Availability of the Danville, Jamestown, Dekoven, Davis, and Seelyville Coals for Mining in Selected Areas of Illinois

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George H. Ryan, Governor

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Cover photo: *Surface mining the Dekoven and Davis Coals at Jader Coal Company's No. 4 Mine*

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Contents

Executive Summary

The Danville, Jamestown, Dekoven, Davis, and Seelyville Coals, as mapped in this study, collectively make up about 23% (48 billion tons) of Illinois' original coal resources. However, less than 1% of the original resources of these five seams has been mined. These coal beds are typically thinner and/or deeper than the more extensively mined Herrin and Springfield Coals (Treworgy et al. 1999a, 2000). The remaining resources of these five seams include 3.6 billion tons of Danville Coal that is thought to have a medium- to low-sulfur content. The degree to which these coal resources are utilized in the future depends on the availability of deposits that can be mined at a cost competitive with other coals and alternative fuels. This report identifies those resources that have the most favorable geologic and land-use characteristics for mining and alerts mining companies to geologic conditions that have the potential for negative impacts on mining costs.

Of all five coals included in this study, a total of approximately 17 billion tons are available for mining. "Available" means that the surface land-use and geologic conditions related to mining the deposit (e.g., thickness, depth, in-place tonnage, and stability of bedrock overburden) are comparable with those of other coals currently being mined in the state.

An additional 1.3 billion tons are available with potential restrictions that make these five coals less desirable for mining, such as the presence of closely spaced oil wells or close proximity to rapidly developing urban areas. Technological factors (geologic conditions and economic parameters such as size of reserve block) are the major restriction to mining and restrict 56% of these combined resources. Land-use factors (e.g., towns and highways) restrict 6% of these resources. The original resources of the five seams studied in this report individually range from 3.6 billion to 19.6 billion tons; however, the respective availability of these coals for mining does not correlate to the tonnage of their original resources (table 1). The seams are discussed in descending stratigraphic order.

The Danville Coal is the third-largest resource (19.6 billion tons) of all coal seams in the state, but only 23% (4.5 billion tons) is available for mining. The majority of the available Danville resources (4.2 billion tons) is available for mining by underground methods, and an additional 300 million tons are available but with potential restrictions. Approximately 360 million tons are available by surface mining methods. Of the total amount of available Danville Coal, approximately 1.2 billion tons have a medium- to low-sulfur content. Technological factors restrict 69% (13.5 billion tons) of the Danville resources, and land-use factors restrict 6% (1.1 billion tons).

The Jamestown Coal constitutes the eighth-largest resource (3.6 billion tons) of all seams in the state and is available only for underground mining. A total of 26% of the resources (about 1 billion tons) is available for mining; 100 million of these tons are potentially restricted by numerous oil wells. Technological factors restrict 62% of the resources, and land-use factors restrict 10%.

The Dekoven Coal is the seventh-largest resource of all the coal seams in the state, but only 5% (300 million tons) are available for mining. Two hundred million tons of these are available by underground mining methods. Just over 100 million tons of the Dekoven Coal are available by surface mining methods, when mined in combination with the underlying Davis Coal. Technological factors restrict 89% of the Dekoven Coal resources, and land-use factors restrict 4%.

The Davis Coal ranks sixth among the state's coal seams in terms of total resources (9.6 billion tons), and 49% of this amount (4.7 billion tons) is available for mining. Of the available coal, 4.6 billion tons are available by underground methods; an additional 500 million tons are available but with potential restrictions. Only about 100 million tons of the Davis Coal are available by surface mining methods, when mined in combination with the overlying Dekoven Coal. Technological factors restrict 41% of the Davis Coal, and land-use factors restrict 4%. Restrictions to surface mining of the Dekoven and Davis Coals include high stripping ratios and unfavorable drift thickness.

The Seelyville Coal is the fifth-largest resource (9.7 billion tons) of all seams in the state: 6.7 billion tons (69% of its original resources) are available for mining. An additional 300 million tons are available with potential restrictions. The Seelyville Coal is only available by underground mining methods, and major restrictions to mining are the numerous partings within the coal and areas heavily drilled for oil.

Whether or not these coal resources are ultimately mined is still dependent upon a variety of other factors that are beyond the scope of this study to assess, including the willingness of local landowners to lease the coal, demand for a particular quality of coal, accessibility of transportation infrastructure, proximity of the deposit to markets, and cost and availability of competing fuels. To avoid high mining costs resulting from unfavorable geologic conditions, companies should avoid areas of thick drift and thin bedrock cover, areas with sandstone in the immediate mine roof, large areas of excessive partings in the coal, and faulted areas. Areas with low-cost, surface-minable resources are limited and will support only small, short-term operations.

This report is the third of a series that explains the availability of coal in Illinois for future mining. Previous reports assessing the availability of the Springfield and Herrin Coals (Treworgy et al. 1999a, 2000) contain important background information explaining the criteria used in this report to identify available coal. These statewide assessments of coal resources are based on earlier reports that assessed the availability of coal in 21 study areas. The study areas were 7.5-minute quadrangles that are representative of mining conditions found in various parts of the state. Coal resources and related geology were mapped in these study areas, and the factors that restricted the

Table 1 Availability of the Danville, Jamestown, Dekoven, Davis, and Seelyville Coals for mining in selected areas of Illinois (billions of tons). See appendix 1 for a listing of results by county.

	Total		Potential mining method[1] Surface		Underground		Sulfur (lb./10^6 BTU) <1.67		>1.67	
Danville Coal										
Original	19.6		4.4		18		3.6		16.0	
Mined	0.2	(1)[2]	0.1	(3)	0.1	(1)	0.0		0.2	(1)
Remaining	19.4	(99)	4.3	(97)	17.9	(99)	3.6	(100)	15.8	(99)
Available	4.5	(23)	0.4	(8)	4.2	(23)	1.2	(33)	3.3	(21)
Available with conditions	0.3	(1)	< 0.1	(0)	0.3	(2)	0.1	(3)	0.2	(1)
Technological restrictions	13.5	(69)	3.2	(74)	12.5	(69)	2.1	(59)	11.4	(71)
Land-use restrictions	1.1	(6)	0.7	(15)	0.9	(5)	0.2	(5)	0.9	(6)
Jamestown Coal										
Original	3.6		< 0.1		3.6		*[3]			
Mined	0.0		0.0		0.0					
Remaining	3.6	(100)	< 0.1		3.6	(100)				
Available	0.9	(26)	0.0		0.9	(26)				
Available with conditions	0.1	(2)	0.0		0.1	(2)				
Technological restrictions	2.2	(62)	< 0.1	(100)	2.2	(62)				
Land-use restrictions	0.4	(10)	0.0		0.4	(10)				
Dekoven Coal										
Original	6.0		0.2		5.9		*			
Mined	0.1	(1)	< 0.1	(20)	< 0.1	(<1)				
Remaining	5.9	(99)	0.2	(80)	5.9	(100)				
Available	0.3	(5)	0.1	(75)	0.2	(4)				
Available with conditions	0.1	(1)	0.0		< 0.1	(<1)				
Technological restrictions	5.3	(89)	< 0.1	(4)	5.4	(92)				
Land-use restrictions	0.2	(4)	< 0.1	(1)	0.2	(4)				
Davis Coal										
Original	9.6		0.2		9.6		*			
Mined	< 0.1	(1)	< 0.1	(18)	< 0.1	(1)				
Remaining	9.5	(99)	0.2	(82)	9.5	(99)				
Available	4.7	(49)	0.1	(73)	4.6	(48)				
Available with conditions	0.5	(5)	0		0.5	(5)				
Technological restrictions	3.9	(41)	< 0.1	(8)	4.0	(42)				
Land-use restrictions	0.4	(4)	< 0.1	(1)	0.4	(4)				
Seelyville Coal										
Original	9.7		–[4]		9.7		*			
Mined	< 0.1	(<1)			< 0.1	(<1)				
Remaining	9.7	(100)			9.7	(100)				
Available	6.7	(69)			6.7	(69)				
Available with conditions	0.3	(3)			0.3	(3)				
Technological restrictions	2.1	(22)			2.1	(22)				
Land-use restrictions	0.6	(6)			0.6	(6)				

[1] Note: surface and underground resources do not add to the total because coal that lies between 75 and 200 feet deep is included in both categories.

[2] Numbers in parentheses are percent of original resources.

[3] Asterisk indicates that available information is not sufficient to categorize resources by sulfur content**.**

[4] All of the Seelyville Coal resources lie greater than 200 feet deep and thus were evaluated for underground mining only.

availability of coal in the quadrangles were identified through interviews with more than 40 mining engineers, geologists, and other mining specialists representing 17 mining companies, consulting firms, and government agencies experienced in mining Illinois coals. The major restrictions identified in these individual study areas were used for the statewide assessments of the availability of coals for mining.

Introduction

This report is the third in a series that assesses the availability of coal resources for future mining in Illinois and is patterned after earlier assessments. The reader is referred to Treworgy et al. (1999a, 2000) for details on the background of the project and the general criteria used to define resources available for mining.

Coal Resource Classification System

The Illinois State Geological Survey (ISGS) follows the terms and definitions of the U.S. Geological Survey (USGS) coal resource classification system (Wood et al. 1983). With minor modifications to suit local conditions, these definitions provide a standardized basis for compilations and comparisons of nationwide coal resources and reserves.

The term "original resources" refers to the amount of coal originally in the ground prior to any mining. In this report, the ISGS defines "surface minable coal" as all coal in the ground that is 18 or more inches thick and lies less than 200 feet deep, whereas "underground minable coal" is all coal 28 or more inches thick and lying 75 or more feet deep. Coal 28 or more inches thick and lying from 75 to 200 feet in depth is considered in calculations as being both surface minable and underground minable.

In recent years, the USGS has promoted the idea of further defining the characteristics of resources by dividing remaining resources into two categories: restricted and available (Eggleston et al. 1990). Restricted resources are those that have some land-use or technological restriction that makes it unlikely they will be mined in the foreseeable future. Land-use restrictions include manmade or natural features that are illegal or impractical to disturb by mining. Technological restrictions include geologic or mining-related factors that negatively impact the economics or safety of mining. Resources in the available category are not necessarily economically minable at the present time, but these deposits are expected to have mining conditions comparable with those currently being mined. Determining the actual cost and profitability of these deposits requires further engineering and marketing assessments and site-specific studies.

This study follows the USGS example of dividing resources into categories of available and restricted. The ISGS also uses an additional category called "available with potential restrictions." This term is used to designate resources that are not restricted by the land-use or technological restrictions, but that have some known special condition that makes them less favorable for mining. Close proximity to rapidly developing urban areas, the presence of a relatively high density of oil wells or test holes, and potentially unstable roof conditions are examples of potential restrictions that have resulted in resources being placed in this category. In this study, therefore, remaining resources = resources restricted by land use + resources restricted by technology + resources available with potential restrictions + available resources.

The USGS classification system uses the terms "measured," "indicated," and "inferred" to indicate the reliability of resource estimates based on the type and density of data (Wood et al. 1983). The ISGS uses similar categories, which in previous reports have been called Class Ia, Class Ib, and Class IIa (Treworgy et al. 1997b). Because these earlier ISGS categories are essentially equivalent to the USGS categories, the USGS terminology defined by Wood et al. (1983) is used in this report. Collectively, the resources in these three categories are termed "identified resources" to distinguish them from resources based on less reliable estimates.

Sources of Data, Limitations, and Mapping Procedure

Resources of the five coals covered by this report have been mapped by a number of previous studies (appendix 2). The maps used for this study were compiled from data obtained from a variety of public and private sources: drilling logs, core descriptions, and geophysical logs obtained from companies and descriptions of mine and outcrop exposures made by ISGS geologists. The maps have varying degrees of completeness and accuracy, are designed for a regional assessment, and have a scale of 1:500,000. Features or details of features smaller than about 0.5-mile across may not be accurately portrayed or may be omitted altogether.

The coal resource maps used for this study are in digital format, which facilitates map updates, revisions, and accessibility adjustments. When the original paper maps were digitized into a common digital map database, adjustments were commonly necessary in areas where two studies met or overlapped. Past ISGS studies describe in detail the process of constructing digital coal resource base maps from original paper sources, and the resulting necessary adjustments made to certain map areas and, therefore, coal tonnage calculations (Treworgy 1997b, Treworgy and Bargh 1982).

For this study, resources of the Davis and Dekoven Coals were revised or newly mapped in five counties, and the Danville Coal was newly mapped in two counties utilizing data acquired since the previous investigations. Minor corrections and revisions were made in a number of other counties. New mapping was prioritized in areas where the coals were thought to be of minable thickness and where the density of available coal test data was the greatest. For the Dekoven and Davis Coals, geophysical logs spaced at approximately 3 miles were used in the

Figure 1 Extent of the Pennsylvanian System in the Illinois Basin (modified from Treworgy et al. 2000).

northern third of the study area to supplement sparse or nonexistent coal test drilling data, and mapping was extended up to 2 miles beyond any given data point. Mined areas were updated to January 1, 2000, by using maps obtained from coal companies.

Geology and Mining of the Coals

The coal-bearing rocks of Illinois were deposited during the Pennsylvanian Period approximately 295 to 325 million years ago (Haq and Van Eysinga 1998). The strata of the Pennsylvanian System underlie about two-thirds of the state. Only the northern fourth of Illinois and narrow belts along the Mississippi, Ohio, and Illinois Rivers have no Pennsylvanian rocks. The coal-bearing strata of Illinois extend into southwestern Indiana and western Kentucky as a single continuous coal field known as the Illinois Basin or Eastern Interior Coal Field (fig.1).

Within the Pennsylvanian strata, coal seams are present as part of cyclic rock sequences called cyclothems— of which a succession of sandstone, shale, limestone, and coal units mark the shifting ancient shoreline environment during a complete cycle of marine invasion and retreat (Jacobson 1973). The seams are not evenly distributed over the approximately 3,000-foot-thick sequence of coal-bearing rocks in Illinois, and most occur in the middle of the Pennsylvanian sequence. These Pennsylvanian coals are continuous over large areas, and they generally crop out along the margins of the basin (fig. 2), although the thickness of any particular seam may be quite variable.

Dozens of coal seams have been mined commercially in Illinois, but only some are important in terms of past and present production. These economically important seams are included in figure 3; in order of geologic age these major seams in Illinois are the Danville (youngest), Herrin, Springfield, Colchester, Seelyville, Dekoven, and Davis Coals. Some of the coals in the Illinois Basin can be correlated across state boundaries; however, the names of these coals are subject to change from one state to another (table 2).

In Illinois, the five coals discussed in this report are typically thinner and/or deeper than the more extensively mined Herrin and Springfield Coals that were described previously (Treworgy et al. 1999a, 2000). However, ample resources of these five coals remain, and their presence in selected areas of the state is discussed herein.

Danville Coal The 19.6 billion tons of Danville Coal resources are the third largest in the state and constitute about 9% of the total coal resources. The Danville Coal Member of the Shelburn Formation can be traced throughout two-thirds of the state of Illinois, although the coal exceeds 42 inches in thickness (the minimum thickness for coal seams available for underground mining) primarily in a narrow band along the eastern and northern edges of the coal field (fig. 4). Resources of the Danville Coal were mapped by

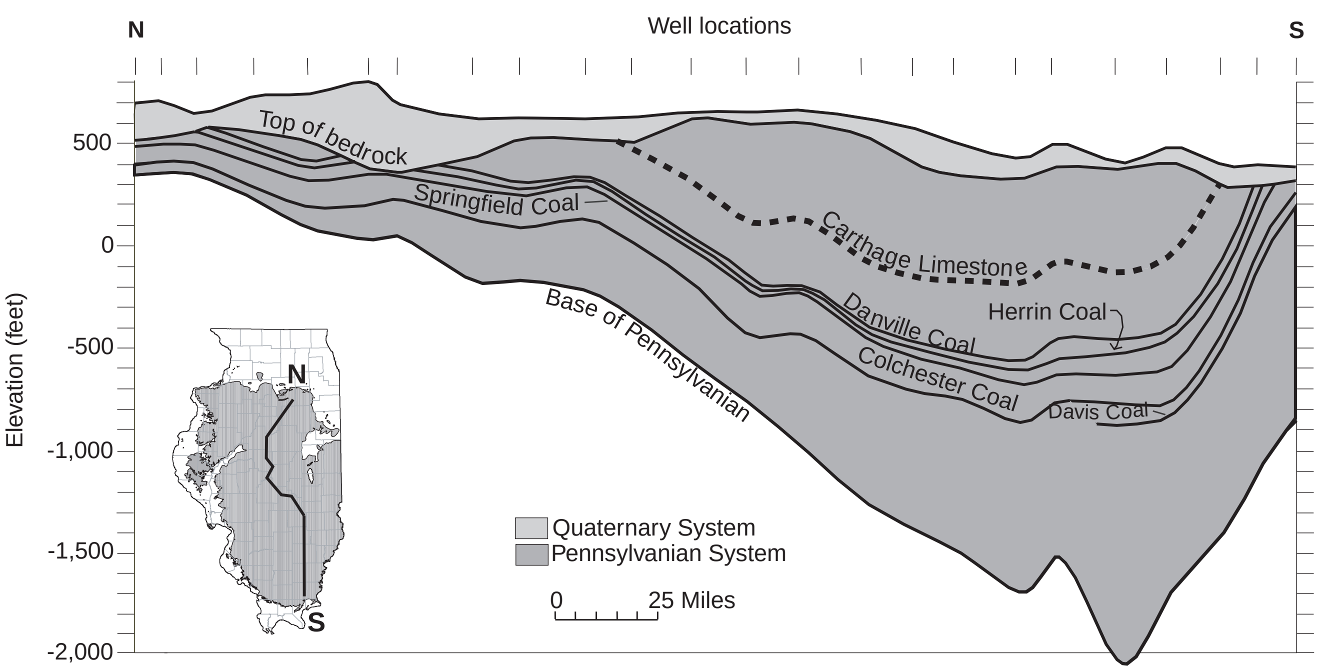

Figure 2 North-south cross section of the Pennsylvanian System in Illinois (from Treworgy et al. 2000). The Seelyville Coal is not included in this cross section.

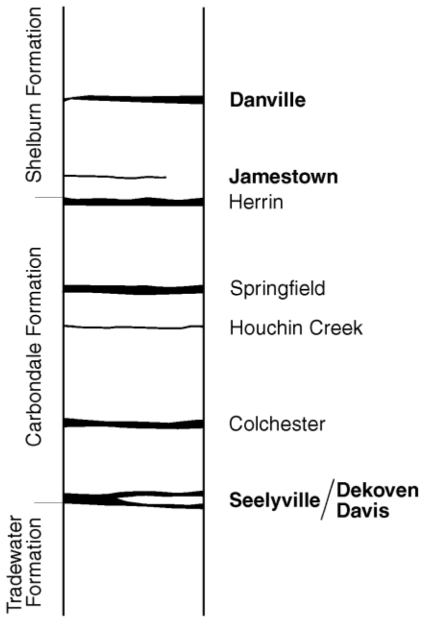

Figure 3 General stratigraphic position of coals mentioned in this report (bold type). Coals are shown in order of geologic age (youngest seam at top). Formal nomenclature is from Jacobson et al. 1985.

Table 2 Variation in names of some major coal seams in the Illinois Basin (Jacobson et al. 1985, Shaver et al. 1986, Greb et al. 1992).

Illinois	Indiana	Western Kentucky
Danville (No. 7)	Danville (VII)	Wheatcroft
Jamestown	Hymera (VI)	Paradise (No. 12)
Herrin (No. 6)	Herrin	Herrin (No. 11)
Springfield (No. 5)	Springfield (V)	Springfield (No. 9)
Colchester (No. 2)	Colchester(IIIa)	Colchester
Seelyville	Seelyville (III)	
Dekoven	Dekoven	Dekoven (No. 7)
Davis	Davis	Davis (No. 6)

previous studies along this band and in scattered areas of southern, central, and northwestern Illinois (appendix 2), and for this study in Douglas and Mc Lean Counties using coal test drilling data acquired since the earlier investigations. Elsewhere the coal is probably too thin to be of economic interest. The Danville Coal is the youngest of the five coals covered by this report (fig. 3). The coal crops out along the margins of the Illinois Basin and reaches a maximum depth in southeastern Illinois of about 1,300 feet (fig. 5).

The Danville Coal has been mined in Illinois for over 100 years (fig. 6), but only about 1% of the original resources has been depleted. The most extensive area of mining was in east-central Illinois near the city of Danville where the coal has been mined by both surface and underground methods. The coal was also mined by underground methods at scattered localities in the northern part of the state (Colfax and Chenoa in Mc Lean County; Fairbury, Pontiac, and Streator in Livingston County; and several locations in La Salle and Bureau Counties) and has been surface mined at a number of locations in southern and western Illinois. Except for mines in east-central Illinois, most large surface mines recover the Danville Coal only as part of their operation to remove overburden to mine the underlying Herrin Coal. In many cases, the Danville seam has been considered to be too thin or too poor in quality to justify recovery and was simply discarded in the spoil pile with other rock overburden. In Indiana, mines from Terre Haute southward in the western and southwestern parts of the state have and continue to work the Danville Coal.

