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Resource Assessment of the Springfield, Herrin, Danville, and Baker Coals in the Illinois Basin

Introduction

This assessment provides overviews of the geologic setting, distribution, quantity, and quality of the major producing coals in the Illinois Basin. The coal-bearing rocks of the Illinois Basin are of Pennsylvanian age and underlie 36,800 mi² in Illinois, 6,500 mi² in Indiana, and 6,400 mi² in western Kentucky. The major economic coals in the basin are the Springfield, Herrin, Danville, and Baker Coals.

The principal products of this assessment are:

A. Coal resource estimates categorized by State, mining district, county, geologic reliability of the estimate, and coal thickness and depth;

B. Regional and statewide maps that depict coal extent, thickness, elevation (structure), mined-out areas, areas where the coal may potentially be mined at the surface or underground, and geographic distributions of ash, sulfur, and major, minor, and trace-element contents; and

C. Digital databases that contain all publicly available point-source data on coal thickness and depth (more than 40,000 records) and coal quality (more than 6,900 records).

This assessment was a cooperative effort between the U.S. Geological Survey and the State Geological Surveys of Illinois, Indiana, and Kentucky.

Stratigraphy—The Pennsylvanian rocks were deposited between about 325 and 290 million years before present. They reach a maximum thickness of nearly 2,500 ft in southeastern Illinois and generally thin toward the north, northwest, and northeast. The Pennsylvanian rocks in the Illinois Basin are divided into the Raccoon Creek Group, Carbondale Formation or Group, and the McLeansboro Group. **Figure 1** shows the relative stratigraphic positions of the Springfield, Herrin, Danville, and Baker Coals.

Structure—The major structural features in the Illinois Basin are the La Salle anticlinal belt, the DuQuoin monocline, and the Cottage Grove–Rough Creek fault system. These structures bound the Fairfield Basin in southeastern Illinois **(fig. 2)**. In Illinois and Indiana, the major coals crop out along the margins of the basin and generally dip to depths of more than 1,000 ft at the center of the Fairfield Basin, as shown for the Springfield Coal in **figure 2**. In western Kentucky, structures affecting the coal-bearing rocks are different on either side of the east-west-trending Rough Creek fault system. North of the Rough Creek fault system, the rocks dip gently to the west at about 15–20 ft/mi. South of the Rough Creek fault system, the structure is characterized by east-west-oriented synclines with much steeper dips, between 50 and 250 ft/mi.

