

Coal Geology of Illinois

Illinois

The coalfields of Illinois, Indiana, and western Kentucky constitute the Eastern Region of the Interior Coal Province, known better as the Illinois Basin. About 36,800 square miles in Illinois are underlain by the coal-bearing sequence of rocks that constitute the Pennsylvanian System.

General Coal Characteristics

Rank: Illinois coals cover the full range of the high-volatile bituminous coals. Studies indicate that the calorific value of Illinois coals increases systematically from about 11,000 Btu/lb (moist, mineral-matter-free) in the northwestern part of the coalfield to about 15,000 Btu/lb in the southeastern part of the state (Table 1). Across the same area, moisture (mmf) drops from around 20% to less than 5%. The increase in rank with increase in depth at a given point is not as well exhibited as the regional increase in rank from the northwest to the south and southeast. An increase of 100 ft in depth corresponds to about 150 Btu/lb increase in calorific value in the lower rank coals of northern Illinois and to about 60 Btu/lb increase in the higher rank coals of southern Illinois.

Ash and Mineral Matter: The occurrence of ash is irregular and unpredictable for large areas of the individual coal seams. Illinois coals with an ash content (on an as-received basis) of less than 6% are unusual. On the other hand, an ash content of more than 14% (exclusive of readily discardable bedded impurities more than 3/8-in. thick) also is unusual. The average ash content of Illinois coals is about midway between these two extremes, or about 10%, with local variations commonly in the order of 2 to 3%.

Ash must not be confused with mineral matter which is the form in which most incombustible components occur in coal. The composition of mineral matter in Illinois coals varies significantly from place to place and between coal seams. The data in the following table were computed from a large number of channel samples for the two principal coals mined in Illinois; it shows average weight percentages as well as ranges of the main minerals found in Illinois coals, on a whole coal basis:

	Herrin coal	Springfield coal
Clay minerals	9.4 (5.0 - 13.5)	7.0 (3.0 - 13.0)
Quartz	2.4 (1.0 - 3.8)	2.4 (1.2 - 4.3)
Pyrite	3.4 (1.0 - 11.6)	3.9 (0.5 - 18.0)
Calcite	1.3 (0.3 - 5.2)	1.6 (0.3 - 4.9)
Total minerals*	16.5 (10.7 - 22.7)	14.8 (9.8 - 28.0)

*= weight % low temperature ash

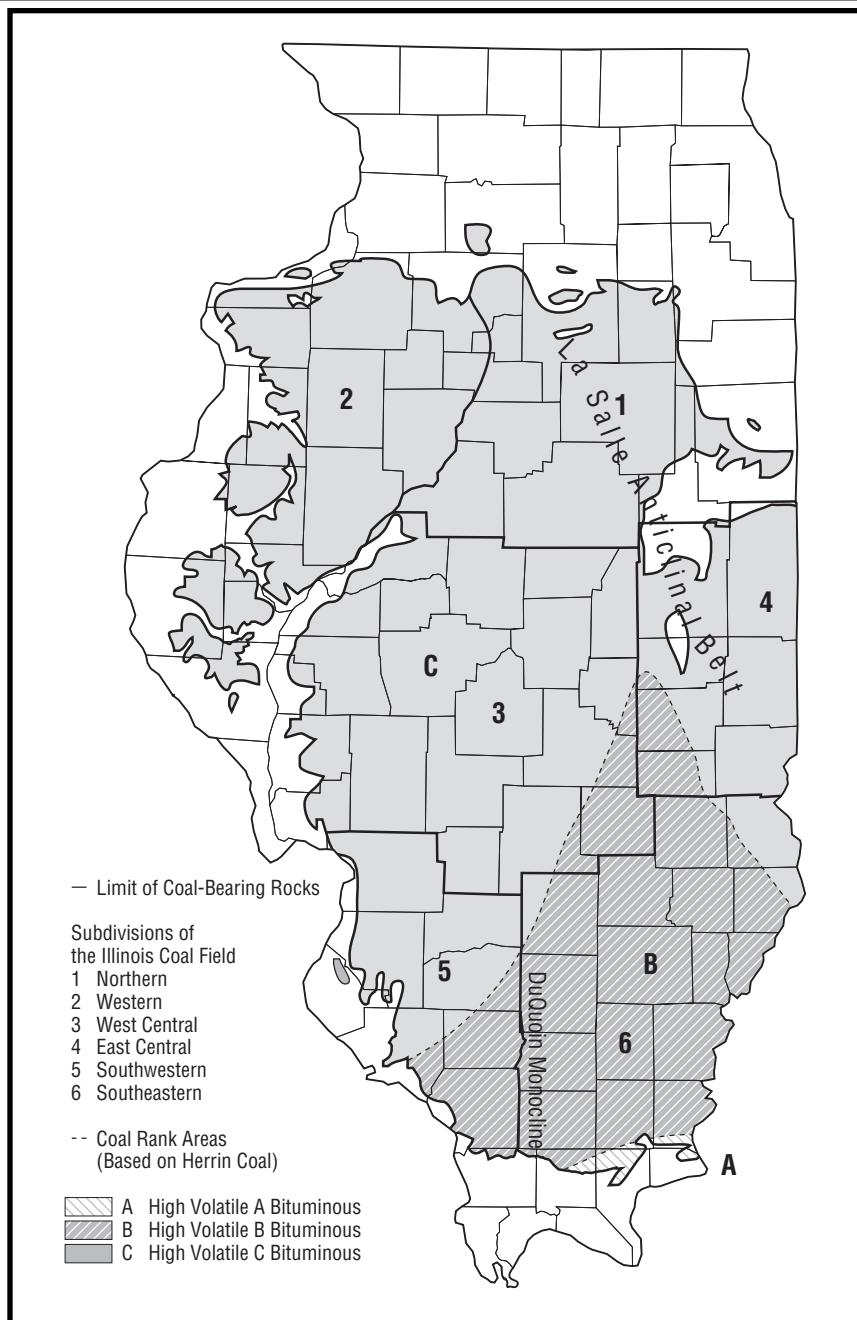


Fig. 1. Subdivisions of the Illinois coalfield and approximate areas of high-volatile A, B and C bituminous rank coals based on the Herrin Coal

Sulfur: Sulfur in Illinois coalbeds is commonly related to the character of the strata overlying the coal. Usually the coals are overlain by marine strata, most commonly by marine black fissile shale or limestone. The sulfur content of the coal below such strata normally ranges from 3 to 5%. In certain areas, however, nonmarine, silty gray shale units intervene between the coal and the overlying black shales and limestones. When the gray shale exceeds about 20 ft in thickness, the sulfur content generally is less than 2.5%, commonly averaging 1.5%.

Total sulfur content of Illinois coals has been reported from as low as 0.5% to more than 7%. The sulfur content is less than 2.5% in a few significant areas; the resources in these areas are estimated to constitute about 6% of the remaining resources. The organic sulfur content of Illinois coals varies from a minimum of about 0.4% to a maximum of about 3%. Pyritic sulfur varies from nearly zero to values of 4 to 5%. Sulfate sulfur constitutes only a negligible amount; it results from weathering of pyrite in coal.

Coal Geology of Illinois

Trace and Minor Elements: Most trace elements in Illinois coals occur in abundances not greatly different from those in the average rock making up the crust of the earth. Only boron, chlorine, and selenium are significantly enriched. An economic potential may exist for removal of certain elements that are valuable and otherwise scarce, such as rare earths or zinc. These elements commonly occur in amounts up to 0.2% of the whole coal and up to 1.5% or more of coal slurry and refuse in some samples from western Illinois.

The 1990 Amendments to the Clean Air Act listed a number of minor and trace elements that commonly occur in coal as "hazardous air pollutants" (HAPs). The following list provides the arithmetic averages and standard deviations of the HAP elements for coals currently marketed by Illinois mines. Essentially all coal shipped from Illinois mines is cleaned. The concentrations of most trace and minor elements are reduced significantly during the cleaning process because of the close association of most elements with mineral matter in coal.

Average trace and minor element composition of coal shipped by Illinois mines (dry basis, in parts per million, except for sulfur) based on 34 samples:

Element	Arithmetic Mean	Standard Deviation
As Arsenic	7.5	8.1
B Boron	90	45
Be Beryllium	1.2	0.7
Cd Cadmium	0.5	0.9
Cl Chlorine	1671	1189
Co Cobalt	3.5	1.3
Cr Chromium	14	6
Cu Copper	9.2	2.5
F Fluorine	93	36
Hg Mercury	0.09	0.06
Li Lithium	9.4	7.1
Mn Manganese	38	32
Mo Molybdenum	8.4	5.7
Ni Nickel	14	5
P Phosphorus	87	83
Pb Lead	24	21
S Sulfur	2.88%	0.99%
Sb Tin	0.9	0.7
Se Selenium	1.9	0.9
Th Thorium	1.5	0.4
U Uranium	2.2	1.9
V Vanadium	31	16
Zn Zinc	84.4	84.2

Coking: Illinois coal is agglutinating when freshly mined, but for the lower ranks of these coals, only weakly so. In general, coking character improves southward with the rank of the coal. Low-sulfur coals produced from the Herrin (No. 6) and Springfield (No. 5) coals in southern Illinois are used commercially in blends

Table 1. Typical ranges of analyses for coals in northwest and southeast Illinois

	Moist, mineral-matter-free basis			Dry, mineral-matter-free basis				
	Calorific Value (Btu/lb)	%Bed Moisture	%Carbon	%Oxygen	%Hydrogen	%Vol Fixed Matter	%Fixed Carbon	R*
Northwest	11,000-11,600	18-21	75-78	10.5-13.5	5-6	40-53	47-60	.43-.60
Southeast	13,700-15,000	4-7	81-84	5-8	5-6	36-43	57-64	.65-.90
R* = % reflectance of polished vitrinite under oil immersion								

with higher rank coking coals from the Appalachian coalfields to produce good metallurgical coke.