During or immediately following the accumulation of the peat that eventually formed the Danville Coal, part of the peat swamp was flooded and covered by a sequence of shale, siltstone, and sandstone. Distributary channels within the deltaic system that deposited this sequence are preserved as linear deposits of sandstone in areas of east-central Illinois (fig. 7). This sandstone is commonly tens of feet above the coal, but in some areas the sandstone lies only a few feet above or directly on the coal. Thinner coal is shown on some logs where the sandstone lies directly on the coal, indicating that the top of the seam may have been eroded.

Because of the variable spacing between data points used to map resources and the relatively narrow sandstone bodies, the locations and lateral extent of the sandstone channels are only generally known, and the continuity of the coal seam below the sandstone is uncertain. An explanation for the channels could be that prior to the Danville deposition, these areas compacted more rapidly and were topographically lower than surrounding areas; thus, they received more of the distributary channel sediments.

There is no experience mining the Danville Coal in Illinois below the sandstone channels and only limited experience in Indiana. In the limited Indiana experience, as well as similar situations in Illinois involving the Anvil Rock Sandstone overlying the Herrin Coal, mine productivity was reduced in areas where the sandstone was within about 5 feet of the top of the coal because of unstable roof conditions, wet mining conditions, and abrupt thinning or absence of the coal (ISGS mine notes). Similar mining conditions are anticipated for the Danville Coal in Illinois where sandstone forms the roof rock or is a short vertical distance above the coal.

Jamestown Coal The Jamestown Coal Member of the Shelburn Formation makes up about 2% (3.6 billion tons) of the resources of the state. Although the coal has never been mined in Illinois, it has been extensively mined, both at the surface and underground, just across the state line in Indiana where it is called the Hymera Coal. The Jamestown Coal lies 20 to 50 feet below the Danville Coal and 1 to 10 feet above the Herrin Coal (fig. 3). The Jamestown Coal can be traced as a thin bed—or as coal streaks and carbonaceous shale, typically a few inches thick—in cores and mine exposures over much of central and southern parts of Illinois, but is known to be greater than 42 inches thick only along the east border of the state in Clark,

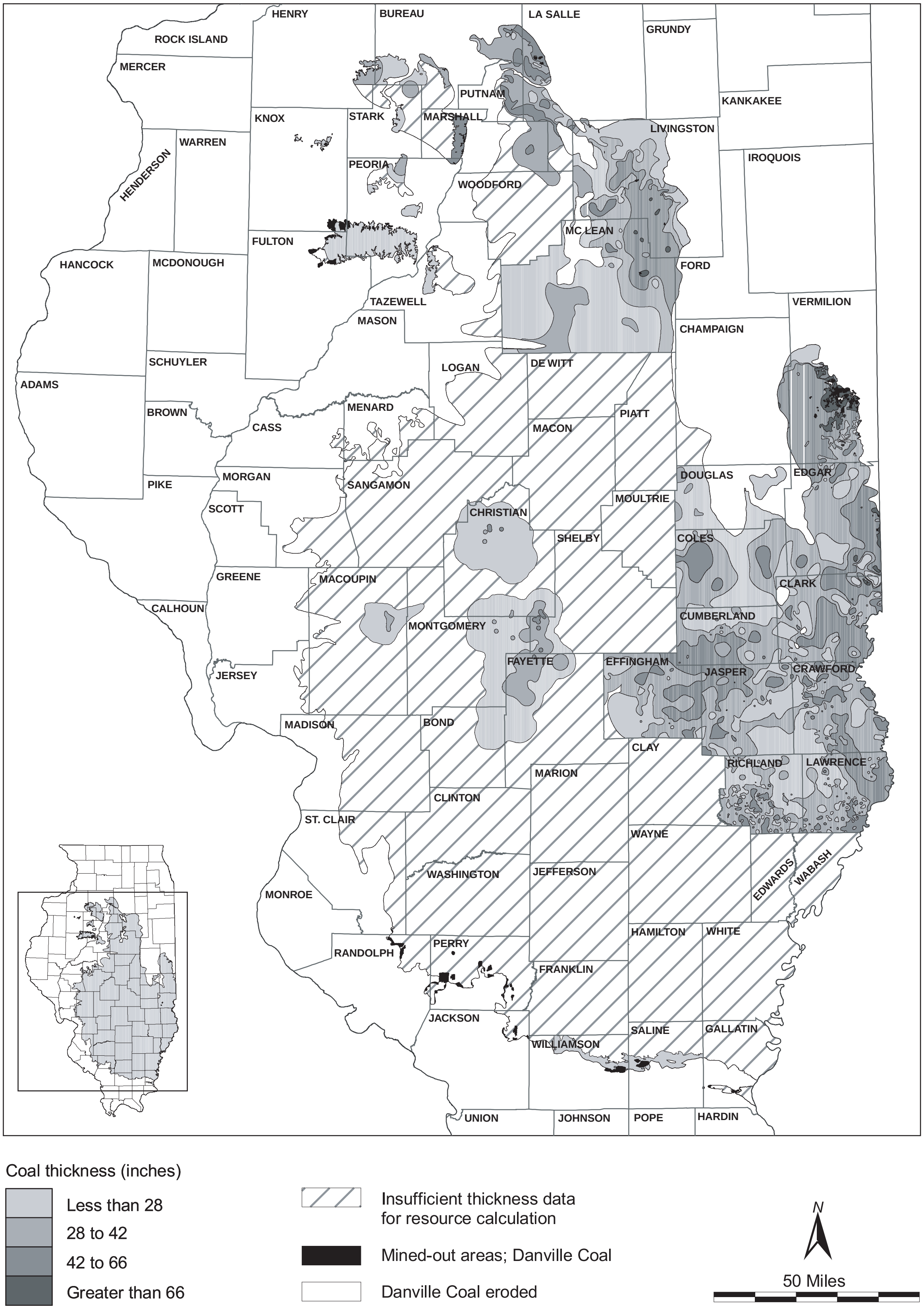

Figure 4 Thickness of the Danville Coal.

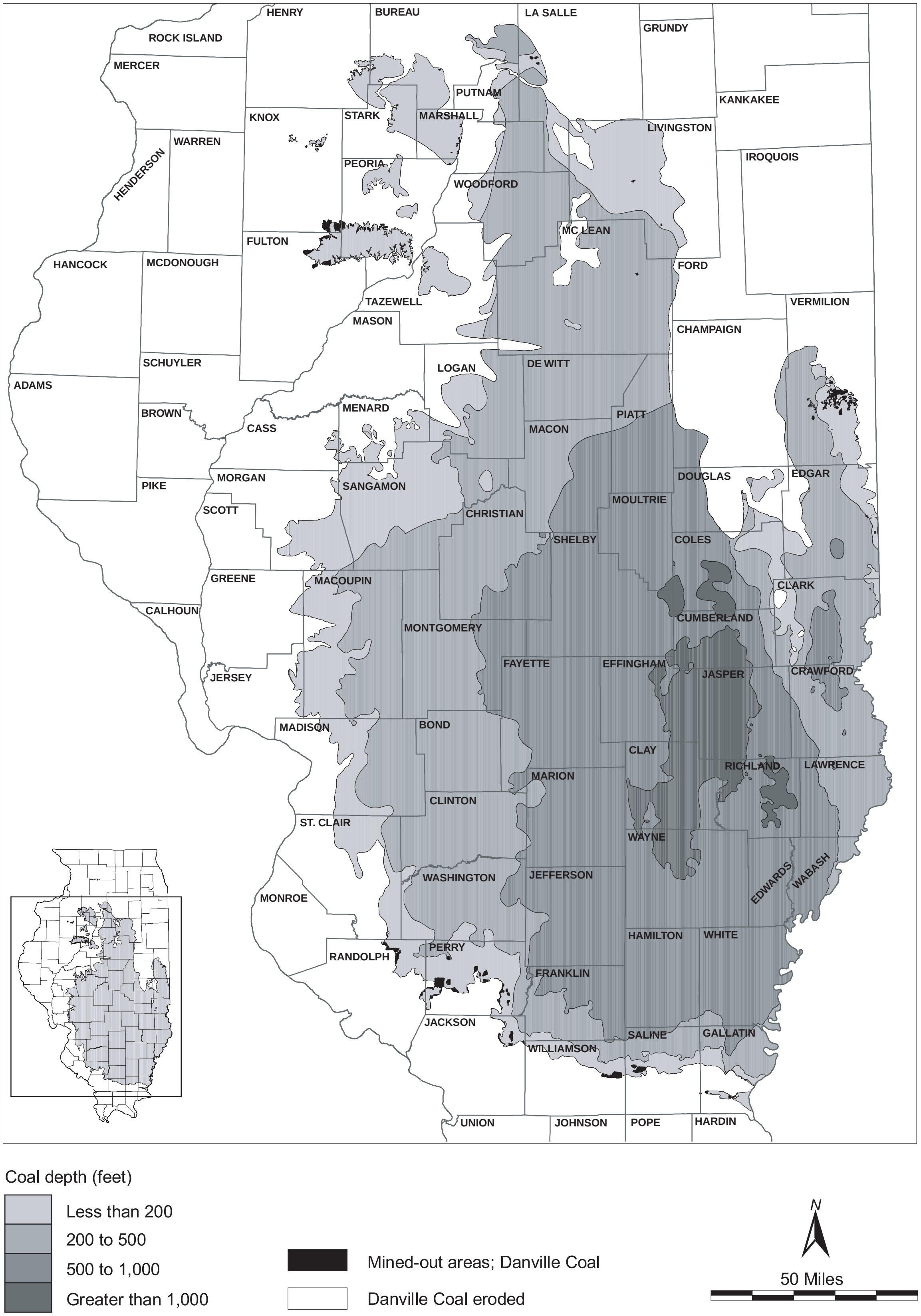

Figure 5 Depth of the Danville Coal.

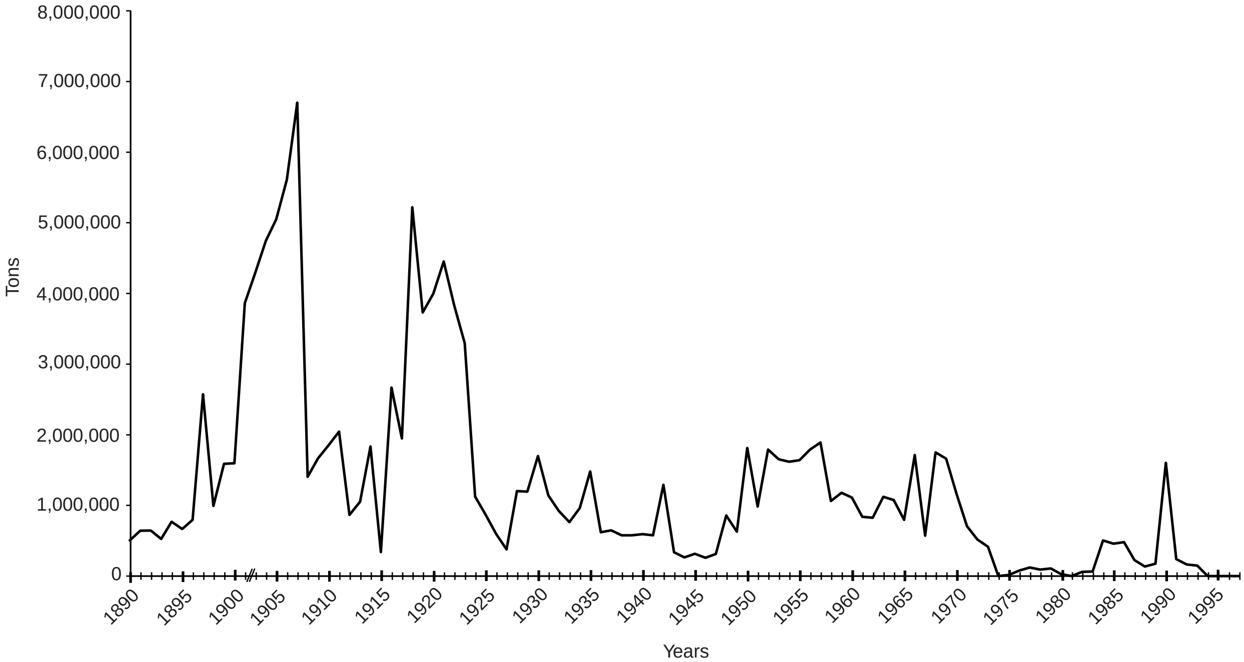

Figure 6 Annual production of the Danville Coal in Illinois. The // on the x-axis indicates no data for 1902.

Crawford, and Lawrence Counties (fig. 8; Treworgy et al. 1997b). In this area of resources, the seam ranges in depth from approximately 150 to 1,000 feet (fig. 9). Lack of mining of the Jamestown Coal in Illinois is attributed to its being shallower and thicker just across the state line in Indiana. In addition, thicker Herrin and Danville Coals are closer to the surface near this area. In Kentucky, the Jamestown is called the Paradise (No.12) Coal. Thick deposits occur in the western part of the state, where the Paradise has been strip mined extensively in a three-county region (Greb et al. 1992).

Because of the lack of any past mining of the Jamestown Coal in Illinois, the mining conditions that will be encountered can only be inferred from nearby mines in Indiana. Harper (1988, 1994) describes underground mining of the Hymera in Indiana as being limited by geologic conditions. The Thunderbird Mine, the last major underground mine active in the Hymera and the closest mine to Illinois, had a roof sequence consisting of laminated gray shale and sandstone. Mining problems encountered included failure of the shale after exposure to the atmosphere, seepage of water from the sandstone where it closely overlies the coal, and features described as "faults" or "roof rolls." Miners use these latter terms to refer to a variety of displacements, discontinuities, and irregularities in the coal and overlying roof strata. Similar conditions were reported in other underground mines in the Hymera Coal. Many of these mines were very shallow, and some roof stability problems may have been caused or exacerbated by insufficient bedrock cover or weathering of the bedrock cover. Some resources of Jamestown Coal in Illinois will probably be found to be difficult or costly to mine because of some of these geologic conditions. Because of the scarcity of suitable drilling records and lack of mining experience, it is impossible at this time to delineate the areas or estimate the amount of resources that will be affected by adverse geologic conditions.

Dekoven Coal The 6 billion tons of Dekoven Coal resources are the seventh largest in Illinois and make up about 3% of the state's total coal resources. Earlier studies of the coal (Cady 1952, Smith 1957, Jacobson 1993) were confined to the southern third of the study area (Franklin, Williamson, Saline, and Gallatin Counties). Using new subsurface data, this study expanded mapping of the Dekoven to include White, Hamilton, Wayne, Edwards, and Wabash Counties.

The Dekoven Coal Member of the Carbondale Formation (fig. 3) is widespread across southeastern Illinois. Jacobson (1987) found the Dekoven Coal and the underlying Davis Coal to be equivalent to the benches of the Seelyville Coal that were formed by the presence of several clastic partings to the north and east of this study area.

The Dekoven Coal ranges from 28 to 42 inches thick over approximately two-thirds of the area studied for this report and in smaller areas up to 66 inches in thickness (fig. 10). The Dekoven increases in depth from its crop line northward (fig. 11) and reaches depths exceeding 1,400 feet toward the center of the deep basin, or Fairfield Basin (fig. 12), and depths exceeding 1,000 feet occur in smaller areas of downdropped fault blocks (grabens) in Gallatin and White Counties.

In southeastern Illinois, a parting occurs in the Dekoven Coal, producing a split of coal from the main bench of the Dekoven that Jacobson (1993) referred to as the lower Dekoven Coal. Smith (1957) and Jacobson (1987) had recognized this split but had not

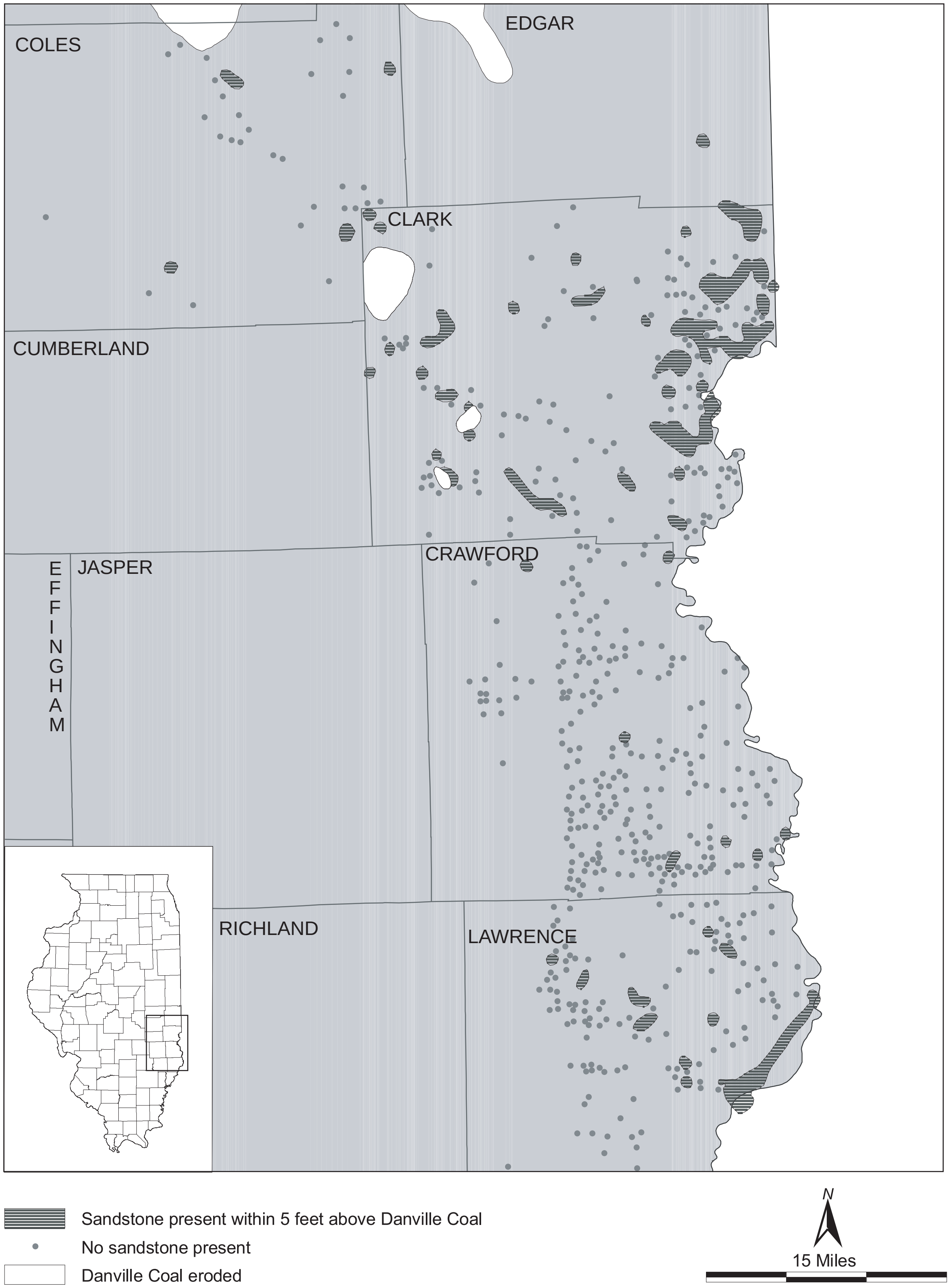

Figure 7 Location of sandstone channels above the Danville Coal.