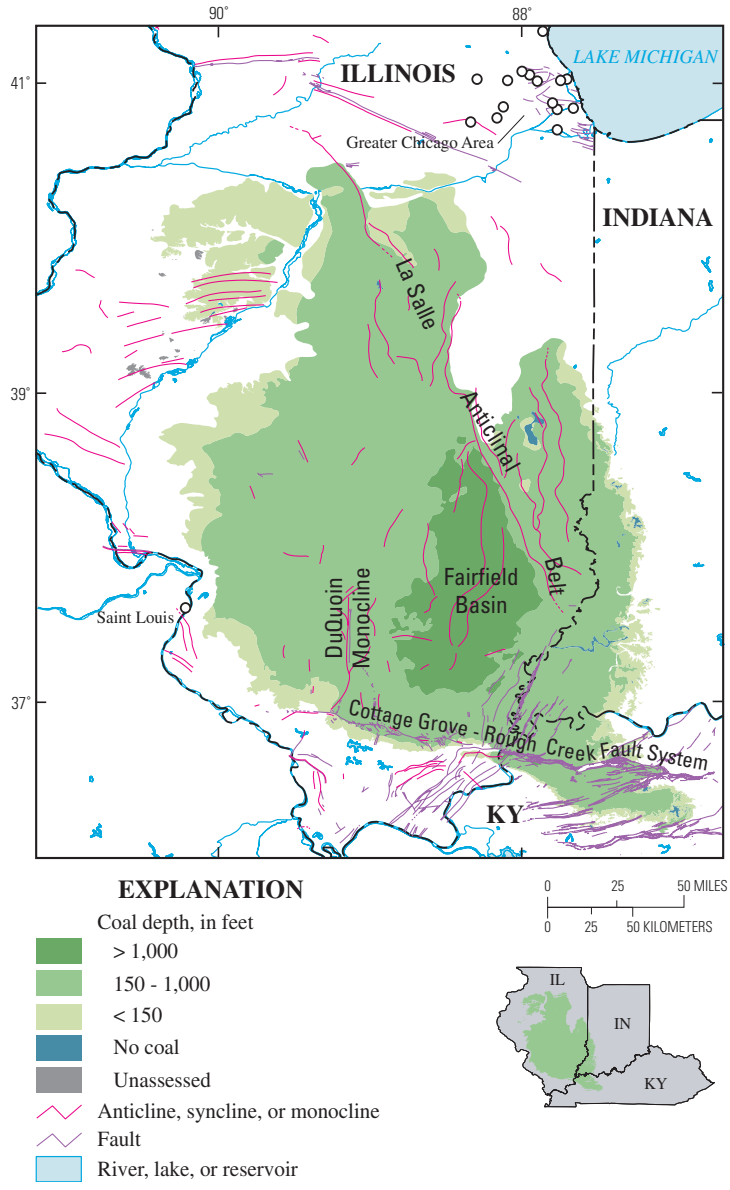


Figure 2 (above). *Major structural features and extent and depth of the Springfield Coal in the Illinois Basin. Modified from Hatch and Affolter (2002, Chapter A, fig. 4).*

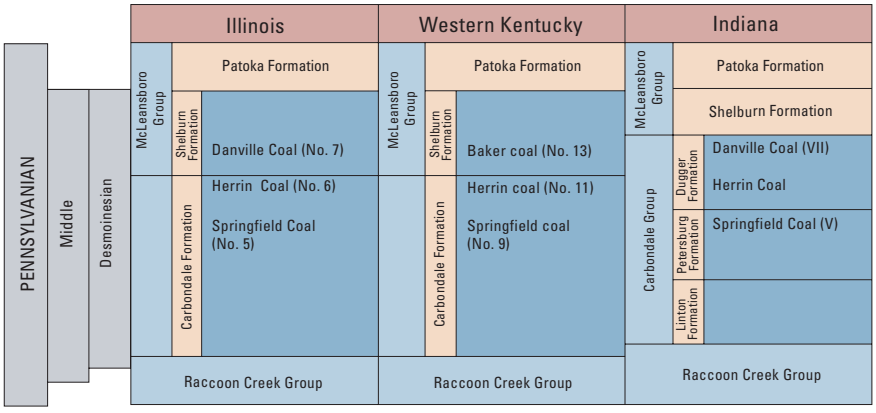
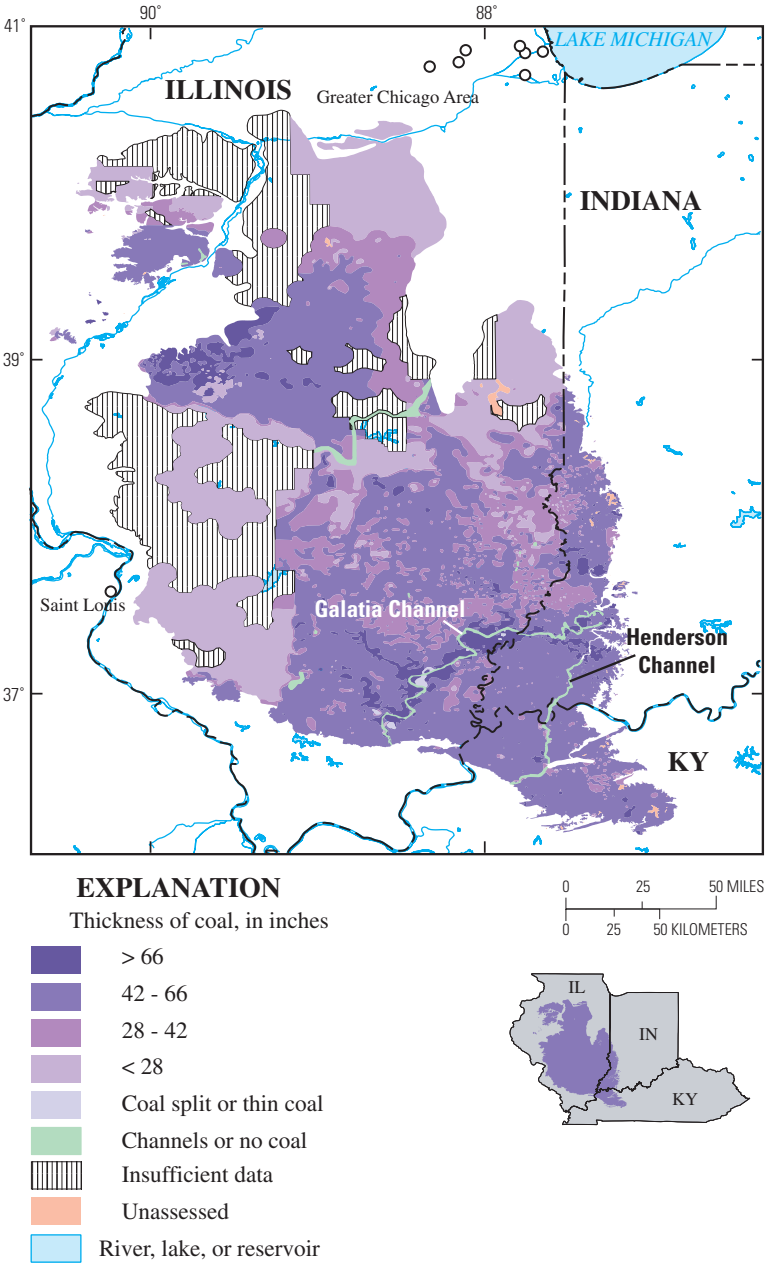


