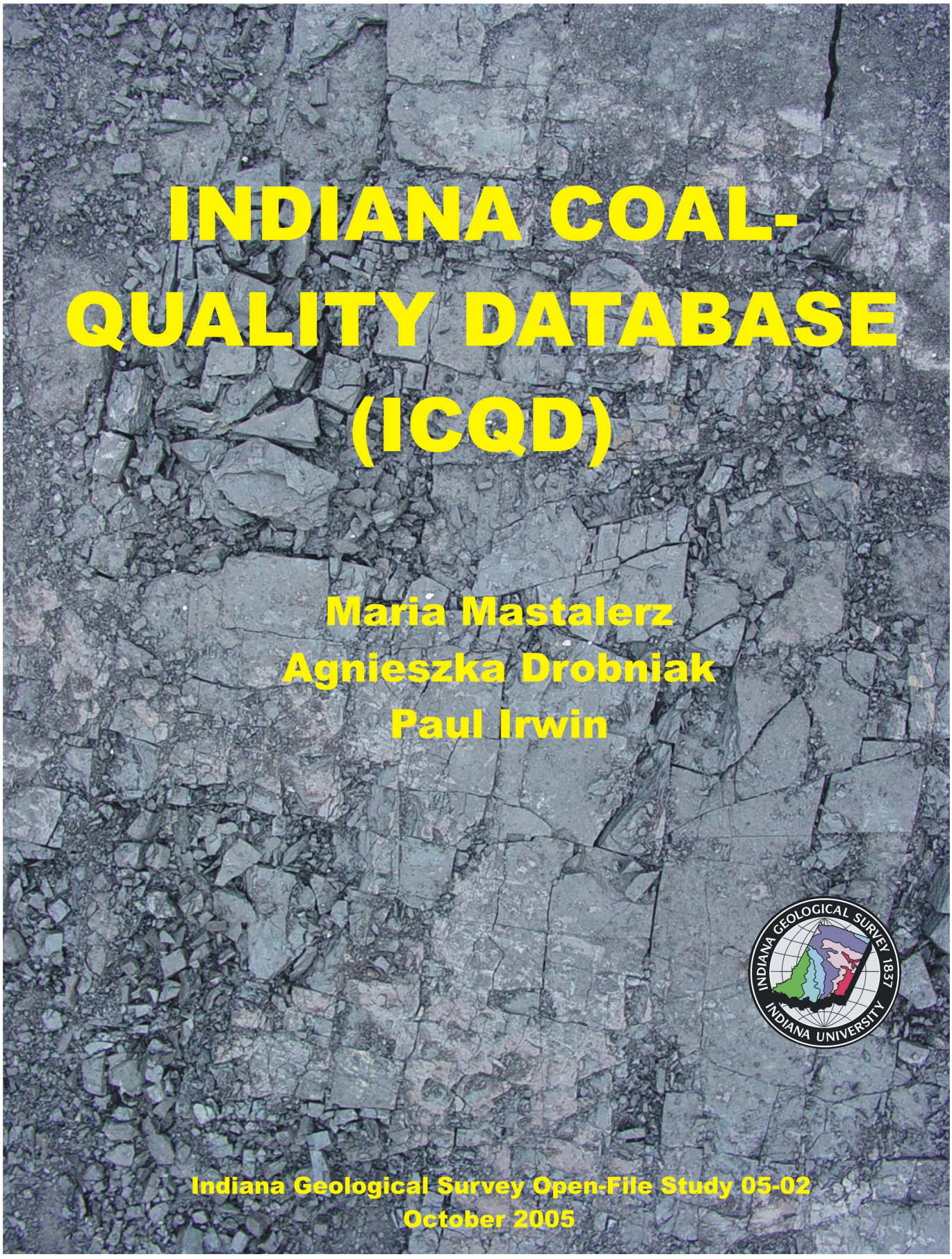

INDIANA COAL-QUALITY DATABASE (ICQD)

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DATABASE DISCLAIMER

This database was compiled by Indiana University, Indiana Geological Survey, using data believed to be accurate; however, a degree of error is inherent in all data. This product is distributed "AS-IS" without warranties of any kind, either expressed or implied, including but not limited to warranties of suitability to a particular purpose or use.

