KENTUCKY GEOLOGICAL SURVEY
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UNIVERSITY OF KENTUCKY, LEXINGTON

GEOLOGIC MAP 29
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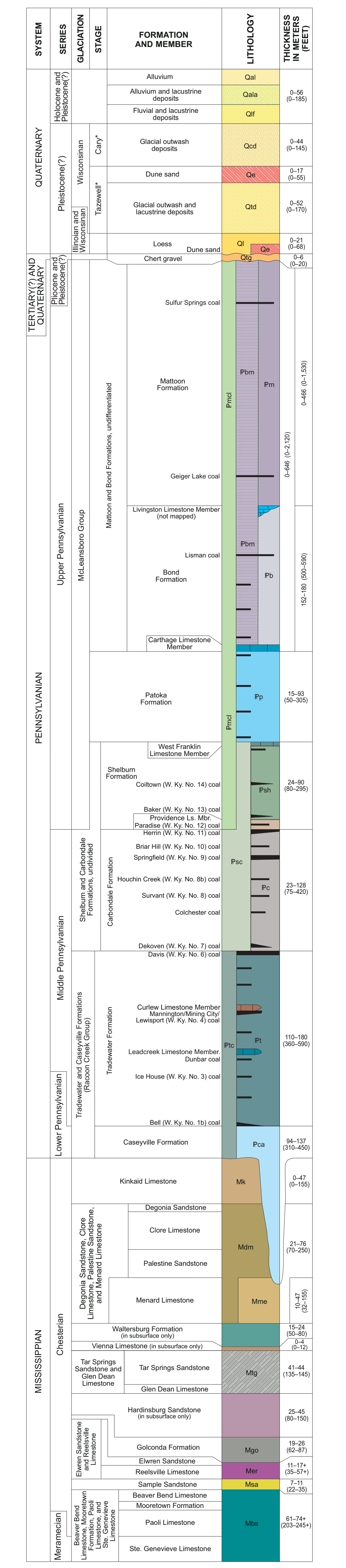

