Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

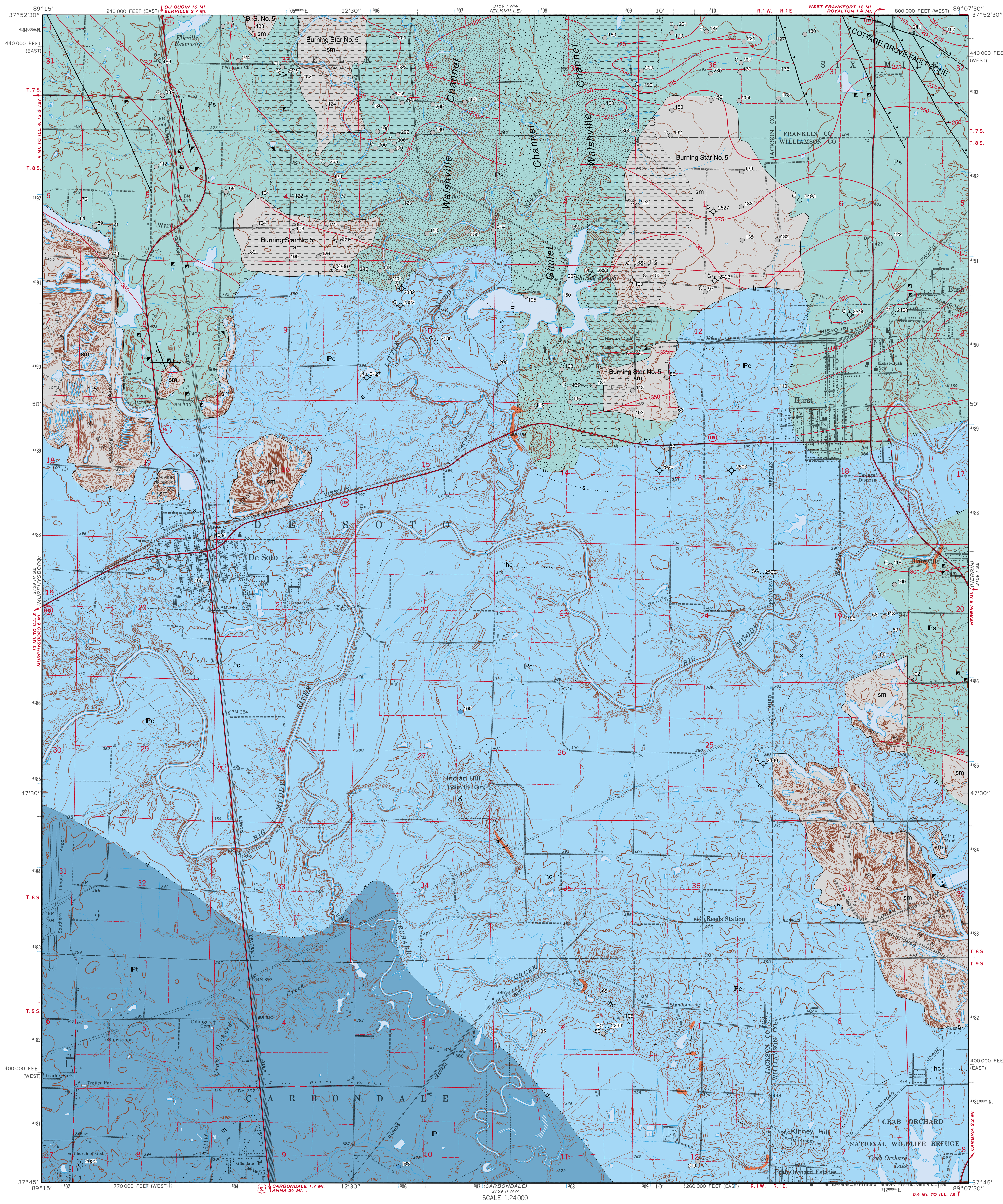
Bedrock Geology of De Soto Quadrangle

Franklin, Jackson, and Williamson Counties, Illinois

Illinois Geologic Quadrangle Map
IGQ De Soto-BG

W. John Nelson

2019



System	EXPLANATION		Series
	sm	Surface coal mine (reclaimed)	
Pennsylvanian	Ps	Shelburn Formation	Desmoinesian
	Pc (h, s, hc, d)	Carbondale Formation h, Herrin Coal Member s, Springfield Coal Member hc, Houchin Creek Coal Member d, Davis Coal Member	
	Pt (m)	Tradewater Formation m, Murphysboro Coal Member	
		Area of "split" Herrin Coal	
		Walshville channel, Herrin Coal thin or absent	
		Gimlet channel, Herrin Coal absent	

Symbols
all mines abandoned

- Drift mine
- Shaft mine
- Slope mine (showing direction of inclination)
- Bedrock outcrop

Drill Holes
from which subsurface data were obtained

- Water well
- Coal test boring
- Dry oil and gas test hole
- CSG 210 — Numeric label indicates total depth of boring in feet. Boring with core (c), samples (s), or geophysical log (g).

Line Symbols
dashed where inferred, dotted where concealed