Coal Seam Nomenclature

The coals of Illinois are referred to by geographic names; however, several of the more important coals also are commonly referred to by number; the lower the number, the older the coal (Table 2). In Illinois a double-name scheme was used until recently on the numbered coal members, such as Danville (No. 7), Herrin (No. 6), Springfield (No. 5), Colchester (No. 2), and Rock Island (No. 1) coals. The stratigraphic correlation of Illinois, Indiana, and western Kentucky coals is shown in Table 2. The recently adopted basin-wide standardized names of the right column of Table 2 are used throughout this text.

Mining Areas

Many different systems have been used to subdivide the coal-producing areas of Illinois. In the following text, Illinois has been subdivided as shown in Fig. 1.

I. Northern Area - In the northern area, underground mining of coal was carried on extensively in the period between 1875 and 1928. Much of the early mining was done by the historic longwall method. After 1915, however, coal production in northern Illinois began to decline due to development of more profitable mining operations in southern Illinois.

Surface mining began in the area about 1928 and, subsequently, all underground mines closed. Since then, practically all of

Table 2. Correlation of coal seams and rock formations in the Illinois Basin

Illinois		Indiana		West Kentucky		Standardized Terms	
Modesto Fm.		Shelburn Fm.					
Carbondale Fm.	Danville (No. 7) Jamestown Herrin (No. 6)	Dugger Fm.	Danville (VII) Hymera (VI) Herrin	Sturgis Fm.	Coalton (W. Ky. No. 14) Baker (W. Ky. No. 13) Paradise (W. Ky. No. 12)	Shelburn Fm.	
	Springfield (No. 5)	Petersburg Fm.	Springfield (V)	Carbondale Fm.	Herrin (W. Ky. No. 11) Briar Hill (W. Ky. No. 10) Springfield (W. Ky. No. 9)	Herrin	
	Summum (No. 4) Shawneetown	Linton Fm.	Houchin Creek Survant (IV)	Ruff Well	Springfield		
	Colchester (No. 2)		Colchester (IIIa)	Tradewater Fm.	Manningtown (W. Ky. No. 4)	Houchin Creek Survant	
Spoon Fm.	Dekoven/Seelyville Davis Murphysboro New Burnside Bidwell Rock Island (No. 1)	Staunton Fm.	Seelyville (III)		Dekoven (W. Ky. No. 7) Davis (W. Ky. No. 6)	Colchester	
Abbott Fm.	Willis	Brazil Fm.	Buffaloville				
			Minshall Upper Block Lower Block				
	Reynoldsburg	Mansfield Fm.	Mariah Hill Blue Creek St. Meinrad		Bell (W. Ky. No. 1b)		
Coseyville Fm.	Gentry		Pinnick French Lick	Coseyville Fm.	Main Nolin		

Coal Geology of Illinois

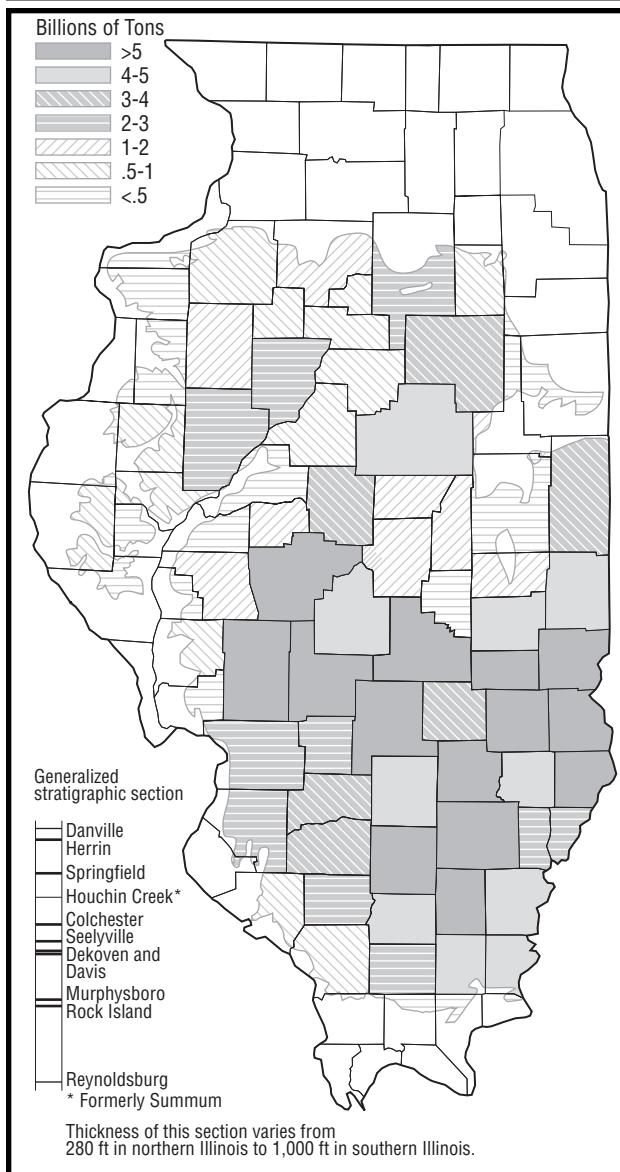


Fig. 2. Remaining coal resources in Illinois, by county

the coal mined in northern Illinois has been from surface operations. The Colchester coal was extensively surface-mined in southwestern Will, western Kankakee, and eastern Grundy counties, and less extensively north of the Illinois River near Morris and westward from the vicinity of Ottawa to Utica in La Salle County. The Houchin Creek was locally surface-mined in eastern Grundy County.

West of the La Salle Anticlinal Belt (Fig. 1) the Colchester coal formerly was mined underground at numerous places in Putnam, Bureau, and La Salle counties. The overlying Herrin and Danville coals also have been mined where they are locally thick.

The Danville coal has been mined underground locally near Pontiac and Fairbury in southern Livingston County

and near Chenoa and Colfax in northeastern McLean County. At Bloomington, in central McLean County, the Colchester and Springfield coals were mined underground. The Springfield seam also has been mined underground near Pekin, Tazewell County.

At present, there are no operating mines in the northern Illinois area (Fig. 3). The last mine in this area was abandoned in 1974. Although some drilling for potential underground minable coal has occurred west of the La Salle Anticlinal Belt, there has been relatively little exploration in the northern Illinois area in recent years.

2. Western Area - The western Illinois area includes all of the coalfields west of the Illinois River and the western half of Bureau County (Fig. 1). Extensive areas of

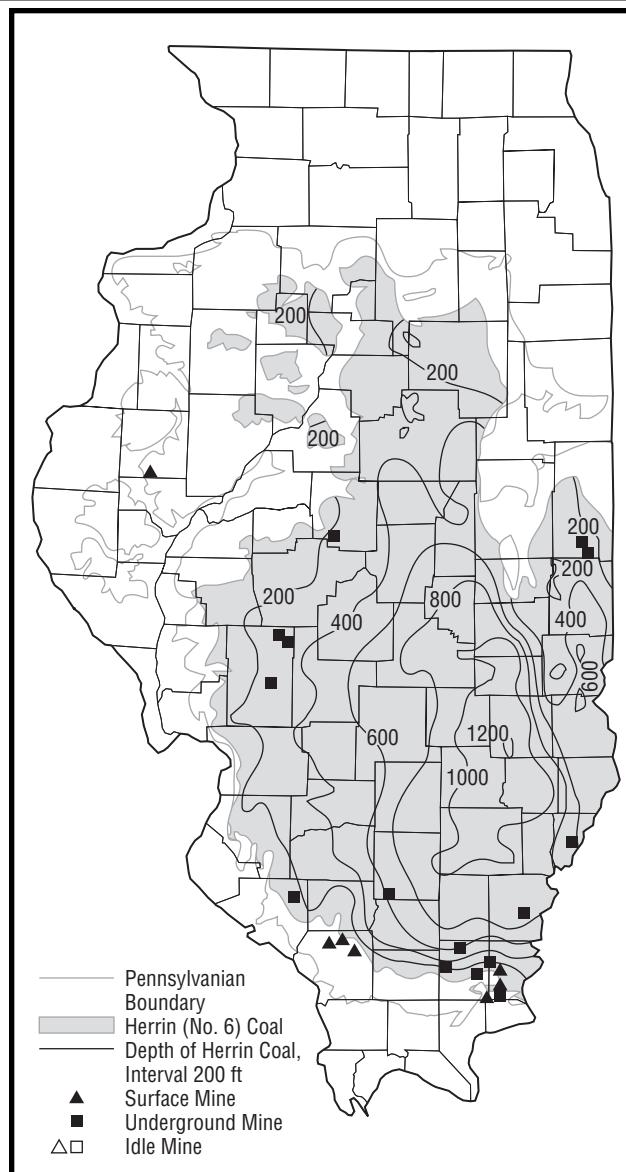


Fig. 3. Active coal mines, mid 2002

the Springfield coal in the vicinity of Canton were favorably situated for surface mining, becoming the sites of some of the earliest large-scale surface mines in the United States. In the past, there were numerous shaft and slope mines throughout western Illinois, but most production since the 1950's has come from surface mines (Fig. 3). Most coal produced in western Illinois has been from the Springfield and Herrin seams. The Colchester coal is the most widespread of all western Illinois coals. It is not as thick as the Springfield and Herrin coals and has not been so extensively surface-mined. It is now being surface-mined in Schuyler and McDonough counties. The Rock Island coal formerly was produced in a number of relatively small mines in Rock Island, Mercer, Henry, Warren, Knox, and Fulton counties.

Coal Geology of Illinois

3. West-Central Area - Currently, mines operate in the west-central Illinois area in Logan and Macoupin counties (Fig. 3). Only one mine produces from the Springfield seam; all other mines produce from the Herrin coal, which is the principal minable seam throughout the southern two-thirds of the region (Fig. 8). Large mines have operated in this area for many years. One area with relatively low-sulfur Herrin coal resources now supports a large underground mine in Macoupin County (Fig. 10). In the northern one-third of the area, the Herrin seam is thinner and of less importance. In this northern part of the area, the underlying Springfield coal is 4 to 6 ft thick (Fig. 9) and has been extensively mined in the vicinity of Springfield; currently one large underground mine operates in this area. Smaller operations also have taken place in Sangamon, Logan, Menard, and Macon counties. Remaining resources within this area are extensive (Table 3).