*Ray, 1965

DESCRIPTION OF ROCK UNITS

Qal Qala Qlf	ALLUVIUM, ALLUVIUM AND LACUSTRINE DEPOSITS, or LACUSTRINE AND FLUVIAL DEPOSITS—Sand, silt, clay, and gravel. Sand grains are dominantly quartz with some shale, coal, and pyrite, mainly very fine but some coarse, subangular to subrounded, intermixed with gravel in the lower part. Silt, partly clayey, and locally fine sand size. Clay, slightly silty, commonly contains calcareous pellets. Gravel, as granules and subangular pebbles, consists mainly of chert but also clasts of fossils, coal, ironstone, and sandstone. Unit includes lacustrine deposits of Wisconsinan age.
Qcd	GLACIAL OUTWASH DEPOSITS—Sand, gravelly sand, and silt. Sand, commonly fine at top and grading downward to medium. Gravelly sand, coarse, with pebbles of quartz, chert, granite, and dark igneous rock. Silt mantles the surface. Deposits underlie low terrace about 30 feet above the Ohio River. Unit identified as Cary stage by Ray (1965).
Qe	EOLIAN SAND, DUNE SAND—Sand and silt. Sand, mostly very fine to fine and subangular. Silt, clayey, slightly micaceous, in part weakly calcareous. Forms conspicuous ridges (dunes) on terrace surfaces, concealed by loess.
Qtd	GLACIAL OUTWASH AND LACUSTRINE DEPOSITS—Outwash; sand, gravel, silt, and clay. Sand, fine to coarse, friable, generally well sorted; mainly consists of subrounded quartz grains but contains many grains of glacially derived igneous and metamorphic rock. Gravel, sandy, subangular to subrounded pebbles of quartz, chert, and igneous and metamorphic rocks of glacial origin. Silt, clay to fine sand size; interbedded with clay, in part calcareous. Clay, silty, plastic; occurs in upper part. Underlies high terrace surface, deposited to an altitude of about 410 feet. Lacustrine deposits; clay, silt, and sand. Primarily clay, locally calcareous, micaceous, sandy, or silty. Silt, locally sandy, calcareous, or micaceous. Some sand in the lower part. Clay and silt derived in part from loess. Units identified as Tazewell stage by Ray (1965).
Ql	LOESS—Silt and sand. Silt, clay to fine sand size, calcareous in the lower part. Sand, very fine to fine. Deposited by wind during the Pleistocene. Greatest thickness adjacent to river valley; mantles all except steepest slopes.
QTg	CHERT GRAVEL—Mainly subangular to rounded granules and pebbles with a few small cobbles and boulders; mostly consists of dense, fossiliferous chert, with lesser amounts of quartz, ironstone, sandstone, and silicified fossil fragments in a matrix of fine sand.
ℙ	PENNSYLVANIAN ROCKS, UNDIVIDED—Unit equivalent to unnamed or unknown Pennsylvanian rocks in mapped fault segments.
ℙmcl	MCLEANSBORO GROUP—Unit equivalent to Mattoon, Bond, Patoka, or Shelburn Formations in mapped fault segments. Previously mapped as Sturgis or Henshaw and Lisman Formations on original 7.5-minute geologic quadrangle maps.
ℙbm	MATTOON AND BOND FORMATIONS, UNDIFFERENTIATED—Sandstone, shale, siltstone, limestone, and coal. Sandstone, fine- to medium-grained, in part argillaceous, micaceous, commonly interbedded with shale. Shale, clayey to sandy, in part carbonaceous; commonly interbedded with sandstone; scattered sideritic nodules; locally abundant plant impressions in dark gray and black shale; where shale is calcareous it contains brachiopod and crinoid fragments. Siltstone, fine- to very fine-grained, sandy, micaceous; commonly grades into sandstone. Limestone, finely crystalline, dense, argillaceous to sandy. Coal, thin and shaly, pyritic in part; coal beds are the Lisman, Geiger Lake, and Sulfur Springs. Previously mapped as Henshaw Formation and upper part of Lisman Formation, and later as upper part of the Sturgis Formation.
ℙm	MATTOON FORMATION—Sandstone, shale, siltstone, limestone, and coal. Description same as above. Coal beds are the Geiger Lake and Sulfur Springs. Base of formation is usually approximated 61 m (200 ft) beneath the Geiger Lake coal based on position of a limestone marker bed in the subsurface. However, the Geiger Lake coal has been mapped consistently across most of the area, it was used as a proxy for the base of the Mattoon.
ℙb	BOND FORMATION—Sandstone, shale, siltstone, limestone, and coal. Description same as above. Coal beds are the W. Ky. No. 18 and Lisman coals. The Carthage Limestone Member is a 1- to 3-m- (3- to 10-ft-) thick, regionally persistent marker bed, commonly recognized on electric logs, and is located at the base of the formation. Previously part of Lisman and Sturgis Formations.
ℙp	PATOKA FORMATION—Shale, sandstone, siltstone, coal, and limestone. Shale, clayey to sandy, in part carbonaceous; commonly interbedded with sandstone; scattered thin beds of calcareous shale contain brachiopod and crinoid fragments. Sandstone, fine- to medium-grained, silty, micaceous. Siltstone, in part sandy, commonly interbedded with shale and sandstone. Coal beds thin, in part shaly and pyritic, and commonly grade into black shale. Coals present, but not mapped, are the W. Ky. Nos. 15, 16, and 17 beds. Limestone, argillaceous, silty. The base of the formation is placed at the top of the West Franklin Limestone Member (formerly mapped as the Madisonville Limestone Member) of the underlying Shelburn Formation (see description below). Previously part of Lisman and Sturgis Formations.
ℙsh	SHELBURN FORMATION—Shale, sandstone, siltstone, coal, and limestone. Shale, clayey to sandy, in part calcareous, locally carbonaceous, commonly interbedded with sandstone and siltstone. Sandstone, fine- to medium-grained, locally coarse-grained, in part crossbedded, micaceous, locally carbonaceous; contains thin lenses of ironstone conglomerate. Siltstone, sandy, micaceous, locally carbonaceous. Coals are, in ascending order, the Paradise coal, Baker coal zone, and the Coiltown coal (formerly mapped as the W. Ky. No. 12 coal bed, No. 13 coal zone, and No.14 coal bed, respectively). The Paradise coal occurs between benches of the Providence Limestone Member. Limestone, finely crystalline, dense, fossiliferous. Providence Limestone Member, at the base of the formation, consists of one to three limestone beds separated by shale. West Franklin Limestone Member (formerly mapped as the Madison Limestone Member) is at the top of the formation and consists of one to three beds of limestone separated by calcareous clay shale. Previously part of Lisman and Sturgis Formations.