I. Introduction

This document provides a brief history of the Indiana Geological Survey's coal-quality database, an explanation of the contents of the database, and suggestions about its use.

ICQD is the most complete Indiana Coal-Quality Database to date and it is recommended to be used without the necessity of referring to the previous databases.

Information about stratigraphy is available in a separate database: NCRDS 2004 – IGS Open-File Study 04-10 (Mastalerz, M., and Drobniak, A., 2004)

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II. Brief history of Indiana Coal-Quality Database (ICQD)

For many years, staff of the Indiana Geological Survey (IGS) have collected data on various physical and chemical parameters of Indiana coals. Below, we list the databases used to compile the ICQD and give a brief description of each.

1) **Indiana Coal Analysis Database (ICAD) (Hasenmueller and Miller, 1992)**. This database was the first comprehensive source of publicly available information on the physical and chemical properties of Indiana coals. It includes analytical data for 1,416 coal samples analyzed by the coal laboratory of the Indiana Geological Survey between 1954 and the late 1980s. Parameters of proximate analyses, as well as selected ultimate and sulfur-form analyses are included. This database does not contain petrographic information on coal, vitrinite reflectance data, or trace-element analyses. Statistical analyses of coal quality of complete channel samples from the ICAD database are presented in Hasenmueller (1994). The ICAD contains analyses of samples taken from trucks, railroad cars, coal piles, tipples (usually taken from conveyor belts), drill cuttings, grab samples taken from within coal-bed benches, and channel samples (both partial and complete). The ICAD is available to the public on disk, accompanied by a short written report, which can be obtained from the Indiana Geological Survey. The database also includes stratigraphic information for the samples.

2) **U.S. Geological Survey (USGS) Coal Quality (COALQUAL) Database (Bragg et al., 1998)**. This database, to a certain extent, can be considered a subset of ICAD, because it reports analyses that were performed on splits of the same coal samples that were analyzed by the Indiana Geological Survey and included in ICAD. However, the analyses in COALQUAL were performed by the U.S. Bureau of Mines and, consequently, the reported values are not equivalent to those in

ICAD, even though they represent the same samples from the same locations. Proximate and ultimate analyses, heating values, ash-fusion temperatures, free-swelling indexes, and air-drying losses of 179 coal samples from Indiana were determined by the U.S. Bureau of Mines. COALQUAL contains fewer coal analyses than ICAD because it includes only channel samples with ash contents that are less than or equal to 33 percent. In addition to proximate and ultimate analyses of coal, the COALQUAL database includes analyses of major and minor oxides in the ash, as well as trace elements in the coal, on a whole-coal, as-received basis. This database does not include petrographic or vitrinite reflectance information, however, and coal rank is estimated from parameters of proximate and ultimate analyses.

3) **Pennsylvania State University (Penn State) Coal Database.** In 1996 we received a subset of this database for Indiana (the data were supplied for us by Dave Glick). This database includes analyses of 48 samples of Indiana coal. In addition to sample location and depth, information is provided on moisture content (as-received), ash content (dry basis), sulfur content (dry basis), calorific value (dry basis), vitrinite reflectance, and trace-element contents (whole-coal, as-received basis).

4) **Organic Petrology Database (OPD, Mastalerz and Padgett Alano, 1999)**. This database was created as a result of a multiyear project on the characterization of Indiana coals for coking; this project was supported by the Indiana Department of Commerce. The OPD includes a wide range of coal analyses acquired during this project (1996–1999) on the Danville, and Upper and Lower Coal Members from Clay, Greene, Knox, and Vigo Counties. The database contains 121 locations and 574 records that include both full-channel and bench samples.

5) **Mercury Database (Mastalerz et al., 2004)**. This database was created as a result of two projects, one on the distribution of mercury in Indiana coals funded by IDOC from 2002 to 2004, and another on the quality of Indiana coal funded by the USGS (NACQI) in 2001–2002. The Mercury Database included new analyses performed from 2001 to 2004, as well as all records from databases 1 through 4 (above) that included mercury data. In total, this database includes 449 full-channel samples and 301 bench samples.