There has been some small-scale surface mining as well as shallow underground mining of the Shelbyville coal within Shelby County, in the vicinity of Shelbyville and Fancher. This coal lies several hundred feet above the Herrin coal and averages 2 ft in thickness in the area where it has been mined.

4. East-Central Area - In recent years, all of the operating mines in the east-central area (Fig. 3) have been in Vermilion and Douglas counties. The Danville seam has been extensively surface-mined and exploited in many small underground mines in the Danville area of Vermilion County. The underlying Herrin coal has been mined mostly by underground methods south of Danville (Vermilion County), and near Murdock in eastern Douglas County, where the Herrin has a low to medium sulfur content. Two newly constructed sloped mines began production

in 1996 and 2000 from such a reserve south of Danville. The coal also has been mined along the outcrop in Vermilion County. Recent exploration reportedly has outlined an area of relatively low-sulfur Danville coal in Clark County. The Springfield, which is thin under most of Vermilion and Douglas counties, formerly was produced from several small mines in Edgar County.

5. Southwestern Area - The boundary between the southwestern and southern areas is along the Du Quoin Monocline (Fig. 1). This is a relatively prominent structural feature trending north-south that separates the deeper part of the Illinois Basin on the east from the shelf area to the west. The Herrin seam is the principal coal mined in the region. However, the underlying Springfield coal, not continuously well developed over this area, also has been surface-mined in Randolph and Perry counties. One area of low-sulfur Herrin coal has been mapped in the vicinity of Troy, including a portion of Madison and St. Clair counties (Fig. 10).

Most production in the southwestern region in recent years has been from large-scale surface mining of relatively thick Herrin coal along the western margin of the coalfield (Fig. 3). Numerous underground mines, some relatively large, have been operated in Madison, St. Clair, Randolph, and Clinton counties. The southwestern Illinois area, along with the southern part of the west-central area, contains the most widespread thick Herrin coal in Illinois and large resources of this coal are present (Table 3, Fig. 8). A few underground mines in the Herrin seam within this area have been operated at shallow depths (less than 150 ft) due to the relatively large amount of stabilizing limestone present within this interval. In several areas, where the Springfield is present in sufficient thickness and at an interval of

about 25 ft below the Herrin coal, both seams have been mined together by surface operations. In southeastern and central Jackson County, the Murphysboro Coal was extensively deep mined between the 1880s and 1940s, and thereafter surface mined in the central and north-central parts of the county. This includes small surface operations that are currently active.

6. Southeastern Area - The southeastern Illinois area has the largest number of operating mines of any of the six areas described (Fig. 3). The greatest quantity of coal is being mined from the Herrin and Springfield seams, principally in Saline, White, Gallatin, and Wabash counties. The Davis and Dekoven coals underlying the Springfield seam have been surface-mined along their outcrops in the southeastern Illinois area. The Davis has been mined in one underground mine since 1996 in Gallatin County; this had not been done for over 50 years.

Southeastern Illinois contains several areas (Figs. 10 and 11) of relatively low-sulfur coal in both the Springfield and Herrin, the two seams which account for the bulk of present production. Extensive surface mining has occurred along the outcrops of the coals in Williamson, Saline, and Gallatin counties.

In southern Gallatin, Williamson, and Saline counties and northern Johnson, Pope, and Hardin counties are local, relatively thin occurrences of older and higher rank coals, some of which have been mined by small drift and surface operations. The Seelyville coal, which lies 160 to 240 ft below the Springfield coal, now has been correlated with the Dekoven and Davis seams (Table 2). It attains sufficient thickness in the northern part of Area 6 and the southern part of Area 4 to warrant exploration. Although the seam has been mined in Indiana, information on its

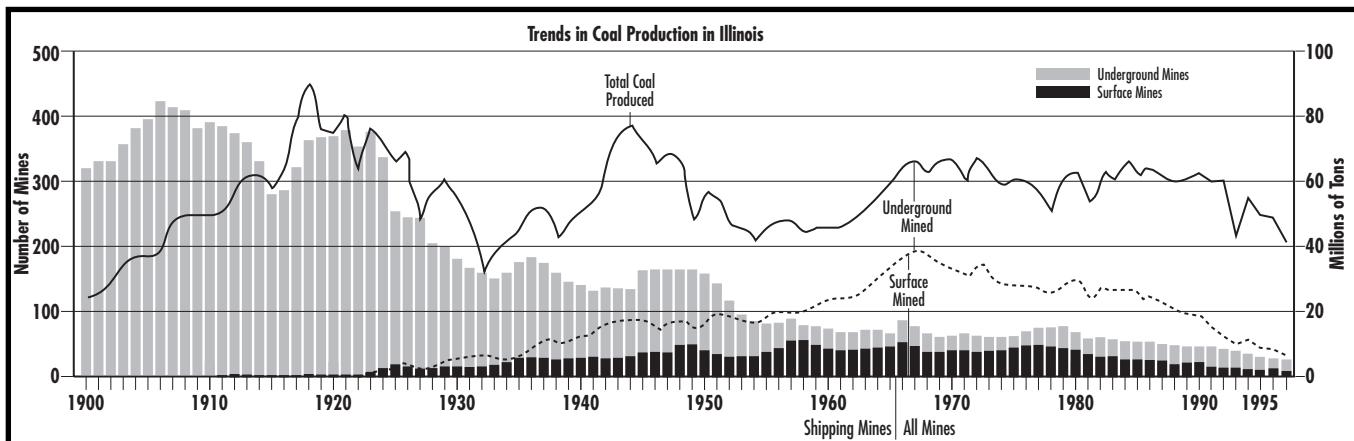


Fig. 4. Trends in Illinois coal production, 1900-1998 (Data from Illinois State Dept. of Natural Resources, Office of Mines and Minerals)

Coal Geology of Illinois

occurrence in Illinois now primarily is based on geophysical logs obtained during exploration for oil.

A large area in southeastern Illinois where oil production has been significant has not been prospected adequately for coal. In much of this area, the Herrin coal generally lies at depths of 650 to more than 1,200 ft (Fig. 3). Using primarily geophysical logs from oil wells, resources of both the Herrin and Springfield seams have been mapped in this deeper portion of the basin. Relatively thin coals, occurring at shallow depths several hundred feet above the Herrin coal, have been mined from time to time in southeastern

Illinois. Production from these stratigraphically high coals has been principally in the vicinities of Obdyke in southeastern Jefferson County, Calhoun in Richland County, Friendsville and Cowling in Wabash County, Flat Rock in Crawford County, and Corinth in Williamson County.

Coal Resources

Illinois has the largest reported bituminous coal resources and the largest stripable bituminous coal resources of any state in the United States. Illinois has the third largest total coal resources of any state and is second only to Montana in

terms of demonstrated reserve base. About 20 coal seams have been mined in Illinois. Most production, however, has come from about eight coal seams, with 85 to 90% of the total production being from the Herrin and Springfield seams. Illinois currently is producing about 40 million tons of coal per year, down from about 60 million tons per year between 1966 and 1992. Surface mining accounts for about 10-15% (Fig. 4).

Approximately 11%, or 22 billion tons, of Illinois coal resources are classified as surface minable or stripable (Table 3). Stripable coal resources are defined as mapped coal greater than 18 in. thick and

Table 3. Remaining identified coal resources in Illinois by county and seam, January 1998 (millions of tons)

County	Danville (No. 7)	Jamestown	Herrin (No. 6)	Springfield (No. 5)	Colchester (No. 2)	Seelyville ²	Dekoven ²	Davis ²	Rock Island (No. 1) ³	Misc.	Resources	Recoverable
										Total	Surface	Reserves ¹
ADAMS	0	0	0	0	616	0	0	0	0	0	616	616
BOND	0	0	2,518	0	2	0	0	0	2	0	2,522	0
BROWN	0	0	0	0	371	0	0	0	0	0	371	363
BUREAU	415	0	680	0	632	0	0	0	0	0	1,729	462
CALHOUN	0	0	0	0	12	0	0	0	0	0	12	12
CASS	0	0	0	137	232	0	0	0	0	0	369	330
CHAMPAIGN	162	0	200	0	0	0	0	0	0	0	363	0
CHRISTIAN	63	0	3,440	1,232	0	0	0	0	43	0	4,779	0
CLARK	1,611	683	419	1,663	0	1,064	0	0	0	0	5,441	158
CLAY	0	0	2,053	1,995	0	33	0	0	0	0	4,083	0
CLINTON	0	0	3,199	99	0	0	0	0	0	0	3,298	0
COLES	1,140	0	1,107	1,080	0	748	0	0	0	0	4,076	146
CRAWFORD	1,212	1,500	366	1,278	0	2,199	0	0	0	50	6,607	50
CUMBERLAND	893	0	1,785	1,315	0	1,335	0	0	0	2	5,332	3
DEWITT	0	0	0	1,496	0	0	0	0	0	0	1,496	0
DOUGLAS	81	0	1,195	459	0	0	0	0	0	0	1,736	199
EDGAR	1,613	0	1,532	772	0	877	0	0	0	0	4,796	401
EDWARDS	0	0	924	1,120	0	0	76	672	0	0	2,794	0
EFFINGHAM	1,202	0	1,334	2,176	0	376	0	0	0	1	5,090	1
FAYETTE	307	0	3,642	2,287	0	0	0	0	0	1	6,239	1
FORD	0	0	0	40	0	0	0	0	0	0	40	0
FRANKLIN	0	0	1,395	2,066	0	0	379	566	0	78	4,485	3
FULTON	56	0	246	656	1,254	0	0	0	8	0	2,221	1,952
GALLATIN	0	0	932	1,263	0	0	956	1,266	0	6	4,424	328
GREENE	0	0	95	0	612	0	0	0	0	0	708	593
GRUNDY	0	0	44	0	803	0	0	0	0	115	963	461
HAMILTON	0	0	2,597	2,426	0	0	738	1,116	0	0	6,878	0
HANCOCK	0	0	0	0	29	0	0	0	0	0	29	29
HENDERSON	0	0	0	0	53	0	0	0	0	0	53	53
HENRY	56	0	249	0	236	0	0	0	64	0	605	601
JACKSON	0	0	78	242	0	0	0	0	0	335	656	322
JASPER	1,243	0	2,904	2,139	0	2,147	0	0	0	0	8,434	0
JEFFERSON	0	0	2,624	2,878	0	0	0	0	0	29	5,532	29
JERSEY	0	0	60	0	269	0	0	0	0	0	329	219
KANKAKEE	0	0	0	0	62	0	0	0	0	14	77	26
KNOX	21	0	212	621	732	0	0	0	51	0	1,640	1,560
LASALLE	560	0	283	0	1,391	0	0	0	0	74	2,309	590
LAWRENCE	1,128	1,398	821	1,499	0	553	0	0	0	156	5,558	0
LIVINGSTON	1,816	0	162	213	1,500	0	0	0	0	145	3,838	846
LOGAN	0	0	823	2,807	0	0	0	0	0	0	3,630	0