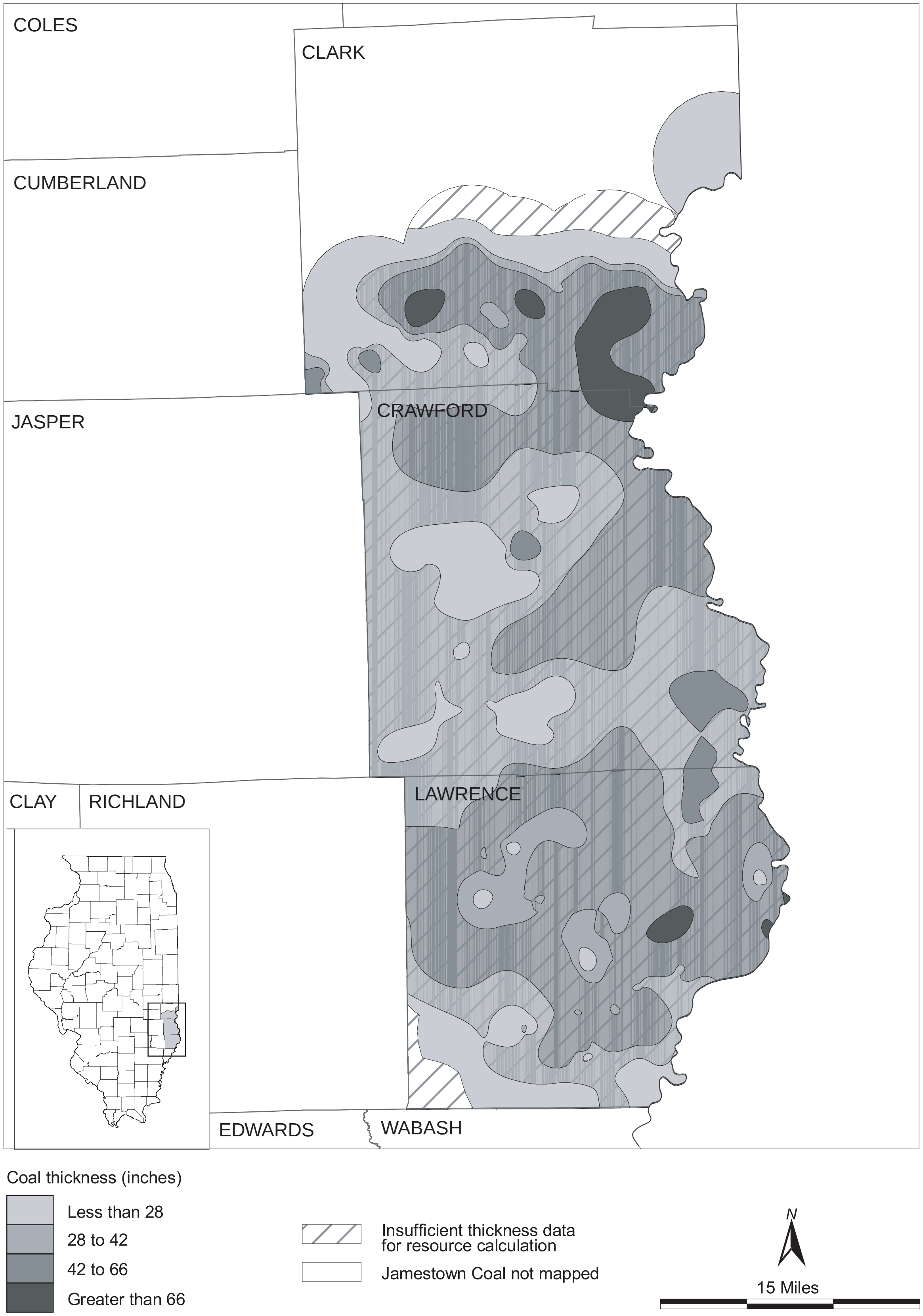

Figure 8 Thickness of the Jamestown Coal.

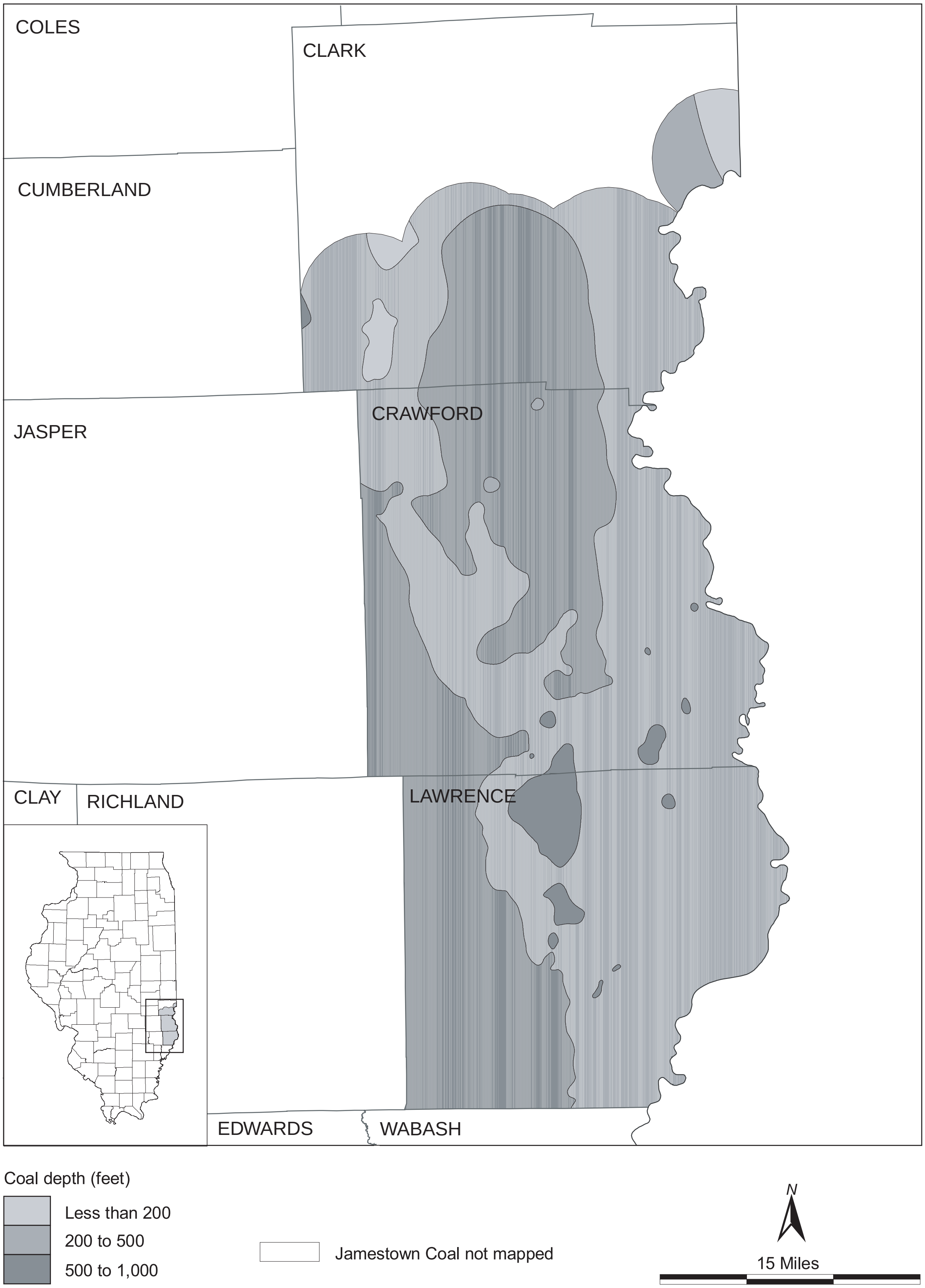

Figure 9 Depth of the Jamestown Coal.

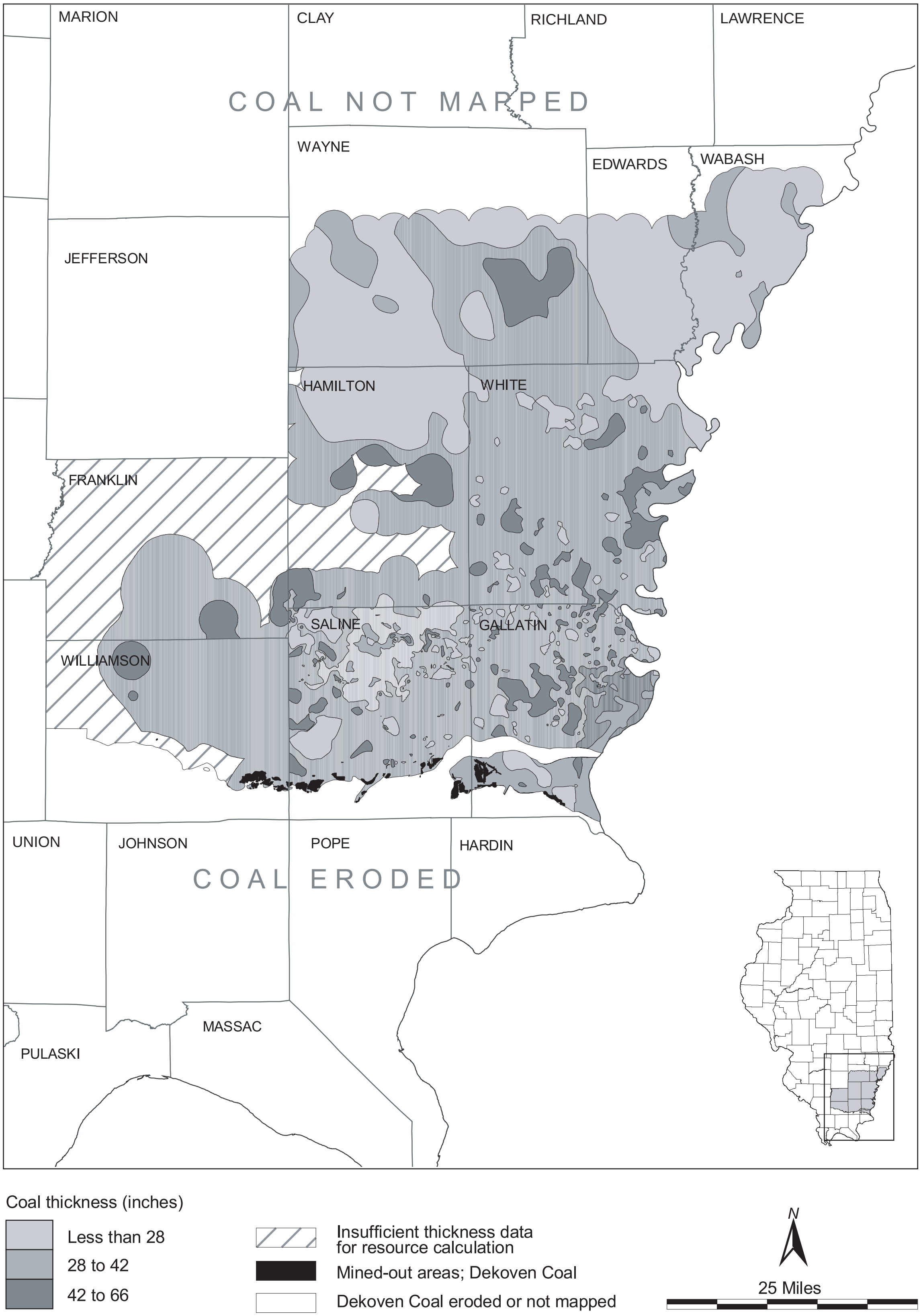

Figure 10 Thickness of the Dekoven Coal.

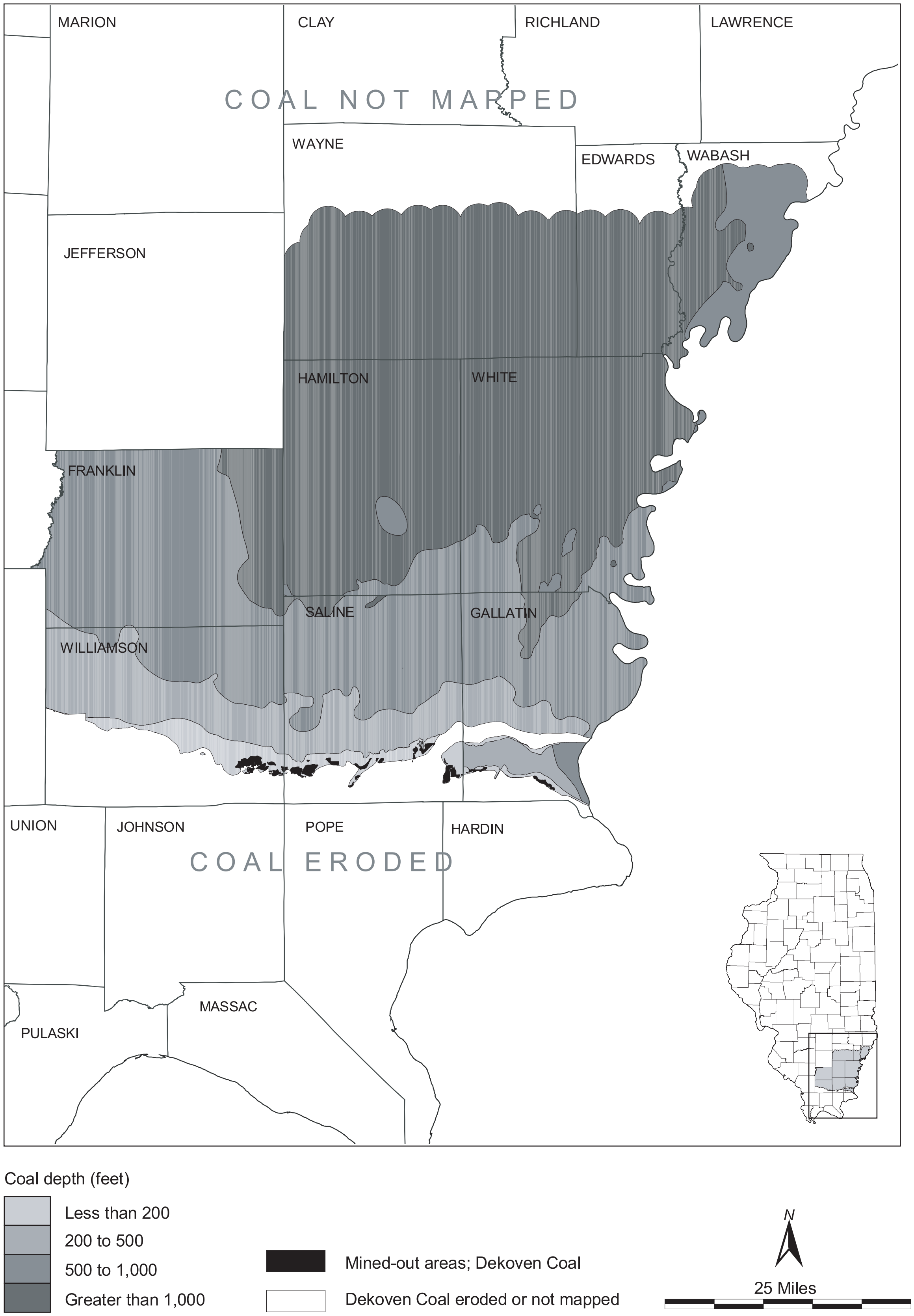

Figure 11 Depth of the Dekoven Coal.

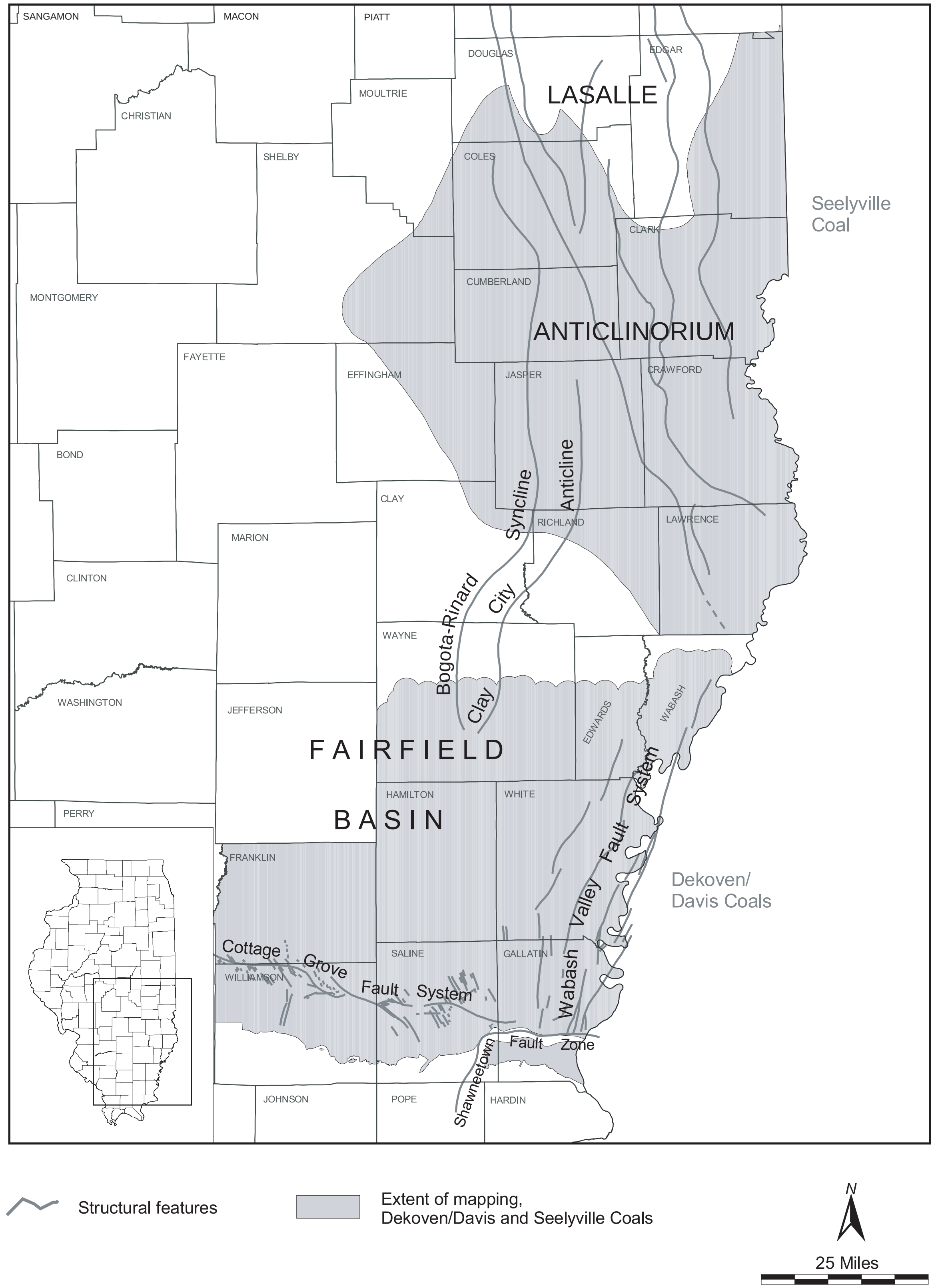

Figure 12 Selected structural features in southeastern Illinois.

mapped it in detail prior to the 1993 study by Jacobson. The lower Dekoven is typically less than 28 inches thick in most of the study area, and the rock parting dividing the Dekoven Coal increases in thickness to the north-northeast from a feather edge to more than 40 feet thick (Jacobson 1993). New subsurface data suggest that this parting extends throughout the northeastern portion of the study area and thins northeastward toward the eastern shelf of the Illinois Basin.

The Dekoven Coal is typically overlain by either medium to dark gray silty shale and siltstone or by massive, thick sandstone. These shales, siltstones, and sandstones are of variable lateral extent and are not easily mappable, but such areas of lateral variation commonly have unstable roof conditions. Thick, well-cemented sandstone can produce a strong roof and may exist in some areas over the Dekoven, but the common presence of shaley sandstones, siltstones, and shales will likely reduce the competence of the Dekoven roof. Two of the three older underground mines in the Dekoven Coal reported water problems that may have been related to porous sandstones, fracturing, faulting, or a combination of such factors (unpublished mine notes, ISGS Coal Section).

Nearly all of the mining in the Dekoven Coal has occurred along its crop line in the southern part of the study area. The Dekoven Coal was often mined along with the underlying Davis Coal because, in this area, these coals are found with the interval between them averaging 25 feet thick. Most mining to date has been in surface mines, but some small underground mines have operated in Gallatin and Saline Counties. The Dekoven Coal has been mined extensively in western Kentucky, both underground and in surface mines.

Interval between the Dekoven and Davis Coals The interval between the main bench of the Dekoven Coal and the underlying Davis Coal ranges from less than 20 feet to more than 60 feet thick over much of the report area; the thinner areas occur to the south-southwest and northeast (fig. 13). The interval between the two coals thins dramatically coming out of the deeper basin where the strata rise up over the La Salle Anticlinorium (fig. 12), and on the eastern shelf of the basin these two coals appear to merge to form the Seelyville (Jacobson 1987).

Over much of the northern half of the study area, the interval thickness is well over 60 feet, and this interval between the Dekoven and underlying Davis Coal includes the clastic parting within the Dekoven Coal. Here, the interval between the Davis and the lower split of the Dekoven averages 10 feet, which is significantly less than in areas where the Dekoven parting is absent and the interval thickness averages 20 to 25 feet. Where the split in the Dekoven is absent, the general lithology of the interval between the Davis and Dekoven is sandstone above the roof shales of the Davis Coal. This sandstone seems to be mostly absent, however, where the overlying Dekoven is split. Thus, where this sandstone thins or is absent, the interval thickness between the Davis and the lower bench of the Dekoven is also thinner.

Davis Coal The 10 billion tons of Davis Coal resources represent the sixth largest in the state and constitute roughly 5% of the total coal resources. Previous studies of the coal (Cady 1952, Smith 1957, Jacobson 1993) were limited to southeastern Illinois, specifically Franklin, Williamson, Saline, and Gallatin Counties. New subsurface data have expanded mapping of the Davis northward to include White, Hamilton, Wayne, Edwards, and Wabash Counties.