Figure 1 (left). *Generalized stratigraphic framework for the major producing coals in the Illinois Basin. Modified from Mastalerz and Harper (1998) and Greb and others (1992).*



Major Economic Coals

Springfield Coal—The Springfield Coal is the most extensively mined coal in the Illinois Basin. In Illinois, this coal has a thickness of between 4.5 and 6 ft in most areas where it has been mined. Thickness of the Springfield Coal (in inches) is shown in **figure 3**. In Indiana, coal thickness is usually between 3 and 7.4 ft, but as much as 13 ft has been reported. South of the Rough Creek fault system in western Kentucky, the coal is 5–6 ft in thickness, but thins to less than 4 ft toward the east and northeast of the Rough Creek fault system.

Herrin Coal—In Illinois, the Herrin Coal averages more than 6 ft thick over extensive areas and locally reaches 15 ft thick. It is thinner and irregular in thickness in much of central and southeastern Illinois. In Indiana, the Herrin is not well developed, and it is not mined. In western Kentucky, the Herrin occurs in two geographically distinct bodies. The thicker of these bodies is in a narrow belt along the south edge of the coal field, where the Herrin is as much as 10 ft thick. Throughout the basin, the lower part of the Herrin Coal contains a prominent claystone parting (the "blue band") that normally is 1–3 in. thick.

Danville and Baker Coals—In east-central Illinois, the Danville Coal is as much as 6 ft thick. In most of the rest of the State, the Danville is thin, generally from a few inches to less than 3 ft thick. In Indiana, the Danville ranges from 0.2 to 6 ft thick, averaging 4 ft in the north and 2 ft in the south. In western Kentucky, the Baker coal is a complex, multiple-bench zone in which mineable coals are separated by rock partings (Weisenfluh and others, 1998). The Danville Coal in southern Indiana is correlative to an upper bench of the Baker coal in western Kentucky. Two distinct bodies of thicker Baker coal are well documented—one south of the Rough Creek fault system and one north.

State and basin-wide maps showing the extent, depth, and thickness of the Herrin, Danville, and Baker Coals can be found in Chapters A, C, and D, and in the Arcview project in Hatch and Affolter (2002).