Coal Geology of Illinois

with less than 150 ft of overburden. Fig. 5 shows the distribution of stripable resources by average seam thickness. Of this 22 billion tons, about 6.1 billion were mapped in 1978 as a stripable resource with a high development potential (HDP). HDP resources consist of mapped coals in areas containing a minimum of 6 million tons of in-place coal meeting the coal thickness-to-overburden criteria and excluding the features listed in Table 4. The location of HDP surface minable resource blocks is shown in Fig. 7.

Underground coal resources consist of all mapped coal more than 28 in. thick and greater than 150 ft deep. This

includes coal within areas heavily drilled for oil and gas. Fig. 6 shows underground resources by thickness category.

The resources include substantial amounts of coal that cannot currently or in the foreseeable future be mined economically. Studies in 1978 and 1982 of surface and underground minable resources found that only about 28% of the resources were comparable to coal reserves actively mined in such key parameters as coal thickness, depth, and size of reserve block. Such resources were deemed to have a high development potential (HDP, Table 4, Fig. 7). The U.S. Department of Energy uses the somewhat differently

defined "demonstrated reserve base" (DRB) to represent that portion of the total coal resource that is potentially minable under current economic conditions. The DRB is defined primarily in terms of a minimum thickness and degree of geologic assurance of its presence. Overall the defining parameters are somewhat less stringent than those for HDP coal resources. A 1997 study found that nearly 53% of the total resources of Illinois meet DRB specifications. The recoverable reserves listed in the last column of Table 3 are derived from the DRB by accounting for mining and cleaning losses.

County	Danville (No. 7)	Jamestown	Herrin (No. 6)	Springfield (No. 5)	Colchester (No. 2)	Seelyville ²	Dekoven ²	Davis ²	Rock Island (No. 1) ³	Misc.	Resources	Recoverable	
											Total	Surface	Reserves ¹
MCDONOUGH	0	0	0	0	578	0	0	0	0	0	578	578	193
MCLEAN	1,703	0	75	3,955	286	0	0	0	0	0	6,021	0	326
MACON	0	0	341	2,382	0	0	0	0	0	0	2,724	0	221
MACOUPIN	16	0	3,817	0	1,576	0	0	0	695	142	6,248	542	1,612
MADISON	0	0	2,220	0	229	0	0	0	7	4	2,461	630	856
MARION	0	0	1,874	2,489	0	0	0	0	0	0	4,364	0	202
MARSHALL	362	0	7	0	493	0	0	0	0	0	862	115	80
MENARD	0	0	12	1,151	0	0	0	0	0	0	1,163	561	361
MERCER	0	0	0	0	15	0	0	0	54	0	69	69	2
MONROE	0	0	7	0	0	0	0	0	0	0	7	7	4
MONTGOMERY	53	0	3,832	0	554	0	0	0	509	648	5,598	0	1,597
MORGAN	0	0	423	38	1,152	0	0	0	0	0	1,614	359	177
MOULTRIE	0	0	1,066	66	0	0	0	0	0	0	1,132	0	82
PEORIA	276	0	1,127	1,200	362	0	0	0	0	0	2,967	2,144	1,169
PERRY	0	0	1,836	321	0	0	0	0	0	642	2,800	700	1,147
PIATT	0	0	85	1,289	0	0	0	0	0	0	1,335	0	0
PIKE	0	0	0	0	145	0	0	0	0	0	145	145	65
PUTNAM	218	0	77	0	374	0	0	0	0	0	671	0	43
RANDOLPH	0	0	248	178	0	0	0	0	0	0	427	331	197
RICHLAND	651	0	1,836	1,702	0	131	0	0	0	6	4,329	6	161
ROCK-ISLAND	0	0	0	0	0	0	0	0	62	0	62	42	0
ST CLAIR	0	0	2,297	0	0	0	0	0	0	0	2,297	1,091	1,038
SALINE	68	0	1,219	823	0	0	734	1,370	0	14	4,230	519	1,229
SANGAMON	0	0	1,995	3,077	0	0	0	0	4	211	5,288	440	1,522
SCHUYLER	0	0	0	104	607	0	0	0	0	0	712	703	346
SCOTT	0	0	1	0	254	0	0	0	0	0	255	225	95
SHELBY	130	0	3,332	1,957	0	207	0	0	7	87	5,722	87	767
STARK	56	0	466	0	26	0	0	0	0	0	549	521	123
TAZEWELL	4	0	216	458	215	0	0	0	0	0	893	154	143
VERMILION	1,913	0	1,872	0	0	29	0	0	0	0	3,815	647	1,402
WABASH	0	0	899	1,097	0	0	106	787	0	167	3,059	167	294
WARREN	0	0	0	0	346	0	0	0	38	0	384	384	92
WASHINGTON	0	0	3,794	37	0	0	0	0	0	0	3,831	9	1,492
WAYNE	0	0	2,890	2,955	0	0	748	1,363	0	0	7,957	0	155
WHITE	0	0	2,404	2,402	0	0	1,513	1,945	0	0	8,266	0	1,689
WILL	0	0	0	0	13	0	0	0	0	0	13	13	2
WILLIAMSON	55	0	561	888	0	0	671	480	0	52	2,710	619	737
WOODFORD	39	0	43	256	517	0	0	0	0	0	857	0	3
TOTAL	19,136	3,583	78,822	62,771	16,548	9,704	5,924	9,569	1,482	2,992	210,550	22,129	40,308

Note: Figures have been rounded.

1 Assumes recovery rates from demonstrated reserve base of 50% for underground minable reserves and 70% to 85% (depending upon location and thickness) for surface minable reserves.

2 The Seelyville coal of east-central Illinois correlates with the Dekoven and Davis coals of southeastern Illinois.

3 Includes the correlative Litchfield and Assumption Coal Members

Coal Geology of Illinois

Coal Seams

In the following look at individual coals, analytical data are presented in table form. These data are largely from published reports of the Illinois State Geological Survey and subsequent unpublished analyses. In the tables, a "range of typical analyses" is given from which all unusual values were excluded. All data are based on standard face channel samples from which all mineral bands (mostly shale and pyrite) more than 3/8 in. thick (1 cm) are excluded. Generally, the coal as mined will have a higher ash and sulfur content; analyses of the coal with average preparation will be similar to that of the channel samples, but somewhat lower in mineral matter and related impurities (e.g. HAPs).

In the tables of analyses following each coal discussion, the ash fusion data are reported from analyses obtained over many years, utilizing different methods and definitions. Therefore, this information should be carefully evaluated before being used.

Rock Island Coal Member - This seam formerly was mined rather extensively in Rock Island, Mercer, and Henry counties, and to a lesser extent in Knox, Fulton, and Warren counties. All production has come from western Illinois. In each mining location, this coal has been found to lie in narrow troughs; its thickness commonly ranged from 49 to 60 in. It is correlated with the Litchfield and Assumption coals, which have been mined at single locations in Montgomery and Christian counties, respectively.

Range of typical analyses, Rock Island coal by counties (as-received)

	Henry, Knox, Fulton	Rock Island, Mercer, Warren
Moisture (%)	14-15	16-18
Volatile matter (%)	35-40	35-39
Fixed carbon (%)	36-42	34-39
Ash (%)	7-10	7-10
Sulfur (%)	4-6	3-5
Calorific value (Btu/lb)	10,700-11,200	10,400-10,900
Rank index*	117-121	115-119
Ash fusion (° F)	1,930-2,370	

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Murphysboro Coal Member - The Murphysboro coal is known with certainty only in Jackson, Perry, and western Williamson counties. In these areas, the coal ranges from about 1 to 7 ft in thickness. The seam has been mined at various places in Jackson County and in western Williamson County.

Near the town of Murphysboro, the

coal, reported to be very low in ash and sulfur, was used for making coke. This low- to medium-sulfur coal near Murphysboro occurs beneath thick non-marine silty gray shales related to an ancient river channel now filled with sandstone. Although the thicker coal near Murphysboro largely is mined out, additional areas of thick coal, ranging from 1.5 to 7.5 ft, have been found in north-central Jackson County and in Perry County. It is probable that additional low- to moderate-sulfur coal more than 4 ft thick will be found in certain areas in Perry, Randolph, and Jackson counties. East and west of the channel, the Murphysboro thins rapidly to less than 1 ft in thickness, except in the area southeast of Carbondale. Recently one surface mine began producing again from the coal in northern Jackson County. The last surface mine in this seam had closed about 20 years ago. This coal has a relatively low sulfur content.