The Davis Coal Member of the Carbondale Formation (fig. 3) is the thickest and most widespread coal below the Colchester Coal in southeastern Illinois. The Davis is typically 42 to 66 inches thick over roughly half of the study area, and, in smaller areas, the coal is greater than 66 inches thick. In other areas, the Davis is thinner, typically ranging from less than 28 inches to 42 inches thick (fig. 14). The Davis Coal increases in depth from its crop line northward and reaches depths of nearly 1,500 feet toward the center of the deep basin, and depths exceeding 1,000 feet occur in smaller areas of downdropped fault blocks (grabens) in Gallatin and White Counties (fig. 15).

The Davis Coal is generally overlain by shale, which core, gamma log, and mine data indicate as black, very fissile, carbonaceous, and marine in origin. This shale averages 5 feet thick over much of the study area. However, in smaller areas, gray silty shales or siltstones occur directly overlying the Davis. This shale, in turn, is overlain by a variable succession of gray shale, siltstone, and sandstone. Above some other coals, black fissile shale is overlain by marine limestone. Although black fissile shale makes a fairly competent mine roof, the general strata overlying the Davis are not as competent as those over other coals where a hard marine limestone is present near the coal. Where planar-bedded sandstone with shale partings is present, roof stability is often even further reduced, and sandstones within 5 feet above the coal can be likely sources of water problems within a mine.

Nearly all of the mining in the Davis Coal has occurred along its crop line in the southern part of the study area. The Davis Coal was often mined along with the overlying Dekoven Coal because, in this area, they average 25 feet apart. As with the Dekoven Coal, most mining to date has been in surface mines, but some small underground operations are found in Gallatin and Saline Counties. At the time of this report, a larger underground operation was mining the Davis Coal in Gallatin County near the Eagle Valley area. Also, numerous surface and underground operations mine the Davis Coal in western Kentucky.

Seelyville Coal The Seelyville Coal Member of the Carbondale Formation underlies approximately 1,900 square miles in central and eastern Illinois and contains about 5% (10 billion tons) of the state's resources. The coal is 42 to 66 inches thick over much of the study area, and, in several large areas, the seam is greater than 66 inches thick (fig. 16). The coal ranges in depth from greater than 200 feet along the eastern edge of the state to about 1,500 feet in the central part of the basin (fig. 17). The coal is found at the same stratigraphic position as the Dekoven and Davis Coals in southern Illinois (fig. 3), and subsurface correlation by Jacobson (1987) indicated that upper

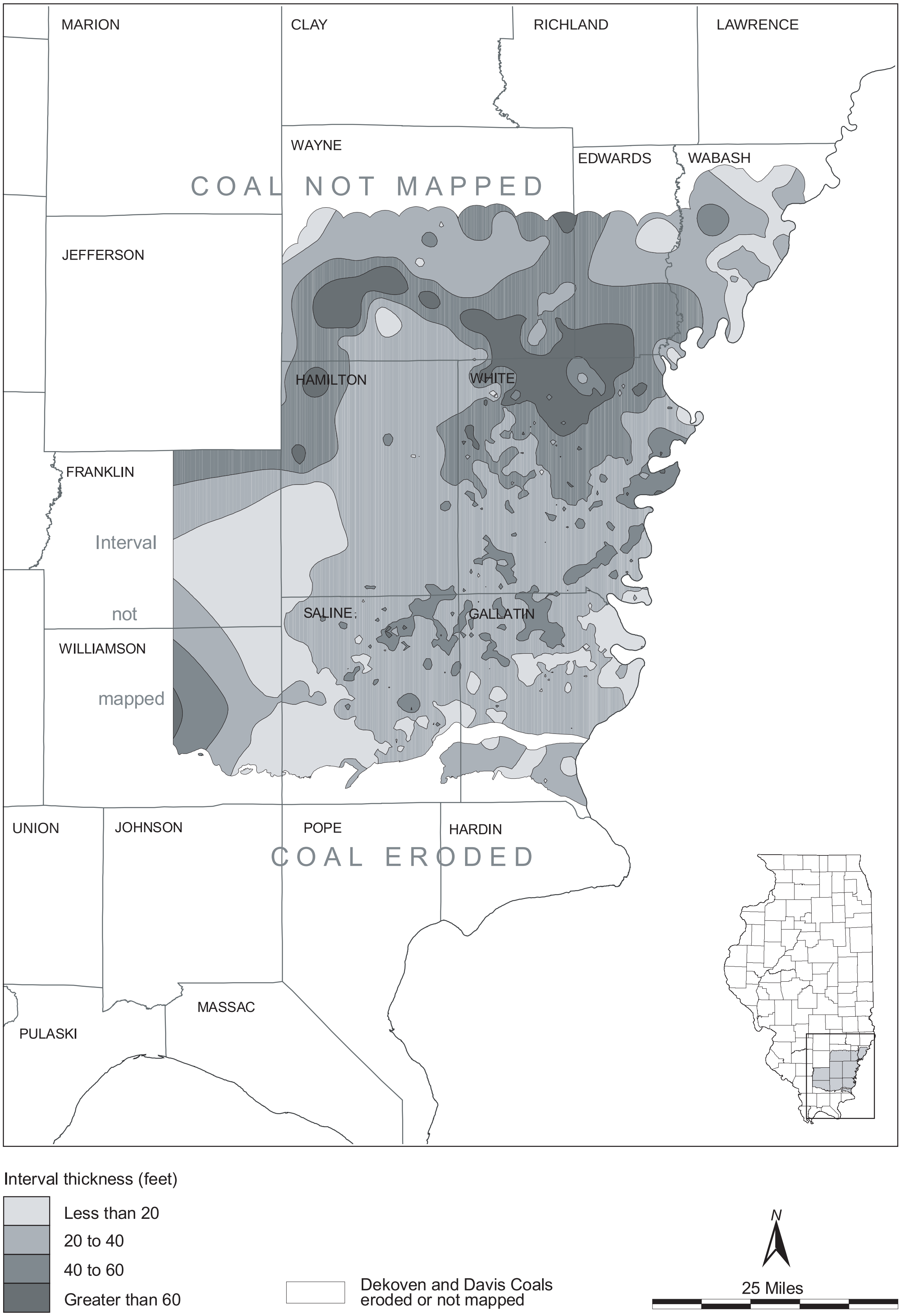

Figure 13 Thickness of the interval between the Dekoven and Davis Coals.

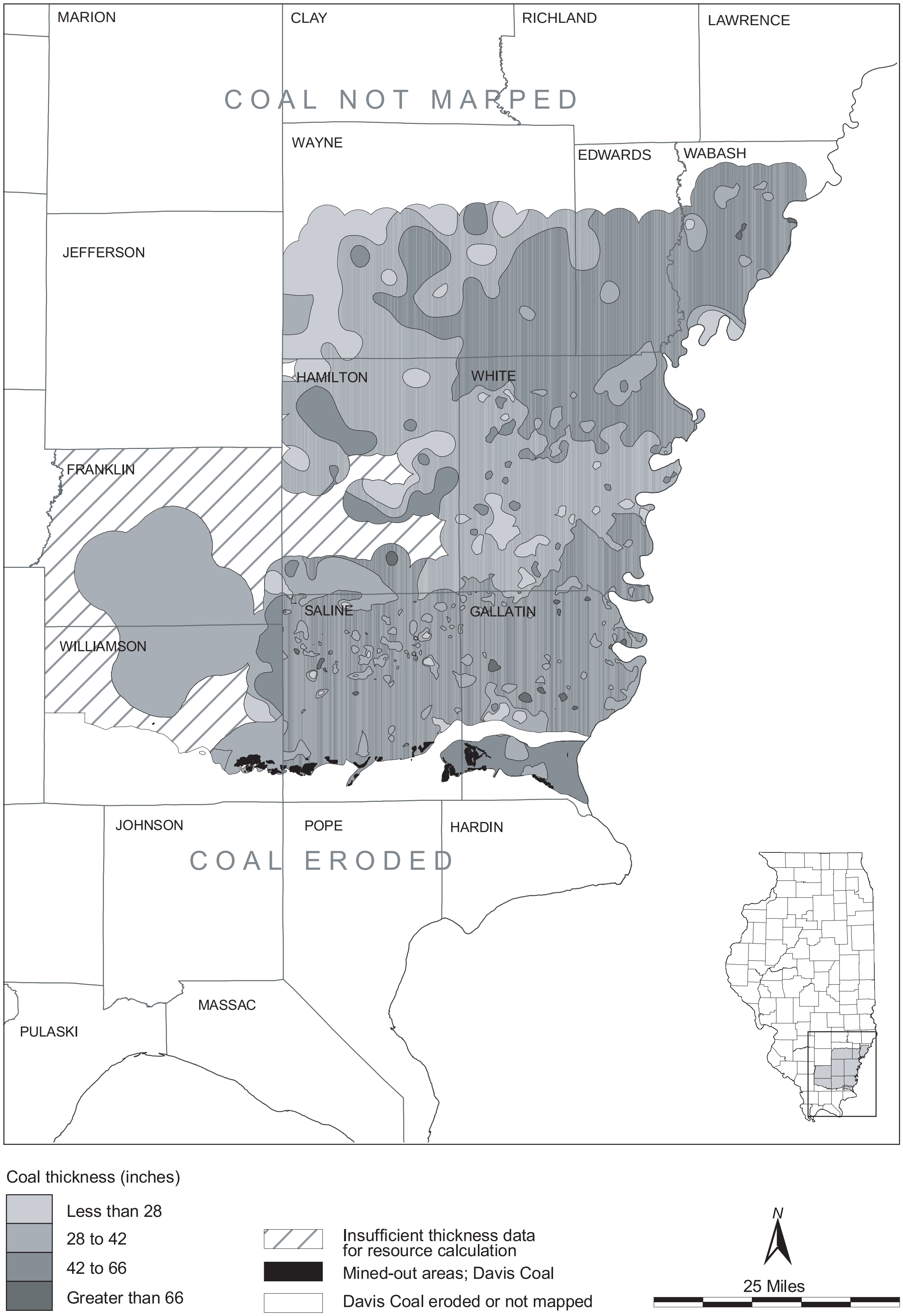

Figure 14 Thickness of the Davis Coal.

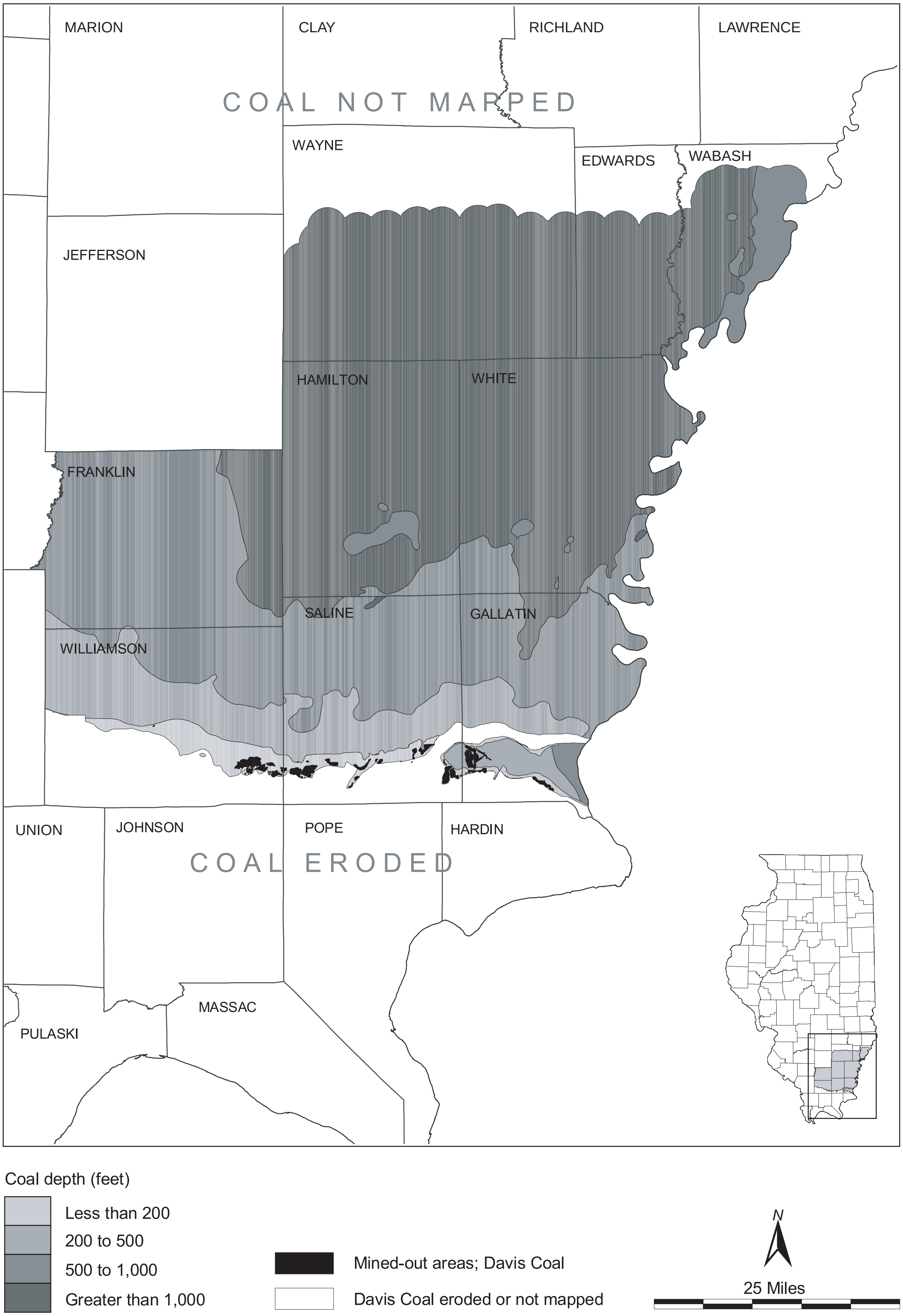

Figure 15 Depth of the Davis Coal.

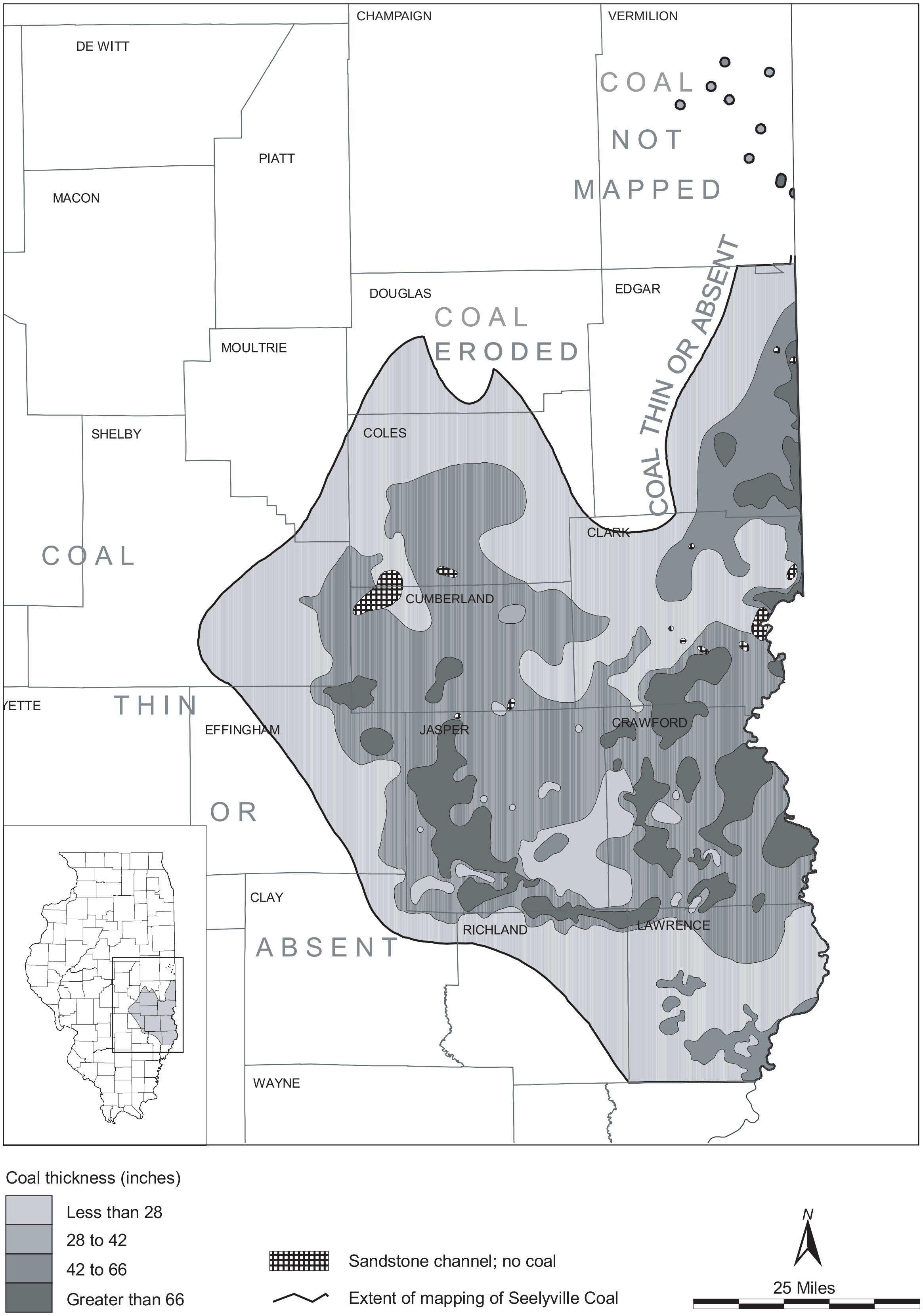

Figure 16 Thickness of the Seelyville Coal.

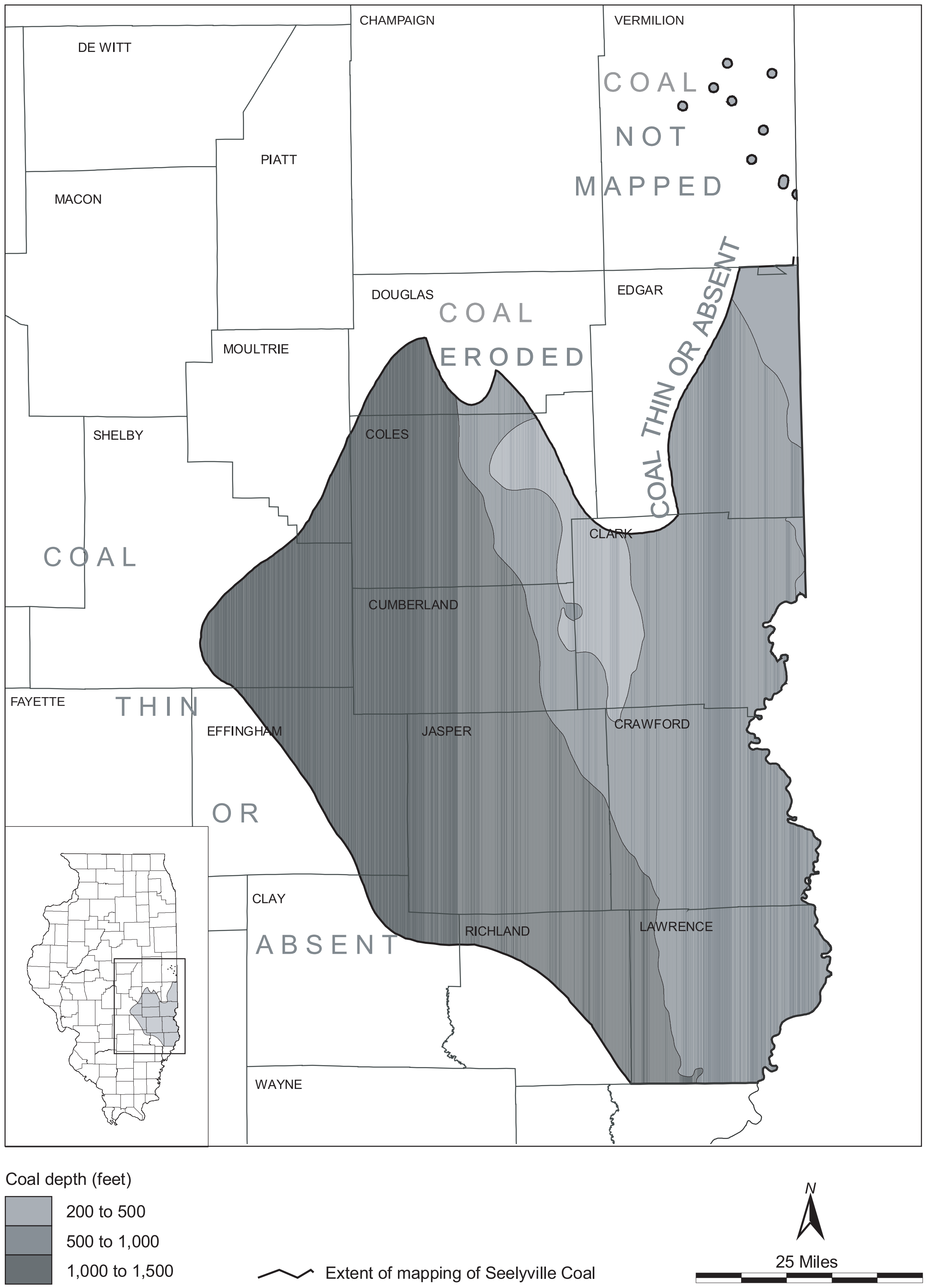

Figure 17 Depth of the Seelyville Coal.

and lower benches of the Seelyville are correlative with the Dekoven and Davis Coals, respectively. The Seelyville has been extensively mined both at the surface and underground in western Indiana. The only mining of this seam in Illinois was in Edgar County, where two underground mines based in Indiana extended their works a few hundred feet into Illinois. The seam has received little attention from Illinois mining companies because of the availability of abundant resources in shallower seams, such as the Herrin and Springfield Coals.

