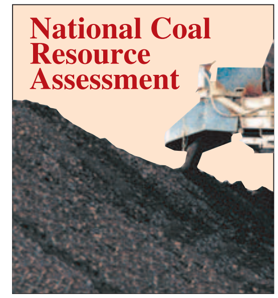
Chapter C

Geologic Overview

By J.R. Hatch *and* R.H. Affolter



Click here to return to Disc 1 Volume Table of Contents

Chapter C *of*

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

Edited by J.R. Hatch *and* R.H. Affolter

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Contents

Figures

Geologic Overview

By J. R. Hatch[1] *and* R. H. Affolter[1]

This overview of the geology of the coal-bearing rocks in the Illinois Basin is made up of five parts:

(1) brief summary of the processes of coal formation,
(2) discussion of the stratigraphic framework of the Pennsylvanian rocks,
(3) characterization of the Illinois Basin structural setting,
(4) descriptions of the mining history, geology, and quality of the Springfield, Herrin, Danville, and Baker Coals, and
(5) brief descriptions of other economic coals in the Illinois Basin.

Coal Formation

Coal is a readily combustible rock containing more than 50 percent by weight and more than 70 percent by volume of carbonaceous material, formed from compaction of variously altered plant remains similar to those of peaty deposits (Schopf, 1956). The original plant materials that became coal accumulated in mires. Mires are an ecosystem where the groundwater table is near (wetland) or slightly above (bogs, fens, swamps) the mineral soil, and the vegetation present produces organic matter (peat) at a rate faster than degradation processes can decompose it (Flores, 1993). The layers of organic matter that accumulated in mires were subsequently buried beneath other sediments. These layers were gradually compressed and chemically transformed by microbial action, heat, and pressure to form lignite and coal (Schopf, 1956).

Plant Material

Many factors control plant growth, accumulation, and preservation in peat-forming environments. These include nutrients, topography, subsidence rates, hydrology, and climate. Climatic factors, in particular, influence rates of plant growth and decomposition, swamp types, and formation of peat. In modern settings, tropical and subtropical climates are more favorable than temperate-zone climates for growth of forest swamps having densities of large trees (Mastalerz and Harper, 1998).

In the tropical Pennsylvanian forest swamps, the flora was dominated by tree forms and herbaceous plants of five major groups—lycopods, ferns, pteridosperms, cordaites and sphenopsids—of lower vascular plants (Francis, 1954; Van Krevelen, 1961; Phillips and others, 1976). Lycopod trees were the predominant form of vegetation. Sphenopsids (horse-tails) such as Calamities and pteridosperms (primitive conifers) were also abundant. The tree forms were mostly composed of periderm (barklike tissue), which became the major constituents of most coals. The plant materials contributing to the peats also included foliage, spores, pollen, stems, and rootlets.

Phases of Coal Formation

There are two main phases in the formation of coals: peatification and coalification. Microbial activity is the main process that alters organic matter during the peatification and early coalification, whereas increased temperatures and pressures are the main factors later in coalification. The change in organic matter with increasing temperature and burial is called maturation. For coal, the term "rank" is used to describe various levels of maturation. In order of increasing rank, the main stages of humic coal formation are: peat, lignite, subbituminous coal, bituminous coal, and anthracite (Parr, 1928; Francis, 1954; Van Krevelen, 1961).

Stratigraphic Framework of the Illinois Basin Coals

In the Illinois Basin, coal-bearing rocks are of Pennsylvanian age and were formed between about 325 and 290 million years before present. Rocks representing all series in the Pennsylvanian system (Morrowan, Atokan, Desmoinesian, Missourian, and Virgilian) are present in the Illinois Basin. Stratigraphic correlations of the Pennsylvanian rocks and coals in Illinois, Indiana, and western Kentucky are shown in figure 1. Each coal shown in figure 1 is referred to by a geographic place name, which is usually that of a locality close to the area where the coal was first described. Until recently, the important coals were also commonly referred to by number: the lower the number, the older the coal. The Pennsylvanian rocks reach a maximum thickness of nearly 2,500 ft in southeastern Illinois and generally thin toward the north, northwest, and northeast (fig. 2). This thinning primarily occurs in the lower stratigraphic units (formations in the Raccoon Creek Group) and in much of western and northern Illinois, these lowermost formations are thin or absent (Hopkins and Simon, 1975).

Typically, 90–95 percent of the Pennsylvanian section consists of clastic sedimentary rocks. For the Morrowan rocks (Caseyville Formation in Illinois and western Kentucky and lower part of the Mansfield Formation in Indiana), quartzose, pebbly sandstone commonly makes up 50–75 percent of the total thickness, with most of the remainder made up of siltstone and silty shale. The Morrowan rocks contain less than 1 percent limestone and thin, lenticular coals (Hopkins and Simon, 1975; Nelson and others, 1991). The Atokan rocks (lower and middle parts of the Tradewater Formation in Illinois and western Kentucky, and the upper part of the Mansfield Formation and Brazil Formation in Indiana) consist largely of lenticular sandstone intertonguing with

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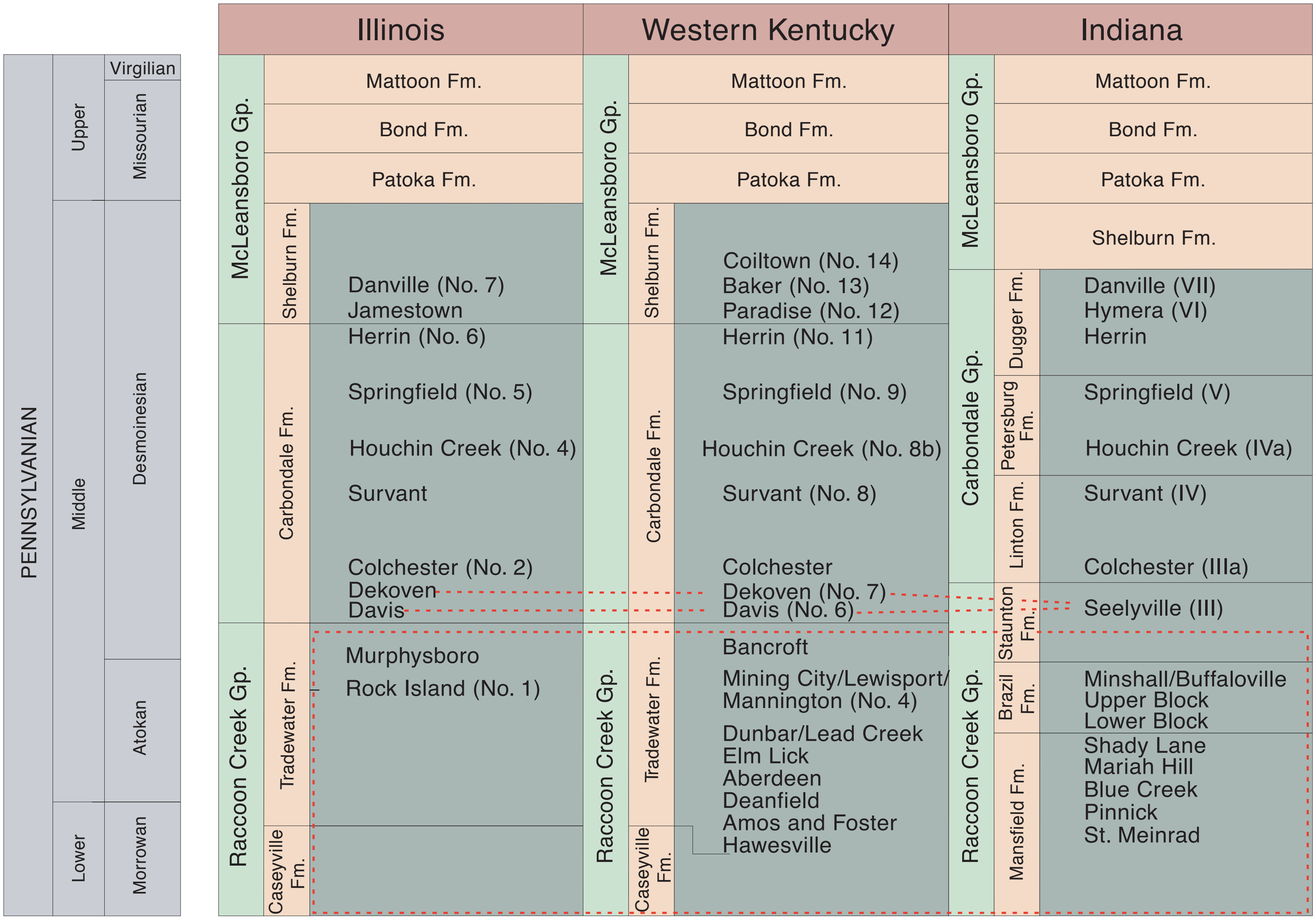

Figure 1. Stratigraphic chart of the Pennsylvanian System in the Illinois Basin, showing major coal members. Modified from Mastalerz and Harper (1998, fig. 2) and Greb and others (1992, fig. 22). Fm., Formation; Gp., Group; ---, problematic coal correlations.

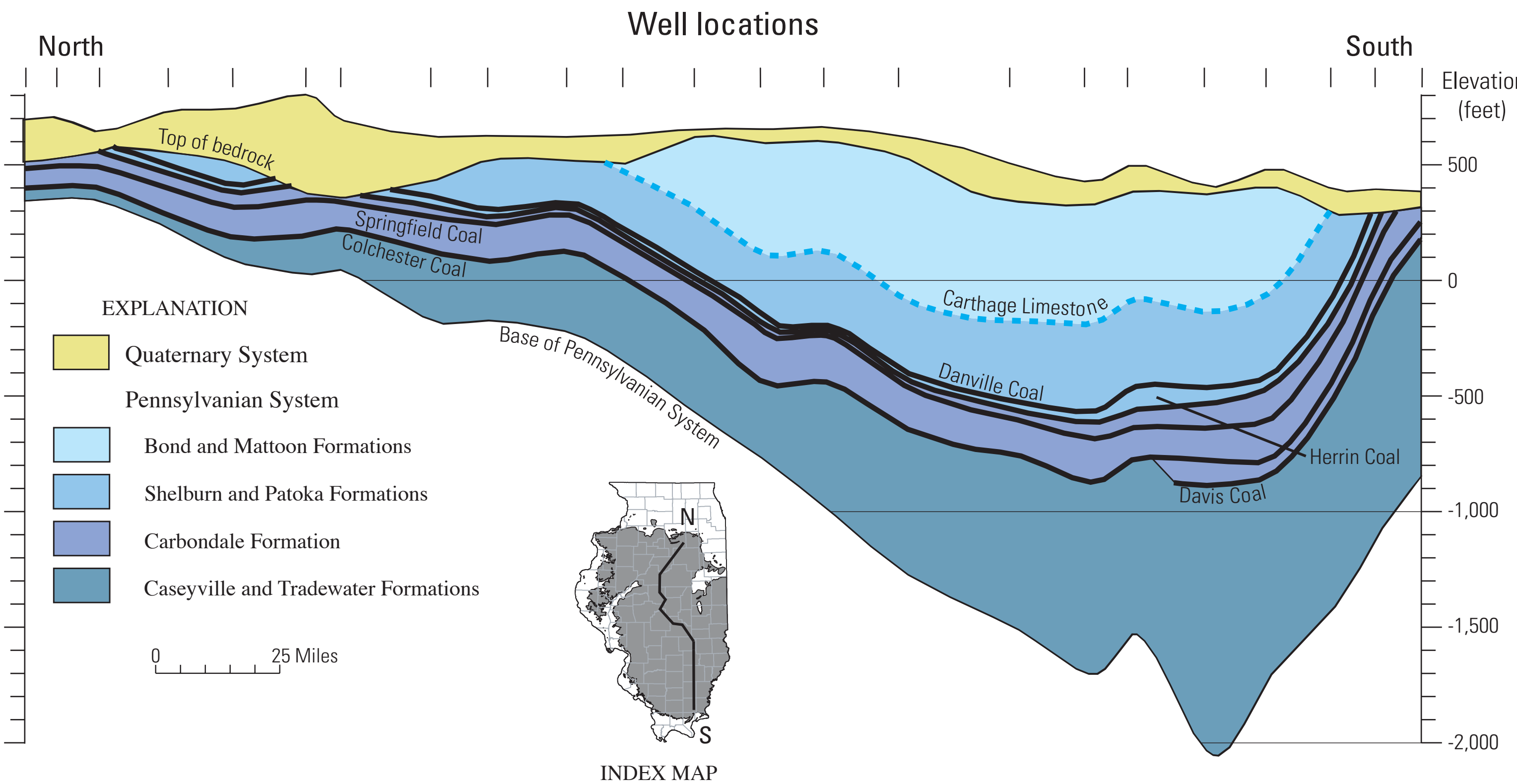

Figure 2. Generalized north-south cross section of the Pennsylvanian System in Illinois. This section illustrates the thickening of the Pennsylvanian strata southward across the basin (provided by C.P. Korose and C.G. Treworgy, Illinois State Geological Survey).

gray shale and siltstone, sandstone being a less predominant lithology than in the underlying Morrowan rocks. Atokan coals in the Illinois Basin are generally thicker and more continuous compared to coals lower in the section (Hopkins and Simon, 1975; Nelson and others, 1991).