Range of typical analyses, Murphysboro coal in Jackson County by district (as-received):

	Murphysboro Dist. West of Du Quoin	Carbondale Dist. East of Du Quoin Monocline
Moisture (%)	8-10	4-6
Volatile matter (%)	33-35	33-38
Fixed carbon (%)	49-53	46-52
Ash (%)	5-7	9-11
Sulfur (%)	0.6-2	3-5
Calorific value (Btu/lb)	12,300-12,700	12,400-12,600
Rank index*	130-136	139-143

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Dekoven and Davis Coal Members - The Dekoven and Davis seams commonly are 10 to 25 ft apart. In surface mines producing from these coals, generally both seams have been mined simultaneously. Resources, most too deep for strip mining, are known to occur in Franklin, Williamson, Saline, White, Hamilton, Wabash, Edwards and Gallatin counties. For many years, these coals were mined along their outcrop in small operations and, subsequently, have been surface mined extensively in portions of southern Saline, eastern Williamson, and Gallatin counties. Recently an underground mine in Gallatin County began producing from the Davis coal. Where mined, the upper coal, the Dekoven, averages 3 to 3.5 ft thick. The lower coal, the Davis, has an average thickness of 3.5 to 4 ft. The Dekoven and Davis coals have been correlated stratigraphically with the Seelyville coal further north and east.

Range of analyses, Dekoven and Davis coals in Saline County (as-received):

	Dekoven coal	Davis coal
Moisture (%)	5-7	5-7
Volatile matter (%)	35-37	35-37
Fixed carbon (%)	46-48	46-48
Ash (%)	8-13	8-10
Sulfur (%)	3-5	3-4
Calorific value (Btu/lb)	11,900-12,700	12,500-12,800
Rank index*	138-143	138-143

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Seelyville Coal Member - The areal extent of the Seelyville coal was not well known until 1981, when Treworgy completed a study of the seam, based primarily on geophysical logs. In an area of approximately 1,900 square miles in 10 counties of east-central Illinois, the seam may be as much as 3.5 to 9 ft thick, with estimated in-place resources of about 10 billion tons. Very little is known about seam structure and coal quality. One or more shale partings often can be inferred from the geophysical logs. Sulfur content is probably 3 to 5%.

Colchester Coal Member - The Colchester seam has been mined principally in northern and western Illinois. Coal thickness is about 42 in. in the La Salle district west of the La Salle Anticlinal Belt (La Salle, Putnam, and Bureau counties); 30 to 40 in. in the Wilmington field (Will, Kankakee, and Grundy counties); 30 to 40 in. in Henry County; and 18 to 30 in. in the southern part of western Illinois. Throughout most of the rest of Illinois, where present, it appears to range from a few inches to less than 24 in. thick. Today, the Colchester is being strip-mined only near Industry in McDonough County of western Illinois.

Range of typical analyses, Colchester coal by counties (as-received):

	Will, Grundy, La Salle, Kankakee	Woodford, Marshall
Moisture (%)	13-17	13-15
Volatile matter (%)	31-40	34-41
Fixed Carbon (%)	37-48	36-47
Ash (%)	3-9	5-9
Sulfur (%)	1-4	2-3
Caloric value (BTU/lb)	10,500-11,700	11,200-11,700
Rank index*	117-125	122-126
Ash fusion (deg. F)		2,140-2,360

	Bureau, Henry, Knox	Hancock, McDonough
Moisture (%)	14-17	15-19
Volatile matter (%)	36-40	33-40
Fixed Carbon (%)	35-40	38-45
Ash (%)	7-10	5-9
Sulfur (%)	2-4	1-5
Caloric value (BTU/lb)	10,400-11,200	10,400-11,200
Rank index*	115-121	115-121

Coal Geology of Illinois

McLean	
Moisture (%)	10-13
Volatile matter (%)	40-45
Fixed Carbon (%)	36-39
Ash (%)	7-11
Sulfur (%)	2-4
Caloric value (BTU/lb)....	11,200-11,700
Rank index*	123-129

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Houchin Creek Coal Member - The Houchin Creek [formerly Summum (No. 4)] coal is a relatively unimportant lenticular coal in western Illinois. When present, it usually lies within 25 ft below the Springfield seam. The Houchin Creek has been mined near Soperville (Knox County), Summum (Fulton County), Greenville (Greene County), and Jerseyville (Jersey County). The most recent surface mining was near south Wilmington (Kankakee and adjacent Grundy counties), where it was mined in conjunction with the nearby Colchester coal. The Houchin Creek also was surface-mined in southern Illinois near Carrier Mills (Saline County). Although the coal seam is one of the most widely traceable coal horizons in Illinois, it is commonly not of minable thickness.

Range of typical analyses, Houchin Creek coal (as-received):

Knox County

Moisture (%)	14-16
Volatile matter (%)	37-39
Fixed carbon (%)	38-40

Ash (%)	7-9
Sulfur (%)	3-4
Calorific value (Btu/lb)....	10,800-11,300
Rank index*	115-124

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Table 4. Criteria for resources of high development potential

Minimum Coal Thickness	Maximum Overburden Limit	Excluded Features
<i>Strippable</i>		
18 to 29 in.	50 ft	Weakly indicated (Class II B) coal; coal within towns, reservoirs, state and federal lands, interstate highways, narrow topographic valleys,
30 to 47 in.	75 ft	areas with extensive drainage; blocks of coal containing less than 6 million tons of in-place coal resources
48 to 71 in.	100 ft	
72 in.+	125 ft	
<i>Deep Minable</i>		
to 54-66 in.	400 ft	Resources below cities, dams, public lands, interstate, closely spaced oil and gas wells
66 in. +	1,000 ft	

area (Fig. 11) and three underground mines were built here since 1973; two are still in production.

One of the characteristics of the Springfield coal in western Illinois and in the Springfield area (Sangamon, Logan, and Menard counties of west-central Illinois) is the occurrence of fairly numerous claystone dikes ("horsebacks"), which may cut through the coal seam from top to bottom, as well as its roof strata. These irregularities may seriously influence the purity of the coal and they weaken the roof strata.

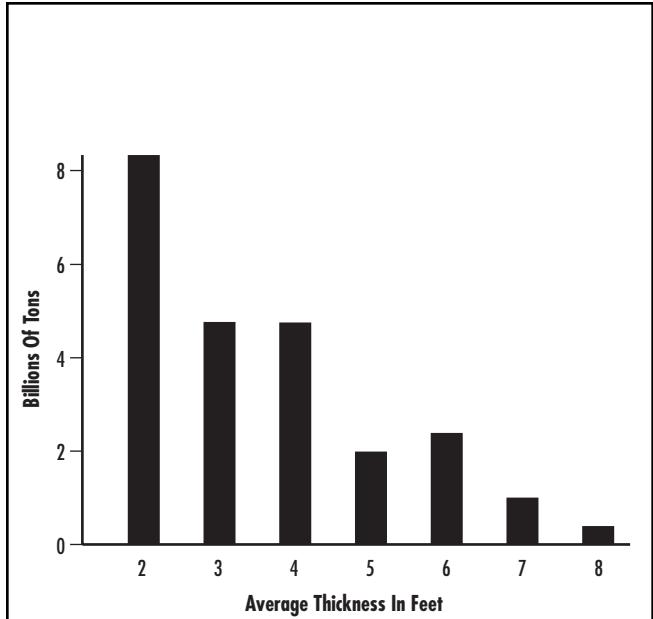


Fig. 5. Strippable coal resources of Illinois by thickness

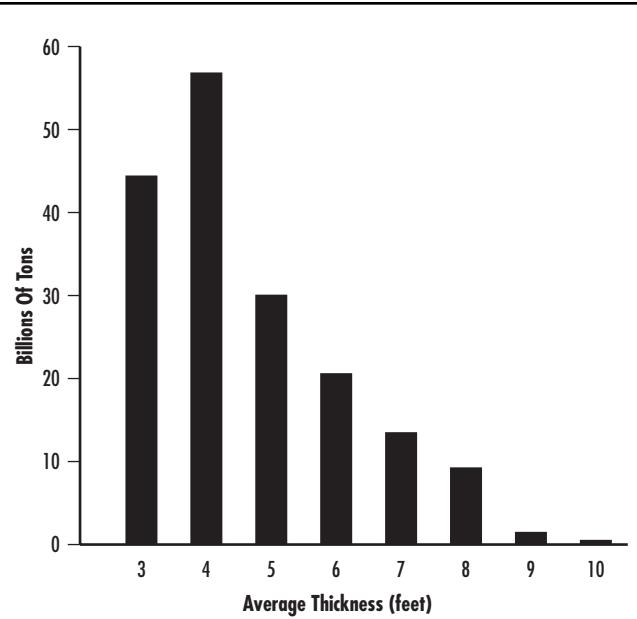


Fig. 6. Underground coal resources of Illinois by thickness

Coal Geology of Illinois

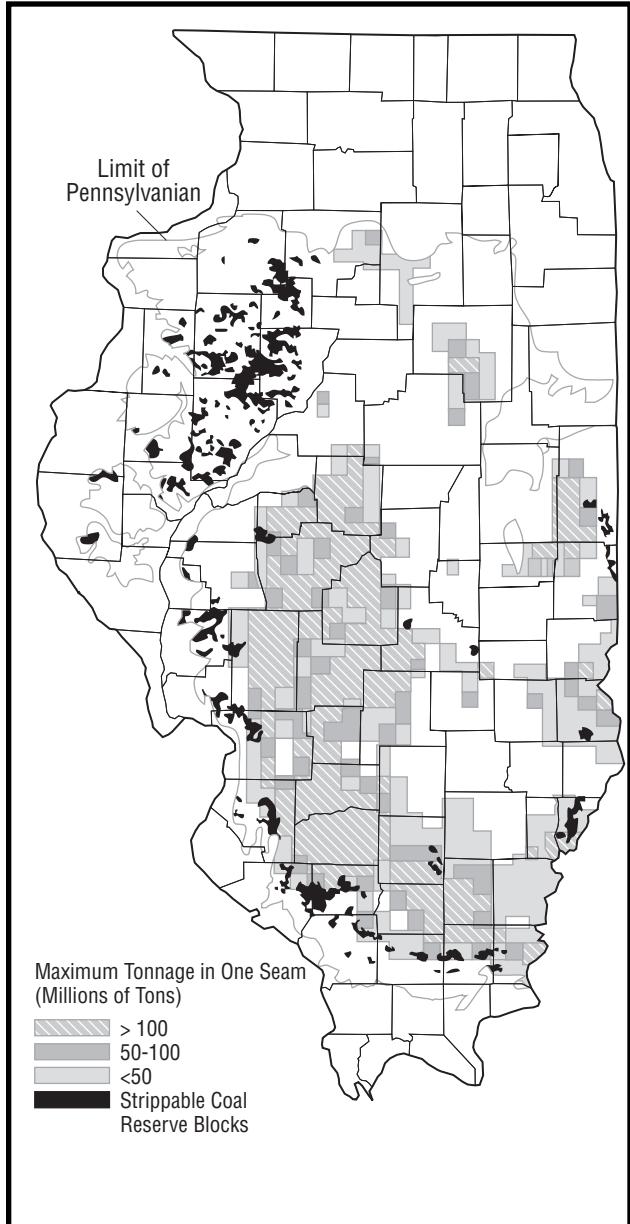


Fig. 7. Townships containing deep-minable and blocks with surface-minable coal with high development potential (based on 1982 and 1978 studies respectively), see Table 4. Underground mines require about 50 to 100 million tons of in-place coal.