ℙsc	SHELBURN AND CARBONDALE FORMATIONS, UNDIVIDED—Combined unit present in Utica 7.5-minute quadrangle; previously mapped as Lisman and Carbondale Formations, undivided.
ℙc	CARBONDALE FORMATION—Shale, sandstone, coal, and limestone. Shale, gray to black, clayey to sandy, slightly micaceous, often coarsening-upward, with scattered small calcareous concretions; commonly interbedded with sandstone. Sandstone, fine-grained, micaceous, in part crossbedded. Coals are the Davis, Dekoven, Houchin Creek, Springfield, Briar Hill, and Herrin beds (previously mapped as the W. Ky. Nos. 6, 7, 8, 9, 10, and 11). Limestone, finely crystalline, medium-bedded, locally sandy, commonly occurs below coal beds.
ℙt	TRADEWATER FORMATION—Sandstone, siltstone, shale, coal, and limestone. Sandstone, very fine- to medium-grained, micaceous, thin- to very thick-bedded, partly crossbedded. Siltstone, poorly exposed, micaceous, grades into shale and limestone. Shale, clayey to sandy, locally carbonaceous. Coals are the Bell, Ice House, and Mannington/Mining City/Lewisport beds or zones (formerly mapped as the W. Ky. Nos. 1b, 3, and 4 coal beds). Curlew Limestone Member is a moderately crystalline, dense, thin- to thick-bedded, locally fossiliferous limestone directly above the No. 4 coal. Other limestones, very fine-grained, dense, cherty.
ℙca	CASEYVILLE FORMATION—Sandstone, conglomeratic sandstone, shale, and coal. Sandstone, quartzose, very fine to coarse, well-rounded grains, thin- to very thick-bedded, commonly crossbedded. Basal part locally conglomeratic; contains rounded quartz pebbles. Shale, silty to sandy, locally carbonaceous and clayey. Coal, blocky, hard, bright, thin; includes Battery Rock coal bed. Base is unconformable with underlying Mississippian units, with some paleovalleys incised to the Menard Limestone.
ℙtc	TRADEWATER AND CASEYVILLE FORMATIONS, UNDIFFERENTIATED—Descriptions same as above.
Mk	KINKAID LIMESTONE—Limestone, very finely crystalline, fine- to coarse-grained, dense, subconchoidal fracture, in part shaly and dolomitic, fossiliferous with many brachiopods and crinoid columnals.
Mdm	DEGONIA SANDSTONE, CLORE LIMESTONE, PALESTINE SANDSTONE AND MENARD LIMESTONE, UNDIFFERENTIATED—Shale, limestone, sandstone, and siltstone. Shale, clayey to sandy, in part calcareous. Limestone, very finely crystalline to coarse-grained, dense; abundant brachiopods, bryozoans, and crinoid columnals in lowermost limestone. Sandstone, very fine- to medium-grained, locally silty. Siltstone, in part sandy and calcareous, locally micaceous. Upper units poorly exposed and often mapped as a combined unit; mapped locally with underlying Menard Limestone in Morganfield and Waverly 7.5-minute quadrangles.
Mme	MENARD LIMESTONE—Limestone, shale, and sandstone. Limestone, finely to coarsely crystalline, fine- to coarse-grained, in part shaly, locally dolomitic. Shale, clayey to sandy, in part calcareous. Sandstone, very fine-grained. Mapped locally in Utica 7.5-minute quadrangle.
Mtg	TAR SPRINGS SANDSTONE AND GLEN DEAN LIMESTONE, UNDIFFERENTIATED—Tar Springs Sandstone consists of sandstone and shale. Sandstone, very fine-grained, quartzitic, laminated to very thin-bedded; interbedded with shale in lower part. Shale, clayey to sandy, in part micaceous; may contain very thin resistant beds of ferruginous ironstone concretions. Glen Dean Limestone composed of finely crystalline, fossil-fragmental limestone. Mapped locally in Morganfield 7.5-minute quadrangle.
Mgo	GOLCONDA FORMATION—Limestone, sandstone, and shale. Golconda Formation consists of an upper Haney Limestone Member overlying the Big Clifty Sandstone Member. Haney Limestone Member, limestone, fossil-fragmental, in part dolomitic, very oolitic, and slightly cherty. Big Clifty Sandstone Member, sandstone and shale. Sandstone, fine- to medium-grained. Shale, clayey to sandy. Mapped as combined unit in Utica 7.5-minute quadrangle.
Mer	ELWREN SANDSTONE AND REELSVILLE LIMESTONE, UNDIFFERENTIATED—Elwren Sandstone consists of sandstone, very fine-grained, argillaceous, micaceous. Reelsville Limestone, composed of limestone, finely crystalline to very fine-grained, fossil-fragmental, in part oolitic, partly dolomitic. Mapped locally in Utica quadrangle. Elwren Sandstone is equivalent to Cypress Sandstone, and the Reelsville Sandstone is equivalent to upper part of the Paint Creek Limestone in other areas.
Msa	SAMPLE SANDSTONE—Sandstone, shale, and siltstone. Sandstone, very fine- to medium-grained. Shale and siltstone, partly sandy. Mapped locally in Utica 7.5-minute quadrangle.
Mbs	BEAVER BEND LIMESTONE, MOORETOWN FORMATION, PAOLI LIMESTONE, AND STE. GENEVIEVE LIMESTONE, UNDIFFERENTIATED—Beaver Bend Limestone, limestone, fine-grained, fossil-fragmental, in part oolitic. Mooretown Formation, sandstone and shale. Sandstone, fine-grained, grains subrounded. Shale, sandy. Paoli Limestone, limestone and shale. Limestone, very finely crystalline to very fine-grained, fossil-fragmental, dense, very oolitic in upper half; subconchoidal fracture. Shale, clayey, calcareous. Ste. Genevieve Limestone, limestone, very finely crystalline to very fine-grained, dense; subconchoidal fracture; in part very oolitic. Mapped locally in Utica 7.5-minute quadrangle.
af	ARTIFICIAL FILL—Compacted rock debris from highway construction.