6) **Energy Information Administration (EIA) coal quality 2000 database**. This database did not contain good descriptions of the original sources of data; however, we suspected, and it turned out to be the case, that it included numerous records from one or more of the above-mentioned databases. This database had 1,680 records.

7) **EPRI database**. We had very limited information about this database, and the sources of the data. Therefore, we did not know if the records are duplicates of those from other databases or represented some additional data. Because, however, this database included many records (3,679), we decided to include them, and made efforts to identify and delete duplicates.

Because of the overlap of records in the databases, data was checked for redundancy, and repeated records were eliminated. Out of about 5,000 records resulting from the compilation of databases 1 through 7 (above), 2,863 records remain. The database was purged of repetitions based on location. A total of 392 records do not have exact locations (county only), however, we decided to retain these because they had reliable values. Records were completed and updated.

III. Content of this CD-ROM

This CD-ROM contains the Indiana coal quality database, **ICQD.mdb;** it is a Microsoft Access database (version 2003) containing a table that provides detailed location and quality information for 2,863 public, point-source coal resource data in southwestern Indiana. This database contains all data that have been collected as of October 2005. Figure 1 illustrates the location of these data points plotted on a 1:1,250,000-scale county base map. Figure 2 shows lithostratigraphy of the Pennsylvanian System in Indiana (modified from Mastalerz and Harper, 1998, and the Tri-State Committee on Correlation of the Pennsylvanian System in the Illinois Basin, 2001).

IV. Database content

Database field descriptions and their explanations are given below. Field descriptions were designed in such a way to be as self-explanatory as possible.

Field header	Explanation
ID-1	Old database ID

Location and stratigraphy

Coal basin	Coal basin name
State	State
County	County
Coalbed age	Coal-bed age
Group	Group name
Formation	Formation name
Coal bed	Coal-bed name
Mine/Drill hole	Mine name or drill hole name or number
Sampling place	Sampling place
Coal rank	Coal rank
Sample type 1	Sample type (full channel, partial channel, bench)
Sample type 2	Sample type (raw, float)
UTMX83	UTM X - coordinate, North American Datum 1983, zone 16
UTMY83	UTM Y - coordinate, North American Datum 1983, zone 16
Latitude	Latitude in decimal degrees
Longitude	Longitude in decimal degrees
TWN	Public land survey system: township number
TWPD	Public land survey system: township direction
RNG	Public land survey system: range number
RNGD	Public land survey system: range direction
Type	Land survey system type or unit designation
Section	Unique land unit identification
Meridian	Principle meridian
Sample depth – feet (core)	Sample depth [feet] for samples collected from cores
Sample depth – cm (full channel)	Sample position in a coal bed [cm] beginning from the seam top
Seam thc – in	Coal-bed thickness [inches]
Seam thc – cm	Coal-bed thickness [cm]
Sample thc – in	Sample thickness [inches]

Sample thc – cm	Sample thickness [cm]