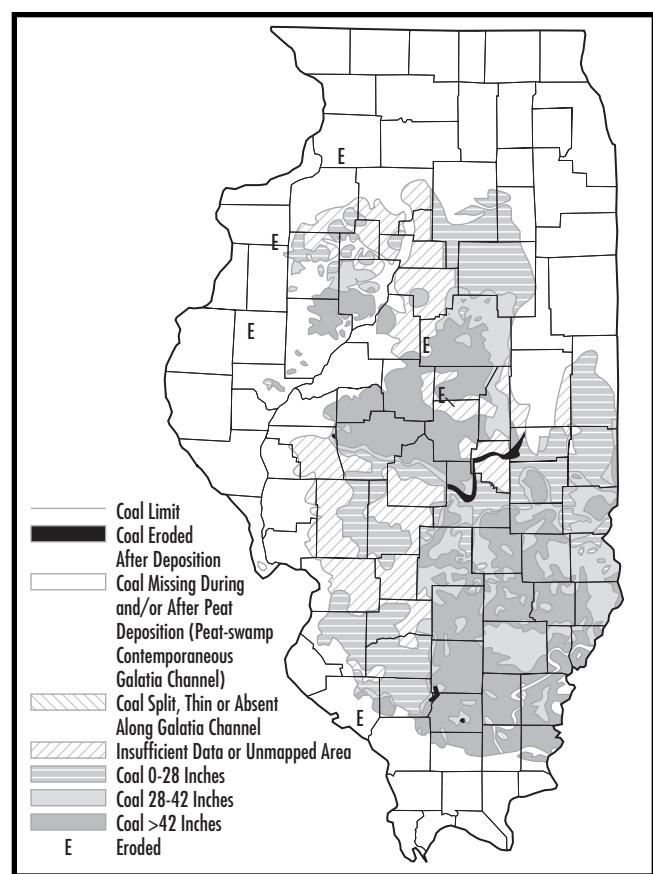
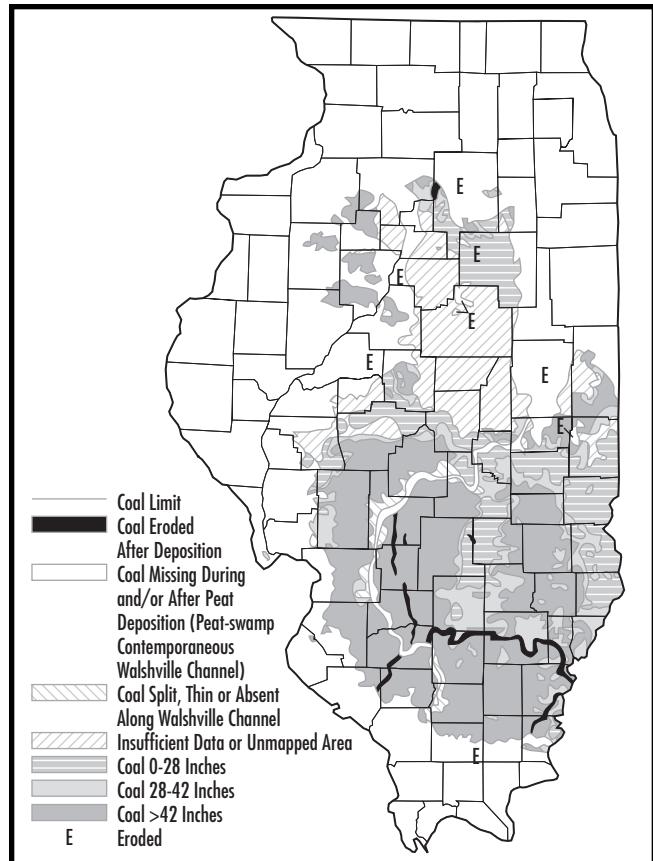


Fig. 9. Generalized thickness of the Springfield Coal

Coal Geology of Illinois

Range of typical analyses, Springfield coal by counties (as-received):

Peoria, Fulton, Tazewell, Schuyler	McLean, Logan, Menard, Sangamon
Moisture (%)	14-18
Volatile matter (%)	33-38
Fixed carbon (%)	34-40
Ash (%)	9-12
Sulfur (%)	2-4
Calorific value (Btu/lb)	10,100-10,800
Rank index*	115-122
Ash fusion (deg F)	1,890-2,270
	1,890-2,600

Macon, Shelby	Edgar
Moisture (%)	12-16
Volatile matter (%)	34-39
Fixed carbon (%)	35-40
Ash (%)	8-12
Sulfur (%)	3-4
Calorific value (Btu/lb)	10,500-11,100
Rank index*	119-127

Randolph, Perry	Jackson
Moisture (%)	8-13
Volatile matter (%)	35-38
Fixed carbon (%)	40-44
Ash (%)	9-12
Sulfur (%)	4-5
Calorific value (Btu/lb)	11,000-11,400
Rank index*	124-135
Ash fusion (deg F)	2,168-2,174
	1,940-2,010

Gallatin, Saline	Gallatin
Williamson	(Eagle Valley)
Moisture (%)	5-7
Volatile matter (%)	33-38
Fixed carbon (%)	47-53
Ash (%)	2-5
Sulfur (%)	2-5
Calorific value (Btu/lb)	11,900-12,500
Rank index*	132-141
Ash fusion (deg F)	2,040-2,090

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Herrin Coal Member - The Herrin coal has been the most extensively mined coal in Illinois, constituting 40% of the total coal resources and almost 75% of the coal in the state deemed to have high development potential. It is the chief source of coal in all of southwestern, southern, and southeastern Illinois, except in the Wabash-Saline-Gallatin County area and the northern part of west-central Illinois and in Vermilion County in eastern Illinois. The Herrin has its lowest ash and sulfur content as well as its greatest thickness in the Jefferson-Franklin-Williamson County district, known as the "Quality Circle" area (Fig. 10). The coal in this area maintains an average thickness in excess of 8 ft. In this area, the Herrin seam has a relatively low sulfur content, ranging from 0.5 to 2.5%, probably aver-

Relatively Low-Sulfur (<2.5% S) Coal Resources in Illinois, as of January 1998 (millions of tons)

Coal Herrin (No. 6)	County	Resources	Recoverable Reserves
	Champaign	20	7
	Christian	448	168
	Clark	378	14
	Clinton	95	26
	Coles	1,069	59
	Crawford	41	0
	Cumberland	802	242
	Douglas	1,032	390
	Edgar	1,462	277
	Franklin	65	17
	Jackson	20	6
	Jefferson	189	61
	Lawrence	110	10
	Macoupin	452	167
	Madison	620	172
	Montgomery	264	74
	Moultrie	271	0
	Perry	46	20
	St. Clair	430	138
	Shelby	559	0
	Vermilion	1,085	406
	Williamson	78	16
	Total	9,535	2,280

NOTE: About 49 million tons of surface-minable coal of high development potential coal resources with a low to moderate sulfur content (<2.5% S) were identified in the Murphysboro Coal in Jackson County.

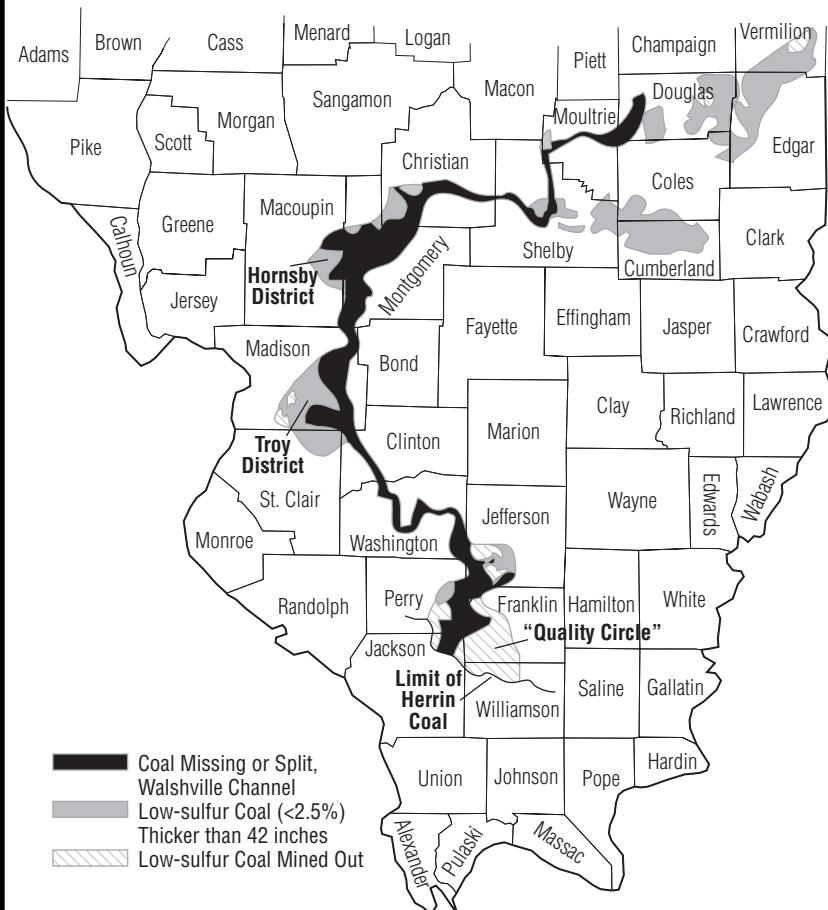


Fig. 10. Remaining relatively low-sulfur (<2.5%) resources for the

Coal Geology of Illinois

aging about 1.5%. This area of relatively low sulfur and thick coal covers approximately 250 square miles; however, most of the "Quality Circle" has been mined out; only one mine remains active in the area. Other areas that probably have relatively low sulfur consist of an area of several townships in northern St. Clair County and adjacent Madison and Clinton counties (Troy District), and an area of a few townships in eastern Macoupin and adjacent Montgomery and Christian counties (Hornsby District, Fig. 10). Relatively low-sulfur Herrin coal also was mined for many years south of Danville in eastern Vermilion County. Two new mines began production from such reserves in 1996 and 2000. Other areas of relatively low-sulfur Herrin coal probably exist in the southern half of the east-central district (Coles, Cumberland, and Shelby Counties).