The Seelyville Coal commonly has one or more shale partings. The thickest partings are usually in the middle or upper part of the seam and range from a few inches to several feet thick. Most of the Seelyville resources were mapped using geophysical logs from oil test holes (Treworgy 1981). These logs seldom had a resolution suitable for detecting partings less than 6 inches thick, so the number and extent of these thinner partings are unknown. In areas where partings exceeded about 2 feet in thickness, only the thickest bench of coal, commonly the lower bench, was considered a resource. The resolution and density of drilling records used to map the Seelyville resources were not sufficient to delineate areas with multiple, thin partings. Our quadrangle studies found that excessive parting material is a common problem with the Seelyville Coal. In this report, total available tonnage of coal has been reduced by 20% to represent the possible amount of resource that may be unavailable because of excess parting material.

As with the Jamestown Coal, the lack of any history of mining the Seelyville Coal in Illinois makes it difficult to evaluate how geologic conditions such as roof stability and the presence of sandstone in the roof strata may affect the availability of coal. Treworgy (1981) described three types of strata overlying the coal that consist of various sequences of shales, claystones, and sandstones. None of these sequences clearly makes an excellent mine roof. Harper (1985) noted that Indiana mines nearest Illinois in the Seelyville (the Talleydale and Green Valley Mines, in northwest Vigo County) reported common problems with roof control such as weakness of laminated sandstones upon exposure to air, and "squeezes," or the sinking of support pillars into the soft, unconsolidated claystones underlying the coal, which often led to constricted mine openings and the weakening of the nearby roof. Also, the map of the Green Valley Mine notes water in at least one location. Thus, for the Seelyville Coal in Illinois, it is reasonable to expect some loss of resources caused by adverse geologic conditions.

Coal Quality

The quality of coal was not considered as a factor in determining its availability. Although coal quality is an extremely important factor in individual sales contracts and the magnitude of demand for a particular coal, availability for mining of a specific resource cannot be ruled out based strictly on quality. Coal washing, blending with other seams, and other techniques can be used to mitigate some undesirable quality characteristics of coals. Because most Illinois coal resources have a relatively high-sulfur content, the demand for these resources is currently limited. However, the market for high-sulfur coal, although reduced in size, is expected to continue and may increase as power plants with new emission control technologies become available.

Rank Illinois coals are high-volatile, bituminous coals that range in rank from rank A in the southeastern corner of the state to rank C in the northwestern two-thirds of the state (Treworgy 1997b). Over the same area, heat content ranges from more than 25 million BTU per ton to less than 20 million BTU per ton (as received). Most Danville and Jamestown resources are rank C, and most Seelyville resources are rank B. The southernmost Dekoven and Davis resources are rank A.

Sulfur The sulfur content of Illinois coals is closely related to the depositional history of the coal and the roof strata (Gluskoter and Simon 1968, Treworgy and Jacobson 1986). In areas where the peat swamp was inundated with marine waters, the sulfur content of the coal is commonly in the range of 3 to 5% (as-received basis, equivalent to 2.5 to 5 pounds of sulfur per million BTU). In these areas, the coal is typically overlain by a sequence of marine rocks including black shale and limestone. In areas where the peat had been buried by a thick (more than 20 feet) layer of sediments (fresh water or brackish water and estuarine or deltaic clastic sediments) before or shortly after the swamp was inundated by marine waters, the sulfur content of the coal is generally less than 2.0% and may be as low as about 0.5%.

Of the five coals covered in this report, only the Danville Coal has been confirmed by analyses to have resources with a low-sulfur content. Based on the geology associated with these deposits, the Danville Coal is projected to have a low- to medium-sulfur content in eastern Clark, Crawford, and Lawrence Counties in east-central Illinois (fig. 18). The sulfur content is inferred to be as low as about 0.5% (as-received basis), the lowest sulfur deposits being adjacent to the border with Indiana. Where the Danville Coal has been sampled elsewhere in the state, the coal has a high-sulfur content (3 to 5% sulfur, as received).

Few analyses are available of the Jamestown, Dekoven, Davis, and Seelyville Coals in Illinois, and all of those report high-sulfur contents of 3 to 5% (as received). However, these coals are known have low- to medium-sulfur contents in areas of Indiana (Wier 1973), and geologic conditions suggest that some localized lower-sulfur deposits could exist in Illinois.

Chlorine The chlorine content of Illinois coals is loosely correlated to depth, and, for the Herrin Coal, chlorine increases from less than 0.1% (as received) at shallow depths along the margins of the basin to more than 0.4% in the central part of the basin (fig. 19, Chou 1991). Few analyses for chlorine are available for the coals covered by this report. Because chlorine is thought to be related to basin fluids, not coal genesis, the Danville and Jamestown Coals are predicted to have chlorine contents similar to that of the underlying Herrin Coal. The Seelyville, Dekoven, and Davis Coals should have slightly higher chlorine levels. Based on this projection, some resources of the

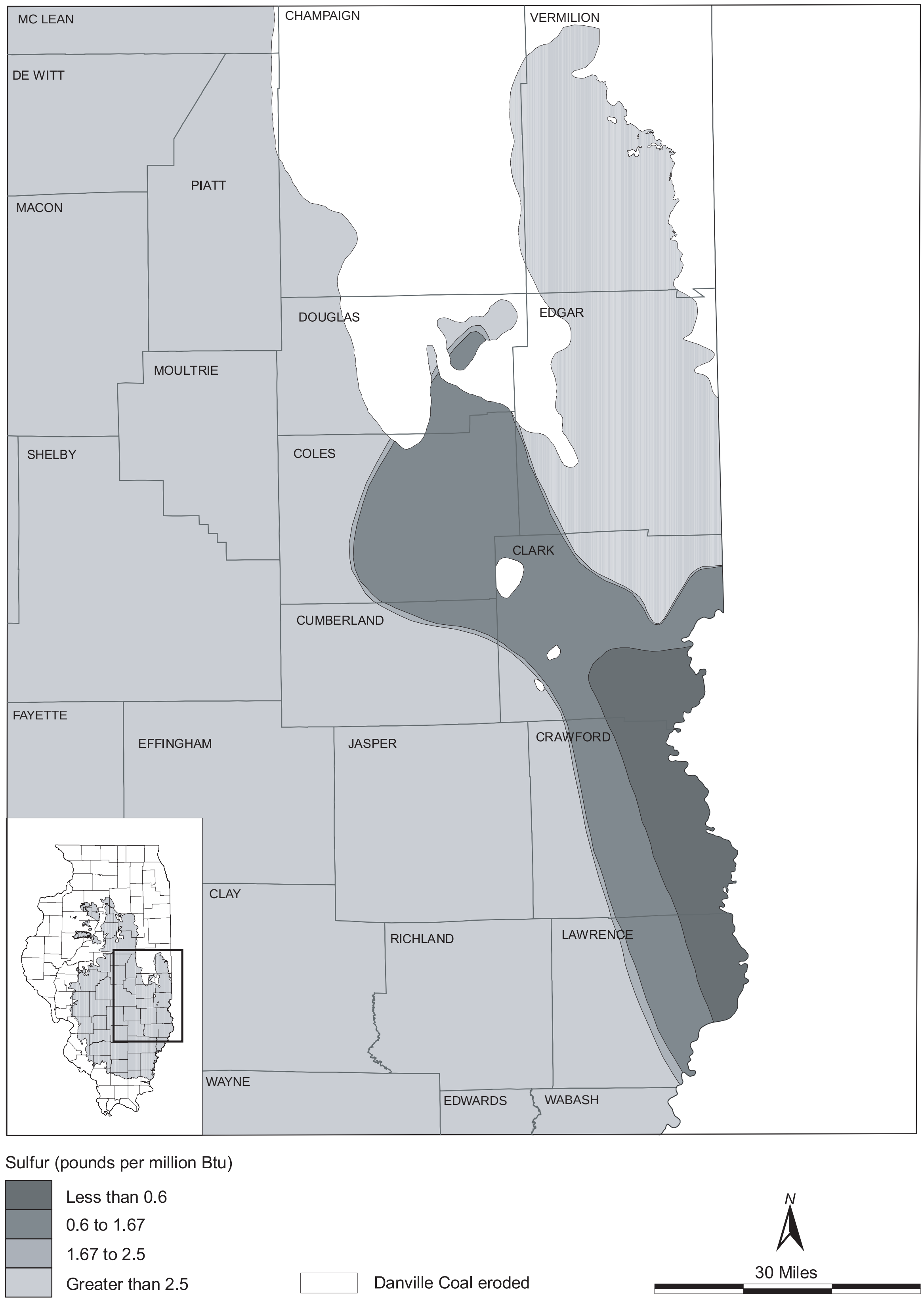

Figure 18 Sulfur content of the Danville Coal.

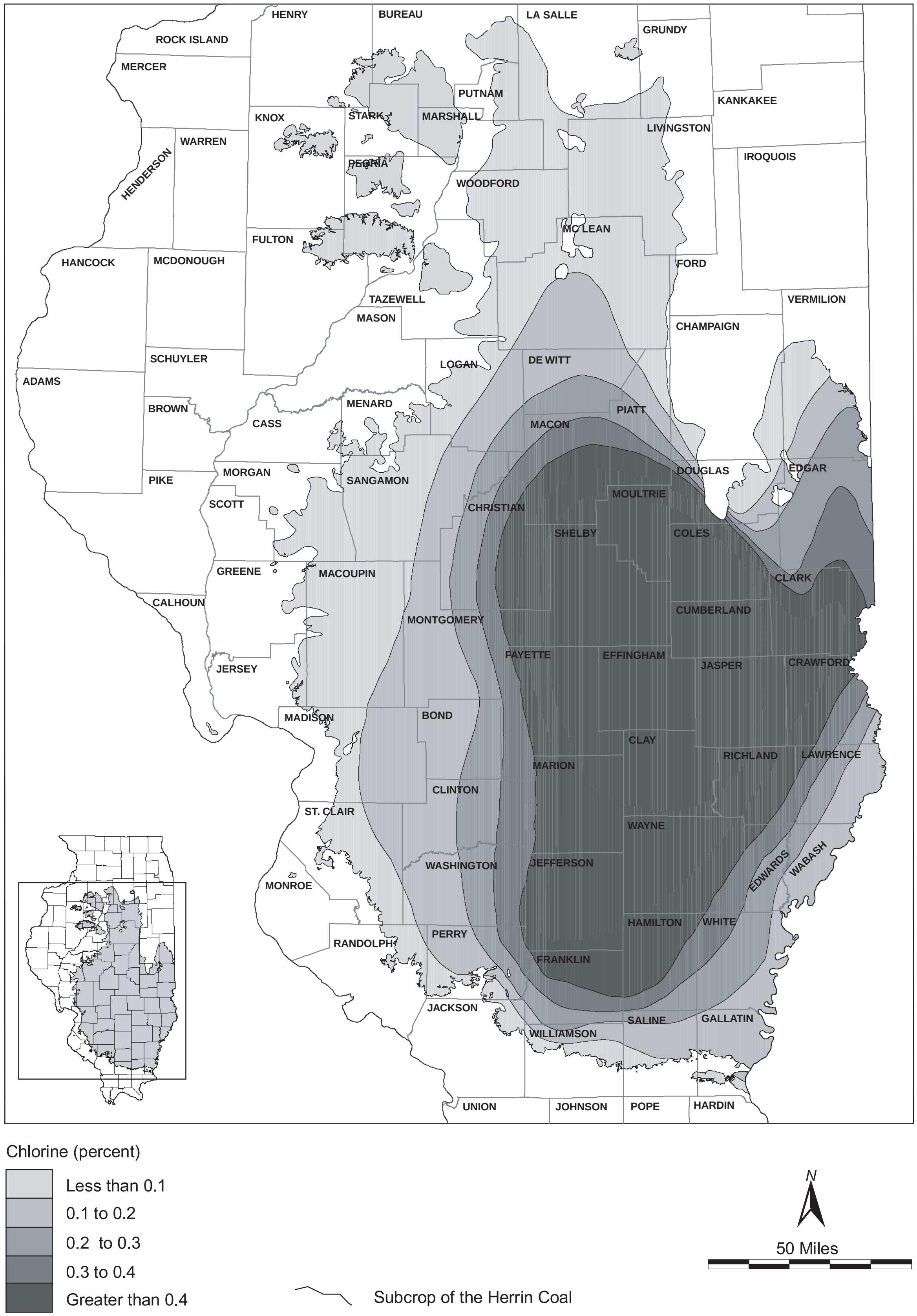

Figure 19 Chlorine content of the Herrin Coal (from Chou 1991).

Table 3 Criteria[1] used to define resources available for surface mining in this study.

Technological restrictions	
Minimum seam thickness	18 inches
Maximum depth	200 feet
Maximum unconsolidated overburden	60 feet
Stripping ratio[2]	
Maximum	25:1
Maximum average	20:1
Minimum size of mine reserve (clean coal)	
Cumulative tonnage needed to support a mine and preparation plant	10 million tons
Individual block size (thousands of tons)	
Less than 50 feet of overburden	150
More than 50 feet of overburden	500
Land-use restrictions (width of unminable coal around feature)	
Cemeteries	not used
State parks and preserves	100 feet
Railroads	100 feet
Federal and state highways	100 feet
Other paved roads	not used
Major airports	100 feet
High-voltage transmission towers	not used
Pipelines	100 feet
Underground mines	200 feet
Towns	0.5 miles
Available with potential restrictions	
Only if surface-mined in combination with overlying or underlying seam	identified[3]
Potential land-use conflicts	
All otherwise available surface minable coal in areas where land-use patterns are incompatible with mining	identified

[1] See previous investigations in this series for a detailed explanation of differences in criteria (Treworgy et al. 1999a, 2000).

[2] Cubic yards of overburden per ton of raw coal; volumes and weights not adjusted for swell factors or cleaning losses.

[3] The Danville Coal was considered to be available regardless of stripping ratio if the underlying Herrin Coal was available for surface mining. The Davis and Dekoven Coals are commonly mined together; thus, their combined tonnage and overburden were used to calculate stripping ratio.

Danville and Jamestown Coals in east-central Illinois and much of the resources of Seelyville Coal may have chlorine levels above those of other coals commonly used in current Illinois markets. Although the chlorine content of British coals has been correlated with corrosion and fouling of high-temperature boilers, no studies have found such a correlation with respect to chlorine in coals from Illinois (Monroe and Clarkson 1994, Chou et al. 1998, 1999).

Quadrangle Studies

The criteria defining available coal resources were developed through a series of 21 assessments of 7.5-minute quadrangles (fig. 20; Jacobson et al. 1996; Treworgy et al. 1994, 1995, 1996a, 1996b, 1997a, 1998, 1999b; Treworgy 1999; Treworgy and North 1999). These assessments included interviews with more than 40 mining engineers, geologists, and other mining specialists representing 17 mining companies, consulting firms, and government agencies actively involved in the Illinois coal industry. Additional background of this program and a detailed description of the framework for the investigations in Illinois are provided in previous reports (e.g., Treworgy et al. 1994).

Table 4 Criteria used to define resources available for underground mining in this study.

Technological restrictions	
Minimum seam thickness	42 inches
Minimum bedrock cover	75 feet
Minimum ratio of bedrock to unconsolidated overburden	1:1
Minimum interburden between minable seams:	40 feet
Minimum size of mining block (clean coal)	40 million tons
Faults (width of zone of no mining)	
Cottage Grove Fault System	
Master fault	500 to 1,000 feet
Subsidiary faults	100 feet
Rend Lake Fault System	200 feet
Centralia Fault	300 feet
Wabash Valley Fault System	800 feet
Sandstone within 5 feet of top of coal[1]	Danville tonnage reduced 25% to account for areas of unstable roof or eroded coal
Partings	Seelyville available tonnage reduced 20% to account for areas unminable because of excessive thickness of parting material
Land-use restrictions (width of unminable coal around feature)	
Surface and underground mines	200 feet
Towns	0 feet
Subdivisions	not used
Churches and schools	not used
Cemeteries	not used
High-voltage transmission towers	not used
Interstate highways	100 feet
Major airports	100 feet
Dams	100 feet
Closely spaced oil wells	<7 wells/40 acres
Available with potential restrictions	
Closely spaced oil well	4 to 7 wells/40 acres
Potential land-use conflicts	all otherwise available underground minable coal within areas where land-use patterns are incompatible with mining
Potentially adverse mining conditions	Danville Coal areas with sandstone within 5 feet of coal (75% remaining after initial tonnage reduction); all available Seelyville Coal, due to unmapped partings
Bedrock cover	greater than minimum, but <100 feet

[1] Danville Coal only. Although all coals in this study may have this condition, the location of sandstone has been mapped only for the Danville Coal.

Technological and Land-Use Factors that Affect the Availability of Coal for Mining

The criteria used in this study to define available and restricted resources are a composite set of rules based on our interviews with mining companies, observations of mining practice, and the assessments of the 21 quadrangles. A detailed description of most of these criteria and their effects on mining was given in previous reports in this series (Treworgy et al. 1999a, 2000). Criteria unique to coals covered by this report (e.g., sandstone overlying the Danville Coal and partings in the Seelyville Coal) are described in the Geology and Mining section.

In tables 3 and 4, the criteria are organized according to the relevant mining methods (surface or underground mining) as currently practiced in Illinois. Because surface mining can be used to mine coal lying as deep as 200 feet and underground mining can be used to extract coal lying as shallow as about 75 feet (if there is sufficient bedrock), resources that are 75 to 200 feet deep were evaluated for their availability for both surface and underground mining.

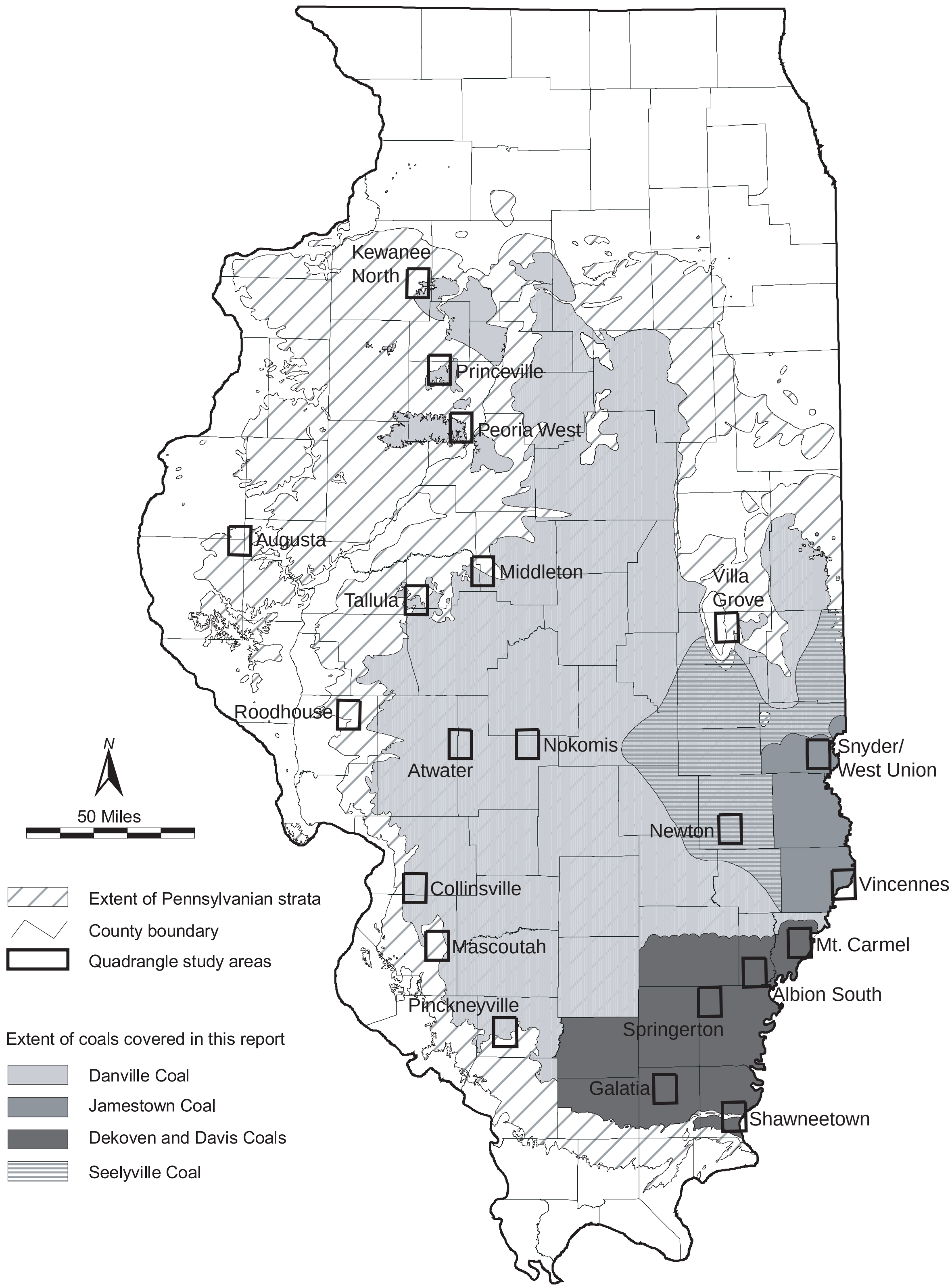

Figure 20 Quadrangle study areas used to identify coal available for mining.