ACKNOWLEDGMENTS: This map was digitally generated from 1:24,000-scale geologic maps under the STATEMAP Program authorized by the National Geologic Mapping Act of 1992, and was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program.

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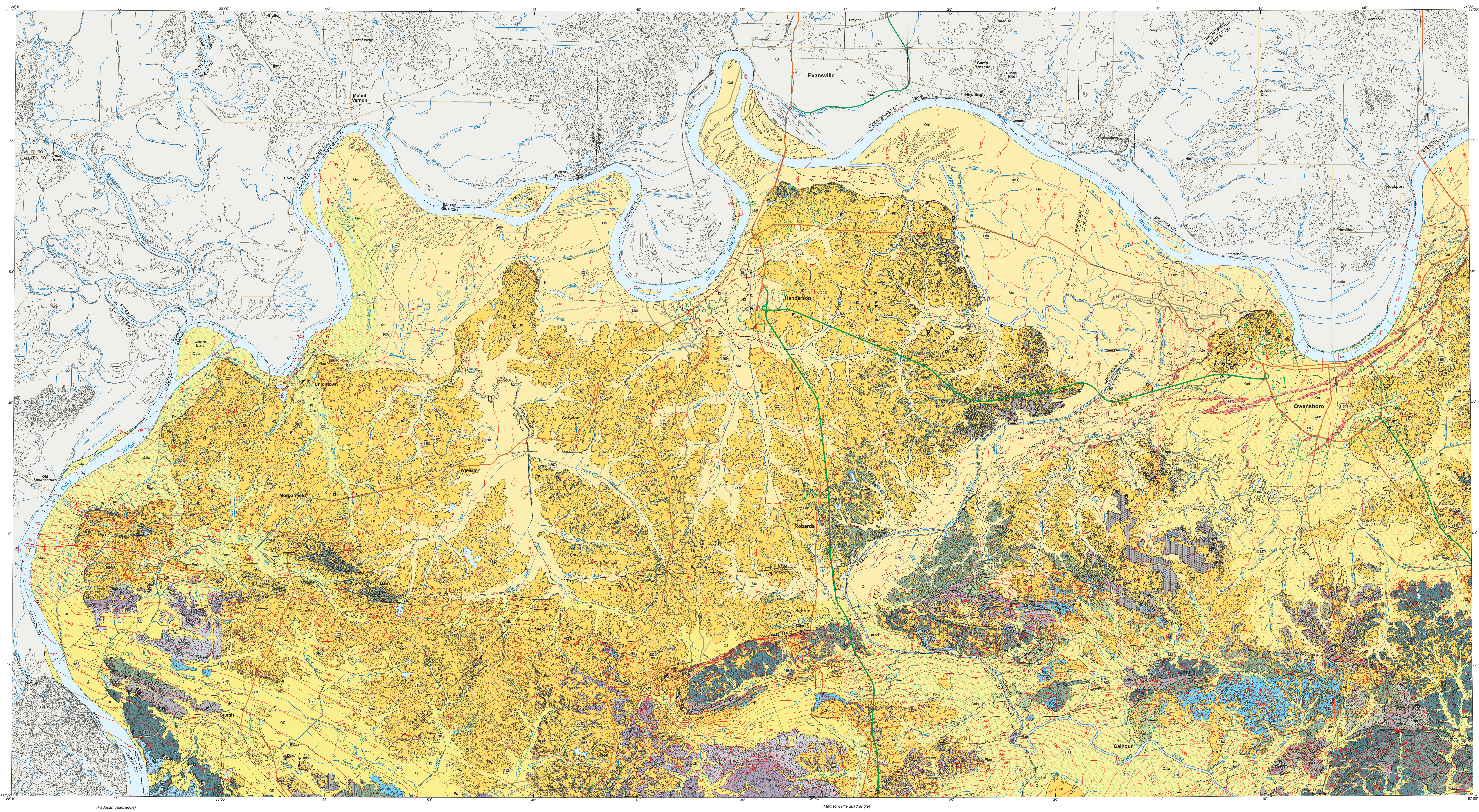
EXPLANATION

▬	Interstate highway or parkway
▬	U.S. highway
▬	State highway
— - - —	State boundary
— - — -	County boundary
·······	City boundary
┼┼┼	Railroad
U/D	Normal fault (U, upthrown side; D, downthrown side)
R	Reverse fault
·······	Concealed fault
∼	Contact
∼	Concealed contact
∼	Inferred contact
200	Structure contour, feet
·······	Datum horizon boundary
✕	Synclinal axis
∼	Coal bed
∼	Inferred coal bed
∼	Concealed coal bed
∼	Strip mine
⚒	Abandoned stone quarry or mine
✕	Active pit; clay
✕	Abandoned pit; gravel, shale
x	Mineral prospect, barite
◩	Abandoned mine shaft; coal
◩	Abandoned inclined mine shaft; coal

Note: Symbols for surface mining activity reflect what was observed at the time of geologic mapping (1968–1976).



GEOLOGIC MAP OF THE KENTUCKY PARTS OF THE EVANSVILLE AND WEST FRANKFORT 30 x 60 MINUTE QUADRANGLES, WESTERN KENTUCKY

Thomas N. Sparks, Michael P. Solis, Matthew M. Crawford, Stephen F. Greb, and Warren H. Anderson