Proximate and ultimate analysis

Moist-ar	Moisture content [%, as-received basis]
Moist-equil	Equilibrium moisture content [%]
Ash-ar	Ash content [%, as-received basis]
Ash-dry	Ash content [%, dry basis]
S-pyr-ar	Pyritic sulfur content [%, as-received basis]
S-pyr-dry	Pyritic sulfur content [%, dry basis]
S-sulf-ar	Sulfate sulfur content [%, as-received basis]
S-sulf-dry	Sulfate sulfur content [%, dry basis]
S-org-ar	Organic sulfur content [%, as-received basis]
S-org-dry	Organic sulfur content [%, dry basis]
S-pa-dry	Sulphur content base on proximate analysis [%, dry basis]
S-tot-ar	Total sulfur content [%, as-received basis]
S-tot-dry	Total sulfur content [%, dry basis]
Btu-ar	Heating value [Btu/lb, as-received basis]
Btu-dry	Heating value [Btu/lb, dry basis]
Btu-daf	Heating value [Btu/lb, dry and ash free basis]
VM-ar	Volatile matter content [%, as-received basis]
VM-dry	Volatile matter content [%, dry basis]
VM-daf	Volatile matter content [%, dry and ash free basis]
Fix-C-ar	Fixed carbon content [%, as-received basis]
Fix-C-dry	Fixed carbon content [%, dry basis]
Fix-C-daf	Fixed carbon content [%, dry and ash free basis]
Ult-C-ar	Carbon content [%, as-received basis] from ultimate analysis
Ult-C-dry	Carbon content [%, dry basis] from ultimate analysis
Ult-C-daf	Carbon content [%, dry and ash free basis] from ultimate analysis
Ult-H-ar	Hydrogen content [%, as-received basis] from ultimate analysis
Ult-H-dry	Hydrogen content [%, dry basis] from ultimate analysis
Ult-H-daf	Hydrogen content [%, dry and ash free basis] from ultimate analysis
Ult-N-ar	Nitrogen content [%, as-received basis] from ultimate analysis
Ult-N-dry	Nitrogen content [%, dry basis] from ultimate analysis
Ult-N-daf	Nitrogen content [%, dry and ash free basis] from ultimate analysis
Ult-O-ar	Oxygen content [%, as-received basis] from ultimate analysis
Ult-O-dry	Oxygen content [%, dry basis] from ultimate analysis
Ult-O-daf	Oxygen content [%, dry and ash free basis] from ultimate analysis
Ult-S-ar	Sulfur content [%, as-received basis] from ultimate analysis
Ult-S-dry	Sulfur content [%, dry basis] from ultimate analysis
Ult-S-daf	Sulfur content [%, dry and ash free basis] from ultimate analysis

Petrography

Vit	Vitrinite content [volume %]
Lip	Liptinite content [volume %]
Iner	Inertinite content [volume %]
MM	Mineral matter content [volume %]
Ro	Vitrinite reflectance [%]

Trace elements

Ag	Silver content [ppm, whole coal basis]
Al	Aluminium content [ppm, whole coal basis]
As	Arsenic content [ppm, whole coal basis]
Au	Gold content [ppm, whole coal basis]
B	Boron content [ppm, whole coal basis]
Ba	Barium content [ppm, whole coal basis]
Be	Beryllium content [ppm, whole coal basis]
Bi	Bismuth content [ppm, whole coal basis]
Br	Bromine content [ppm, whole coal basis]
Ca	Calcium content [ppm, whole coal basis]
Cd	Cadmium content [ppm, whole coal basis]
Ce	Cerium content [ppm, whole coal basis]
Cl	Chlorine content [%, whole coal basis]
Co	Cobalt content [ppm, whole coal basis]
Cr	Chromium content [ppm, whole coal basis]
Cs	Cesium content [ppm, whole coal basis]
Cu	Copper content [ppm, whole coal basis]
Dy	Dysprosium content [ppm, whole coal basis]
Er	Erbium content [ppm, whole coal basis]
Eu	Europium content [ppm, whole coal basis]
F	Fluorine content [ppm, whole coal basis]
Fe	Iron content [ppm, whole coal basis]
Ga	Gallium content [ppm, whole coal basis]
Gd	Gadolinium content [ppm, whole coal basis]
Ge	Germanium content [ppm, whole coal basis]
Hf	Hafnium content [ppm, whole coal basis]
Hg	Mercury content [ppm, whole coal basis]
Ho	Homium content [ppm, whole coal basis]
In	Indium content [ppm, whole coal basis]
Ir	Iridium content [ppm, whole coal basis]
K	Potassium content [ppm, whole coal basis]
La	Lanthanum content [ppm, whole coal basis]
Li	Lithium content [ppm, whole coal basis]
Lu	Lutetium content [ppm, whole coal basis]
Mg	Magnesium content [ppm, whole coal basis]
Mn	Manganese content [ppm, whole coal basis]
Mo	Molybdenum content [ppm, whole coal basis]
Na	Sodium content [ppm, whole coal basis]