This study does not consider the availability of coal that could be mined using an auger or highwall miner. Those techniques, which allow additional tonnages of coal to be recovered from the final cut of a surface mine, have been used on a limited basis in Illinois. In many cases, this coal will be minable by underground methods. Most of the factors that restrict underground mining, except for seam thickness, also restrict auger or highwall mining. The amount of additional tonnage that is recoverable by these methods is probably not significant.

Most technological or land-use factors that restrict mining are based on economic and social considerations and are not absolute restrictions on mining. Companies can choose to mine underground in areas of severe roof or floor conditions or thin seams if they are willing to bear the higher operating costs, interruptions and delays in production, and lower employee morale that result from operating in these conditions. It is possible to mine through or under most roads or under small towns if a company is willing to invest the time and expense necessary to gain approval from the appropriate governing units or individual landowners and to mitigate any damage. The maximum stripping ratio is strictly an economic limit, and areas of coal with high stripping ratios may be more economical to mine by underground methods or may remain unmined until the market price for coal increases relative to production costs. Similarly, previous economic and social conditions have, at times, enabled companies to mine in areas where factors are now restrictive. The current highly competitive price environment in the coal industry, which makes coal that is more expensive to mine uneconomic, is expected to prevail in the Illinois Basin indefinitely. Therefore, the criteria used to determine available coal for this report are likely to cover mining conditions for the foreseeable future.

Available Resources

Danville Coal

Of the original resources of Danville Coal, 4.5 billion tons (23%) are available for mining (fig. 21A). Of these available

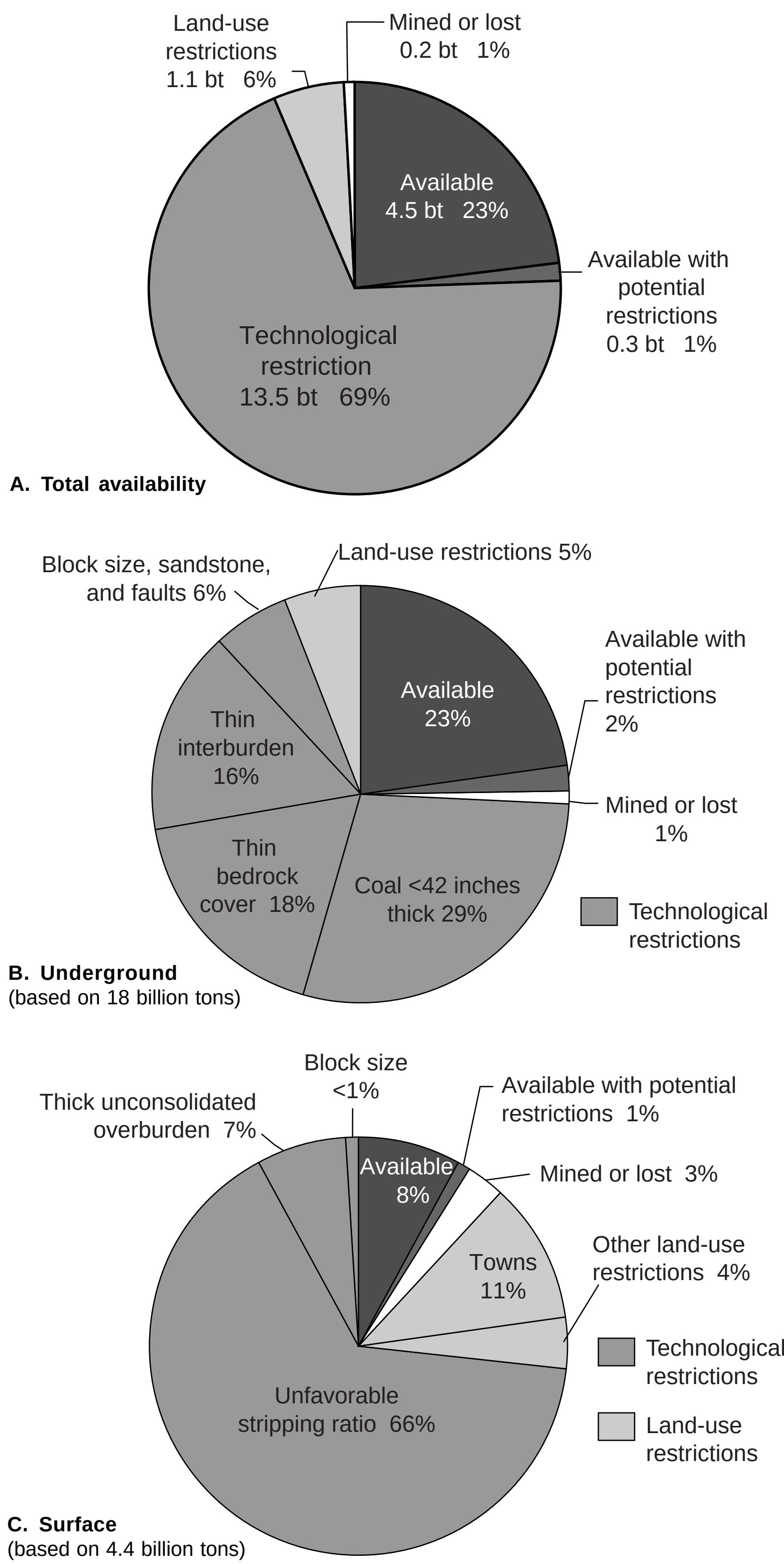

Figure 21 Availability of the Danville Coal for mining in Illinois (bt = billion tons).

Table 5 Availability of the Danville Coal by thickness category (billions of tons).

Danville Coal	18–28 inches	28–42 inches	42–66 inches	>66 inches	Total
Original	1.3	9.5	8.0	0.8	19.6
Mined	< 0.1 (3)[1]	< 0.1 (<1)	< 0.1 (<1)	0.1 (15)	0.2 (1)
Remaining	1.2 (97)	9.5 (100)	8.0 (100)	0.7 (85)	19.4 (99)
Available	0.1 (8)	< 0.1 (1)	4.0 (50)	0.4 (46)	4.5 (23)
Available with conditions	< 0.1 (1)	0.0	0.2 (2)	< 0.1 (4)	0.3 (1)
Technological restrictions	1.0 (77)	8.8 (93)	3.5 (44)	0.2 (26)	13.5 (69)
Land-use restrictions	0.1 (11)	0.6 (6)	0.3 (4)	0.1 (9)	1.1 (6)

[1] Numbers in parentheses are percent of original resource.

Table 6 Availability of the Jamestown, Dekoven, Davis, and Seelyville Coals for mining, by thickness category (billions of tons).

	18–28 inches	28–42 inches	42–66 inches	>66 inches	Total
Jamestown Coal					
Original	0.1	1.3	2.0	0.2	3.6
Mined	0.0	0.0	0.0	0.0	0.0
Remaining	0.1 (100)[1]	1.3 (100)	2.0 (100)	0.2 (100)	3.6 (100)
Available	0.0	0.0	0.9 (44)	< 0.1 (11)	0.9 (26)
Available with conditions	0.0	0.0	0.1 (3)	0.0	0.1 (2)
Technological restrictions	< 0.1 (93)	1.1 (84)	0.9 (45)	0.2 (88)	2.2 (62)
Land-use restrictions	< 0.1 (7)	0.2 (16)	0.2 (8)	< 0.1 (1)	0.4 (10)
Dekoven Coal					
Original	0.1	4.8	1.1	0	6.0
Mined	< 0.1 (56)	< 0.1 (1)	< 0.1 (1)		0.1 (1)
Remaining	< 0.1 (44)	4.8 (99)	1.1 (99)		5.9 (99)
Available	< 0.1 (37)	0.1 (2)	0.2 (19)		0.3 (5)
Available with conditions	0.0	0.0	0.1 (2)		0.1 (1)
Technological restrictions	< 0.1 (7)	4.5 (92)	0.8 (77)		5.3 (89)
Land-use restrictions	0.0	0.2 (5)	< 0.1 (1)		0.2 (4)
Davis Coal					
Original	0	3.5	5.8	0.3	9.6
Mined		< 0.1 (1)[2]	< 0.1 (1)	0.0	< 0.1 (1)
Remaining		3.5 (99)	5.7 (99)	0.3 (100)	9.5 (99)
Available		< 0.1 (1)	4.5 (77)	0.2 (84)	4.7 (49)
Available with conditions		0.0	0.5 (9)	< 0.1 (10)	0.5 (5)
Technological restrictions		3.3 (94)	0.5 (9)	< 0.1 (2)	3.9 (41)
Land-use restrictions		0.2 (4)	0.2 (4)	< 0.1 (4)	0.4 (4)
Seelyville Coal					
Original	–[3]	< 0.1	7.0	2.7	9.7
Mined		0.0	0.0	< 0.1 (<1)	< 0.1 (<1)
Remaining		< 0.1 (100)	7.0 (100)	2.7 (100)	9.7 (100)
Available		0.0	4.8 (69)	1.9 (69)	6.7 (69)
Available with conditions		0.0	0.2 (3)	0.1 (3)	0.3 (3)
Technological restrictions		< 0.1 (100)	1.6 (22)	0.5 (20)	2.1 (22)
Land-use restrictions		0.0	0.4 (6)	0.2 (8)	0.6 (6)

[1] Numbers in parentheses are percent of original resources.

[2] Minimum surface minable thickness category; only coal less than 200 feet deep was evaluated.

[3] Minimum surface minable thickness category. As all of the Seelyville Coal resources lie greater than 200 feet deep, coal in the 18- to 28-inch thickness range was not evaluated.

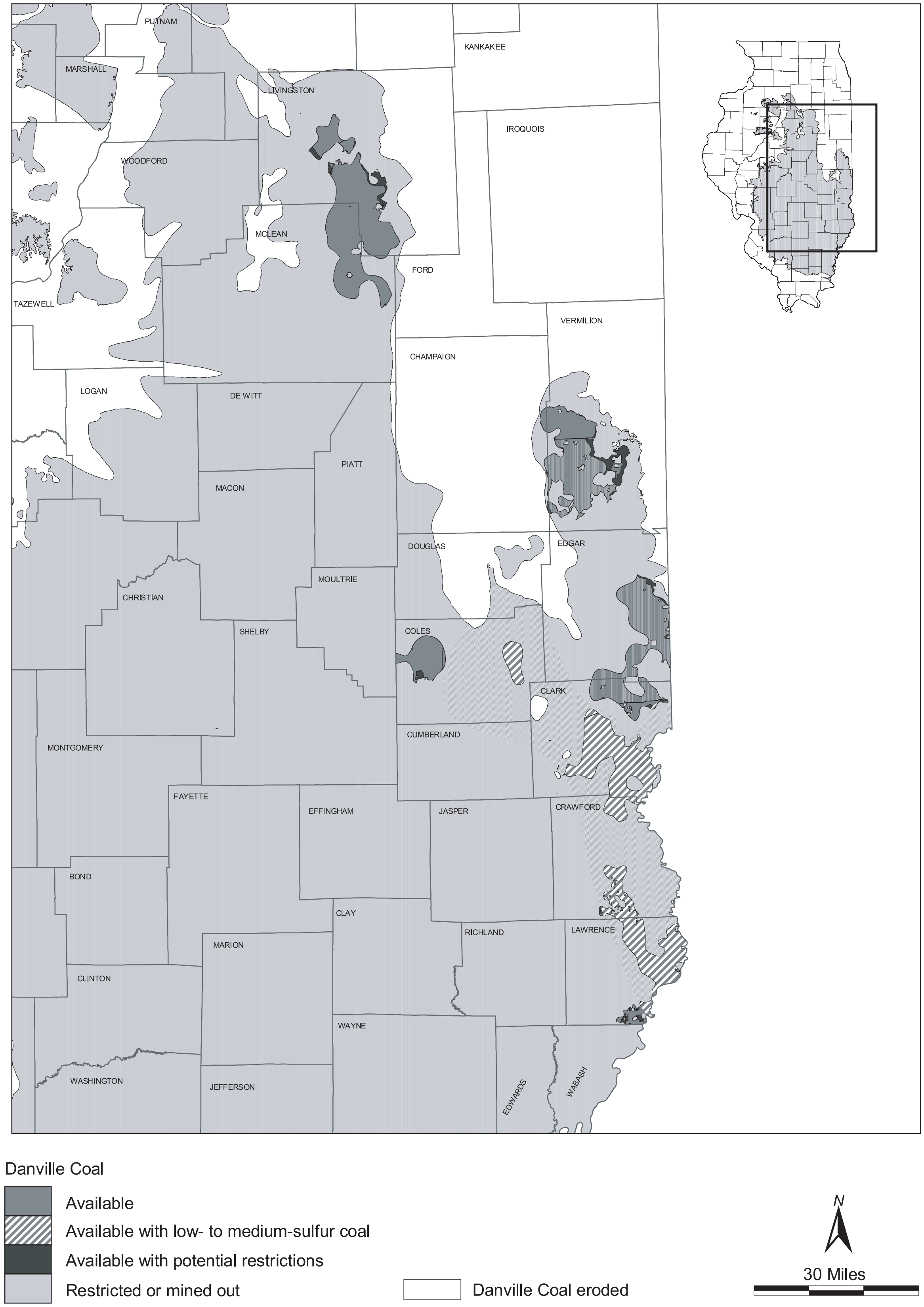

Figure 22 Areas of the Danville Coal available for underground mining.

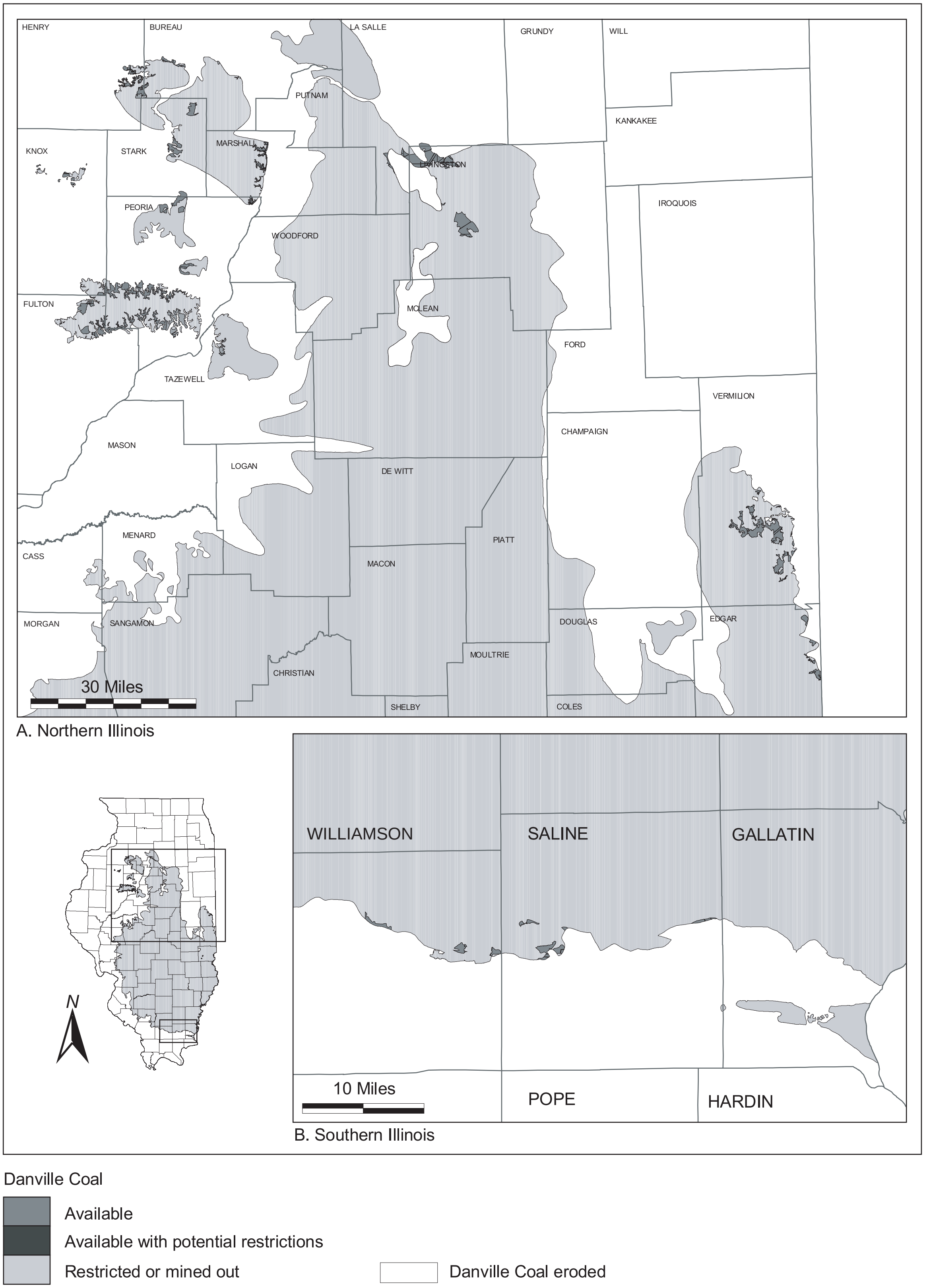

Figure 23 Areas of the Danville Coal available for surface mining.