- Contact or coal subcrop
- Normal fault: bar and ball on downthrown side
- Fault, direction of throw unknown, from coal mine map
- Strike-slip fault
- 425 — Elevation of top of Herrin Coal, contour interval 25 feet

Base map compiled by Illinois State Geological Survey from digital data (1968 [photorevised 1978] Raster Feature Separates) provided by the United States Geological Survey.

North American Datum of 1927 (NAD 27)
Projection: Transverse Mercator
10,000-foot ticks: Illinois coordinate system, east and west zone
1,000-meter ticks: Universal Transverse Mercator grid system, zone 16

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SCALE 1:24,000
1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

BASE MAP CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology based on field work by W.J. Nelson, 2012–2018.

Digital cartography by Deette M. Lund, Jennifer E. Carrell, Brittany Walbright, and Emily Bunse, Illinois State Geological Survey.

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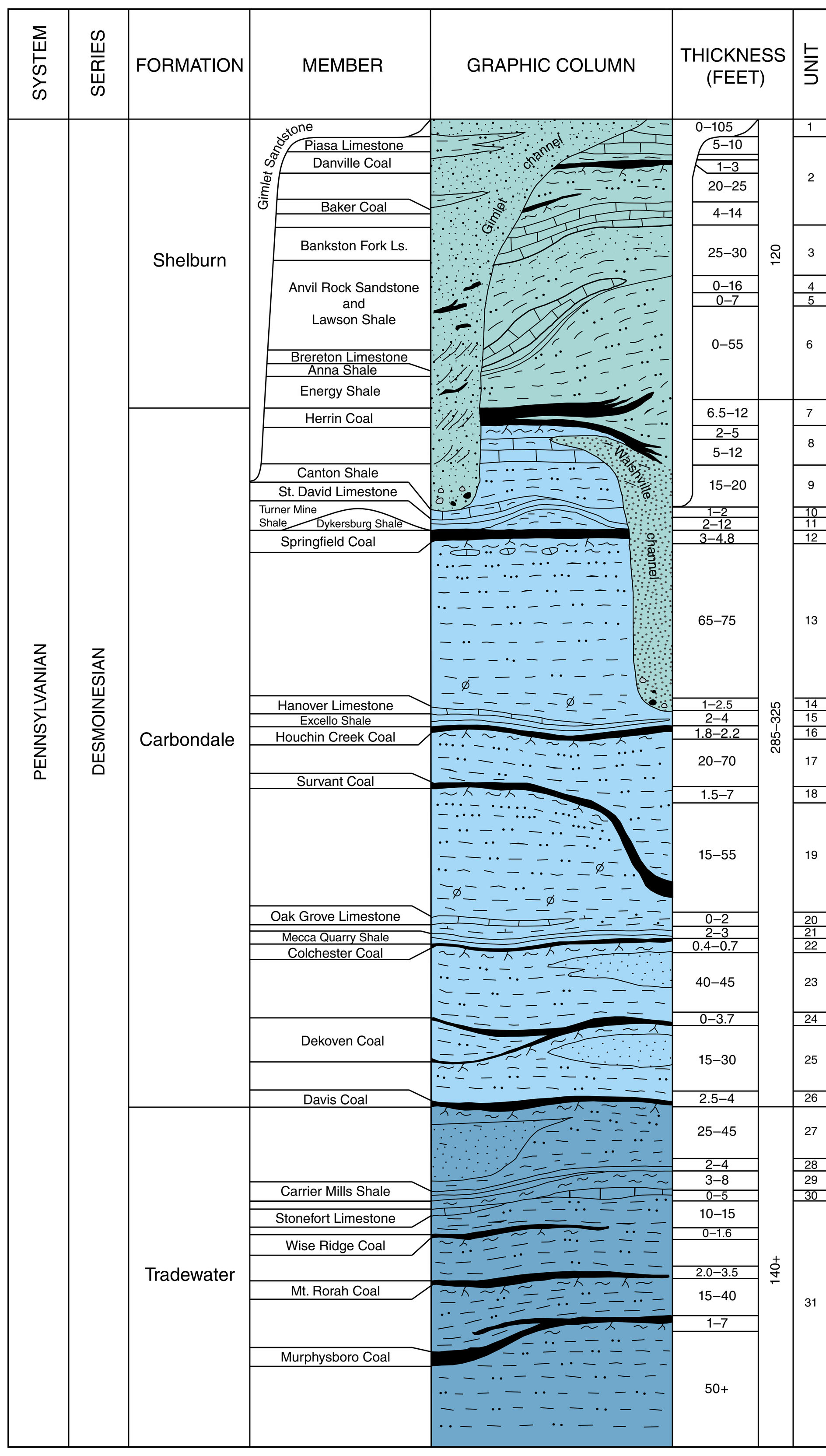
4		5
6	7	8