Nb	Niobium content [ppm, whole coal basis]
Nd	Neodymium content [ppm, whole coal basis]
Ni	Nickel content [ppm, whole coal basis]
Os	Osmium content [ppm, whole coal basis]
P	Phosphorus content [ppm, whole coal basis]
Pb	Lead content [ppm, whole coal basis]
Pd	Palladium content [ppm, whole coal basis]
Pr	Praseodymium content [ppm, whole coal basis]
Pt	Platinum content [ppm, whole coal basis]
Rb	Rubidium content [ppm, whole coal basis]
Re	Rhenium content [ppm, whole coal basis]
Rh	Rhodium content [ppm, whole coal basis]
Ru	Ruthenium content [ppm, whole coal basis]
S	Sulfur content [ppm, whole coal basis]
Sb	Antimony content [ppm, whole coal basis]
Sc	Scandium content [ppm, whole coal basis]
Se	Selenium content [ppm, whole coal basis]
Si	Silicon content [ppm, whole coal basis]
Sm	Samarium content [ppm, whole coal basis]
Sn	Tin content [ppm, whole coal basis]
Sr	Strontium content [ppm, whole coal basis]
Ta	Tantalum content [ppm, whole coal basis]
Tb	Terbium content [ppm, whole coal basis]
Te	Tellurium content [ppm, whole coal basis]
Ti	Titanum content [ppm, whole coal basis]
Th	Thorium content [ppm, whole coal basis]
Tl	Thallium content [ppm, whole coal basis]
Tm	Thulium content [ppm, whole coal basis]
U	Uranium content [ppm, whole coal basis]
V	Vanadium content [ppm, whole coal basis]
W	Tungsten content [ppm, whole coal basis]
Y	Yttrium content [ppm, whole coal basis]
Yb	Ytterbium content [ppm, whole coal basis]
Zn	Zinc content [ppm, whole coal basis]
Zr	Zirconium content [ppm, whole coal basis]

Ash composition and other ash properties

Ash Al2O3	Aluminum oxide value [%] as determined on coal ash
Ash BaO	Barium oxide value [%] as determined on coal ash
Ash CaO	Calcium oxide value [%] as determined on coal ash
Ash Fe2O3	Ferric oxide value [%] as determined on coal ash
Ash K2O	Potassium oxide value [%] as determined on coal ash
Ash MgO	Magnesium oxide value [%] as determined on coal ash
Ash MgO2	Magnesium dioxide value [%] as determined on coal ash
Ash MnO	Manganese oxide value [%] as determined on coal ash
Ash MnO2	Manganese dioxide value [%] as determined on coal ash

Ash Na2O	Sodium oxide value [%] as determined on coal ash
Ash P2O5	Phosphorus pentoxide value [%] as determined on coal ash
Ash SiO2	Silicon dioxide value [%] as determined on coal ash
Ash SO3	Sulfur trioxide value [%] as determined on coal ash
Ash SrO	Strontium oxide value [%] as determined on coal ash
Ash TiO2	Titanum dioxide value [%] as determined on coal ash
ADLOSS	Air-dried loss value [%] as determined by ASTM method D-2013
GSASH	Ash value [%] as determined by USGS laboratories (ash obtained at 525 deg. C)
Slag Visc	Slag viscosity
Foul Ind	Fouling index
Foul Type	Fouling type
Slag Inx	Slagging index
Slag Type	Slagging type
Silica	Silica value
Alk % Na2O	% alkali as Na2O
Agi	Agglomerating index
Id	Initial deformation temperature in degrees Fahrenheit in the fusibility of coal-ash test
Id+	A plus sign in this field indicates that the sample had not yet undergone initial deformation at Id temp
Heqw	Height-equals-width temperature (deg. F) in the fusibility of coal-ash test; the temperature at which the height of the ash cone equals its width in a reducing atmosphere
Heqw+	A plus sign in this field indicates that the sample had not yet reached the height-equals-width condition at the temperature recorded in the Heqw field
Fluid	Fluid temperature (deg. F) in the fusibility of coal-ash test; temperature at which ash becomes fluid in a reducing atmosphere
Fluid+	A plus sign in this field indicates that the sample had not yet reached a fluid condition at the temperature recorded in the Fluid field
FSI	Free-swelling index
HGI	Hardgrove grindability index
Base/acid ratio	Base/acid ratio
AFTR_INIT	Initial ash fusion temperature (deg. F) in reducing conditions
AFTR_SOFT	Softening ash fusion temperature (deg. F) in reducing conditions
AFTR_HEM	Hemispherical ash fusion temperature (deg. F) in reducing conditions
ASFR_FINAL	Final ash fusion temperature (deg. F) in reducing conditions
AFTO_INIT	Initial ash fusion temperature (deg. F) in oxidizing conditions
AFTO_SOFT	Softening ash fusion temperature (deg. F) in oxidizing conditions
AFTO_HEMI	Hemispherical ash fusion temperature (deg. F) in oxidizing conditions
AFTO_FINAL	Final ash fusion temperature (deg. F) in oxidizing conditions
ASDEFT	Ash deformation temperature (deg. F) in reducing conditions
ASH SOFT	Ash softening temperature (deg. F) in reducing conditions
ASHFLDT	Ash fluid temperature (deg. F) in reducing conditions
ASH_UNDET	Concentration of undetermined compounds in ash (%) - (% of ignited basis)