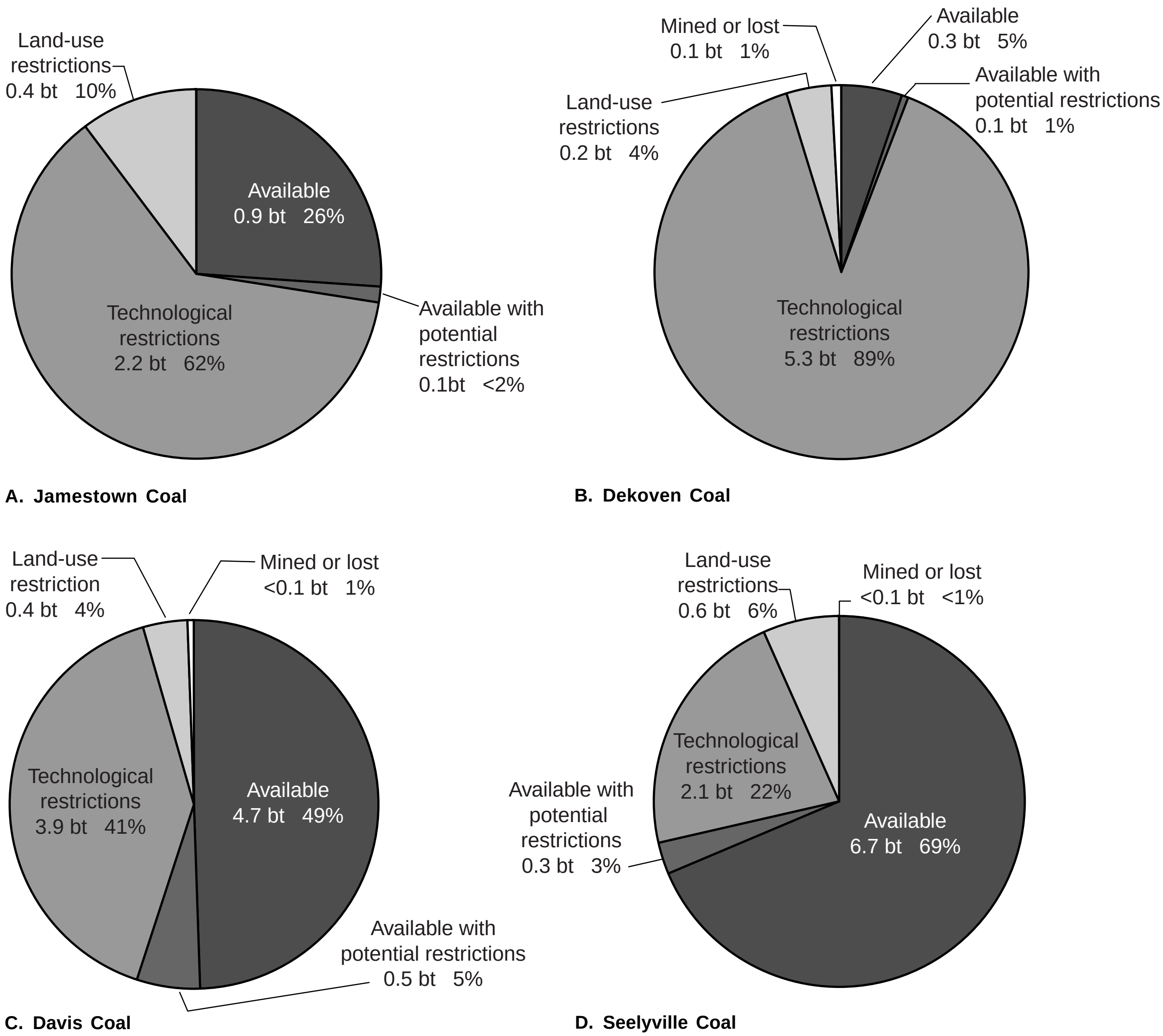

Figure 24 Availability of the Jamestown, Dekoven, Davis, and Seelyville Coals for mining in Illinois (bt = billion tons).

resources, 4 billion tons are 42 to 66 inches thick, and 400 million tons are greater than 66 inches thick (table 5). Of available Danville Coal resources, 1.2 billions tons have a medium- to low-sulfur content (less than 1.67 pounds of sulfur per million BTU). An additional 300 million tons are available but with potential restrictions. Geologic or land-use conditions may increase the cost of mining. These areas include those that have a medium density of oil wells (4 to 7 wells per 40 acres), 75 to 100 feet of bedrock, sandstone within 5 feet of the top of the coal, or location near rapidly developing areas. Technological factors restrict 69% of the resources (13.5 billion tons), and land use restricts 6% (1.1 billion tons).

About 18 billion tons of the original Danville Coal resources lie at depths greater than 75 feet and are potentially minable by underground methods. Of these, 4 billion tons (23%) are available for underground mining, and an additional 300 million tons (2%) are available with potential restrictions (fig. 21B). The available resources lie in the eastern and north-central parts of the state (fig. 22).

Technological factors restrict 69% (12.5 billion tons) of the underground minable resources, and land use restricts 5% (fig. 21B). The major technological restrictions are coal less than 42 inches thick (29%), thin bedrock and/or thick unconsolidated overburden (18%), and thin interburden between the Danville Coal and resources in underlying coals (16%). Mining blocks of insufficient size and sandstone in the immediate roof restrict a total of almost 6% of the resources.

About 4.4 billion tons of the original Danville Coal resources lie at depths

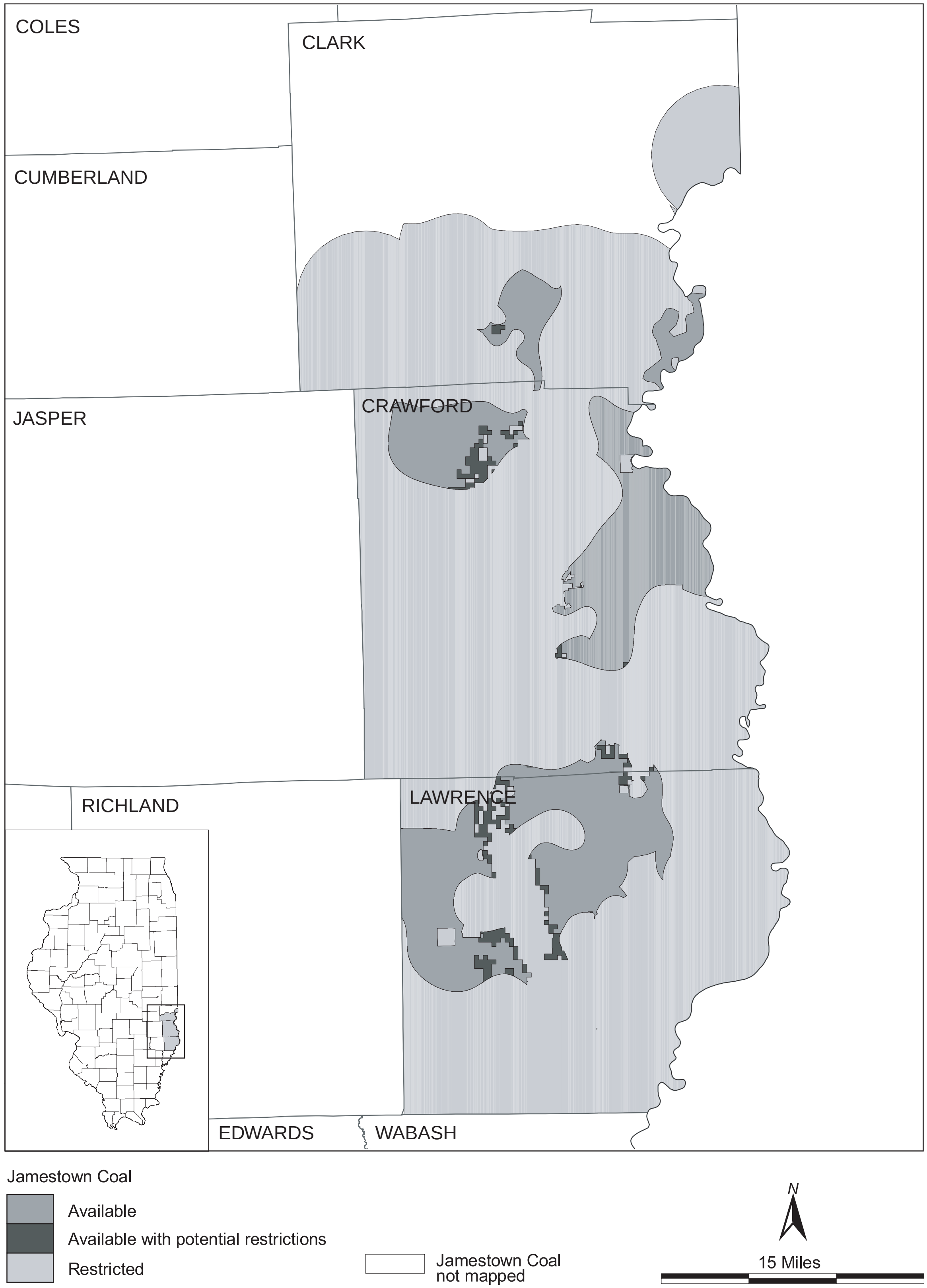

Figure 25 Areas of the Jamestown Coal available for underground mining.

Table 7 Resources of the Dekoven and Davis Coals available for surface mining (millions of tons).

Surface minable coal	Dekoven Coal		Davis Coal		Total	
Original	158		202		360	
Mined	31	(20)[1]	37	(18)	68	(19)
Remaining	127	(80)	165	(82)	292	(81)
Available	118	(75)	148	(73)	266	(74)
Available with conditions	0		0		0	
Technological restrictions	7	(4)	15	(8)	22	(6)
Land-use restrictions	2	(1)	2	(1)	4	(1)

[1] Numbers in parentheses are percent of original resources.

shallow enough to be considered for surface mining (less than 200 feet deep). Of these, 360 million tons (about 8%) are available for surface mining (fig. 21C). An additional 4 million tons are available if the Danville is mined in conjunction with the underlying Herrin Coal, and 11 million tons are available but with potential land-use restrictions. Technological factors restrict 74% (3 billion tons) of the resources, and the majority of these are restricted by unfavorable stripping ratio (66% of resources). Unfavorable drift thickness restricts 7% of the resources, and the size or geometry of the mining block restricts less than 1%. Land use restricts surface mining of 15% of the resources, and the majority (11% of the resources) is from towns. Major areas of Danville Coal are available for surface mining in the eastern and north-central parts of the state, but smaller surface-minable blocks are also present along the southern crop of the coal in Saline and Williamson Counties (fig. 23).

Jamestown Coal

Less than 1 billion tons (26%) of the original resources of Jamestown Coal are available for mining (fig. 24A), and essentially all of these available resources are 42 to 66 inches thick (table 6). An additional 58 million tons (less than 2%) are available but in potentially restricted areas that have a medium density of oil wells present. All of the available coal resources are minable only by underground methods and are located in the east-central part of the state (fig. 25). Technological factors restrict mining of 62% of the resources (2.2 billion tons): the major restrictions are coal less than 42 inches thick (27%), thin interburden between the Jamestown and overlying Danville Coal (24%), and mining block size or geometry (11%). Land use, primarily a high density of oil wells, restricts mining of 10% of the resources. All of the resources of Jamestown Coal less than 200 feet deep have an unfavorable stripping ratio.

Dekoven Coal

Of the 6 billion tons of original resources of the Dekoven Coal, only 300 million tons (5%) are available for mining (fig. 24B). Two-thirds of these available resources are 42 to 66 inches thick, and the remaining are less than 42 inches thick (table 6). An additional 100 million tons (1%) are available but with potential restrictions. Technological factors restrict 89% (5.3 billion tons) of the resources, and land-use factors restrict 4% (200 million tons).

Almost all of the original Dekoven Coal resources lie deep enough to be potentially minable by underground methods. Of these resources, 200 million tons (4%) are available for underground mining. An additional 24 million tons are available but within areas that have a medium density of oil wells. The major technological factors that restrict underground mining of the Dekoven Coal are thin interburden between the Dekoven Coal and resources in the underlying Davis Coal (55%), coal less than 42 inches thick (25%), and size of mining block (7%). Thin bedrock and/or thick unconsolidated overburden and faults within the coal restrict a total of about 4% of the resources. Land use restricts 4% of the resources. Based on the current extent of mapping of the Dekoven Coal, the resources available for underground mining are limited to select areas in Hamilton and Wayne Counties in southeastern Illinois (fig. 26). Surface minable resources of Dekoven Coal are commonly mined together with the Davis seam; thus, their combined availability for surface mining is addressed later in this report.

Davis Coal

About 4.7 billion tons (49%) of the original 9.6 billion tons of Davis Coal resources are available for mining (fig. 24C). Most of these available resources (4.5 billion tons) are 42 to 66 inches thick; 200 million tons are greater than 66 inches thick; and fewer than 100 million tons are only 28 to 42 inches thick (table 6). An additional 500 million tons (5% of resources) are available but with potential restrictions. Technological factors restrict 41% (3.9 billion tons), and land-use factors restrict about 4% (400 million tons).

Almost all of the original Davis Coal resources lie deep enough to be potentially underground minable, and 4.6 billion tons of these underground resources (48%) are available for mining. An additional 500 million tons (5%) are available but within areas of potential restrictions that have a medium density of oil wells or 75 to 100 feet of bedrock overburden. Technological factors that restrict underground mining are coal less than 42 inches thick (34%) and size of mining block (3%). Thin bedrock and/or thick unconsolidated overburden and faults within the coal restrict a total of about 4% of the resources. Land use restricts about 4% of the resources. As currently mapped, Davis Coal resources available for underground mining are located in the southeastern part of the state (fig. 27). Surface minable resources of Davis Coal are commonly mined together with the Dekoven seam; thus, their combined availability is assessed.

Surface Mining of the Dekoven and Davis Coals

About 202 million tons of the original Davis Coal resources lie at depths less than 200 feet, which is shallow enough to be considered for surface mining.

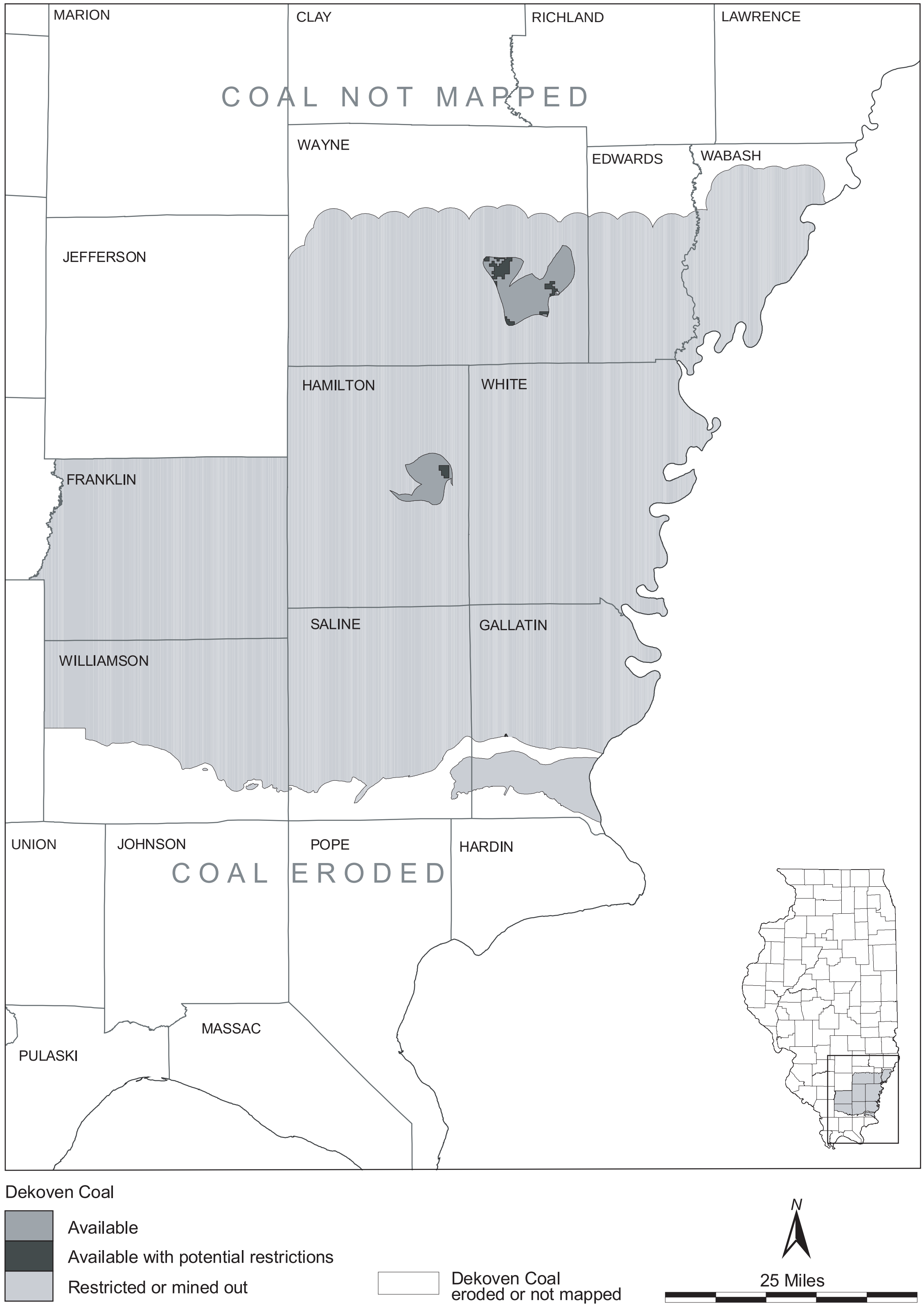

Figure 26 Areas of the Dekoven Coal available for underground mining.

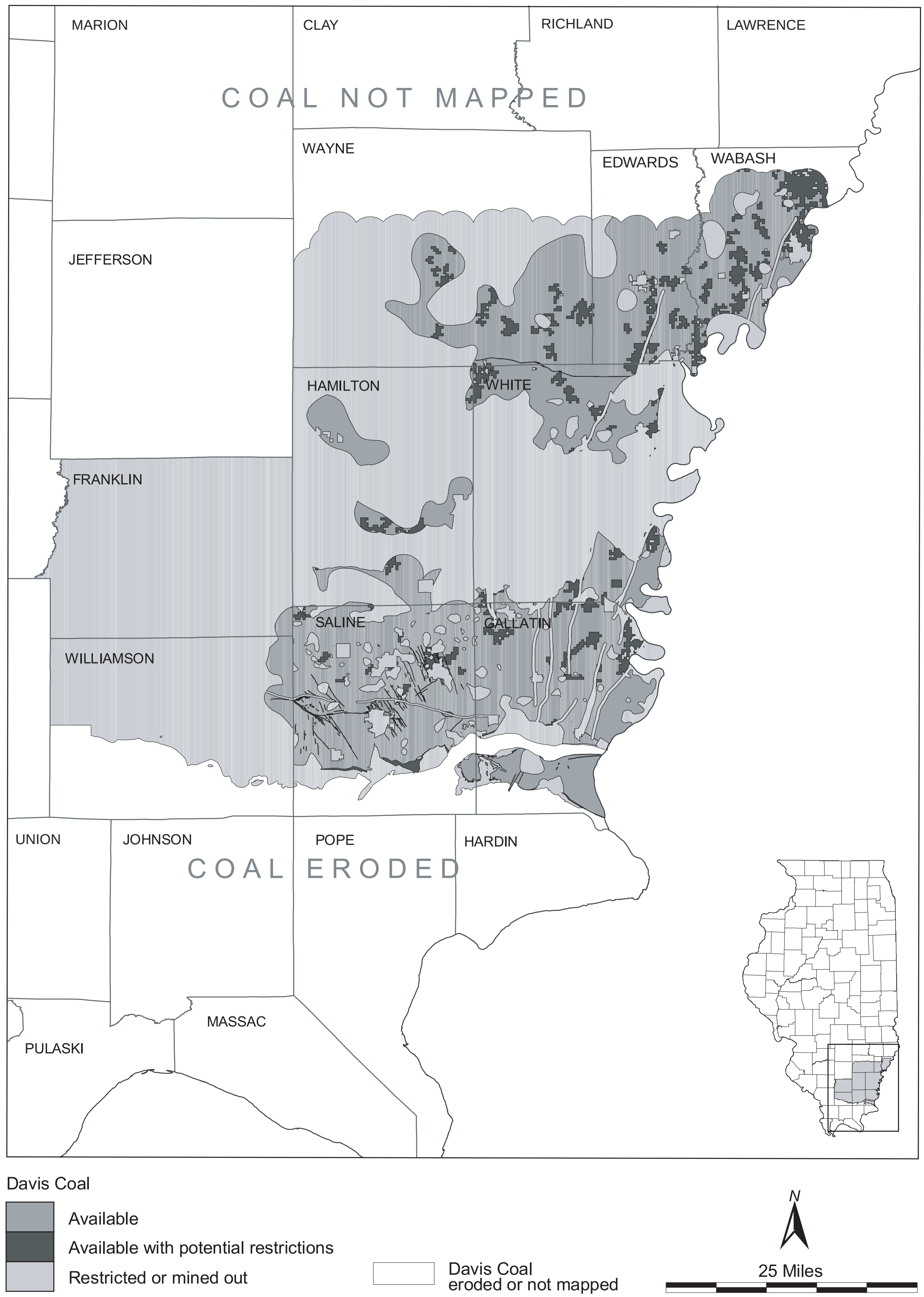

Figure 27 Areas of the Davis Coal available for underground mining.