Desmoinesian strata consist principally of medium- to dark-gray shale and siltstone, along with lesser quantities of subgraywacke. Numerous highly persistent beds of mineable coal, limestone, and marine black shale are present, particularly in the Carbondale Formation or Group (Nelson and others, 1991). The Desmoinesian rocks contain greater than 96 percent of the remaining coal resources in Illinois (Cady, 1952; Hopkins and Simon, 1974; Treworgy and others, 1978; Treworgy and Bargh, 1982), 98 percent in Indiana (Spencer, 1953), and about 80 percent in western Kentucky (Smith and Brant, 1980).

Rock types in the Missourian and Virgilian strata are similar to those in the Desmoinesian, except that they contain a greater proportion of limestone and less coal. Coals in this part of the section are not as thick (most less than 1 ft thick), nor as extensive as those coals lower in the section (Hopkins and Simon, 1975; Nelson and others, 1991, Mastalerz and Shaffer, 2000).

In the Illinois Basin, the Pennsylvanian rocks are divided into the Raccoon Creek Group, the Carbondale Group or Formation, and the McLeansboro Group. The Raccoon Creek Group, Carbondale Formation, and McLeansboro Group are defined the same in Illinois and western Kentucky (Jacobson and others, 1985). However, stratigraphic definitions accepted in these two states differ from those in Indiana (see fig. 1). The main differences are that

(1) The Raccoon Creek Group in Illinois and western Kentucky is divided into the Caseyville and Tradewater Formations. The Raccoon Creek Group in Indiana consists of the Mansfield, Brazil, and Staunton Formations.
(2) The Carbondale Formation is recognized in Illinois and Kentucky; the Carbondale Group is recognized in Indiana. In Indiana, the Carbondale Group is divided into the Linton, Petersburg, and Dugger Formations.
(3) In Indiana, the Seelyville Coal Member is at the top of the Staunton Formation of the Raccoon Creek Group. In Illinois and western Kentucky, the Seelyville Coal and equivalents are in the Carbondale Formation.
(4) The base of the McLeansboro Group and the base of the Shelburn Formation in Illinois and Kentucky are at the top of the Herrin Coal. In Indiana, the base of the Shelburn Formation is located at the top of the Danville Coal Member.
(5) In Illinois and western Kentucky, the Springfield Coal is in the Carbondale Formation; in Indiana, it is in the Petersburg Formation. In Illinois and western Kentucky, the Herrin Coal is in the Carbondale Formation; in Indiana, it is in the Dugger Formation. In Illinois, the Danville Coal Member is in the Shelburn Formation of the McLeansboro Group; in Indiana, it is in the Dugger Formation of the Carbondale Group. In western Kentucky, the Baker coal is in the Shelburn Formation of the McLeansboro Group.
(6) In Illinois (Hopkins and Simon, 1975) and Indiana (Mastalerz and Harper, 1998), the Springfield, Herrin, and Danville Coal Members, as well as most other coals, are formally recognized stratigraphic members. In western Kentucky, coals are not given that same status (for example, Baker coal) (Greb and others, 1992). For this assessment report, when discussing coals in a given state, we will follow the stratigraphic nomenclature previously established for that state. When referring to a coal, or coals, in an area that includes parts of states with different stratigraphic nomenclatures, we will list the coal name as the "Springfield Coal" or "Herrin Coal."

Figure 3 shows the mining areas of the Illinois basin and the extent of coal-bearing rocks in Illinois, Indiana, and western Kentucky. The mining areas in Illinois are from Damberger (2000, fig. 1) and, in general, are based on historic mining districts.

Raccoon Creek Group

In Illinois and western Kentucky, the Raccoon Creek Group is divided into the Caseyville and Tradewater Formations. In southern Illinois and western Kentucky, the Caseyville Formation is between 100 and 600 ft thick and contains several thin, lenticular coals, the most persistent of which is the Nolin coal in Grayson and Edmonson Counties, Ky. The Tradewater Formation has a maximum thickness of 650–700 ft in southern Illinois, but in western Illinois, it is generally less than 100 ft thick (Hopkins and Simon, 1975). In western Kentucky, the Tradewater Formation is 400–600 ft thick (Greb and others, 1992). Tradewater Formation coals in Illinois and western Kentucky are thicker and more continuous compared to coals in the Caseyville Formation. In Illinois, coals mined from the Tradewater Formation include the Rock Island and Murphysboro Coal Members. In western Kentucky, the Tradewater Formation contains more than 20 mined coals (Greb and others, 1992). The most extensive of these mined coals are the Mannington, Mining City, and Lewisport coals, near the top of the formation. These three coals are thought to be continuous. Likewise, the Dunbar and Lead Creek coals lower in the section are thought to be continuous. Other, more localized, Tradewater Formation coals in western Kentucky include the Bancroft coal, in the western half of the coal field; Amos, Foster, and Aberdeen coals, in the southeastern part of the coal field; and Hawesville, Deanfield, and Elm Lick coals, in the northeastern part of the coal field (Greb and others, 1992, fig. 22).

In Indiana, the Raccoon Creek Group consists of three formations. In ascending order, these are the Mansfield Formation (50–400 ft thick), the Brazil Formation (40–90 ft thick), and the Staunton Formation (75–125 ft thick.). As many as twelve coals are present in the Mansfield Formation, and at least five coals have been given formal stratigraphic names (St. Meinrad, Pinnick, Blue Creek, Mariah Hill, and Shady Lane Coal Members) (fig. 1). Thicknesses of coals in the Mansfield Formation are highly variable over short distances, and only two or three of these coals may be present at any one location (Mastalerz and Shaffer, 2000). Generally, the Brazil Formation includes four named coals, the Lower Block, Upper Block, Minshall, and Buffaloville Coal Members. The last two named coals are thought to be lateral equivalents. Raccoon Creek Group coals in Indiana that have been mined in the last decade include the St. Meinrad, Blue Creek, and Mariah Hill Coal Members of the Mansfield Formation, and the Lower Block, Upper Block, and Minshall or Buffaloville Coal Members of the Brazil Formation. As many as eight coals occur within the Staunton Formation. The Seelyville Coal Member, at the top of the formation, is the only coal that has been traced

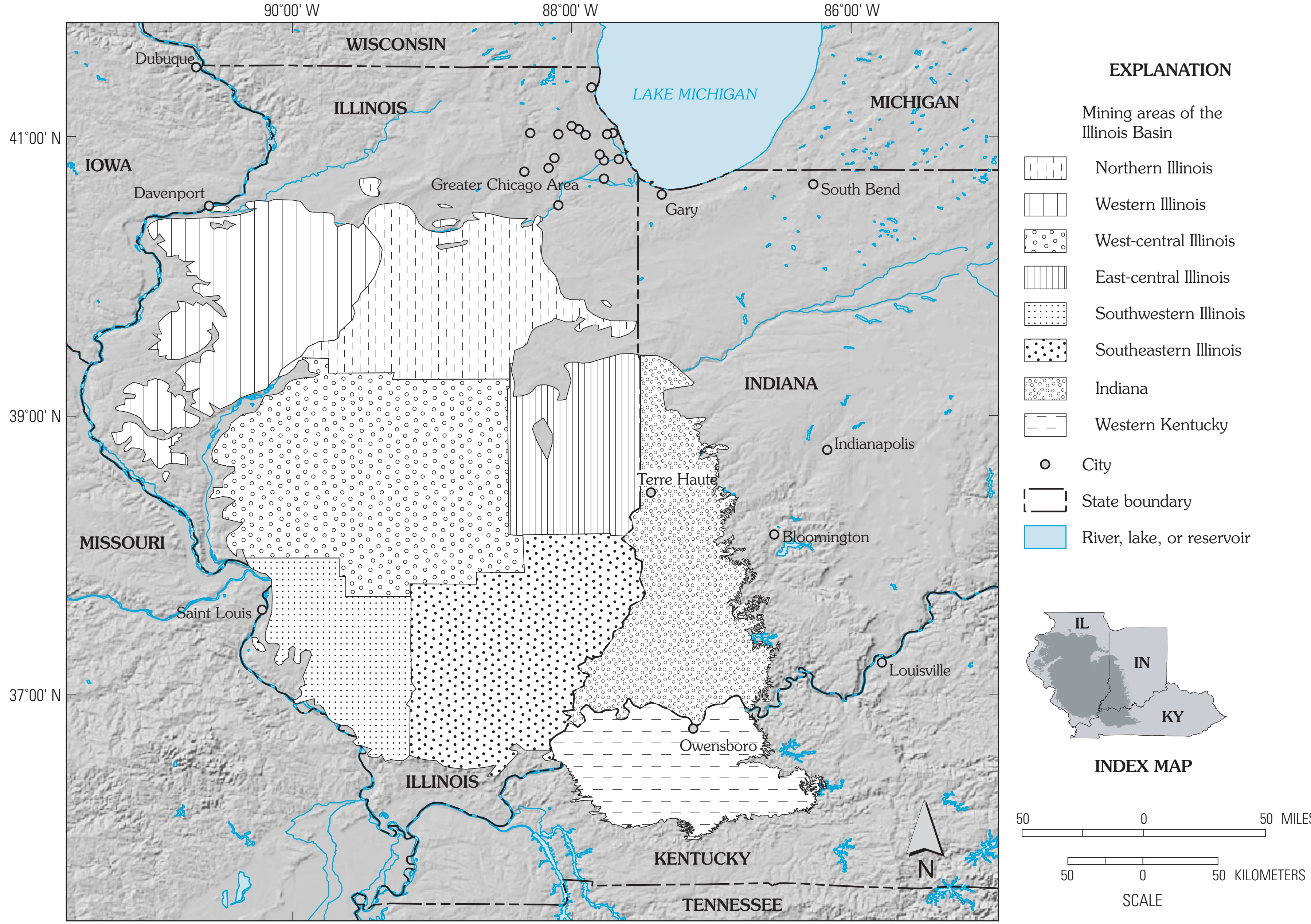

Figure 3. Map showing mining areas of the Illinois Basin and extent of coal-bearing rocks in Illinois, Indiana, and western Kentucky. The mining areas in Illinois are from Damberger (2000, fig. 1). This illustration was modified from regional shapefiles contained in the Illinois Basin ArcView project (Gunther and others, this publication).

regionally (Mastalerz and Shaffer, 2000). The Seelyville Coal Member in Indiana is correlative with the Davis and Dekoven Coal Members (Carbondale Formation) in southern Illinois, the Seelyville Coal Member (Carbondale Formation) in east-central Illinois, and the Davis and Dekoven coals (Carbondale Formation) in western Kentucky.

Carbondale Formation or Group

The Carbondale Formation varies from more than 400 ft thick in southern Illinois to less than 150 ft in western and northeastern Illinois (Hopkins and Simon, 1975). In western Kentucky, the Carbondale Formation is more than 400 ft thick in the western part of the coal field, maintains a fairly consistent thickness over most of the area, then thins rapidly on the eastern flanks of the basin to a minimum thickness of 195 ft (Gildersleeve, 1975). In Indiana, the Carbondale Group consists of the Linton Formation (43–162 ft thick), the Petersburg Formation (70–190 ft thick), and the Dugger Formation (73–185 ft thick) (Mastalerz and Shaffer, 2000).

The Carbondale Formation or Group consists of a large number of named members, many of which possess remarkable lateral persistence in thickness and lithologic character. In the sandstone and gray silty shale units, however, rapid lateral changes are common. Gray shale is the most abundant rock type; with most of the thick gray shale units being either delta front or pro-delta deposits (Hopkins and Simon, 1975). The Carbondale Formation or Group contains the principal economic coals in the Illinois Basin, including the Davis, Dekoven, Colchester, Survant, Springfield, and Herrin Coals (Hopkins and Simon, 1975; Greb and others, 1992; Mastalerz and Shaffer, 2000).

The Hymera and Danville Coal Members of the Dugger Formation (Carbondale Group) in Indiana are correlative with the Jamestown and Danville Coal Members of the McLeansboro Group in Illinois and with the Paradise and Baker coals of the McLeansboro Group in western Kentucky.