Rheological properties

G_MAXFLUID	Maximum fluidity (DDPM)
GTEMP_MAXFLUID	Temperature at maximum fluidity (deg. C)
GTEMP_START	Temperature of plasticity start (1DDPM, deg. C)
GSTEMP_FINAL	Temperature of plasticity final (1DDPM, deg. C)
GTEMP_RANGE	Temperature range between start and final (deg. C), plasticity range
ARNUTEMP_INIT	Initial softening temperature (deg. C)
ARNUTEMP_MAXCONTRACT	Maximum contraction temperature (deg. C)
ARNUTEMP_MAXDIL	Maximum dilatation temperature (deg. C)
ARNUTEMP_MAXCON	Maximum contraction (%)
ARNUMAX_DIL	Maximum dilatation (%)

Washability tests

155% FF	Contribution of float fraction (%), SG=1.55 (at specific gravity 1.55 g/cm^3)
155_ASH-dry	Ash content [%, dry basis] of float sample
155_BTU-dry	Heating value [Btu/lb, dry basis] of float sample
155_ SUL-dry	Total sulfur content [%, dry basis] of float sample

Other identification

Data source	Name of an old database from which data were taken
Data collector	Name of data collector
Date	Date the sample was collected if known (MM/DD/YY or MM/YY or YYYY)
ID-2	Old database ID – 2 (alternative ID used for the sample)
ID-3	Old database ID – 3 (alternative ID used for the sample)
ID-4	Old database ID – 4 (alternative ID used for the sample)
ID-5	Old database ID – 5 (alternative ID used for the sample)

V. Using ICQD.mdb

To work with the database ICQD.mdb, take the following steps:
1) Copy ICQD.mdb to your local hard drive;
2) Right-select ICQD.mdb**;**
3) Left-select “Properties,” then left-select the “General” tab;
4) Uncheck the “Read-only” box;
5) Double-click ICQD.mdb to open the database.

The database is composed of a single table – ALL DATA.
To run a query for a specific type of information:
1) Go to “Queries” (menu on the left side);
2) Click on “Create query in a design view;”
3) Add the table (ALL DATA);
4) Select the desired fields by double clicking;
5) Each query MUST include columns “Sample type 1” and “Sample type 2;” Sample type 1 specifies if the sample came from full channel, partial channel, benches, grab, etc.;

Sample type 2 specifies if it is raw or float (washed) sample;
6) Go to Query in the main upper menu and click "Run."

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V. Acknowledgments

Numerous data included in this database were collected, and often analyzed, with the help of Indiana mining companies. Funding and sponsoring organizations, including the USGS and IDOC, were instrumental in acquiring data.