ADJOINING QUADRANGLES
1 Vergennes
2 Elkville
3 Christopher
4 Murphysboro
5 Herrin
6 Pomona
7 Carbondale
8 Crab Orchard Lake

2° TRUE NORTH MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2019

ROAD CLASSIFICATION
- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Unimproved road
- U.S. Route
- State Route



Shelburn Formation

1 Gimlet Sandstone Sandstone, light gray fresh, weathering yellowish to brownish gray, largely medium to coarse grained, friable. Upper part is finer grained and contains interbeds of siltstone showing cross-lamination and slumped lamination. In Burning Star No. 5 surface mine (now reclaimed), large-scale trough and planar cross-bedding and large-scale lateral accretion surfaces were evident and carbonaceous plant debris, casts of stems and logs, and coal stringers were common. Lower contact erosive, commonly marked by basal conglomerate. Fills a major incised valley that truncates the Herrin Coal and cuts at least as deeply as the St. David Limestone. Identified as Anvil Rock Sandstone by Palmer and Dutcher (1979), who interpreted the unit as channel and point-bar deposits of a large meandering river.

2 Piasa Limestone through Bankston Fork Limestone Drilling near northeast corner of quadrangle indicates Piasa Limestone is about 5 to 10 feet thick, Danville Coal 1 to 3 feet thick, Baker Coal 0 to 1 foot thick, and Bankston Fork Limestone generally 4 to 8 feet thick but locally as thick as 14 feet. Core records indicate the Bankston Fork is light brownish gray limestone that is microgranular to finely granular, glauconitic, crinoidal, and contains interbeds of greenish gray shale and mudstone. Younger units in this interval were not cored.

3 Anvil Rock Sandstone and Lawson Shale The succession coarsens upward from shale at the base to sandstone at the top. Dark gray, fissile, silt-free shale in the lower part contains siderite bands and nodules, disseminated pyrite, and pectenoid pelecypods. This grades upward through silty shale and siltstone to sandstone that is very fine to medium grained, laminated, and burrowed.