Figure 3 (left). *Extent and thickness of the Springfield Coal in the Illinois Basin. Modified from Hatch and Affolter (2002, Chapter A, fig. 7).*

Table 1. *Estimated, remaining, identified resources of the Springfield, Herrin, Danville, and Baker Coals in Illinois, Indiana, and western Kentucky.*

[Resource numbers are rounded to two significant figures, or to nearest 100 million tons for numbers greater than 10 billion short tons. Columns may not sum exactly due to rounding. NC, resources not calculated. Summarized from Hatch and Affolter (2002, Chapter D, Appendixes 1-3]

Area	Coal depth (feet)	Remaining, identified resources (million short tons)											
		Springfield Coal				Herrin Coal				Danville and Baker Coals			
		Coal thickness (inches)				Coal thickness (inches)				Coal thickness (inches)			
		14-28	>28-42	>42	All	14-28	>28-42	>42	All	14-28	>28-42	>42	All
Illinois	0–150	410	560	3,000	4,000	280	1,300	5,900	7,600	910	880	630	2,400
	>150	0	11,900	45,800	57,700	0	10,500	60,900	71,400	590	7,600	7,300	15,500
	Subtotal	410	12,500	48,800	61,700	280	11,800	66,800	78,900	1,500	8,500	8,000	17,900
Indiana	0–150	25	280	1,800	2,100	NC	NC	NC	NC	210	840	500	1,600
	>150	150	1,500	8,400	10,100	NC	NC	NC	NC	1,200	2,900	670	4,700
	Subtotal	180	1,800	10,200	12,100	NC	NC	NC	NC	1,400	3,700	1,200	6,300
Western Kentucky	0–150	1	17	960	980	47	74	430	550	310	360	260	930
	>150	9	180	5,800	6,000	140	460	1,500	2,100	580	500	1,300	2,400
	Subtotal	10	200	6,800	7,000	180	530	1,900	2,600	890	870	1,600	3,400
Total Illinois Basin	0–150	430	860	5,700	7,000	320	1,400	6,300	8,100	1,400	2,100	1,400	4,900
	>150	160	13,500	60,000	73,700	140	11,000	62,400	73,500	2,300	11,000	9,200	22,500
	Total	590	14,400	65,700	80,700	460	12,400	68,700	81,600	3,700	13,100	10,600	27,400

Coal Resource Assessment

Coal Production—Coal production in Illinois Basin began in the early 1800's. From 1890 to 1998, about 5,600 million short tons (mst) of coal were produced from all mineable coals in Illinois, about 2,500 mst in western Kentucky, and about 2,100 mst in Indiana. A maximum of about 148 mst was produced from the basin in 1984. In 2000, coal production from the Illinois Basin was about 88.4 mst.

Remaining Coal Resources—For this assessment, estimated remaining coal resources are categorized by coal, State, mining area, county, overburden thickness (0–150 ft and >150 ft), coal thickness (14–28 in., >28–42 in., and >42 in.), and reliability of estimate (Hatch and Affolter, 2002, Chapter D, Appendixes 1–3). For Illinois and Indiana, reliability categories are I-A (0–0.5 mi from a data point), I-B (>0.5–2 mi), and II-A (>2–4 mi). For western Kentucky, the categories are measured (0–0.25 mi from a data point), indicated (>0.25–0.75 mi), inferred (>0.75–3.0 mi), and hypothetical (>3 mi). The remaining identified resources (reliability categories I-A + I-B + II-A or measured + indicated + inferred) categorized by coal, coal depth, and coal thickness for each State and for the basin are tabulated in table 1.

Resource quantities tabulated in table 1 can be summarized as follows:

A. For the Springfield Coal, remaining, identified resources in deposits >42 in. thick and at depths of 0–150 ft (potentially surface mineable) are about 5.7 billion short tons (bst). For depths >150 ft (potentially mineable by underground methods), resources are about 60 bst. As an example, areas where the Springfield Coal is at depths of 0–150 ft and >150 ft are shown in figure 2.

B. For the Herrin Coal, remaining, identified resources in deposits >42 in. thick and at depths of 0–150 ft are about 6.3 bst; for depths >150 ft, they are about 62.4 bst.