McLeansboro Group

The McLeansboro Group in the Illinois Basin is divided into the Shelburn, Patoka, Bond, and Mattoon Formations. The Shelburn and Patoka Formations together vary from more than 450 ft thick in southern Illinois to less than 125 ft thick along the LaSalle Anticlinal Belt in east-central Illinois (fig. 4), and they average about 350 ft thick. The Bond Formation varies from more than 300 ft thick in southern Illinois to less than 150 ft thick in eastern Illinois; the average is about 250 ft thick. A maximum of slightly more than 600 ft of the Mattoon Formation is preserved in southeastern Illinois. In Illinois, the top of the Mattoon Formation is an erosional surface (Hopkins and Simon, 1975). In Indiana, the Shelburn Formation is 50–250 ft thick, the Patoka Formation is 100–310 ft thick, and the Bond Formation is 150–250 ft thick. In Indiana, about 150 ft of the lowest part of the Mattoon Formation is preserved (Mastalerz and Shaffer, 2000). In western Kentucky, the Shelburn Formation is 155–245 ft thick, the Patoka Formation is 235–325 ft thick, the Bond Formation is 310–390 ft thick, and the Mattoon Formation is 1,100 ft thick (Greb and others, 1992).

Economically important McLeansboro Group coals include the Danville Coal Member in east-central Illinois and the Paradise, Baker, and Coiltown coals (Shelburn Formation) in western Kentucky. Above the Danville in Illinois and Indiana, coals in the McLeansboro Group are not as thick, nor as extensive as the coals in the underlying Carbondale Formation or Group (Hopkins and Simon, 1975; Mastalerz and Shaffer, 2000). Most McLeansboro Group coals are less than 1 foot thick, although some coals locally are as much as 4 ft thick (Hopkins and Simon, 1975; Mastalerz and Harper, 1998). In western Kentucky, coal has also been produced from the No. 15 coal (Patoka Formation) and from the Lisman coal (Bond Formation) (Greb and others, 1992).

Structural Setting

The major structural features within the Illinois and Indiana parts of the Illinois Basin are the La Salle anticlinal belt, the DuQuoin monocline, and the Cottage Grove fault system. In Illinois, these structures bound the Fairfield Basin (fig. 4) (Buschbach and Kolata, 1991). In Illinois and Indiana, the major coal beds crop out along the margins of the basin and generally dip basinward to depths of more than 1,000 ft subsurface at the center of the Fairfield Basin in southeastern Illinois as shown for the Springfield Coal in figure 4. The La Salle anticlinal belt flanks the Fairfield Basin to the northeast and consists of sub-parallel north-south-trending anticlines that extend north-northwestward from Lawrence County, Ill., for a distance of about 180 mi. For much of its length, the western side of the La Salle anticlinal belt is bounded by a pronounced monoclinal fold that rises above the basin floor as much as 2,000 ft. The DuQuoin monocline trends north-south along the western edge of the Fairfield Basin. The steep side of the monocline dips to the east. Its western flank forms the relatively shallow Sparta shelf, which is the southern part of the larger Western shelf. The Cottage Grove and Rough Creek fault systems mark the southern margin of the Fairfield Basin. The Rough Creek fault system consists of multiple high-angle, normal faults that form a series of narrow horsts and grabens, trending roughly east to west. At its western end in southern Illinois, the Rough Creek fault system turns abruptly southwestward. The Cottage Grove fault system is a right-lateral wrench fault (Nelson and Lumm, 1984) that extends westward across much of southern Illinois, from Gallatin to Jackson Counties, a distance of about 70 mi. This complex structure is as much as 10 mi wide (Buschbach and Kolata, 1991).

In western Kentucky, the structure of the coal fields is distinctly different on either side of the east-west trending Rough Creek fault system (figs. 5 and 6). North of the Rough Creek fault system, the rocks dip gently to the west at about 15–20 ft/mi, in general conformity with the broad north-south, asymmetrical syncline that generally characterizes the structure of the Illinois Basin. South of the Rough Creek fault system, the structure is characterized by east-west-oriented synclines having much steeper dips. Within the Moorman syncline, southeast of the Central fault system (fig. 5), dips range between 50 and 65 ft/mi. Northwest of the Central fault system, in the Webster syncline and the Eagle Valley syncline in southern Gallatin County, in southeastern Illinois, dips are as great as 250 ft/mi. Along the axis of these southern synclinal structures and within some graben structures, depth to the lower Carbondale Formation coals can exceed 1,500 ft. Both the northern and southern structural areas are modified by a number of northeast-trending graben structures, many having considerable displacement (Greb and others, 1992).

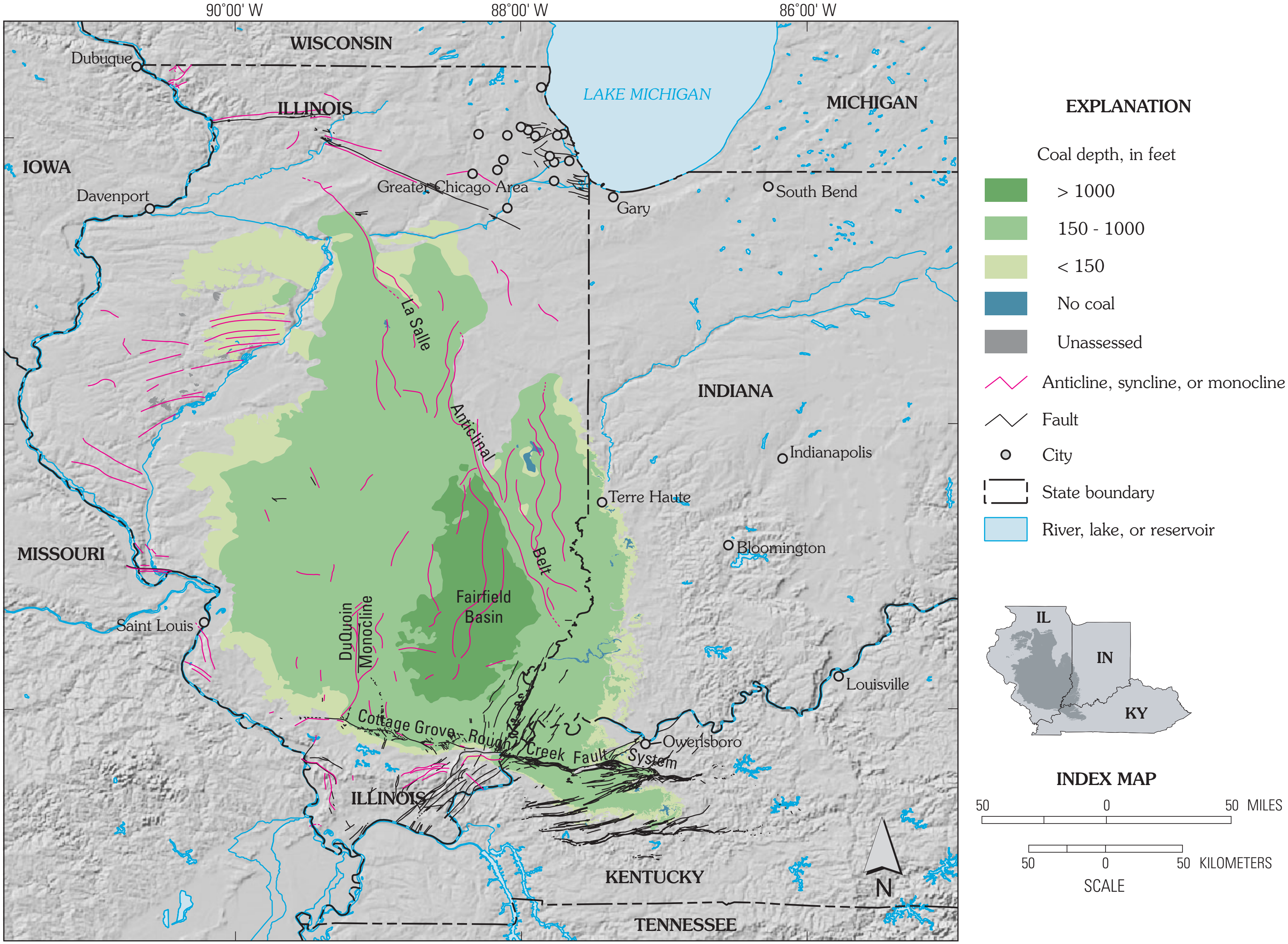

Figure 4. Map showing locations of the major structural features in the Illinois Basin and depth to the Springfield Coal. Structure locations are from Buschbach and Kolata (1991). The Springfield Coal reaches depths of 1,000 ft or greater in the Fairfield Basin, in southeastern Illinois, and in the Webster and Moorman synclines, in western Kentucky (locations shown in fig. 5). This illustration was modified from regional shapefiles contained in the Illinois Basin ArcView project (Gunther and others, this publication).

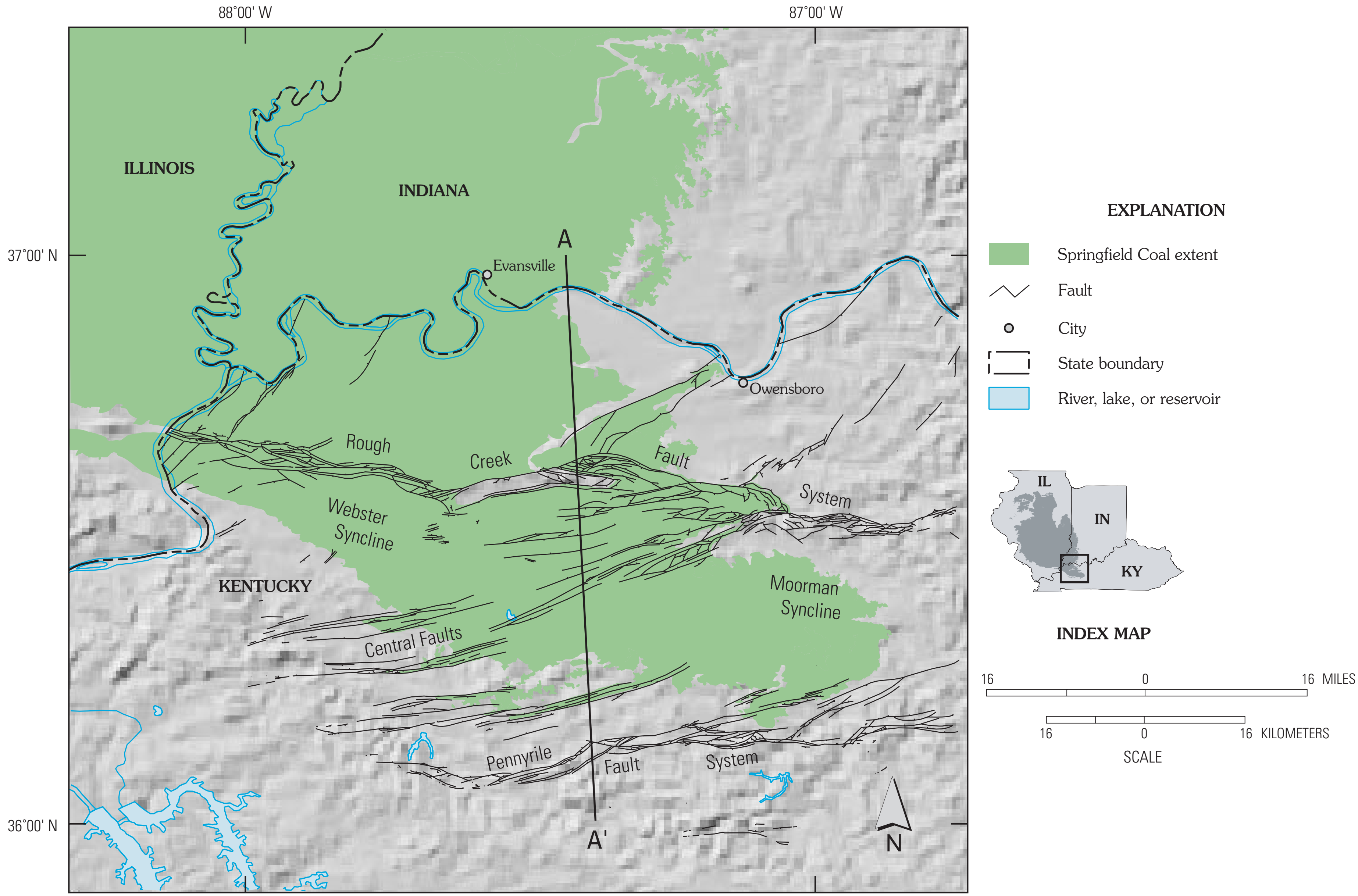

Figure 5. Map showing the major structural features of the western Kentucky coal field. Modified from Cobb and others (1985) and Greb and others (1992). Section A–A′ is the approximate location of the cross section shown in figure 6.