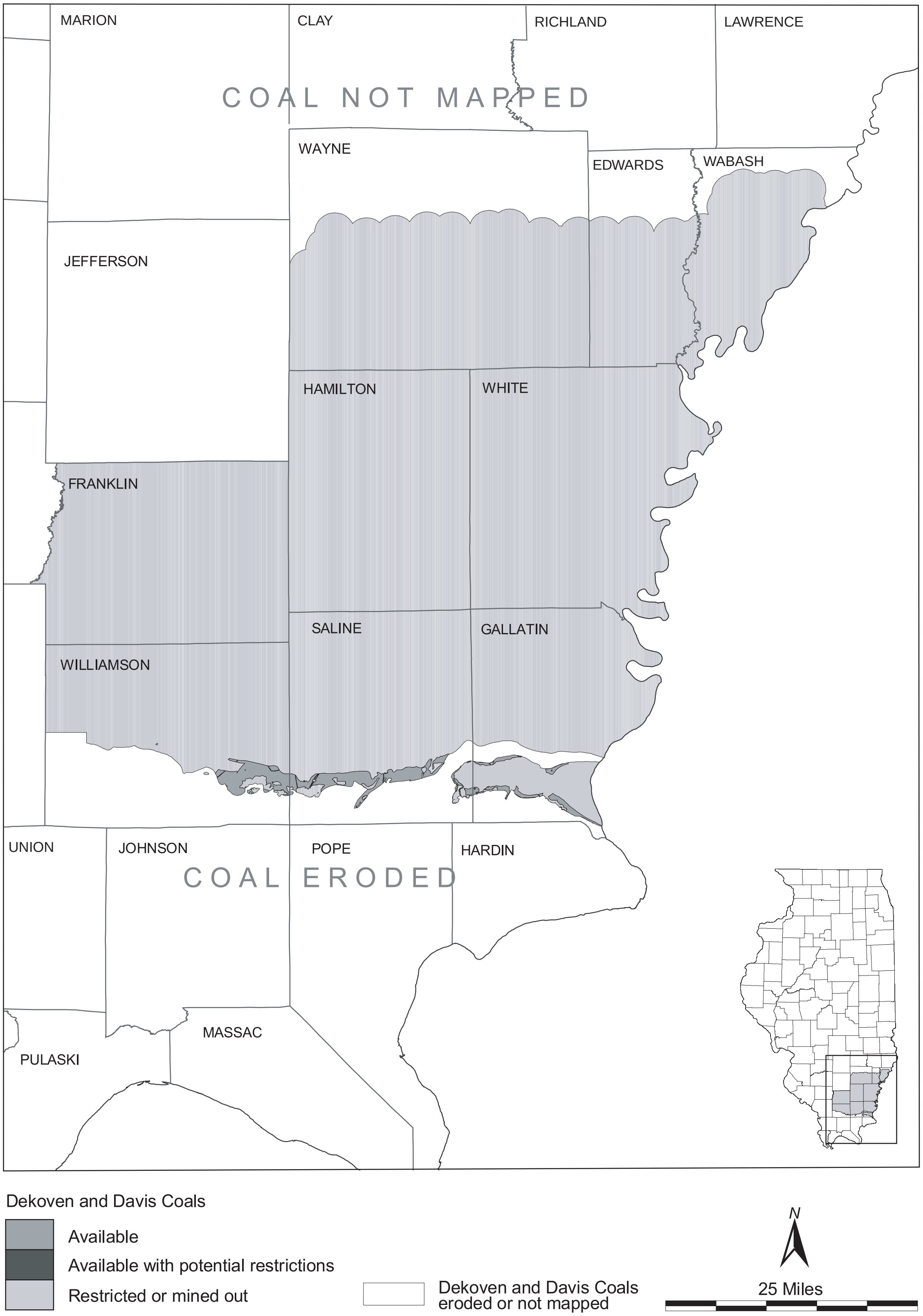

Figure 28 Areas of the Dekoven and Davis Coals available for surface mining.

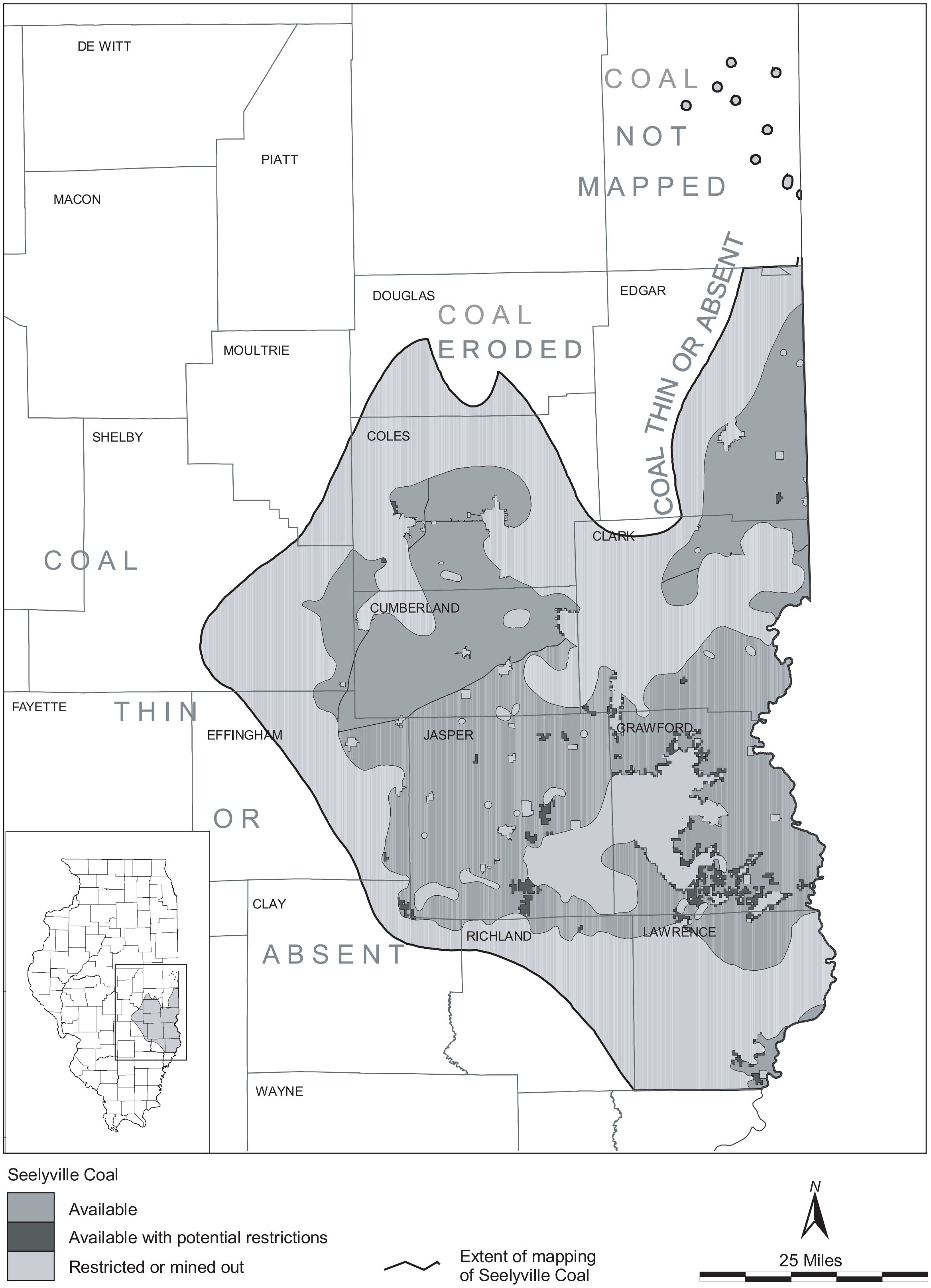

Figure 29 Areas of the Seelyville Coal available for underground mining.

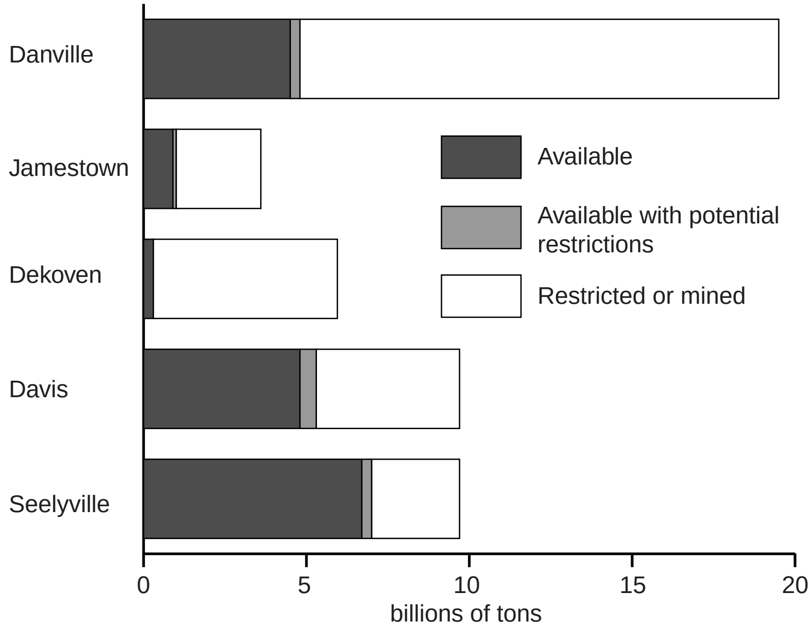

Figure 30 Availability of coal resources by seam.

As the Davis Coal is deeper than the Dekoven Coal, its depth is the main limiting factor when these two coals are considered together for surface mining. The Dekoven contains about 158 million tons of potentially surface minable resources, but when these two coals are combined, about 360 million tons of coal are potentially surface minable. The Davis Coal, which is generally thicker than the Dekoven, contains the majority of the combined resources (table 7). Of the combined original resources, 266 million tons (74%) are available for surface mining. Technological factors restrict about 6% (22 million tons) of the resources. Major restrictions include unfavorable stripping ratio (3% of resources, based on depth of Davis Coal and combined thickness of both coals) and unfavorable drift thickness (3%). A total of about 1% of the resources are restricted by land use and geometry or size of the mining block. Resources of the Dekoven and Davis Coals available for surface mining are located in the southern part of the state, along the crop lines of these coals in Gallatin, Saline, and Williamson Counties (fig. 28).

Seelyville Coal

About 6.7 billion tons (69%) of the original resources of Seelyville Coal are available for mining (fig. 24D). This amount reflects a 20% reduction in the total available tonnage, which represents the possible amount of resource that may be unavailable because of excess parting material in the Seelyville Coal. All of the available Seelyville Coal is minable only by underground methods. Of these available resources, 4.8 billion tons are 42 to 66 inches thick, and 1.9 billion tons are greater than 66 inches thick (table 6). An additional 270 million tons (about 3%) are available but in potentially restricted areas that have a medium density of oil wells present (fig. 29). Technological factors restrict mining of 22% of the original resources. The major restrictions are partings within the coal (20% of available coal) and mining-block size or geometry (4% of the original resources). Land use, primarily areas with a high density of oil wells, restricts mining of 6% of the resources. All of the Seelyville Coal resources lie greater than 200 feet deep and thus are not likely to be surface mined.

Conclusions

The Danville, Jamestown, Dekoven, Davis, and Seelyville Coals collectively represent 48 billion tons (23%) of the state's original coal resources. A total of approximately 17 billion tons of these five seams are available for mining (fig. 30), representing nearly 8% of the state's original resources. "Available" means that the land use and physical characteristics of the deposit (e.g., thickness, depth, in-place tonnage, and stability of bedrock overburden) are comparable with the conditions where these and other coals are currently being mined in the state. Other coal may be available but with potential restrictions that make it less desirable to mine, such as the presence of closely spaced oil wells and test holes, less stable roof strata, or close proximity to developing areas. Because of the lack of experience in underground mining of these coals in Illinois, additional geologic conditions may exist that restrict mining but that were not identified by this study.

The 19.6 billion tons of Danville Coal resources are the third largest in the state (after the Herrin and Springfield Coals, respectively); however, only 23% of original Danville resources (4.5 billion tons) are available for mining. The majority of the available Danville resources (4.2 billion tons) is minable by underground methods, and an additional 300 million tons are available but with potential restrictions. Approximately 360 million tons are available by surface mining methods. Of the total amount of available Danville Coal, approximately 1.2 billion tons have a medium- to low-sulfur content. Major restrictions to underground mining of this seam are thin coal, undesirable overburden characteristics, and thin interburden between the Danville and resources in the underlying Jamestown and/or Herrin Coals. Restrictions to surface mining include high stripping ratios, thick drift cover, and land use.

The Jamestown Coal resources rank eighth in the state (3.6 billion original tons), and, because of its depth, this coal must be mined underground. A total of about 900 million tons (26% of original Jamestown resources) are available for mining; 100 million of these tons are in areas with numerous oil wells. Major restrictions to mining the Jamestown are thin coal and thin interburden between the Jamestown and the resources in the overlying Danville Coal.

Of the 6 billion original tons of Dekoven Coal, only 300 million tons (5%) are available for mining. Of these, 200 million tons are available by underground mining methods, and just over 100 million tons are available by surface mining methods, when mined in combination with the underlying Davis Coal. Major restrictions to underground mining of the Dekoven are thin coal and thin interburden between this seam and the Davis Coal. Restrictions to surface mining include high stripping ratios and thick drift cover.

The 9.6 billion tons of Davis Coal resources are the sixth largest of all seams in the state, and 4.7 billion tons (49%) are available for mining. Of these, the vast majority (4.6 billion tons) is available for mining by underground methods; an additional 500 million tons are available but with potential restrictions. Of this available coal, only about 100 million tons are available by surface mining methods, when combined with the overlying Dekoven Coal. Major restrictions to underground mining of the Davis Coal are thin coal, undesirable overburden characteristics, and faults within the coal. As with the Dekoven, restrictions to surface mining of the Davis Coal include high stripping ratios and thick drift.

The 9.7 billion tons of Seelyville Coal are the fifth-largest resource in the state, and 6.7 billion tons (69% of its original resources) are available for mining. An additional 270 million tons are available but are located in areas with numerous oil wells. The Seelyville Coal is only available by underground mining methods, and major restrictions to mining are the numerous partings within the coal and areas heavily drilled for oil.

Technological factors cause the most significant restrictions to the availability of each of the coals in this report. For underground mining, these factors include the thickness of interburden between seams, thickness of drift and bedrock overburden, and thickness of the coal seam itself. To minimize negative impacts of geologic conditions on mining costs, companies should avoid areas of thick drift and thin bedrock cover, areas with sandstone in the immediate mine roof, large areas of excessive partings in the coal, and faulted areas.

For surface mining, the major technological restrictions to mining the coals in this study are stripping ratio and thickness of drift. These conditions make the cost of surface mining too high to compete successfully with local underground mines or with surface-mined coal from western states in today's markets.

In most parts of Illinois, land use is a relatively minor restriction to underground mining of these seams. The major land-use restrictions to underground mining are areas of closely spaced oil wells, and areas related to urban development. Land use, particularly a close proximity to towns, is a significant restriction to surface mining.

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Appendix 1

Remaining resources by county and availability by mining method (millions of tons).

	Remaining resources	Total available	Available by mining method[1]	
			Surface	Underground
Danville Coal				
Bureau	422	6	6	-
Champaign	162	29	-	29
Christian	63	-	-	-
Clark	1,611	784	-	784
Coles	1,140	285	-	285
Crawford	1,213	176	-	176
Cumberland	894	0	-	-
Douglas	179	-	-	-
Edgar	1,609	530	20	510
Effingham	1,202	-	-	-
Fayette	307	-	-	-
Fulton	57	15	15	-
Henry	56	15	15	-
Jasper	1,243	-	-	-
Knox	20	5	5	-
Lasalle	563	10	10	-
Lawrence	1,129	410	-	410
Livingston	1,996	727	75	659
McLean	1,704	515	-	515
Macoupin	16	-	-	-
Marshall	362	15	15	-
Montgomery	53	-	-	-
Peoria	276	53	53	-
Putnam	218	-	-	-
Richland	652	-	-	-
Saline	69	5	5	-
Shelby	130	-	-	-
Stark	56	16	16	-
Tazewell	5	-	-	-
Vermilion	1,918	913	128	808
Williamson	56	3	3	-
Woodford	39	-	-	-
Total	19,420	4,512	366	4,175
Jamestown Coal				
Clark	684	109	-	109
Crawford	1,500	419	-	419
Lawrence	1,399	403	-	403
Total	3,583	931	-	931
Dekoven Coal				
Edwards	76	-	-	-
Franklin	379	-	-	-
Gallatin	950	19	19	-
Hamilton	738	74	-	74
Saline	723	61	61	-
Wabash	107	-	-	-
Wayne	748	140	-	140
White	1,513	-	-	-
Williamson	672	37	37	-
Total	5,908	331	117	213

	Remaining resources	Total available	Available by mining method	
			Surface	Underground
Davis Coal				
Edwards	672	520	-	520
Franklin	566	19	-	19
Gallatin	1,266	907	29	892
Hamilton	1,117	308	-	308
Saline	1,369	1,109	74	1,046
Wabash	788	484	-	484
Wayne	1,363	675	-	675
White	1,946	617	-	617
Williamson	480	125	45	81
Total	9,568	4,764	148	4,642
Seelyville Coal				
Clark	1,064	737	-	737
Clay	34	22	-	22
Coles	748	540	-	540
Crawford	2,199	1,206	-	1,206
Cumberland	1,335	1,007	-	1,007
Edgar	877	674	-	674
Effingham	376	288	-	288
Jasper	2,148	1,621	-	1,621
Lawrence	554	308	-	308
Richland	132	104	-	104
Shelby	207	164	-	164
Vermilion	29	-	-	-
Total	9,703	6,671	-	6,671

[1] Surface and underground availability do not add to the total availability because coal that lies between 75 and 200 feet deep is included in both categories.

Appendix 2

Source maps for coal resources.

County	Seam	Source (ISGS publications)	Map year	Scale (×1,000)
Bureau	Danville	Cady 1952, Smith and Berggren 1963, Smith 1968	1950	125
Champaign	Danville	Treworgy and Bargh 1982	1978[1]	62.5
Christian	Danville	Cady 1952	1950	62.5
Clark	Danville	Treworgy et al. 1997b	1996	50
Clark	Jamestown	Treworgy et al. 1997b	1996	50
Clark	Seelyville	Treworgy 1981	1978	62.5
Clay	Seelyville	Treworgy 1981	1978	62.5
Coles	Danville	Treworgy et al. 1997b	1996	50
Coles	Seelyville	Treworgy 1981	1978	62.5
Crawford	Danville	Treworgy et al. 1997b	1996	50
Crawford	Jamestown	Treworgy et al. 1997b	1996	50
Crawford	Seelyville	Treworgy 1981	1978	62.5
Cumberland	Danville	Treworgy et al. 1997b	1996	50
Cumberland	Seelyville	Treworgy 1981	1981	62.5
Douglas	Danville	This study	2001	50
Edgar	Danville	Treworgy et al. 1997b	1996	50
Edgar	Seelyville	Treworgy 1981	1981	62.5
Edwards	Dekoven	This study	2001	50
Edwards	Davis	This study	2001	50
Effingham	Danville	Treworgy et al. 1997b	1996	50
Effingham	Seelyville	Treworgy 1981	1981	62.5
Fayette	Danville	Cady 1952	1950	62.5
Franklin	Dekoven	Cady 1952	1950	62.5
Franklin	Davis	Cady 1952	1950	62.5
Fulton	Danville	Smith and Berggren 1963	1963	125
Gallatin	Dekoven	Jacobson 1993	1993	62.5
Gallatin	Davis	Jacobson 1993	1993	62.5
Hamilton	Dekoven	Cady 1952	1950[1]	62.5
Hamilton	Davis	Cady 1952	1950[1]	62.5
Henry	Danville	Smith and Berggren 1963	1963	125
Jasper	Danville	Treworgy et al. 1997b	1996	50
Jasper	Seelyville	Treworgy 1981	1981	62.5
Knox	Danville	Smith and Berggren 1963,	1963[1]	125
La Salle	Danville	Jacobson 1985	1985[1]	62.5
Lawrence	Danville	Treworgy et al. 1997b	1996	50
Lawrence	Jamestown	Treworgy et al. 1997b	1996	50
Lawrence	Seelyville	Treworgy 1981	1981	62.5
Livingston	Danville	Jacobson 1985	1985[1]	62.5
McLean	Danville	This study	2001	50
Macoupin	Danville	Cady1952	1950	62.5
Marshall	Danville	Cady 1952, Smith and Berggren 1963	1950	62.5
Montgomery	Danville	Cady 1952	1950	62.5
Peoria	Danville	Smith and Berggren 1963	1963	125
Putman	Danville	Cady 1952	1950	62.5
Richland	Danville	Work map by C.Treworgy	1978	62.5
Richland	Seelyville	Treworgy 1981	1981	62.5
Saline	Danville	Smith 1957	1957	125
Saline	Dekoven	Smith 1957, Jacobson 1993	1957	125
Saline	Davis	Smith 1957, Jacobson 1993	1957	125
Shelby	Danville	Cady 1952	1950	62.5
Shelby	Seelyville	Treworgy 1981	1981	62.5
Stark	Danville	Smith and Berggren 1963	1963	125
Tazewell	Danville	Smith and Berggren 1963	1963	125
Vermilion	Danville	Jacobson and Bengal 1981	1981[1]	62.5
Wabash	Dekoven	This study	2001	50

County	Seam	Source (ISGS publications)	Map year	Scale (×1,000)
Wabash	Davis	This study	2001	50
Wayne	Dekoven	This study	2001	50
Wayne	Davis	This study	2001	50
White	Dekoven	Cady 1952	1950[1]	62.5
White	Davis	Cady 1952	1950[1]	62.5
Williamson	Danville	Smith 1957	1957	125
Williamson	Dekoven	Cady 1952, Smith 1957	1950	125
Williamson	Davis	Cady 1952, Smith 1957	1950	125
Woodford	Danville	Cady 1952	1950	62.5

[1] Minor revisions made for this report.