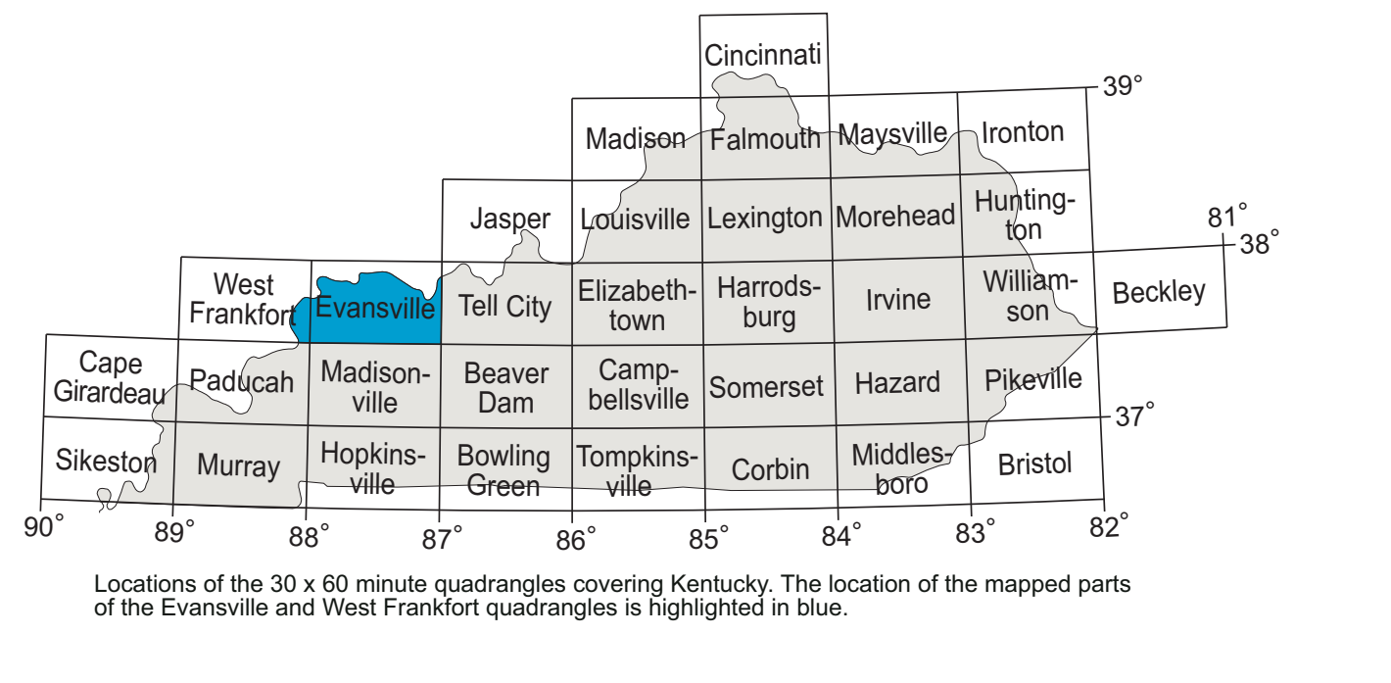
Cartography by Terry D. Hounshell

1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 KILOMETERS
1 0 1 2 3 4 5 6 7 8 9 10 MILES
1000 0 5000 10 000 15 000 METERS
5000 0 10 000 20 000 30 000 40 000 50 000 FEET

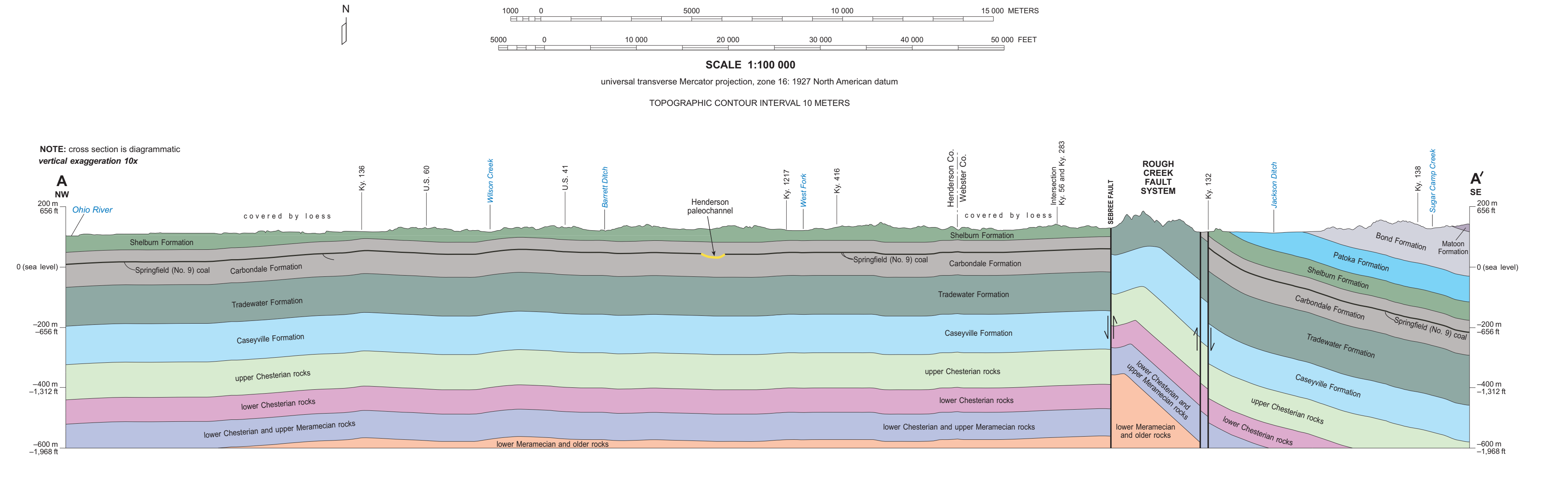
SCALE 1:100 000

universal transverse Mercator projection, zone 16: 1927 North American datum

TOPOGRAPHIC CONTOUR INTERVAL 10 METERS



Locations of the 30 x 60 minute quadrangles covering Kentucky. The location of the mapped parts of the Evansville and West Frankfort quadrangles is highlighted in blue.



INTRODUCTION

The geology of the Kentucky parts of the Evansville and West Frankfort 30 x 60 minute quadrangles was digitally compiled mostly from U.S. Geological Survey 7.5-minute geologic quadrangle maps (GQ's), as cited in the references. The original GQ's are products of a cooperative mapping project between the U.S. Geological Survey and the Kentucky Geological Survey from 1960 to 1978. The conversion into digital format has been another USGS-KGS cooperative program funded through the National Cooperative Geologic Mapping Program (STATEMAP). Recent geologic investigations on the geology and stratigraphy of western Kentucky have resulted in changes in the stratigraphic nomenclature and correlation of coal-bearing formations in the Western Kentucky Coal Field, as summarized in Greb and others (1992). The 7.5-minute quadrangles that make up the Kentucky portions of the Evansville and West Frankfort 30 x 60 minute quadrangles are shown in the index map (Fig. 1).

The data files resulting from the digitization of the GQ's are part of a comprehensive relational and spatial data set, being released as Digitally Vectorized Geologic Quadrangles (DVGQ's) by the Kentucky Geological Survey (Anderson and others, 1999). These DVGQ's are available on CD-ROM, and can be purchased from the KGS Public Information Center via the Internet. Users of the DVGQ data can prepare custom geologic maps by overlaying data using their own GIS or CAD software. KGS has also developed an Internet map service where users can prepare similar maps without purchasing DVGQ's via an interactive Geologic Map Information Service (kgs.uky.edu/kgsmap/KGSGeology) (Weisenfluh and others, 2005).