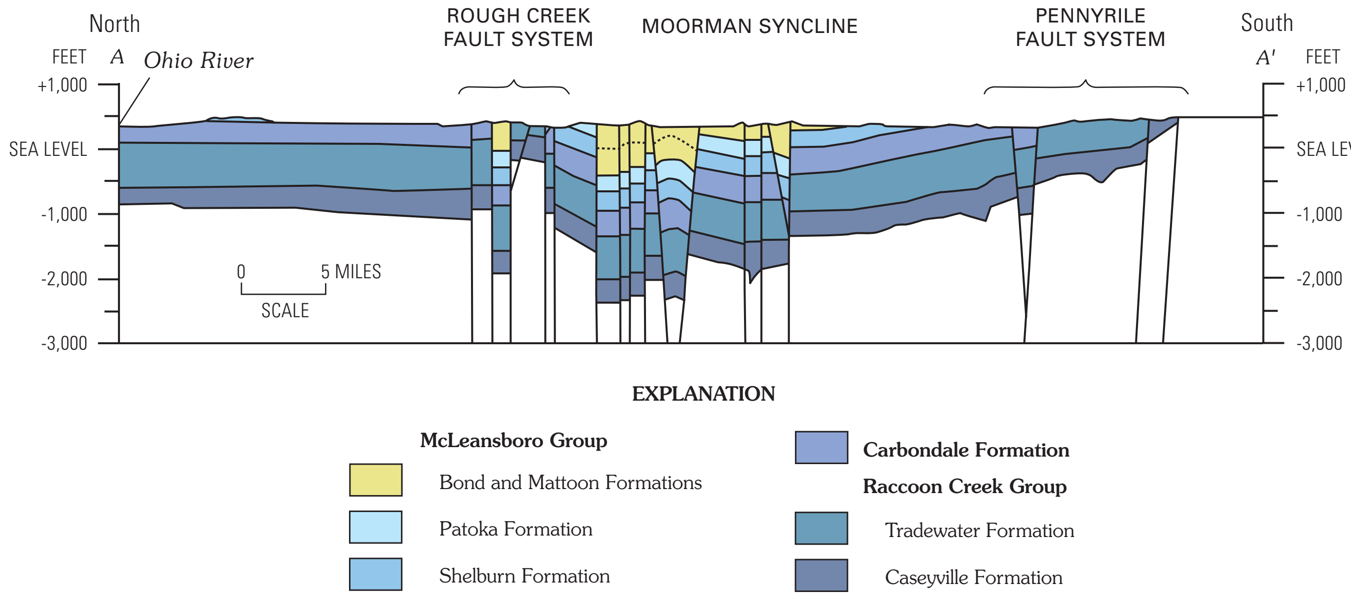

Figure 6. Generalized north-south cross section through western Kentucky. The approximate location of cross section A–A′ is shown on figure 5. Figure provided by S.F. Greb.

Descriptions of the Springfield, Herrin, Danville, and Baker Coals

The Springfield, Herrin, Danville, and Baker Coals are the primary focus of this assessment of Illinois Basin coal resources because most past, current, and expected future coal production has been and will be from these coals.

Springfield Coal (Ill. No. 5; Ind. V; W. Ky. No. 9)

In Illinois, the Springfield Coal Member has a usual thickness of between 4.5 and 6 ft in most areas where it has been mined (Damberger, 2000) (fig. 7). In Indiana, the Springfield Coal Member generally averages about 5 ft thick, but coal thicknesses as much as 13 ft have been reported. Mined coal thickness averages between 3.0 and 7.4 ft (Mastalerz and Shaffer, 2000). Within the Moorman syncline of western Kentucky, the Springfield coal ranges from 5 to 6 ft in thickness, but thins to less than 4 ft toward the east and northeast of the Rough Creek fault system (Greb and others, 1992; Chesnut and others, 2000).

The lithologies of roof rocks overlying the Springfield Coal are variable. Over much of its extent, the Springfield is normally overlain by black, fissile shale that is 6–24 in. thick. However, in a 4- to 10-mi-wide area extending from Gibson County, Ind., to Saline County, Ill., a delta distributary system (Galatia channel system, see fig. 7) was contemporaneous with the swamps depositing the peat that formed the coal. Within this belt, the coal is absent or irregularly developed and is overlain by the gray, silty Dykersburg Shale Member of the Carbondale Formation (Illinois and Kentucky) or Dugger Formation (Indiana) (Hopkins, 1968; Hopkins and Simon, 1975). Adjacent to the channel system, the coal is relatively thick (from 5 to 10 ft) and is more commonly split by shale partings. Where the Dykersburg Shale Member is greater than about 20 ft in thickness, the coal commonly is relatively low in sulfur (1.5–3 percent, fig. 8, Cady, 1935; and Damberger, 2000). In Henderson and Webster Counties, in western Kentucky, the interval of the Springfield coal is replaced by the Henderson channel, a south-southwest-oriented feature less than 1.5 mi wide (fig. 7). This channel appears to be a result of contemporaneous sedimentation, but evidence of post-depositional erosion has been found (Beard and Williamson, 1979).

One of the characteristics of the Springfield in western and 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 through its roof strata. These irregularities may seriously influence the purity of the coal and strength of the roof strata (Damberger, 2000).

Cady (1952) estimated remaining resources for the Springfield Coal Member in Illinois at 38.5 billion short tons; Hopkins and Simon (1974) estimated 42.6 billion short tons, whereas Damberger (2000) listed 61.7 billion short tons. For the Springfield Coal Member in Indiana, Spencer (1953) estimated 13.7 billion short tons, and for the Springfield coal in western Kentucky, Smith and Brant (1980) estimated 9.4 billion short tons.

Calorific value (as-received basis) for the Springfield Coal Member in northern, western, and west-central Illinois ranges from 10,100 to 11,100 Btu/lb, in east-central and southwestern Illinois, from 11,000 to 11,800 Btu/lb, and in southeastern Illinois, from 11,900 to 12,700 Btu/lb. Ash content of the Springfield in Illinois generally ranges from 8 to 12 percent and sulfur content from 3 to 5 percent (Damberger, 2000). Average calorific value (as-received basis) for the Springfield in Indiana is about 11,300 Btu/lb, ash content 10.4 percent, and sulfur content 3.3 percent (modified from Mastalerz and Harper, 1998, table 3). Average calorific value (as-received basis) for the Springfield coal in western Kentucky is 11,700 Btu/lb, ash content 10.5 percent, and sulfur content 3.3 percent (Cobb and others, 1985, table 5; Greb and others, 1992, table 1).

Herrin Coal (Ill. No. 6, W. Ky. No. 11)

In Illinois, the Herrin Coal Member averages more than 6 ft thick over extensive areas and locally reaches 15 ft thick (Hopkins

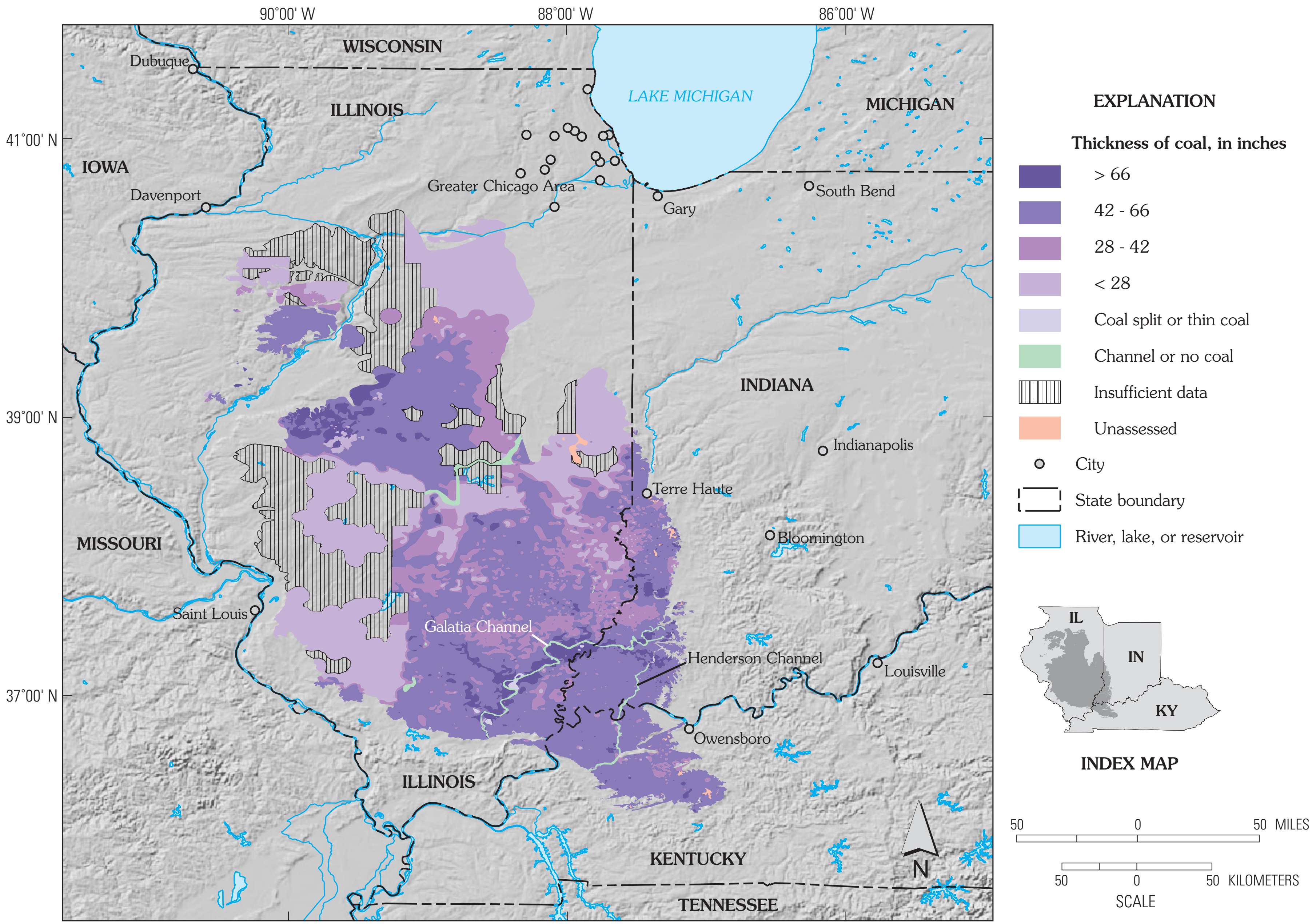

Figure 7. Map showing thickness of the Springfield Coal in Illinois, Indiana, and western Kentucky. This illustration was modified from regional shapefiles contained in the Illinois Basin ArcView project (Gunther and others, this publication).