C. For the Danville and Baker Coals, remaining, identified resources in deposits >42 in. thick and at depths of 0–150 ft are about 1.4 bst; for depths >150 ft, they are about 9.2 bst.

D. For the Springfield, Herrin, Danville, and Baker Coals, total remaining, identified resources in deposits >42 in. thick are estimated at 145 bst.

Coal Availability—Coal resources available for mining are often significantly less than the original coal resource because coal has been mined, or because the coal resource is unavailable due to land-use or technological restrictions. Examples of land-use restrictions include cities, national forests, major roads, or cemeteries. Examples of technological restrictions include areas where the coal is <42 in. thick, or where the interburden between beds is too thin.

Cooperative studies by the USGS and the State Geological Surveys show that for nineteen selected 7.5-minute quadrangles in Illinois, 46 percent (4.6 bst) of the original coal resource (Springfield, Herrin, Danville, and two other coals) is available for mining. For ten selected 7.5-minute quadrangles in Indiana, 57 percent (3.3 bst) of the original coal resource (Springfield, Danville, and three other coals) is available, and for twelve selected 7.5-minute quadrangles in western Kentucky, 53 percent (2.7 bst) of the original coal resource (Springfield, Herrin, Baker, and two other coals) is available (table 2).

Table 2. *Summary of coal availability for nineteen 7.5-minute quadrangles in Illinois, ten 7.5-minute quadrangles in Indiana, and twelve 7.5-minute quadrangles in western Kentucky.*

[Resource numbers are rounded to two significant figures (modified from Hatch and Affolter, 2002, Chapter A, table 3]

	Coal resources (billion short tons)			
Resource Category	Illinois	Indiana	Western Kentucky	Total
Original	10.0	5.8	5.1	21.0
Mined-out	0.7	0.7	1.0	2.4
Land-use restrictions	0.8	0.3	0.2	1.3
Technological restrictions	3.9	1.5	1.3	6.7
Available	4.6	3.3	2.7	11.0

A statewide study of the availability of the Springfield Coal in Illinois (Treworgy and others, 1999) demonstrated that of an original resource of 52 bst of coal, in deposits >42 in. thick, about 57 percent (30 bst) is available or conditionally available for mining. Four percent (2.2 bst) is not available because it has been mined-out, 5 percent (2.5 bst) is not available because of land-use restrictions, and 34 percent (18 bst) is not available because of technological restrictions. Less than 1 percent (0.5 bst) of the Springfield Coal resource lies beneath public lands.

Coal Quality—Statistical summaries of calorific value, ash yield, and total sulfur, arsenic, and mercury contents for the Springfield, Herrin, Danville, and Baker Coals are listed in table 3. Statistical summaries for 14 additional coal characterization parameters and for 36 other major, minor, and trace-element contents in these coals are listed in Hatch and Affolter (2002, Chapter E, Appendixes 2 and 3). Table 3 shows that ash yields, calorific values, total sulfur, arsenic, and mercury contents of these coals have similar statistics. Most other coal characterization parameters (such as fixed carbon, volatile matter, forms of sulfur and ash fusion temperatures) and elemental compositions (such as nitrogen, lead, uranium, antimony) are also similar for these coals. Geographic distributions and contents of 16 coal characterization measures and element contents for each coal can be found in Hatch and Affolter (2002, Chapter E, Appendix 7). An example of these distributions, mercury contents in the Springfield Coal, is shown in figure 4.

Table 3. *Means and ranges of ash yield, calorific value, and total sulfur, arsenic, and mercury contents for the Springfield, Herrin, Danville, and Baker Coals in the Illinois Basin.*

[Summary data are on a whole-coal, as-received basis; ppm, parts per million; n, number of analyses. Summarized from Hatch and Affolter (2002, Chapter E, Appendixes 2 and 3]