4 Brereton Limestone Limestone, medium-dark to dark gray, lime mudstone to wackestone with brachiopods, crinoids, bivalves, gastropods, fusulinids, and phylloid algae. Bedding is commonly wavy to strongly rolling, with dark shaly bands separating layers.

5 Anna Shale Shale, grayish black to black, hard, highly fissile, pyritic, commonly contains phosphatic laminae and lenses. Fossils include brachiopods *Lingula, Orbiculoidea, Composita,* and *Crurythyris*; the bivalve *Aviculopecten*; gastropods, cephalopods, bryozoans, shark remains (*Petrodus*), and plant fragments.

6 Energy Shale Shale, siltstone, fine-grained sandstone. Away from the Walshville channel, the unit is largely medium to dark gray, gray, slightly silty to silt-free shale that is weakly to moderately fissile and contains numerous siderite bands and nodules. Closer to the channel, silty shale, siltstone, and sandstone become more prevalent. These rocks display planar, ripple, and cross-lamination along with common slumped lamination. Palmer and Dutcher (1979) reported a variety of fossil land plants along with scattered arthropods, crustaceans, and the branchiopod *Leaia tricarinata*.

Carbondale Formation

7 Herrin Coal and Walshville channel deposits Coal with shale and mudstone laminae and interbeds. Away from the Walshville channel, the coal is dominantly bright banded and contains varying amounts of pyrite in the form of laminae, lenses, and cleat facings. The only conspicuous clastic layer is the "blue band," 1 to 3 inches thick and 1.5 to 2 feet above the base. Approaching the channel from both sides, the blue band thickens to at least several feet and may exceed 20 feet thick in places. Additional laminae and interbeds of dark gray shale and claystone enter proximal to the channel. In places, the Herrin Coal expands to 30 feet or thicker with the introduction of major "splits" of shale and siltstone. Within the axial area of the channel, the coal is absent or reduced to stringers that probably represent rafted mats of peat. The Walshville channel contains a complex assemblage of valley-fill deposits that underlie and occur lateral to the Herrin Coal. The lower part of the Walshville is dominantly sandstone that truncates underlying strata as deep as the Hanover Limestone (Unit 14). At the level of the Herrin Coal, the channel deposits are finer grained, largely shale and siltstone.

8 Claystone and limestone Directly below the Herrin Coal is claystone (underclay) that is 2 to 5 feet thick, olive to greenish gray, massive to blocky, and thoroughly slickensided. The upper part exhibits stigmarian root casts; the lower part is typically calcareous and bears nodules of limestone, siderite, and pyrite. Contact is gradational to the limestone, which is 5 to 12 feet thick and mottled light to medium brownish gray, largely micritic, and sparsely fossiliferous. The upper part has a nodular or "cobbly" structure with matrix of greenish gray mudstone. The lower part becomes more massive and less argillaceous, and contains brachiopods.

9 Canton Shale Varying proportions of gray shale, siltstone, and fine-grained sandstone that coarsen upward overall. Dark gray shale at the base contains razor clams, *Lingula*, and a variety of articulate brachiopods.

10 St. David Limestone Less than 1 to about 2 feet thick and generally dark gray, argillaceous lime mudstone to wackestone with brachiopods, corals, and crinoid fragments. In places, it grades to calcareous shale, containing lenses of limestone.

11 Turner Mine Shale and Dykersburg Shale The Turner Mine (younger) is black, fissile shale similar to the Anna Shale (Unit 5). Spheroidal carbonate concretions as large as 3 feet across are common. "Hash" of pyritic shell debris may occur at the base. The Dykersburg is a lenticular unit of medium to dark gray, slightly to moderately fissile, carbonaceous, and contains small brachiopods along with poorly preserved plant remains.

12 Springfield Coal Dominantly bright-banded coal, lacking consistent clastic partings. Sulfur content (largely in the form of pyrite) is relatively high. Contacts are sharp.