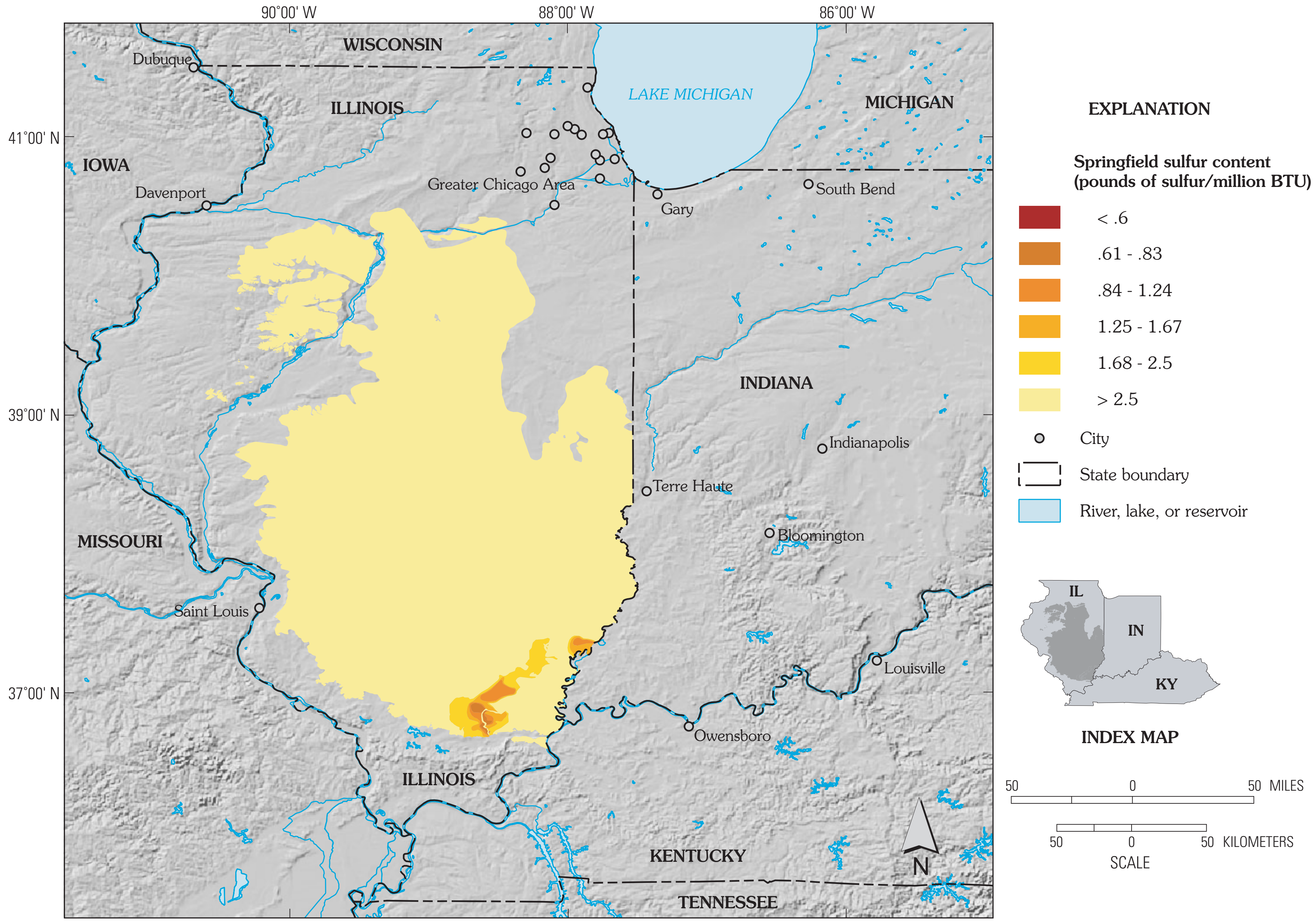

Figure 8. Map showing sulfur contents of the Springfield Coal in Illinois. This figure illustrates the areas of lower sulfur coal associated with the Galatia channel in southern Illinois (see fig. 7 for location of Galatia channel). Figure provided by C.P. Korose and C.G. Treworgy, Illinois State Geological Survey.

and Simon, 1975) (fig. 9). It is thinner and more irregular in thickness in much of central Illinois and in southeastern Illinois, in Saline and Gallatin Counties. The Herrin Coal is not well developed in Indiana. There, the Herrin coal varies from about 2 to 5 ft in thickness in Posy County, southwestern Gibson County, and western Vanderburgh County and is present as a thin coal at shallow depths in Warrick County. To the north and east in Indiana, the coal is thin or absent (Mastalerz and Shaffer, 2000). In western Kentucky, the Herrin coal occurs in two geographically distinct bodies (fig. 9). The thickest of these bodies is in a narrow belt along the southern edge of the coal field in Union, Webster, Hopkins, and Muhlenburg Counties, where the Herrin is as much as 10 ft thick. The second body of coal is north of the Rough Creek fault system (see fig. 6). Here, the Herrin coal is thin (<2.4 ft) or absent (Greb and others, 1992; Weisenfluh and others, 1998; Chesnut and others, 2000).

The roof rocks overlying the Herrin Coal are also lithologically variable. Over much of its extent in Illinois, the coal is normally overlain by the Anna Shale Member or the Brereton Limestone Member of the Carbondale Formation. However, in parts of southern and central Illinois, a delta distributary system (Walshville channel system) was contemporaneous with the swamps depositing the peat that formed the Herrin. Within this belt, the coal is cut out by a channel sandstone as much as a 1 mi wide and 60–80 ft thick, or is irregularly developed and overlain by the silty, gray Energy Shale Member of the Carbondale Formation, which is as much as 100 ft thick (Allgaier and Hopkins, 1975; Nelson, 1983). Adjacent to this distributary system, the coal is relatively thick (from 5 to 10 ft) and is more commonly split by shale partings. Where the Energy Shale Member is thick, the sulfur content of the coal is relatively low in many places (0.5–2.5 percent) (fig. 10). The Energy Shale overlies the coal in four areas: (1) the Franklin-Williamson-Jefferson County area of southeastern Illinois (known as the "Quality Circle" area); (2) northern St. Clair County and adjacent Madison and Clinton Counties, in southwestern Illinois; (3) eastern Macoupin County and adjacent Montgomery and Christian Counties, in west-central Illinois; and 4) southern Vermillion County, in east-central Illinois. The “Quality Circle” area of relatively low sulfur and thick coal in the Franklin-Williamson-Jefferson County area extends for approximately 250 square miles; however, most of the "Quality Circle" has been mined out (Hopkins and Simon, 1975; Damberger, 2000).

The lower part of the Herrin Coal contains a prominent claystone parting (the “blue band”) that normally is 1–3 in. thick (Hopkins and Simon, 1975). The blue band may have been deposited by basin-wide flooding (Nelson, 1983). The blue band and other partings and splits thicken along a trend associated with the contemporaneous Walshville channel (fig. 9).

Cady (1952) estimated remaining resources for the Herrin Coal Member in Illinois at 62.2 billion short tons, Hopkins and Simon (1974) estimated 65.8 billion short tons, whereas Damberger (2000) listed 78.9 billion short tons. For western Kentucky, Smith and Brant (1980) estimated remaining combined resources for the Herrin coal and overlying Paradise coal at 8.4 billion short tons.

In western and west-central Illinois, calorific value (as-received basis) for the Herrin Coal Member ranges from 9,700 to 10,900 Btu/lb, in east-central and southwestern Illinois, from 10,000 to 11,300 Btu/lb, and in northern Illinois, from 10,500 to 11,400 Btu/lb. Ash content of the Herrin in Illinois generally ranges from 7 to 13 percent. For most of northern, western, and west-central Illinois, sulfur contents range from 3 to 5 percent, whereas in southwestern and east-central Illinois, sulfur contents range from 1 to 4 percent (Damberger, 2000). In western Kentucky, calorific value (as-received basis) for the Herrin coal averages 12,100 Btu/lb, ash content is 9.7 percent, and sulfur content is 4.0 percent (Cobb and others, 1985, table 5; Greb and others, 1992, table 1).

Danville Coal (Ill. No. 7, Ind. VII) and Baker Coal (W. Ky. No. 13)

In east-central Illinois, the Danville Coal Member is as much as 6 ft thick in parts of Vermilion County (fig. 11). In most of the rest of the state, the Danville is thin, generally from a few inches to less than 3 ft thick (Hopkins and Simon, 1975). In Indiana, the Danville ranges from 0.2 to 6.5 ft in thickness, averaging 4.3 ft in the northern Indiana counties and 2.1 ft in the south (fig. 11) (Mastalerz and Shaffer, 2000).

In western Kentucky, the Baker coal is a complex, multiple-bench zone consisting of mineable coals separated by rock partings (Weisenfluh and others, 1998). The Danville Coal Member in southern Indiana is correlative with an upper bench of the Baker coal in western Kentucky. The lower benches of the Baker coal in Kentucky are the mined benches near the Indiana border, but the mineable Baker coal as mapped elsewhere in western Kentucky may include this upper bench (Danville) in some places (W. A. Andrews, written commun., 1999). Development of thick coal bodies in the Baker coal is typically found in areas where the underlying Herrin and Paradise coals are thin or absent (Greb and others, 1992; Weisenfluh and others, 1998). Two distinct bodies of thicker Baker coal are well documented; one south of the Rough Creek fault system and one north (fig. 11). Each coal body is either bisected or bounded by contemporaneous or post-depositional paleo-channels that split or entirely replace the coal (Weisenfluh and others, 1998).

Cady (1952) estimated remaining resources for the Danville Coal Member in Illinois at 7.8 billion short tons; Hopkins and Simon estimated 7.6 billion short tons, and Damberger (2000) listed 17.8 billion short tons. For the Danville Coal Member in Indiana, Spencer (1953) estimated 13.7 billion short tons, and for the Baker coal in western Kentucky, Smith and Brant (1980) estimated 3.1 billion short tons.

Calorific value (as-received basis) of the Danville Coal Member in northern Illinois ranges from 9,600 to 10, 300 Btu/lb, ash content from 12 to 15 percent and sulfur content from 3 to 4 percent. In east-central Illinois, calorific value (as-received basis) ranges from 10,500 to 11, 300 Btu/lb, ash content from 9 to 11 percent, and sulfur content is about 3 percent (Damberger, 2000). Average calorific value (as-received basis) of the Danville in Indiana is 11,000 Btu/lb, ash content 11.1 percent, and sulfur content 2.5 percent (modified from Mastalerz and Harper, 1998, table 3). Limited analyses of the Baker coal in western Kentucky indicate an average calorific value (as received basis) of 10,970 Btu/lb, an ash content of 15.3 percent, and a sulfur content of 3.5 percent (Cobb and others, 1985; Greb and others, 1992).

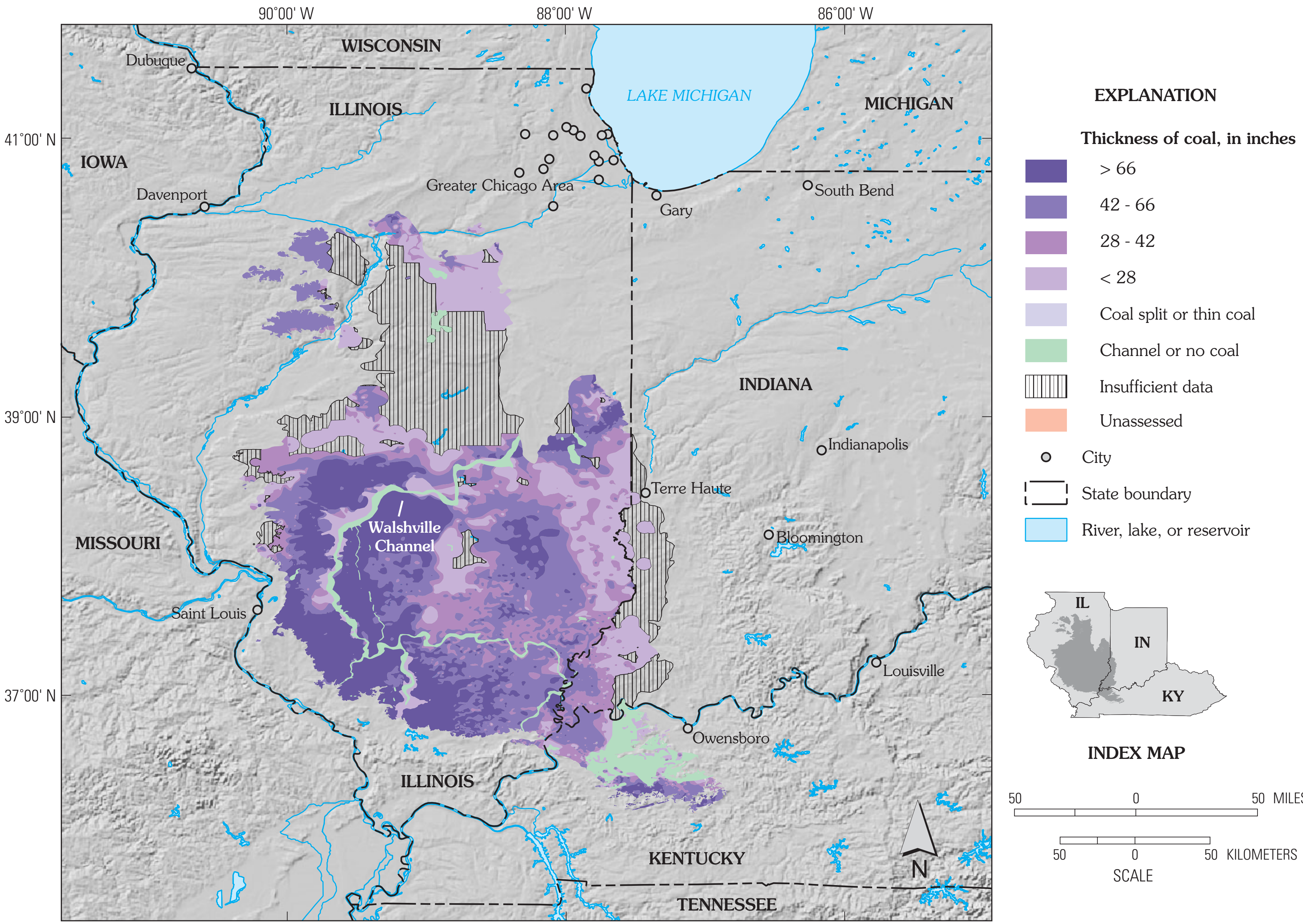

Figure 9. Map showing thickness of the Herrin Coal in Illinois, Indiana, and western Kentucky. This illustration was modified from regional shapefiles contained in the Illinois Basin ArcView project (Gunther and others, this publication).