PROCEDURE

The 7.5-minute quadrangle maps were digitally compiled using a semi-automated data-capture technique to convert hard-copy geologic maps into digital format. Compiling 7.5-minute maps into a 30 x 60 minute map required the resolution of significant problems, such as correlating geologic formations across quadrangle boundaries, resolving nonuniform structure-contour datums or intervals, and resolving discrepancies in Quaternary alluvium boundaries and inferred contacts. The metadata portion of the DVGQ file provides detailed sources of data and information about the conversion process. Formation codes were assigned using the American Association of Petroleum Geologists' standard stratigraphic code (Cohee, 1967), which was modified by KGS for state-specific use. Formations and formation boundaries were not mapped consistently on each of the 7.5-minute maps as they were compiled between 1960 and 1978. Resolution of the differences between quadrangles was necessary for topological analysis in a GIS environment. In addition, numerous small members mapped on individual 7.5-minute maps are too small to be mapped at a scale of 1:100,000 on a 30 x 60 minute map. These problems were resolved by adhering to geologic, cartographic, and GIS standards appropriate for the scale of the map.

This map is a compilation of existing maps, and no additional field work was attempted. When there were problems in stratigraphic correlation between quadrangles, the best current data available were used to resolve these differences.

GEOLOGIC SETTING AND STRUCTURAL GEOLOGY

The surface geology of the Evansville and West Frankfort 30 x 60 minute quadrangles consists of gently to steeply dipping sedimentary rocks of Mississippian through Pennsylvanian age overlain by flat-lying unconsolidated sediments of the Tertiary(?) and Quaternary. These rocks occur in the Western Kentucky Coal Field, which comprises the southern tip of the Illinois (Eastern Interior) Basin of Illinois, Indiana, and Kentucky. The southern part of these quadrangles extends across the Rough Creek Fault System. The fault system is an east–west-trending basement fault complex that extends from southern Illinois eastward into west-central Kentucky. This fault system marks the northern margin of a failed rift basin (Rough Creek Graben), depicted as a half graben with vertical offset of as much as several thousand feet on its western end. Pennsylvanian strata dip into the Moorman Syncline along the graben (Greb and others,1992; Hickman, 2011).

Faulting may have controlled the thickness and extent of some of the mapped rock units in the quadrangle. Episodic subsidence occurred throughout the Paleozoic Era above the Rough Creek Graben. Fault movement may have influenced Silurian reef trends (Seal, 1985), Carboniferous paleochannel trends (Greb, 1989; Greb and others, 1992), and other sedimentation.

Several major fluvial paleochannels have incised into underlying rocks in the quadrangle. In the subsurface, the Bethel Channel is fault-bound and parallel to structural trends (Sedimentation Seminar, 1969). The Bethel Channel is a Mississippian sandstone channel that cuts into the Renault, Aux Vases, and Ste. Genevieve Limestones (Reynolds and Vincent, 1967). A Pennsylvanian channel, the Henderson Channel, incises the Herrin and Springfield coals and trends south from the city of Henderson to the Rough Creek Fault System (Beard and Williamson, 1979). Other channels and paleovalleys are in the Caseyville Formation (Davis and others, 1974; Greb, 1989; Greb and others, 1992).

During the Pleistocene Epoch, there were at least two major episodes of glaciation, the Illinoian and Wisconsinan Stages, which contributed to the geologic development of this part of the Ohio River. Glacial and fluvial processes reworked local and distant bedrock units and redistributed them as unconsolidated sand and gravel deposits along the Ohio River. Glacial lakes contributed fine-grained, slackwater lacustrine sediments to the area. Eolian sand dunes created linear sand bodies in the Owensboro area. Glacially derived silts and fine sands are deposited by wind in massive units of loess (as much as 60 ft in thickness) and typically mantle much of the upland bedrock.

ECONOMIC AND ENGINEERING GEOLOGY

Coal, petroleum, clay, sand, and gravel have been the most important mineral resources in the Evansville and West Frankfort quadrangles. The locations of industrial mineral resources, including mining operations, were mapped and described by Anderson and Dever (2001) and Broyles and Malone (2010).

Petroleum and natural gas

Oil was first discovered in 1865 in the Long Fall Field near Calhoun in McLean County (Schwalb and others, 1972). The most prolific oil production occurs north of the Rough Creek Fault System and has come from Pennsylvanian and Mississippian formations. The largest field, the Uniontown Field in Union County, has produced approximately 24 million barrels of oil. The Mississippian units provide the majority of the reservoirs. Producing sandstones, in stratigraphically descending order, are the Palestine, Waltersburg, Tar Springs, Hardinsburg, Paint Creek, Bethel, and Renault Sandstones. The Ste. Genevieve, Salem, and Warsaw Limestones have also produced oil. Total oil production for the area is more than 300 million barrels of oil.

The petroleum potential for Mississippian reservoirs is discussed in Bruce (1949) and Rose (1967), Silurian reservoirs in Seale (1985), and natural gas potential of the Devonian black shale in Hasenmueller and Comer (2000) and Hamilton-Smith (1993). The potential for natural gas in Cambrian sandstones is discussed in Drahovzal (1997).

Table 1. Cumulative oil production (million barrels) by county (1925–2009).