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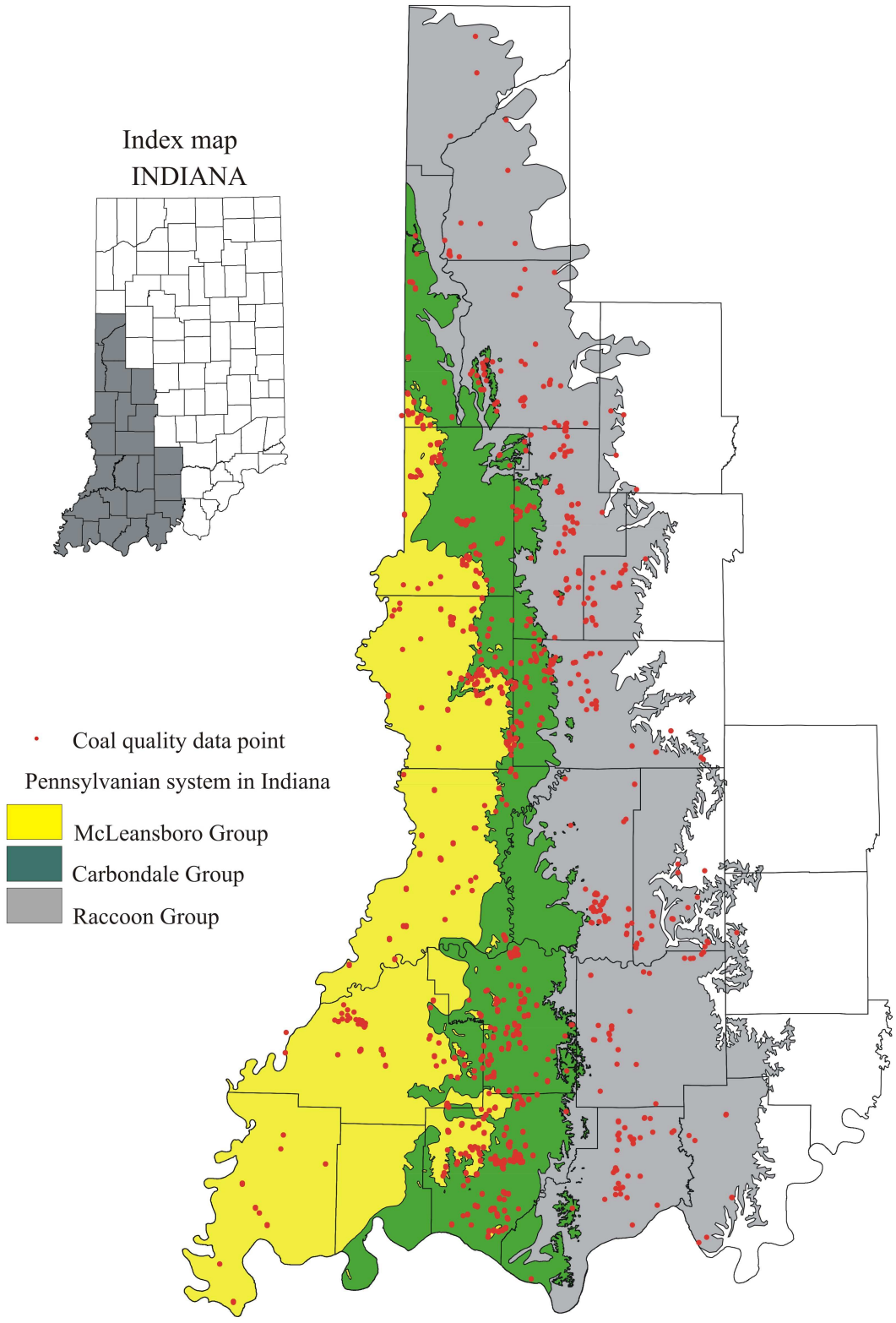

Figure 1. Map of southwestern Indiana showing the location of coal quality points as of October 2005. Map scale: 1:1,250,000

Note: 1) 392 records have only county locations, and they are not included on the map;
2) each coal quality data point on the map may represent multiple records.