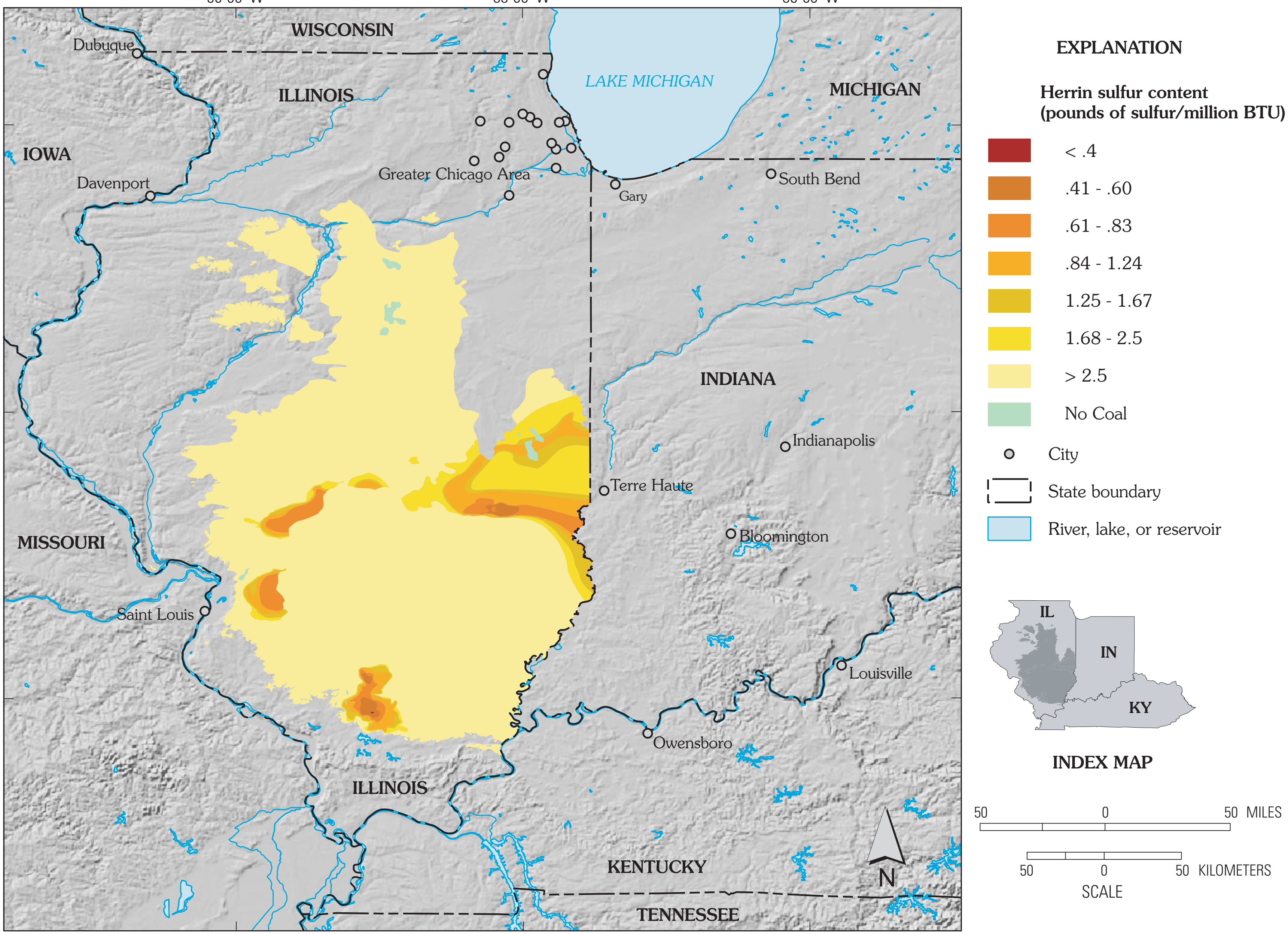

Figure 10. Map showing sulfur contents of the Herrin Coal in Illinois. This figure illustrates the areas of lower sulfur coal associated with the Walshville channel in central and southern Illinois (see fig. 9 for location of Walshville channel). Figure provided by C.P. Korose and C.G. Treworgy, Illinois State Geological Survey.

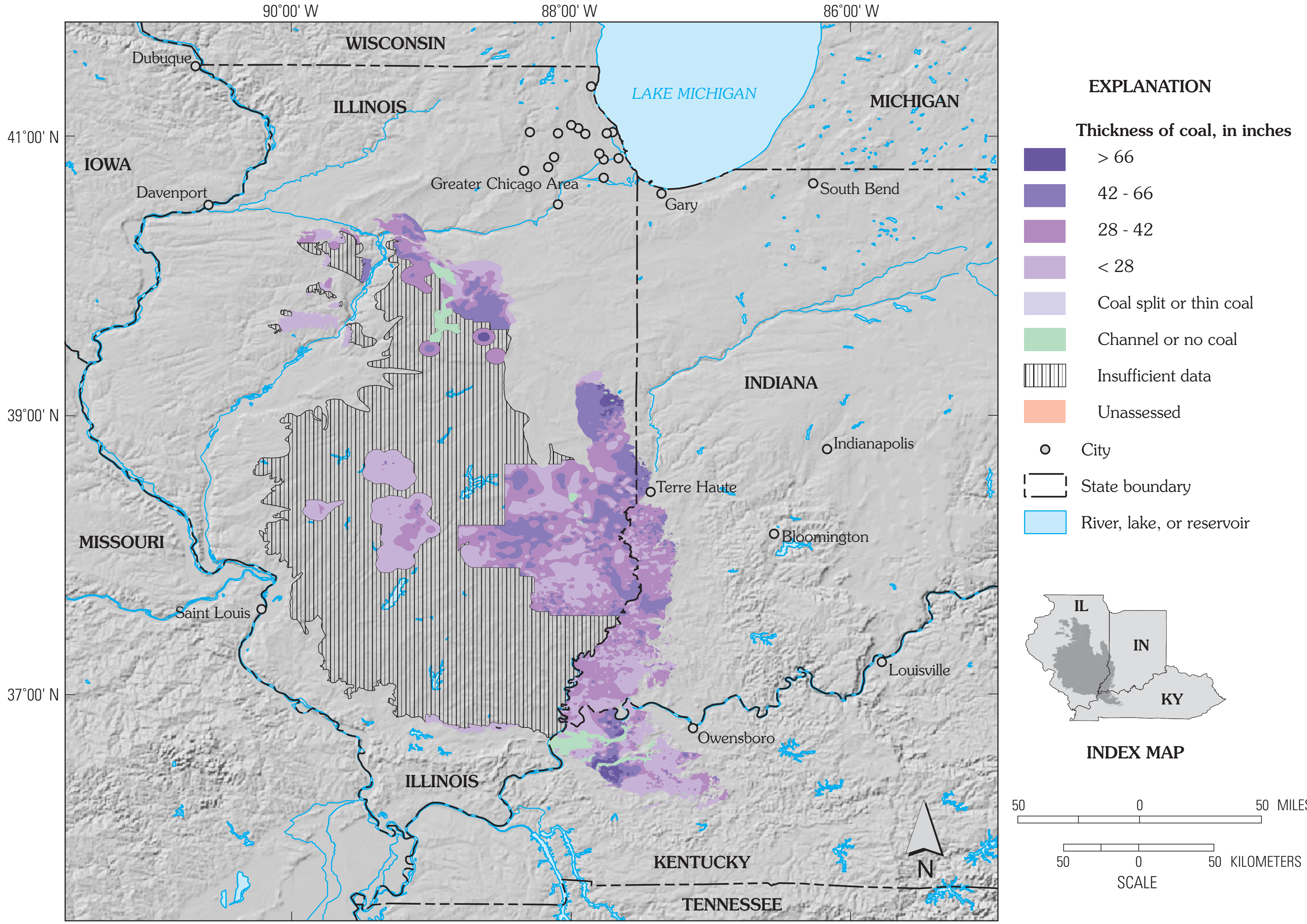

Figure 11. Map showing thickness of the Danville Coal in Illinois and Indiana and the Baker coal in western Kentucky. This illustration was modified from regional shapefiles contained in the Illinois Basin ArcView project (Gunther and others, this publication).

Other Illinois Basin Coals

In addition to the Springfield, Herrin, Danville, and Baker Coals, many other coals in the Raccoon Creek Group, Carbondale Group or Formation, and McLeansboro Group have been previously mined. Cumulative production from these other coals, however, has been much less than production from the four principal coals that are the focus of this assessment. Brief descriptions of these other coals are included here for completeness.

Raccoon Creek Group

Tradewater Formation—Illinois

Rock Island Coal Member (Ill. No. 1)

Production from this coal has come from western Illinois. In each mined location, this coal has been found to lie in narrow troughs, where coal thickness commonly ranges from 4 to 5 ft. It is correlated with the Litchfield and Assumption Coal Members of the Tradewater Formation in west-central Illinois (Montgomery and Christian Counties, respectively) (Damberger, 2000). Cady (1952) estimated remaining resources at 262 million short tons for the Rock Island Coal Member and 1.3 billion short tons for the Litchfield and Assumption Coal Members. Damberger (2000) listed a combined estimate of 1.55 billion short tons for the three coals. For the Rock Island in western Illinois, typical calorific value (as-received basis) ranges from 10,400 to 11,200 Btu/lb, ash content from 7 to 10 percent; and sulfur content from 3 to 6 percent (Damberger, 2000).

Murphysboro Coal Member

This coal is found only in Jackson and Perry Counties and in western Williamson County, in southwestern Illinois, where the coal ranges from about 1 to 7 ft in thickness. Near the town of Murphysboro, the coal, which was reported to have very low ash and sulfur contents, was used for making coke. Here, the coal occurs beneath thick, nonmarine, silty, gray shales that are related to a channel now filled with sandstone. Although the thicker coal near Murphysboro is largely mined out, additional areas of thick coal, ranging in thickness from 1.5 to 7.5 ft, have been found in north-central Jackson County and in Perry County (Damberger, 2000). Cady (1952) estimated remaining resources for the Murphysboro Coal Member at 392 million short tons. For the Murphysboro in southwestern Illinois, calorific value (as-received basis) ranges from 12,200 to 12,700 Btu/lb and ash contents from 5 to 11 percent. Sulfur contents range from 0.6 to 2.0 percent west of the DuQuoin monocline and from 3 to 5 percent east of the DuQuoin monocline (Damberger, 2000).

Tradewater Formation—Kentucky

Hawesville Coal

This coal is distributed in lenticular patches that reach thicknesses of 5 ft in Hancock County, Ky., although thicknesses of 3 ft or less are more common. Where the coal is thick, it commonly contains a 6-in.-thick pyritic parting and may be cut out by sandstone. The Hawesville coal was one of the most heavily mined coals in western Kentucky before the Civil War (Greb and others, 1992). Smith and Brant (1980) estimated the remaining resources for the Hawesville coal to be 72 million short tons.

Amos and Foster Coals

In the southeastern part of the western Kentucky coal field, this coal zone may contain as many as four coals in an interval 40 ft thick. The coals are cut out in many places by 10- to 40-ft-thick, cross-bedded sandstone units. The Foster coal has been reported to be as much as 4 ft thick in Butler County, Ky., where it is extensively mined. The Amos coal is a low-sulfur (1.2 percent), low-ash (3.9 percent) coal and is the most persistent of the four coals. The Foster coal has higher average sulfur content (2.7 percent) and ash content (7.7 percent) (Williams and others, 1990; Greb and others, 1992). Smith and Brant (1980) estimated the remaining resources for the combined Amos and Foster coals to be 23 million short tons.

Deanfield Coal

This coal is about 50 ft above the Hawesville coal. In Hancock County, Ky., it is as thick as 4 ft (Greb and others, 1992). Smith and Brant (1980) estimated the remaining resources for the Deanfield coal to be 290 million short tons.

Aberdeen Coal

In Butler County, Ky., this coal occurs 90–100 ft above the Foster coal. Here, the Aberdeen coal is 0–2.5 ft thick and overlain (and in some areas cut out) by the Aberdeen Sandstone Member of the Tradewater Formation. Smith and Brant (1980) estimated the remaining resources for the Aberdeen coal to be 39 million short tons.