The thickness of the Herrin coal in southwestern Illinois generally is between 6 and 8 ft (Fig. 8). In southeastern Illinois, in Saline and Gallatin coun-

ties, the Herrin becomes thinner and irregular in thickness. To the north, in the deeper part of the coalfield, it also is irregular in thickness, but does appear to be 6 ft thick or more in some areas.

The Herrin coal of Areas 1-4 is affected by claystone dikes and related disturbances, in particular "white top." The dikes, commonly called "horsebacks," vary in width between fractions of an inch to a few feet and commonly are in the inch to foot range. Many are inclined at variable degrees and associated with mostly small displacements, especially at the top of the coalbed. They generally extend some distance into the roof strata and may thus weaken the roof. "White top" is a mixture of coal and claystone, commonly associated with large clay dikes; it affects primarily the top 1-3 ft of the coal, but locally may reach down through half or more of the coal seam.

Range of typical analyses, Herrin coal by counties (as-received):

La Salle, Bureau, Stark,	Peoria, Sangamon,
Grundy	Fulton, Macoupin
Moisture (%)	Moisture (%)
13-16	15-19
6-20	12-16

Henry, Knox	Christian, Douglas,
Moisture (%)	Moisture (%)
13-16	12-14
6-20	4-16

Moisture (%)	Moisture (%)
13-16	12-14
6-20	4-16

Moisture (%)	Moisture (%)
13-16	12-14
6-20	32-36

Fixed carbon (%)	Fixed carbon (%)
38-41	37-41
38-41	37-41
9-11	9-11
8-13	8-13

Ash (%)	Ash (%)
9-11	9-11
8-12	8-12
8-13	8-13
9-11	9-11

Sulfur (%)	Sulfur (%)
3-5	3-5
3-5	3-5
2-4	2-4
3-5	3-5

Calorific value (Btu/lb)	Calorific value (Btu/lb)
10,500-11,400	10,700-10,300
10,500-11,000	10,400-10,900
10,000-10,700	10,800-11,300
10,500-11,000	10,400-11,100

Rank index*	Rank index*
116-123	111-118
111-120	116-123
1,950-2,150	1,900-2,120
1,930-2,160	1,930-2,160

Ash fusion (deg F)	Ash fusion (deg F)
1,920-2,170	2,080-2,220
1,920-2,090	1,920-2,610
1,920-2,090	1,920-2,610
1,920-2,090	1,920-2,610

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

Marion Clinton, Washington, St. Clair Randolph, Perry

Moisture (%)	Moisture (%)
10-13	8-12
35-40	35-39
37-42	38-44
9-12	9-13

Sulfur (%)	Sulfur (%)
1-4	1-4
1-4	1-4
10,800-11,300	10,800-11,300
121-129	124-133

Ash fusion (deg F)	Ash fusion (deg F)
1,920-2,090	1,920-2,610
1,920-2,090	1,920-2,610
1,920-2,090	1,920-2,610
1,920-2,090	1,920-2,610

Marion Clinton, Washington, St. Clair Randolph, Perry

Moisture (%)

10-13

8-12

35-40

38-44

9-13

1-4

10,800-11,300

124-133

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

1,920-2,610

Coal Geology of Illinois

Range of typical analyses, Danville coal by counties (as-received):

	Bureau, Marshall	Vermilion
Moisture (%)	15-19	13-17
Volatile matter (%)	33-38	37-39
Fixed carbon (%)	34-38	37-40
Ash (%)	12-15	9-11
Sulfur (%)	3-4	3
Calorific value (Btu/lb)	9,600-10,300	10,500-11,300
Rank index*	112-118	116-128
Ash fusion (deg F)	2,040-2,160	1,940-2,180

*Calorific value of moist coal on a mineral-matter-free basis to the nearest 100 Btu/lb.

This section was prepared by Russell J. Jacobson, Geologist and Acting Head, and Christopher Korose, Geologist, Coal Section, Illinois State Geological Survey, Natural Resources Building, 615 E. Peabody Dr., Champaign, IL 61820-6964, Tel: 217-333-5115, E-mail: jacobson@isgs.uiuc.edu

Selected references*

Algaeier and Hopkins, 1975, Reserves of the Herrin (No. 6) Coal in the Fairfield Basin in Southeastern Illinois. Illinois State Geological Survey, Circular 489, 31p.

American Society for Testing and Materials, Vol. 05.05, Sect. 5 of Annual Book of ASTM Standards, Designation: D-388.

Cady, G.H., 1915, Coal Resources of District I (Longwall). Illinois State Geological Survey, Coop. Min. Inv. Bull. 10, 149p.

Cady, G.H., 1916, Coal Resources of District VI. Illinois State Geological Survey, Coop. Min. Inv. Bull. 15, 94p.

Cady, G.H., 1917, Coal Resources of District II (Jackson County). Illinois State Geological Survey, Coop. Min. Bull. 16, 53p.

Cady, G. H., 1919, Coal Resources of District V. Saline and Gallatin Counties. Illinois State Geological Survey, Coop. Min. Inv. Bull. 19, 135p.

Cady, G.H., 1919, Geology and Mineral Resources of the Hennepin and La Salle Quadrangles. Illinois State Geological Survey, Bull. 37, 136p.

Cady, G.H., 1921, Coal Resources of District IV. Illinois State Geological Survey, Coop. Min. Inv. Bull. 26, 247p.

Cady, G.H., 1935, Classification and Selection of Illinois Coals. Illinois State Geological Survey, Bull. 62, 354p.

Cady, G.H., 1942, The Illinois Coalfield: in Analysis of Illinois Coals. U.S. Bureau of Mines, Tech. Paper No. 641, pp. 1-23.

Cady, G.H., 1948, Analysis of Illinois Coals. Illinois State Geological Survey, Supplement to Bull. 62, 77p.

Cady, G.H., et al., 1938, Structure of Herrin (No. 6) Coalbed in Central and Southern Jefferson, Southeastern Washington, Franklin, Williamson, Jackson and Eastern Perry Counties. Illinois State Geol. Survey, Circ. 24, 12p.

Cady, G.H., et al., 1939, Structure of Herrin (No. 6) Coalbed in Hamilton, White, Saline and Gallatin Counties, North of Shawneetown Fault. Illinois State Geological Survey, Circ. 42, 16p.

Cady, G.H., et al., 1951, Subsurface Geology and Coal Resources of the Pennsylvanian in Certain Counties of the Illinois Basin. Illinois State Geological Survey, Rept. Inv. 148, pp. 9-25.

Cady, G.H., et al., 1952, Minable Coal Reserves of Illinois. Illinois State Geological Survey, Bull. 78, 138p.

Cady, G.H., et al., 1955, Subsurface Geology and Coal Resources of the Pennsylvanian System in Wabash County. Illinois State Geological Survey, Rept. Inv. 183, 24p.

Clegg, K.E., 1959, Subsurface Geology and Coal Resources of the Pennsylvanian System in Douglas, Coles, and Cumberland Counties, Illinois. Illinois State Geological Survey, Circ. 271, 16p.

Clegg, K.E., 1961, Subsurface Geology and Coal Resources of the Pennsylvanian System in Sangamon, Macon, Menard and Parts of Christian and Logan Counties. Illinois State Geological Survey, Circ. 312, 28p.

Clegg, K.E., 1965, Subsurface Geology and Coal Resources of the Pennsylvanian System in Clark and Edgar Counties, Illinois. Illinois State Geological Survey, Circ. 380, 28p.

Clegg, K.E., 1972, Subsurface Geology and Coal Resources of the Pennsylvanian System in DeWitt, McLean, and Piatt Counties, Illinois. Illinois State Geological Survey, Circ. 473, 25p.

Cobb, J.C., Masters, J.M., Treworgy, C.G., and Helfinstine, R.J., 1979, Abundance and Recovery of Sphalerite and Fine Coal from Mine Wastes in Illinois. Illinois State Geological Survey, IMN 71, 11p.

Cobb, J.C., Steele, J.D., Treworgy, C.G., and Ashby, J.F. 1980, The Abundance of Zinc and Cadmium in Sphalerite-bearing Coals of Illinois. Illinois State Geological Survey, IMN 74, 28p.

Culver, H.E., 1925, Coal Resources of District III (Western Illinois). Illinois State Geological Survey, Coop. Min. Inv. Bull. 29, 128p.

Damberger, H.H., 1971, Coalification Pattern of the Illinois Basin. Economic Geology, v. 66, no. 3, p. 488-495. Illinois State Geological Survey Reprint 1971-D.

Damberger, H.H., et al., 1997, Coal Industry in Illinois: 1:500,000 scale color wall map showing coalfield, mines, mined areas, power plants, coal handling docks, etc. Illinois State Geological Survey, Illinois Map 9.

Demir, I., et al., 1994, Characterization of Available (Marketed) Coals from Illinois Coal Mines. Illinois State Geological Survey, OFS 1994-2, 26p.

