086  A 20 LB BAG

PROJECT TITLE:
COAL STRUCTURE AND REACTIVITY USING K-CROWN ETHER REAGENT

QIONG, L.  
144 MECH ENG., UNIVERSITY OF ILLINOIS, URBANA, IL 61801

SAMPLE #  DATE (MM/DD/YR)

02161300  052386  A 20 LB BAG

PROJECT TITLE:
DESULFURIZATION USING STEAM AT 700 DEG. C.
SERIO, MICHAEL A. ADV. FUEL RESEARCH, 87 CHURCH, EAST HARTFORD, CT 06108

SAMPLE # DATE (MM/DD/yr)

01180409 050885
01180414 050885
02160507 050885
02160510 050885
04030612 050885 2-1 LB BAGS 12, 14

PROJECT TITLE:
CHEMICAL AND PHYSICAL DEVELOPMENT OF CHAR PARTICLES DURING DEVOLATILIZATION.

OBJECTIVE: WILL PROVIDE ACCURATE PREDICTIONS FOR THE THERMAL, OPTICAL, PHYSICAL, AND REACTIVE PROPERTIES OF CHARS AS THEY DEVELOP DURING DEVOLATILIZATION UNDER CONDITIONS TYPICAL OF GASIFIER OPERATION.

SMITH, CARL J. WV GEOLOGICAL SURVEY, PO BOX 874, MORGANTOWN, WV 26507

SAMPLE # DATE (MM/DD/yr)

01000000 081586
02000000 081586
04000000 081586

PROJECT TITLE:
ASH FUSION STUDY OF WEST VA

TO DEVELOP EQUATIONS TO PREDICT ASH FUSION TEMPERATURE FROM OTHER KNOWNS; E.G., ASH/TOTAL SULFUR/PYRITIC SULFUR. WE WANT TO LOOK AT COAL FROM INTERIOR BASIN VS OUR MODEL.

S00, S. L. UNIV. OF ILL., 123 MECH. ENG. BLDG, URBANA, IL 61801

SAMPLE # DATE (MM/DD/yr)

01180200 092383
01181000 071784
02150100 072783
02160100 072783
02160600 071784
03160200 092383
01120800 011285

PROJECT TITLE:
STEAM ENHANCED OXIDATIVE DESULFURIZATION

RESULTS: AN EXPERIMENT PERFORMED WITH HERRIN NO. 6 COAL, ACHIEVED SULFUR REMOVAL UP TO 65% OF TOTAL SULFUR IN HERRIN NO. 6 COAL.
RAUCHFUSS, T.  UNIV. OF ILL., 335 NOYES LAB., URBANA, IL 61801

SAMPLE # DATE(MM/DD/yr)

01180102  09/23/83
02160202  09/23/83
03160102  09/23/83
03160410  03/08/85

PROJECT TITLE:

MOLECULAR MODELS FOR DESULF. CATALYSIS

SCHARFF, M. F.  SCI. APPL’TN INT’L, 10401 ROSELLE, SAN DIEGO, CA 92121

SAMPLE # DATE(MM/DD/yr)

03160408  08/25/85
04030615  08/25/85

PROJECT TITLE:

REDUCTION OF PHOSPO-GYPSUM FROM FLA. PHOSPHATES TO PRODUCE CONCENTRATED SULFUR.

RESULTS: COAL PROVIDES HEAT AND REDUCTANT GASES TO CONVERT CASO4 TO A SULFUR PRODUCT. RESULTS ARE COMPLETED FOR COALS FROM OHIO, E. KY, AND IDCSP #3. ALL COALS GAVE CONVERSION TIMES WELL LESS THAN 1 MINUTE, BUT THE ILLINOIS COAL SAMPLE WAS THE BEST.
RESULTS: HIGH SULFUR COAL SAMPLES WERE PYROLYZED TO REDUCE THE SULFUR CONTENT FROM ABOUT 4% TO 2.8% AND THEN TREATED WITH HYDROGEN TO REDUCE THE SULFUR CONTENT TO 1% OR LESS.

THE NATURE AND CHEMISTRY OF THE SULFUR COMPOUNDS IN ILLINOIS COAL. ELEMENTAL SULFUR, PRESENT IN WEATHERED SAMPLES OF THE ILLINOIS COALS, IS ABSENT IN THE SINGLE PRISTINE SAMPLE NOW AVAILABLE. OXIDIZED ORGANIC SULFUR COMPOUNDS ARE ALSO PRESENT IN THE WEATHERED COALS. NEITHER ALIPHATIC THIOLS NOR AROMATIC THIOLS APPEAR TO BE PRESENT IN THE ILLINOIS COALS. HENCE, WE POSTULATE THAT THE PRINCIPAL SULFUR-CONTAINING ORGANIC CONSTITUENTS ARE APPOINTED AMONG DIARYL SULFIDES, ARYL ALKYL SULFIDES, AND HETERO CYCLIC COMPOUNDS. IN AN EARLIER STUDY, WE ESTABLISHED THAT THE SULFUR COMPOUNDS THAT ARE PRESENT IN ILLINOIS COALS ENHANCE THEIR LIQUEFACTION REACTIONS SIGNIFICANTLY. DESULFURIZATION REACTIONS USING REDUCTIVE, ANION-RADICAL CHAIN REACTIONS AND CATION-RADICAL PROCESSES ARE ALSO UNDER INVESTIGATION.

TWO QUITE DIFFERENT REACTION SYSTEMS HAVE BEEN FOUND FOR THE CLEAVAGE OF CARBON-SULFUR BONDS.
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PROJECT TITLE:
MECHANISMS AFFECTING SULFUR REMOVAL FROM COAL IN H₂ OR H₂O+H₂ ENVIRONMENT.

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PROJECT TITLE:
MICROCHEMISTRY OF COAL AND ORGANIC S BY SCAN TRANS ELECTRON MICROSCOPY.

WHAM, ROBERT OAK RIDGE NAT. LAB., BLDG 4501, MS 217, OAK RIDGE TN 37831

PROJECT TITLE:
NOT YET AVAILABLE

YOUNG, JOHN E. ARGONNE NAT'L LAB., 9700 CASS, BLDG 205, ARGONNE, IL 60439

?SAMPLE #