Elm Lick Coal

This coal is probably limited geographically to Ohio and Butler Counties, Ky., where the coal generally ranges from 0 to 3.5 ft in thickness. This coal may contain partings as much as 1.5 ft thick, and is commonly truncated or cut out by a thick sandstone (Johnson, 1971a,b). Thick Elm Lick coal (greater than 3.5 ft) occurs in a thin belt that extends from Hartford in Ohio County, southeast to the Ohio-Butler-Grayson County line (Greb and others, 1992). Smith and Brant (1980) estimated the remaining resources for the Elm Lick coal to be 69 million short tons.

Dunbar and Lead Creek Coals

Unpublished studies correlate the Lead Creek coal with the Dunbar coal (Greb and others, 1992). In Hancock County, Ky., the Lead Creek coal is generally thin but may be thicker than 4 ft. Farther south, in Butler and Warren Counties, Ky., the Dunbar coal is as thick as 3.7 ft (Shawe, 1968). The Lead Creek and Dunbar coals commonly contain 5–8 percent sulfur and 11–18 percent ash. However, in northwestern Butler County and southeastern Daviess County, the Dunbar coal locally is a low-ash (3.5–4.3 percent) and low-sulfur (0.8–1.8 percent) coal (Hower and others, 1982). Smith and Brant (1980) estimated the remaining resources for the Lead Creek coal to be 223 short million tons but did not estimate resources for the Dunbar coal.

Mannington, Mining City, and Lewisport Coals (W. Ky. No. 4)

These three coals were correlated by Williams and others (1982). In the northeastern part of the western Kentucky coal field, the Lewisport coal ranges from 0 to 4.5 ft in thickness and may be split by as much as 5 ft of shale. In the southeastern part of the coal field (Butler County), the Mining City coal is as thick as 4.5 ft. In the western part of the coal field, the Mannington coal is generally between 3 and 4 ft thick. Although these coals can be correlated across the western Kentucky coal field, the thickness of the coal is quite variable (Shepard, 1980; Baynard and Hower, 1984). Mean calorific value (as-received) for the Mannington, Mining City, and Lewisport coals is 11,900 Btu/lb, ash content is 10 percent, and sulfur content is 3.0 percent (Cobb and others, 1985). Smith and Brant (1980) estimated the remaining resources for the combined Mannington, Mining City, and Lewisport coals to be 6.8 billion short tons. Between 1980 and 1990, combined average annual production from the Mannington, Mining City, and Lewisport coals was about 1,500,000 short tons.

Bancroft Coal

This coal occurs about 100 ft above the western Kentucky No. 4 coal in Muhlenburg County, in the south-central part of the coal field. Smith and Brant (1980) estimated the remaining resources for the Bancroft coal to be 113 million short tons.

Mansfield Formation—Indiana

Spencer (1953) estimated remaining resources of 340 million short tons for all coals in the Mansfield Formation in southwestern Indiana

St. Meinrad Coal Member

This coal is semi-blocky and contains numerous thin partings throughout much of its extent. It is highly variable in thickness, ranging from 0.1 to 5.0 ft. Mined thickness averages about 3.5 ft (Mastalerz and Shaffer, 2000).

Blue Creek Coal Member

This coal is extremely variable in thickness and quality. It splits into two benches in some localities. The coal is replaced by black, fissile shale throughout much of its extent. Mined thickness averages about 2.5 ft (Mastalerz and Shaffer, 2000). For the Blue Creek, calorific value (as-received basis) averages 11,300 Btu/lb, ash content 6.6 percent, and sulfur content 1.5 percent (modified from Mastalerz and Harper, 1998, table 3).

Mariah Hill Coal Member

This coal is moderately bright and semi-blocky, and it ranges from 2 to 4 ft thick where it is best developed. Mined thickness averages about 3.0 ft (Mastalerz and Shaffer, 2000). For the Mariah Hill, calorific value (as-received basis) averages 11,100 Btu/lb, ash content 9.7 percent, and sulfur content 1.5 percent (modified from Mastalerz and Harper, 1998, table 3).

Brazil Formation—Indiana

Lower Block Coal Member

The Lower Block Coal Member typically consists of a moderately dull banded, slabby coal having two conspicuous sets of cleats that cause it to break out in large blocks. The bed is absent or unidentifiable north of southern Park County, Ind. The Lower Block Coal Member, and its probable equivalent south of Green County, Ind., has been mined mostly from small surface mines during the last decade. The Lower Block Coal Member ranges from 0.7 to 5.8 ft in thickness, having a maximum thickness near the centers of small basins. Mined thickness averages about 3.5 ft in the northern counties. South of Green County, the Lower Block averages about 3 ft thick where mined. Spencer (1953) estimated remaining resources for the Lower Block Coal Member at 74 million short tons (Mastalerz and Shaffer, 2000). For the Lower Block, calorific value (as-received basis) averages 10,900 Btu/lb, ash content 9.5 percent, and sulfur content 1.5 percent (modified from Mastalerz and Harper, 1998, table 3).

Upper Block Coal Member

This coal is typically a moderately dull banded, semi-splint coal having two sets of cleats that cause it to break out in blocks. A band of fusain, usually about 1.5 ft above the base, divides the coal into two benches. The Upper Block Coal Member and its probable equivalent south of Green County, Ind., have been mined mostly in small surface mines during the last decade. In the northern counties, mined thickness of the coal varies from 1.4 to 5 ft, averaging about 4 ft. South of Greene County, the coal in the Upper Block position averages about 3 ft where mined, with a range of 2 to 4 ft (Mastalerz and Shaffer, 2000). Spencer (1953) estimated remaining resources for the Upper Block Coal Member at 81 million short tons. For the Upper Block, calorific value (as-received basis) averages 10,800 Btu/lb, ash content 8.1 percent, and sulfur content 1.4 percent (modified from Mastalerz and Harper, 1998, table 3).

Minshall and Buffaloville Coal Members

These coal members are thought to be a single continuous bed. The name "Minshall Coal Member" is applied in Clay, Fountain, Greene, Owen, and Parke Counties, Ind., whereas "Buffaloville Coal Member" is applied farther south, in Daviess, Dubois, Spencer, and Warrick Counties, Ind. In Clay County, the Minshall is typically a bright- to dull-banded pyritiferous coal with a pyritiferous shale or limestone roof and gray, carbonaceous plastic underclay. The Buffaloville is a blocky coal with a black shale, calcareous black shale, or argillaceous limestone roof and an underclay as much as 3 ft thick. During the past decade, the Minshall and Buffaloville have been mined mostly at small surface mines, where they range from less than 1 ft to more than 6 ft in thickness. Mined thicknesses average from slightly more than 2 ft in the southern counties to almost 4.5 ft in some northern counties (Mastalerz and Shaffer, 2000). Spencer (1953) estimated remaining resources for the Minshall Coal Member at 158 million short tons. For the Minshall and Buffaloville Coal Members, calorific value (as-received basis) averages 11,100 Btu/lb, ash content 10.7 percent, and sulfur content 3.3 percent (modified from Mastalerz and Harper, 1998, table 3).

Carbondale Formation or Group

Davis, Dekoven, and Seelyville Coals (Ind. III; W. Ky. No. 6 and No. 7)

The Davis, Dekoven, and Seelyville Coals occur within the same coal zone. In Illinois and western Kentucky, the Davis and Dekoven Coals are near the base of the Carbondale Formation. In Indiana, the Seelyville Coal Member is near the top of the Staunton Formation. In Illinois, the Davis and Dekoven are commonly 10–25 ft apart and the beds are usually co-produced in surface mines. Resources, most too deep for strip mining, are known to occur in Franklin, Williamson, Saline, and Gallatin Counties, in southern Illinois. These beds have been extensively mined at the surface in parts of southern Saline County, eastern Williamson County, and Gallatin County. Where mined, the Davis Coal Member has an average thickness of 3.5–4 ft, whereas the Dekoven Coal Member has an average thickness of 3–3.5 ft (Damberger, 2000). The Davis and Dekoven have been correlated with the Seelyville Coal Member in east-central Illinois (Jacobson, 1987). In an area of approximately 1,900 square miles in 10 counties of east-central Illinois the Seelyville may be 3.5–9 ft thick (Treworgy, 1981). Very little is known about coal structure and coal quality in this area. One or more shale partings can be inferred in many places from the geophysical logs.

In Indiana, the Seelyville Coal Member has been mined in surface operations in Clay, Davies, Greene, Pike, Sullivan, and Warrick Counties during the last 15 years. Mined thickness in Indiana averages about 6 ft in the northern counties and about 3 ft in the southern counties (Mastalerz and Shaffer, 2000).

Although the Davis coal is widespread in western Kentucky, it has been intensively mined only in the southern part of Union County. An interval of relatively thick coal extends across the northern part of Union and Henderson Counties and into the western edge of Daviess County (Greb and others, 1992). The Dekoven coal is 3 ft thick in western Union County but thins southeastward along the outcrop.

Cady (1952) estimated remaining resources for the Davis Coal Member in Illinois at 3.4 billion short tons, Hopkins and Simon (1974) estimated 3.4 billion short tons, and Damberger (2000) listed 3.6 billion short tons. For the Dekoven Coal Member, Cady (1952) estimated 2.5 billion short tons, Hopkins and Simon (1974) estimated 2.5 billion short tons, and Damberger (2000) listed 2.7 billion short tons. Damberger (2000) listed remaining resources for the Seelyville Coal Member in Illinois at 10 billion short tons. Spencer (1953) estimated remaining resources for the Seelyville in Indiana at 5.9 billion short tons. Smith and Brant (1980) estimated the remaining resources for the Davis coal in western Kentucky to be 7.5 billion short tons, and for the Dekoven coal they estimated 290 million short tons. A combined total resource estimate for the Davis, Dekoven, and Seelyville Coals from the three states would be about 30 billion short tons.

For the Davis Coal Member in southern Illinois, calorific value ranges from 12,500 to 12,800 Btu/lb (moist, mineral-matter-free basis), ash content from 8 to 11 percent (as-received basis), and sulfur contents from 3 to 4 percent (as-received basis). For the Dekoven Coal Member, calorific value (as-received basis) ranges from 11,900 to 12,700 Btu/lb, ash content from 8 to 13 percent, and sulfur content from 3 to 5 percent (Damberger, 2000).). For the Seelyville Coal Member in Indiana, calorific value (as-received basis) averages 11,200 Btu/lb, ash content 13.1 percent, and sulfur content 4.5 percent (modified from Mastalerz and Harper, 1998, table 3). For the Davis coal in western Kentucky, calorific value (as-received basis) averages 12,300 Btu/lb, ash content 8.2 percent, and sulfur content 2.9 percent (Greb and others, 1992).

Colchester Coal (Ill. No. 2, Ind. IIIa)

In Illinois, the Colchester Coal Member is in the Carbondale Formation; in Indiana, it is part of the Linton Formation. In Illinois, the Colchester has been mined principally in northern and western Illinois. The coal is 2.5–3.5 ft thick in northern Illinois; 2.5 to 3.3 ft in Henry County in the northern part of western Illinois and 1.5–2.5 ft 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 2 ft thick. Currently, the Colchester is being mined only in western Illinois (Damberger, 2000). In Indiana, the Colchester is generally thin, varying from 0.1 ft to more than 4 ft in thickness. There, it has been mined only in a few small surface mines. In Indiana, the roof of the coal is typically black, fissile shale, 1–7 ft thick (Mastalerz and Shaffer, 2000).

Cady (1952) estimated remaining resources for the Colchester Coal Member in Illinois at 17.5 billion short tons, Hopkins and Simon (1974) estimated 20.9 billion short tons, and Damberger (2000) listed 16.6 billion short tons. No coal resource estimates have been made for the Colchester in Indiana. For the Colchester Coal Member in northern and western Illinois, calorific value (as-received basis) ranges from 10,500 to 11,700 Btu/lb, ash content from 3 to 11 percent, and sulfur content from 1 to 5 percent (Damberger, 2000). For the Colchester in Indiana, calorific value (as-received basis) averages about 10,800 Btu/lb, ash content 11.6 percent, and sulfur content 3.7 percent (modified from Mastalerz and Harper, 1998, table 3).

Survant Coal (Ind. IV; W. Ky. No. 8)

In Indiana, the Survant Coal Member is in the Linton Formation; in western Kentucky, the Survant coal is in the Carbondale Formation. In Indiana, it is best developed in Greene and Vigo Counties, where it generally carries a medial parting as much as a few feet thick. The upper part of the coal is variously black fissile shale, a canneloid coal, or a banded coal. The roof is typically gray shale or sandstone. Thickness of the coal in Indiana varies from 0.2 to 8 ft; mined thicknesses vary from 2 to 6.5 ft. In the last 10 years, the coal has been mined in Pike, Greene, Warrick, and Clay Counties, Ind. (Mastalerz and Shaffer, 2000). In western Kentucky, the Survant coal is one of the least persistent Carbondale Formation coals and is usually less than 3 ft thick. It is cut out in many places by overlying channel sandstones. In western Kentucky, the coal commonly occurs in two benches separated by as much as 10 ft of shale and siltstone (Greb and others, 1992).