County	Production
Daviess	56.335
Henderson	112.149
McLean	34.565
Union	85.979
Webster	36.580
TOTAL	325.609

Source: Kentucky Geological Survey oil and gas production database, kgs.uky.edu/kgsmap/OGProdPlot/OGProduction.asp [accessed 7/07/11].

Several deep tests have been drilled in search of deeper oil and gas resources in the subsurface. The Exxon No. 1 Jimmy Bell was drilled to a depth of 14,340 ft into andesitic rocks, and the Exxon No. 1 Choice Duncan was drilled to a depth of 15,200 ft into andesitic basement rocks, both in Webster County, in the mid-1970's. Conoco drilled the No. 1 Turner, a basement test, to a depth of 14,200 ft and bottomed in granitic rocks in McLean County in 1992. The targets for these wells were the pre-Knox Cambrian sandstones, and although these wells did not have commercial hydrocarbons, there were shows of oil and gas.

Coal production

The two quadrangles on this map comprise a significant part of the Western Kentucky Coal Field. Several major coal beds have been mined in the quadrangle (Greb and others, 1992). In descending stratigraphic order, the mined coal beds are the Coiltown (W. Ky. No. 14), Baker (W. Ky. No. 13), Paradise (W. Ky. No. 12), Herrin (W. Ky. No. 11), Briar Hill (W. Ky. No. 10), Springfield (W. Ky. No. 9), Survant/Houchin Creek (W. Ky. No. 8), Dekoven (W. Ky. No. 7), and Davis (W. Ky. No. 6). Several other coals have been mined locally, but without significant production. The Springfield coal accounts for the majority of production. Of an estimated 9.9 million short tons (MT) of coal, 6.2 MT are available for development, or 62.7 percent of the original resource (Andrews and others, 2000). Additional information about coal geology can be found in Greb and others (1992). Information about coal bed resources can be found in Smith and Brant (1978) and Andrews and others (2000), and information about coal quality in Cobb and Eble (1992).

Table 2. Cumulative coal production (million short tons) by county and mining method (1820–2009).

County	Undifferentiated	Underground	Surface	Total
Daviess	2.077	6.859	54.398	63.333
Henderson	6.844	53.638	31.619	92.101
McLean	3.261	5.149	11.293	19.703
Union	15.824	314.990	5.008	335.822
Webster	19.772	289.966	42.828	352.566
TOTAL	47.778	670.602	145.145	863.525

Source: Kentucky Geological Survey coal production database, kgs.uky.edu/kgsweb/DataSearching/Coal/Production/prodsearch.asp [accessed 7/06/11].

Clay, sand, and gravel

Clay has been mined in Daviess and McLean County for commercial uses, although it is not currently mined. Analysis of samples from Webster County indicates potential for industrial uses for clay in the pottery, brick, and tile industry, and for use as lightweight aggregate (McGrain and Kendall, 1972). Sand and gravel have been dredged along the Ohio River, and some small sand and gravel pits have been mined throughout the region. Sandstone has been mined from the Tradewater and Caseyville Formations in areas where it crops out in Webster and Union Counties, and a silica sand deposit was mined in McLean County. A dune sand deposit was mined for foundry sand near Pup Creek in the Owensboro East 7.5-minute quadrangle.

ENGINEERING GEOLOGY AND SEISMIC HAZARDS

The Evansville and West Frankfort quadrangles are located near the Wabash Valley Seismic Zone and the New Madrid Seismic Zone, and any major seismic events would affect the entire western Kentucky area. Detailed investigations of historic seismic events and the basement structure of the Rough Creek Fault System are found in Nuttli (1973), Rhea and others (1996), Drahovzal (1997), and Woolery and others (1999). According to Rhea and others (1996), seven major earthquakes have occurred in the quadrangles since 1811, three of which had epicenters in the Henderson-Evansville area. The area lies in a high-risk seismic zone for earthquakes, as classified by modified Mercalli zones VII and VIII (Nuttli, 1973), and any major earthquakes near New Madrid, Mo., would probably have a significant impact in the mapped area.

Approximately half of the surface area in the Evansville quadrangle is underlain by Quaternary alluvium and lacustrine deposits, and these unconsolidated sediments are prone to ground-motion amplification during seismic events. Areas underlain by thick alluvium may be susceptible to liquefaction during a major earthquake. Liquefaction is a process in which alluvial soils lose their shear strength and behave as a fluid during long-duration seismic events. Slope instability is also a concern in the shales and alluvium. When water-saturated slopes are subjected to dynamic loads (i.e., earthquakes), landslides or slumps could occur. Development in earthquake-prone areas should follow construction and building specifications recommended by federal, State, and local building codes.

HYDROGEOLOGY

The Evansville and West Frankfort quadrangles cover parts of the Ohio River Basin watershed. The availability and quality of groundwater is discussed in Gallaher (1963, 1964a–c) and Carey and Stickney (2004a–c, 2005a, b). Wells in Ohio and Green River alluvium, or near other major tributaries, are usually less than 400 ft deep and may provide as much as several thousand gallons of water per minute for farms or commercial operations.

Sandstone aquifers in the McLeansboro (previously Lisman) Formation also produce water at a rate of 300 to 500 gallons per minute. Sandstones in the Carbondale Formation produce water, but the volumes are much less, usually 100 to 200 gallons per minute. There are also some deeper, freshwater Pennsylvanian paleochannel aquifers (Davis and others, 1974). Some aquifers may contain "hard" water (water that has a high concentration of calcium and magnesium), and others may have high salt content.