Coal	Ash yield (percent)		Calorific value (Btu/pound)		Total sulfur (percent)		Arsenic (ppm)		Mercury (ppm)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Springfield	11.2	2.8-49.7 *n* = 1,832	11,280	4,810-13,910 *n* = 1,770	3.5	0.5-19.5 *n* = 1,830	12	0.27–130 *n* = 145	0.12	<0.01–1.2 *n* = 123
Herrin	10.9	2.4-43.6 *n* = 2,542	11,170	5,770-13,420 *n* = 2,390	3.0	0.3-14.5 *n* = 2,517	6	<0.2–140 *n* = 216	0.12	<0.01–0.70 *n* = 206
Danville and Baker	11.9	4.4-44.2 *n* = 334	10,920	5,800-12,990 *n* = 295	2.9	0.3-9.7 *n* = 335	19	0.50–70 *n* = 39	0.11	<0.01–0.32 *n* = 39

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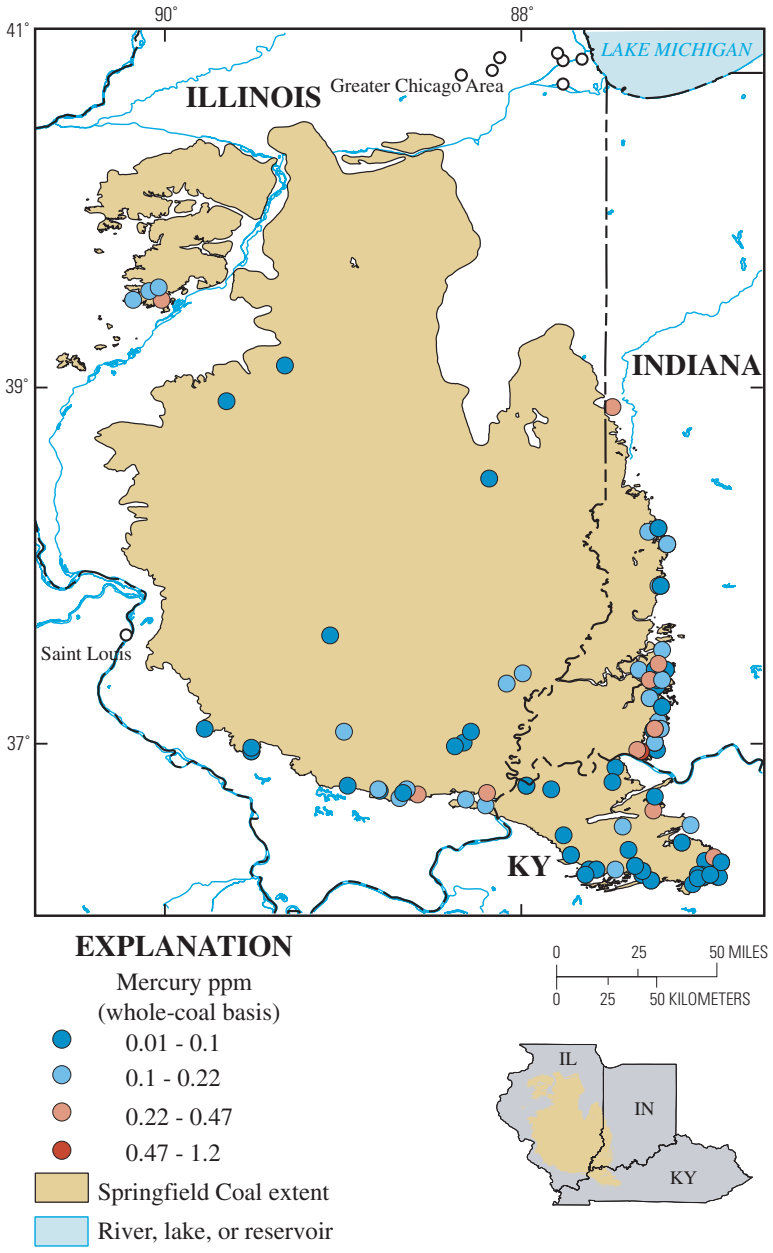

Figure 4. *Extent of the Springfield Coal in the Illinois Basin, localities of coal samples, and mercury contents (whole-coal basis). Modified from Hatch and Affolter (2002, Chapter E, Appendix 7, fig. 44).*

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