Demir, I., et al., 1998, Environmentally critical elements in channel and cleaned samples of Illinois coals. Illinois State Geological Survey Reprint 1998-C. Fuel, v. 77, 95-107p.

DuBois, E.P., 1951, Geology and Coal Resources of a Part of the Pennsylvanian System in Shelby, Moultrie, and Portions of Effingham and Fayette Counties. Illinois State Geological Survey, Rept. Inv. 156, 32p.

Gluskoter, H.J., and Simon, J.A., 1968, Sulfur in Illinois Coals. Illinois State Geological Survey, Circ. 432, 28p.

Gluskoter, H.J., et al., 1977, Trace Elements in Coal: Occurrences and Distribution. Illinois State Geological Survey, Circ. 499, 154p.

Harrison, J.A., 1951, Subsurface Geology and Coal Resources of the Pennsylvanian System in White County, Illinois. Illinois State Geol Survey, Rept. Inv. 153, 40p.

Harvey, R.D., Cahill, R.A., Chou, C.L., and Steele, J.D., 1983, Mineral Matter and Trace Elements in the Herrin and Springfield Coals, Illinois Basin Coalfield. Illinois State Geological Survey, Contr./Grant Rept. 1983-4, 161p.

Hatch, J.R., et al., 1976, Sphalerite in Coals from the Illinois Basin. Economic Geology, v. 71, no. 3, p. 613-624. Illinois State Geological Survey Reprint 1976E, 12p.

Jackman, H.W., Eissler, R.L., and Helfinstine, R.J., 1959, Coke from Medium-Volatile and Illinois Coal. Illinois State Geological Survey, Circ. 278, 24p.

Jackman, H.W. and Helfinstine, R.J., 1961, Use of Illinois Coal Fines in Production of Metallurgical Coke. Illinois State Geological Survey, Circ. 317, 17p.

Jackman, H.W. and Helfinstine, R.J., 1967, A Survey of the Coking Properties of Coals. Illinois State Geological Survey, Circ. 412, 27p.

Jackman, H.W. and Helfinstine, R.J., 1968, Drying and Preheating Coals Before Coking. Part 2. Coal Blends. Illinois State Geological Survey, Circ. 434, 23p.

Jacobsen, R.J., 1983, Murphysboro Coal, Jackson and Perry Counties: Resources With Low- to Medium-Sulfur Potential. Illinois State Geological Survey, IMN 85, 19p.

Jacobsen, R.J., 1985, Coal Resources of Grundy, La Salle, and Livingston Counties, Illinois. Illinois State Geological Survey, Circ. 536, 58p.

Jacobsen, R.J., 1987, Stratigraphic Correlations of the Seelyville, Dekoven and Davis Coals of Illinois, Indiana, and Western Kentucky. Illinois State Geological Survey, Circ. 539, 27p.

Jacobsen, R.J., 1993, Coal Resources of the Dekoven and Davis Members (Carbondale Formation) in Gallatin and Saline Counties, Southeastern Illinois. Illinois State Geological Survey, Circular 551, 41 p.

Jacobsen, R.J., et al., 1985, Unifying Nomenclature in the Pennsylvanian System of the Illinois Basin. Trans. Ill. Acad. Sci., v. 78, p. 1-11. ISGS Reprint 1985K.

Jacobsen, R.J., and Bengal, L.E., 1981, Strippable Coal Resources of Illinois. Part 7-Vermillion and Edgar Counties. Illinois State Geological Survey, Circular 521, 24p.

Kay, F.H., 1915, Resources of District VII. Illinois State Geological Survey, Coop. Min. Inv. Bull. 11, 233p.

Kay, F.H., and White, K.D., 1915, Coal Resources of District VIII (Danville). Illinois State Geological Survey, Coop. Min. Inv. Bull. 14, 69p.

Kosanek, R.M., et al., 1960, Classification of the Pennsylvanian Strata of Illinois. Illinois State Geological Survey, Rept. Inv. 214, 84p.

Krausse, H. F., Damberger, H. H., W. J. Nelson and others, 1979, Engineering Study of Structural Geologic Features of the Herrin (No. 6) Coal and Associated Rock in Illinois: Illinois State Geol. Survey, Contr./Grant Rept. 1979-1, v2; Detailed Report, 218 p.

Nance, R.B., and Treworgy, C.G., 1981, Strippable Coal Resources of Illinois. Part 8-Central and Southern Counties. Illinois State Geological Survey, Circular 515, 32p.

Nelson, W.J., 1983, Geologic Disturbances in Coal Seams: Illinois State Geological Survey, Circular 530, 47 p.

Nelson, W.J., 1987, The Hornsby District of Low-Sulfur Herrin Coal in Central Illinois (Christian, Macoupin, Montgomery and Sangamon Counties). Illinois State Geological Survey, Circ. 540, 40p.

Payne, J.N., 1941, Structure of Herrin (No. 6) Coalbed in Madison County and Western Bond, Western Clinton, Southern Macoupin, Southwestern Montgomery, Northern St. Clair and Northwestern Washington Counties. Illinois State Geological Survey, Circ. 71, 21p.

Payne, J.N., 1942, Structure of Herrin (No. 6) Coalbed in Macoupin County, Eastern Jersey and Greene, Southeastern Scott, and Southern Morgan and Sangamon Counties. Illinois State Geological Survey, Circ. 88, 46 p.

Payne, J.N., and Cody, G.H., 1944, Structure of Herrin (No. 6) Coalbed in Christian and Montgomery Counties and Adjacent Parts of Fayette, Macon, Sangamon and Shelby Counties. Illinois State Geological Survey, Circ. 105, 57p.

Potter, P.E., 1956, Subsurface Geology and Coal Resources of the Pennsylvanian System in Crawford and Lawrence Counties, Illinois. Illinois State Geological Survey, Rept. Inv. 193, 17p.

Rao, C.P., and Gluskoter, H.J., 1973, Occurrences and Distribution of Minerals In Illinois Coals. Illinois State Geological Survey, Circ. 476, 56p.

Reed, F.H., et al., 1947, Use of Illinois Coal for Production of Metallurgical Coke. Illinois State Geological Survey, Bull. 71, 132p.

Reinertsen, D.L., 1964, Strippable Coal Reserves of Illinois. Part 4-Adams, Brown, Calhoun, Hancock, McDonough, Pikes, Schuyler and Southern Parts of Henderson and Warren Counties. Illinois State Geological Survey, Circ. 374, 32p.

Seagert, T.K., and W.H. Smith, 1969, Strippable Coal Reserves of Illinois. Part 5B-Mercer, Rock Island, Warren and Parts of Henderson and Henry Counties. Illinois State Geological Survey, Circ. 439, 22p.

Siever, R., 1950, Structure of Herrin (No. 6) Coalbed in Marion and Fayette Counties and Adjacent Parts of Bond, Clinton, Montgomery, Clay, Effingham, Washington, Jefferson and Wayne Counties. Illinois State Geological Survey, Circ. 164, 100p.

Smith, W.H., and Stoll, J.B., 1975, Coal and Water Resources of Illinois for Coal Conversion. Illinois State Geological Survey, Cooperative Resources Report 4, 79p.

Smith, W.H., 1957, Strippable Coal Reserves of Illinois, Part 1-Gallatin, Hardin, Johnson, Pope, Soline, and Williamson Counties. Illinois State Geological Survey, Circ. 228, 39p.

Smith, W.H., 1958, Strippable Coal Reserves of Illinois, Part 2-Jackson, Monroe, Perry, Randolph and St. Clair Counties. Illinois State Geological Survey, Circ. 260, 35p.

Smith, W.H., 1961, Strippable Coal Reserves of Illinois, Part 3-Madison, Macoupin, Jersey, Greene, Scott, Morgan and Cass Counties. Illinois State Geological Survey, Circ. 311, 40p.

Smith, W.H., 1968, Strippable Coal Reserves of Illinois, Part 6-La Salle, Livingston, Kankakee, Will, Putnam and Parts of Bureau and Marshall Counties. Illinois State Geological Survey, Circ. 419, 29p.

Smith, W.H., and Berggren, D.J., 1963, Strippable Coal Reserves of Illinois, Part 5A-Fulton, Henry, Knox, Peoria, Stark, Tazewell and Parts of Bureau, Marshall, Mercer and Warren Counties. Illinois State Geological Survey, Circ. 348, 59p.

Treworgy, C.G., 1981, The Seelyville Coal: A Major Unexploited Seam in Illinois. Illinois State Geological Survey, IMN 80, 11p.

Treworgy, C.G., et al., 1978, Reserves and Resources of Surface-Minable Coal in Illinois. Illinois State Geological Survey, Circular 504, 44p.

Treworgy, C.G., and Bargh, M., 1982, Deep-Minable Coal Resources of Illinois. Illinois State Geological Survey, Circular 527, 62p.

Treworgy, C.G. et al., 1997, Illinois Coal Reserve Assessment and Database Development: Final Report. Illinois State Geological Survey, Open File Series 1997-4, 105 p.

Treworgy, J.D. and M.H. Bargh, 1984, Coal Resources of Illinois. Illinois State Geological Survey, 5 multicolor statewide 1:500,000 scale wall maps.

Wanless, H.R., 1957, Geology and Mineral Resources of the Beardstown, Glasford, Havana and Vermont Quadrangles. Illinois State Geological Survey, Bull. 82, 233p.

Williams, F.E., and Rolley, M.B., 1955, Subsurface Geology and Coal Resources of the Pennsylvanian System in Jasper County. Illinois State Geological Survey, Rept. Inv. 181, 14p.

Willman, H.B., and Payne, J.N., 1942, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles. Illinois State Geological Survey, Bull. 66, 389p.

Willman, H.B., et al., 1975, Handbook of Illinois Stratigraphy. Illinois State Geological Survey, Bull. 95, 261p.

*Note: A list of publications related to coal in Illinois is available from the Illinois State Geological Survey, 615 E. Peabody Dr., Champaign, IL 61820 (217-333-4747). The Survey's website, www.isgs.uiuc.edu, includes a searchable listing of all of the Survey's publications.