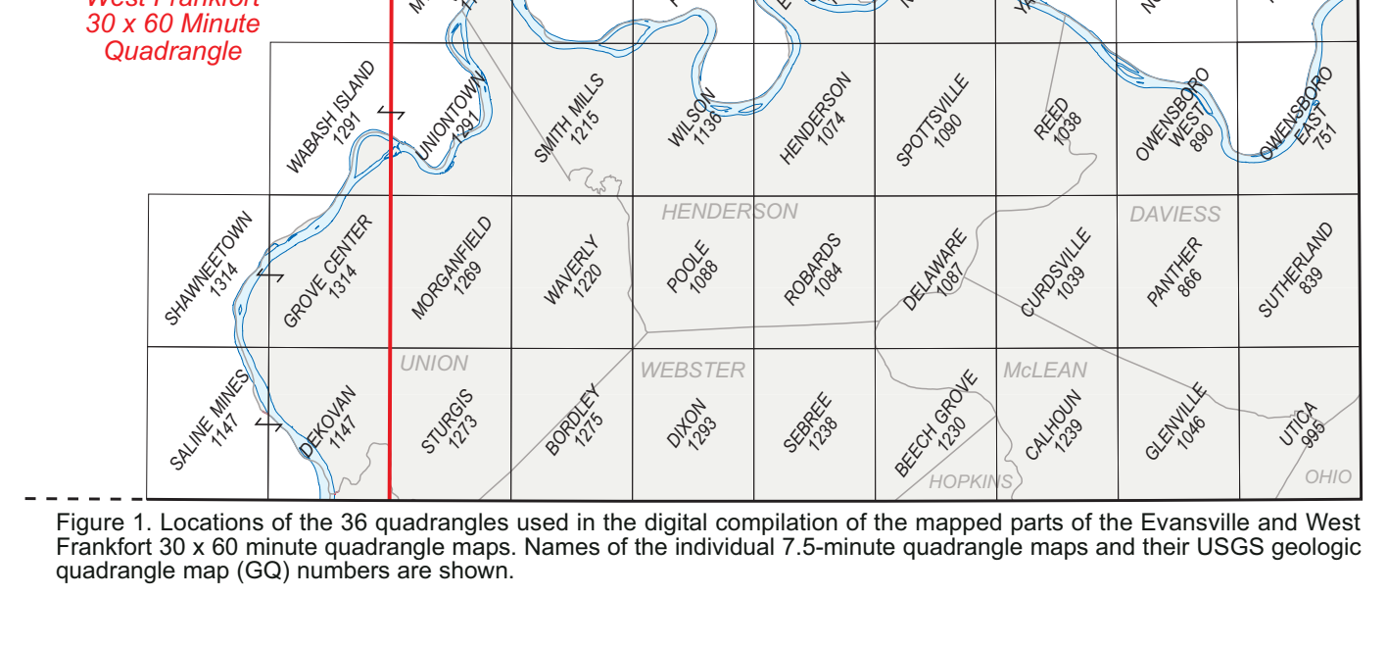


Figure 1. Locations of the 36 quadrangles used in the digital compilation of the mapped parts of the Evansville and West Frankfort 30 x 60 minute quadrangle maps. Names of the individual 7.5-minute quadrangle maps and their USGS geologic quadrangle map (GQ) numbers are shown.

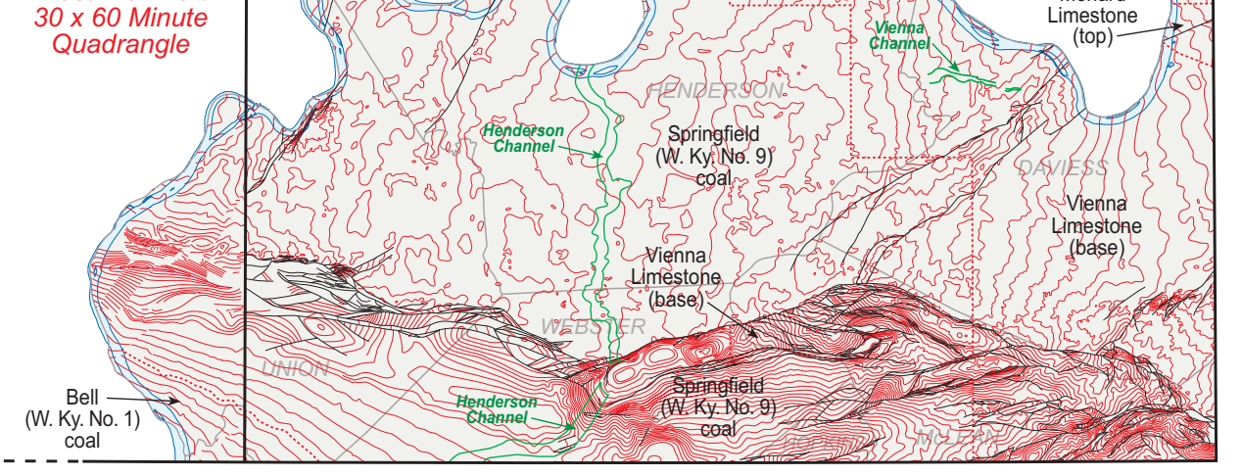


Figure 2. Structure contours in the mapped parts of the Evansville and West Frankfort 30 x 60 minute quadrangles. Names of each mapped horizon are indicated. The horizon boundaries are shown on the geologic map as thin red dashed lines. Contour interval north of the Rough Creek Fault Zone is 40 ft with index contours at every 200 ft. In places south of the fault zone where dip is relatively steep, contour interval is increased to 80, 100, or 200 ft.

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