Spencer (1953) estimated remaining resources for the Survant Coal Member in Indiana at 3.9 billion short tons. For western

Kentucky, Smith and Brant (1980) estimated the remaining resources for the Survant coal to be 116 million short tons. For the Survant in Indiana, calorific value (as-received basis) averages about 11,200 Btu/lb, ash content 9.9 percent, and sulfur content 2.7 percent (modified from Mastalerz and Harper, 1998, table 3).

Houchin Creek Coal (Summum, Ill. No. 4, Ind. IVa, W. Ky. No.8b)

The Houchin Creek Coal is one of the most widely traceable coal horizons in Illinois, Indiana, and western Kentucky (Hopkins and Simon, 1975). In Illinois, the Houchin Creek Coal Member is in the Carbondale Formation, whereas in Indiana it is in the Petersburg Formation. It is normally overlain by the black, fissile Excello Shale Member of the Carbondale Formation (Illinois and Kentucky) or Petersburg Formation (Indiana). Where present, the Houchin Creek is usually within 25 ft of the base of the Springfield Coal. The coal, however, is usually not of mineable thickness (Damberger, 2000). In western Kentucky, the Houchin Creek coal consists of less than 2 ft of impure coal overlain by black shale that ranges from 2 to 6 ft in thickness. The Houchin Creek has been mined in western Illinois (Knox and Fulton Counties), west-central Illinois (Greene and Jersey Counties), southeastern Illinois (Saline County), and, most recently, in northern Illinois (Kankakee and Grundy Counties), where it was mined in conjunction with the Colchester Coal Member. In Indiana, the Houchin Creek Coal Member has been mined in small surface operations in Pike, Clay, Vigo, and Spencer Counties (Mastalerz and Shaffer, 2000).

Cady (1952) estimated resources for the Houchin Creek Coal Member in Illinois at 182 million short tons; Hopkins and Simon (1974) estimated 260 million short tons. Damberger (2000) did not list resource estimates for this coal. Spencer (1953) estimated remaining resources for the Houchin Creek Coal Member in Indiana at 108 million short tons. Smith and Brant (1980) did not estimate resources for the Houchin Creek coal in western Kentucky. For the Houchin Creek in western Illinois, calorific value (as-received basis) ranges from 10,800 to 11,300 Btu/lb, ash content from 7 to 9 percent, and sulfur content from 3 to 4 percent (Damberger, 2000).

McLeansboro Group

Jamestown and Hymera Coal Members and Paradise Coal (Ind. VI; W. Ky. No. 12)

The Jamestown Coal Member in Illinois, Hymera Coal Member in Indiana, and Paradise coal in western Kentucky are equivalent (Hopkins and Simon, 1975; Greb and others, 1992). In Illinois and western Kentucky, the Jamestown Coal Member and the Paradise coal are within the Shelburn Formation. In Indiana, the Hymera Coal Member is in the Dugger Formation of the Carbondale Group. The Jamestown is a widespread but thin coal in southern Illinois.

For Illinois, Cady (1952) estimated resources for the Jamestown Coal Member at 600 million short tons; Damberger (2000) listed 3.6 billion short tons. For the Hymera Coal Member in Indiana, Spencer (1953) estimated 3.7 billion short tons. For western Kentucky, Smith and Brant (1980) estimated remaining combined resources for the Paradise coal and the underlying Herrin coal at 8.4 billion short tons. Average calorific value (as-received basis) for the Hymera in Indiana is about 10,800 Btu/lb, ash content is 12.7 percent, and sulfur content is 2.9 percent (modified from Mastalerz and Harper, 1998, table 3). Analyses of the Paradise coal in western Kentucky indicate an average calorific value (as-received basis) of 11,900 Btu/lb, ash content of 9.7 percent, and sulfur content of 2.0 percent (Cobb and others, 1985; Greb and others, 1992).

Coiltown Coal (W. Ky. No.14)

The Coiltown coal is not persistent in western Kentucky, but where present this coal tends to be one of the thickest beds. In eastern Hopkins County, a coal thickness as much as 151 in. was reported, making the Coiltown coal the thickest coal in western Kentucky. Where the Coiltown coal is thick, it often contains abundant partings (as much as 12 in. thick) and may be cut out by thick sandstone units (Palmer, 1972; Greb and others, 1992). Smith and Brant (1980) estimated remaining resources for the Coiltown coal at 1.2 billion short tons. Analyses of the Coiltown coal indicate an average calorific value (as received basis) of about 11,860 Btu/lb, ash content of 8.7 percent, and sulfur content of 3.2 percent (Cobb and others, 1985; Greb and others, 1992).

References Cited

Allgaier, G.J., and Hopkins, M.E., 1975, Reserves of the Herrin (No. 6) Coal in the Fairfield Basin in southeastern Illinois: Illinois State Geological Survey Circular 489, 31 p.

Baynard, D.N., and Hower, J.C., 1984, Depositional settings of the coal-bearing upper Tradewater Formation in western Kentucky, with emphasis on the Mannington (No. 4) coal zone, in Part 2 of Petrographic characterization of Kentucky coals—Final Report: Lexington, Ky., University of Kentucky Institute for Mining and Minerals Research, 90 p.

Beard, J.G., and Williamson, A.D., 1979, A Pennsylvanian channel in Henderson and Webster Counties, Kentucky: Kentucky Geological Survey Series XI, Information Circular 1, 12 p.

Buschbach, T.C., and Kolata, D.R., 1991, Regional setting of Illinois Basin, in Leighton, M.W., Kolata, D.R., Oltz, D.F., and Eidel, J.J., eds., Interior cratonic basins: American Association of Petroleum Geologists Memoir 51, p. 29–55.

Cady, G.H., 1935, Classification and selection of Illinois coals: Illinois State Geological Survey Bulletin 62, 354 p.

Cady, G.H., 1952, Mineable coal reserves of Illinois: Illinois State Geological Survey Bulletin 78, 138 p.

Chesnut, D.R., Jr., Weisenfluh, G.A., Greb, S.F., Eble, C.F., and Andrews, R.E., 2000, Coal geology of Kentucky, in 2000 Keystone Coal Industry Manual: Chicago, Ill., Primedia Intertec, p. 587–603.

Cobb, J.C., Brant, R.A., Currens, J.C., and Williamson, A.D., 1985, Kentucky coal: Kentucky Geological Survey Series XI, Reprint 20, 17 p.

Damberger, H.H., 2000, Coal geology of Illinois, in 2000 Keystone Coal Industry Manual: Chicago, Ill., Primedia Intertec, p. 562–573.

Flores, R.M., 1993, Coal-bed and related depositional environments in methane gas producing sequences, in Law, B.E., and Rice, D.D., eds., Hydrocarbons from coal: American Association of Petroleum Geologists Studies in Geology, No. 38, p. 13–38.

Francis, Wilfrid, 1954, Coal—Its formation and composition: London, Edward Arnold Ltd., 567 p.

Gildersleeve, Benjamin, 1975, Geologic map of the Cromwell quadrangle, Butler and Ohio Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ–1250, scale 1:24,000.

Greb, S.F., Williams, D.A., and Williamson, A.D., 1992, Geology and stratigraphy of the western Kentucky coal field: Kentucky Geological Survey Bulletin 1, Series XI, 77 p.

Hopkins, M.E., 1968, Harrisburg (No. 5) Coal reserves of southeastern Illinois: Illinois State Geological Survey Circular 431, 25 p.

Hopkins, M.E., and Simon, J.A., 1974, Coal resources of Illinois: Illinois Minerals Note 53, 24 p.

Hopkins, M.E., and Simon, J.A., 1975, Pennsylvanian System, in Willman, H.B., Atherton, E., Bushbach, T.C., Collinson, Charles, Frye, J.C., Hopkins, M.E., Lineback J.A., and Simon, J.A., eds., Handbook of Illinois stratigraphy: Illinois State Geological Survey Bulletin 95, p. 163–201.

Hower, J.C., Koppenaal, D.W., Gong, Z., Wild, G.D., and Trinkle, E.J., 1982, Characterization of coals from western Kentucky—Gil series boreholes with emphasis on Tradewater and Lower Carbondale Formations: University of Kentucky Institute for Mining and Minerals Research Open-File Report 1, 45 p.

Jacobson, R.J., 1987, Stratigraphic correlations of the Seelyville, Dekoven, and Davis Coals of Illinois, Indiana, and western Kentucky: Illinois State Geological Survey Circular 539, 27 p.

Jacobson, R.J., Trask, C.B., Ault, C.H., Carr, D.D., Gray, H.H., Hasenmeuller, W.A., Williams, Dave, and Williamson, A.D., 1985, Unifying Nomenclature in the Pennsylvanian System of the Illinois Basin: Transactions of the Illinois Academy of Science, v. 78, p. 1–11 [Illinois State Geological Survey Reprint 1985K].

Johnson, W.D., 1971a, Geologic map of the Horton quadrangle, Ohio County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ–915, scale 1:24,000.

Johnson, W.D., 1971b, Geologic map of the Rosine quadrangle, western Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ–928, scale 1:24,000.

Mastalerz, Maria, and Harper, Denver, 1998, Coal in Indiana—A geologic overview: Indiana Geological Survey Special Report 60, 45 p.

Mastalerz, Maria, and Shaffer, K.R., 2000, Coal geology of Indiana, in 2000 Keystone Coal Industry Manual: Chicago, Ill., Primedia Intertec, p. 574–579.

Nelson, W.J., 1983, Geologic disturbances in coal seams: Illinois State Geological Survey Circular 530, 47 p.

Nelson, W.J., and Lumm, D.K., 1984, Structural geology of southeastern Illinois and vicinity: Illinois State Geological Survey Contract/Grant Report 1984–2 and U.S. Nuclear Regulatory Commission NUREG/CR–4036, 127 p.

Nelson, W.J., Trask, C.B., Jacobson, R.J., Damberger, H.H., Willamson, A.D., and Williams, D.A., 1991, Absaroka Sequence—Pennsylvanian and Permian Systems, in Leighton, M.W., Kolata, D.R., Oltz, D.F., and Eidel, J.J., eds., Interior cratonic basins: American Association of Petroleum Geologists Memoir 51, p. 143–164.

Palmer, J.E., 1972, Geologic map of the Central City East quadrangle, Muhlenberg and Ohio Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ–1031, scale 1:24,000.

Parr, S.W., 1928, The classification of coal: University of Illinois Engineering Experiment Station, Bulletin 180, 11 p.

Phillips, T.L., Avcin, M.J., and Berggren, D.J., 1976, Fossil peat of the Illinois Basin: Illinois State Geological Survey Educational Series 11, 39 p.

Schopf, J.M., 1956, A definition of coal: Economic Geology, v. 51, no. 6, p. 521–527.

Shawe, F.R., 1968, Geologic map of the Riverside quadrangle, Butler and Warren Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ–736, scale 1:24,000.

Shepard, J.L., 1980, Sedimentology of a Pennsylvanian, coal-bearing, cratonic delta, upper Tradewater Formation, western Kentucky: Urbana, University of Illinois, M.S. thesis, 109 p.

Smith, G.E., and Brant, R.A., 1980, Western Kentucky coal resources: Lexington, Ky., University of Kentucky Institute for Mining and Minerals Research, Energy Resource Series, 148 p.

Spencer, F.D., 1953, Coal resources of Indiana: U.S. Geological Survey Circular 266, 42 p.

Treworgy, C.G., 1981, The Seelyville Coal—A major unexploited seam in Illinois: Illinois State Geological Survey Illinois Mineral Notes 80, 11 p.

Van Krevelen, D.W., 1961, Coal typology—Chemistry-Physics-Constitution: Amsterdam, Elsevier Publishing Company, 514 p.

Williams, D.A., Helfrich, C.T., Hower, J.C., Fiene, F.L., Bland, A.E., and Koppenaal, D.W., 1990, Amos and Foster coals—Low-ash and low-sulfur coals of western Kentucky: Kentucky Geological Survey Report of Investigations 5, Series XI, 34 p.

Williams, D.A., Williamson, A.D., and Beard, J.G., 1982, Stratigraphic framework of coal-bearing rocks in the western Kentucky coal field: Kentucky Geological Survey Information Circular 8, Series XI, 201 p.

Weisenfluh, G.A., Andrews, W.A., and Hiett, J.K., 1998, Availability of coal resources for the development of coal, western Kentucky summary report: Kentucky Geological Survey Interim Report for U.S. Department of Interior Grant 14–08–0001–A0896, 32 p.