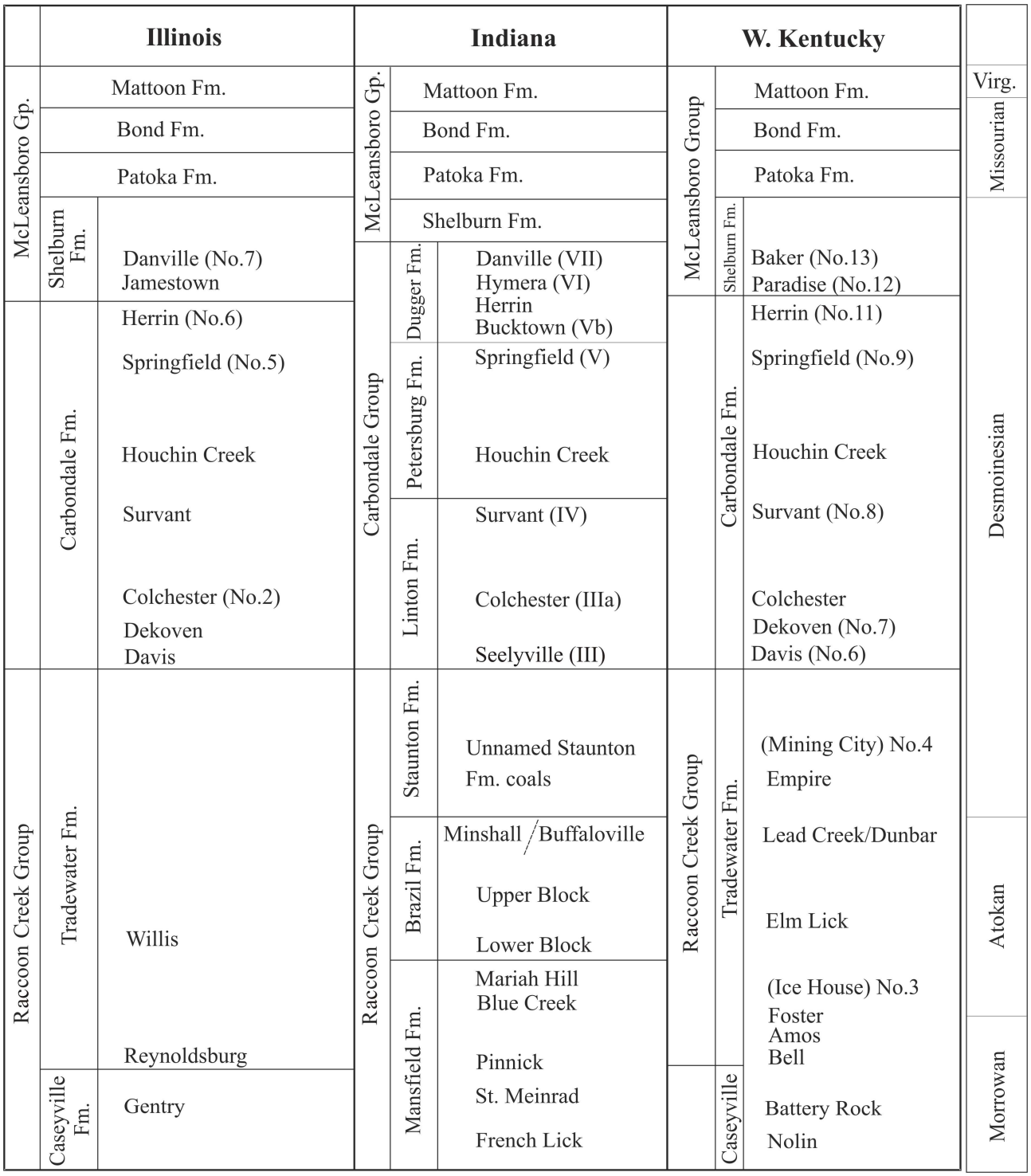

Figure 2. Lithostratigraphy of the Pennsylvanian System in Indiana (modified from Mastalerz and Harper, 1998, and the Tri-State Committee on Correlation of the Pennsylvanian System in the Illinois Basin, 2001). Although numbers of the coal beds have been abandoned in all the three states, they are included here because they are still in common use in coal mines.