13 Unnamed interval Comprises rooted and slickensided claystone (underclay) overlying gray shale, siltstone, and sandstone that coarsen upward. Sandstone is very fine to medium grained and contains laminae and thin interbeds of shale. Siderite bands and nodules and silt-filled burrows occur in dark gray shale near the base of the interval.

14 Hanover Limestone Limestone is medium to dark gray, argillaceous lime mudstone to wackestone containing a variety of fossils, including articulate brachiopods, gastropods, pelecypods, ostracods, and rugose corals.

15 Excello Shale The shale is characteristically black, hard, and fissile, although the upper part can be dark gray, soft, and weakly fissile. Large dolomitic septarian concretions are present, as are pyrite lenses. Fish scales, bivalves, brachiopods, and conodonts have been noted in cores.

16 Houchin Creek Coal The coal is bright-banded coal, pyritic, and lacks clastic layers.

17 Unnamed interval Below the coal is well-developed underclay as thick as 6 feet, composed of light to medium gray claystone to silty mudstone that is soft, slickensided, and rooted. The remainder of the interval generally coarsens upward from shale in the lower part to sandstone in the upper part. Sandstone can be thin- to thick-bedded and laminated to cross-bedded, grading downward to siltstone and silty shale. The lower part of the interval is dark gray shale that contains little or no silt. Siderite bands and nodules and scattered plant fragments are present.

18 Survant Coal Bright-banded coal with fusain and pyrite laminae, no significant clastic layers. Normal thickness averages around 2 feet. In a drill core near the northwest corner of the quadrangle, the Survant is more than 7 feet thick and occurs at the base of a channel eroded within 10 feet of the Colchester Coal.

19 Unnamed interval This is a variable succession of shale, siltstone, and sandstone. Some logs show an upward-coarsening sequence, whereas others indicate a fining-upward sequence in the upper part with an erosive lower contact. Underclay is weakly developed; some cores indicate merely root traces in sandstone or siltstone beneath the Survant.

20 Oak Grove Limestone Cores show medium gray, argillaceous lime mudstone to wackestone that contains brachiopods, bivalves, and crinoid fragments. The limestone is separated from the Mecca Quarry Shale by several feet of dark gray, laminated clay shale that contains siderite nodules. The limestone can be distinguished on some electric logs.

21 Mecca Quarry Shale Shale is black, hard, fissile, and contains small lenses and laminae of phosphatic minerals and of fossiliferous limestone. A "hash" of broken brachiopod and bivalve shells occurs at the base.

22 Colchester Coal Bright-banded, pyritic coal without significant clastic layers.

23 Unnamed interval Rooted mudstone at the top grades downward to siltstone or very fine sandstone that shows planar and ripple lamination. This in turn grades through siltstone to shale that is dark gray, silty, sideritic, and lacks fossils. Some logs indicate sandstone that fines upward from an erosive lower contact.

24 Dekoven Coal Coal may be bright to dull banded and in places is "split" into two beds separated by shale and siltstone as thick as 15 feet.

25 Unnamed interval The interval is largely gray shale and siltstone, overall coarsening upward. Cores show siderite nodules, fish remains, and *Lingula* in the lower portion.

26 Davis Coal Coal may be bright to dull banded and is 2.5 to 4 feet thick.

Tradewater Formation

27 Unnamed interval This is a variable succession of shale, siltstone, and sandstone. Sandstone is a light gray, very fine to medium-grained lithic arenite that contains laminae and partings of dark gray shale.

28 Carrier Mills Shale The shale is black, hard, and fissile. Thin shaly coal locally occurs at the base.

29 Claystone Gray to green (typical), massive to blocky, slickensided, and contains carbonate and siderite nodules.

30 Stonefort Limestone Medium to dark gray, argillaceous lime mudstone to fossiliferous wackestone. Where thin, changes to limestone nodules in a claystone matrix.

31 Older strata Reliable core records and lithologic logs of this interval are lacking. Lithologies depicted on the graphic column have been interpreted from electric logs and well cuttings. Several coal seams are present but most are thin. However, the Murphysboro Coal Member attains a thickness of 7 feet.

Introduction

This map shows the distribution of bedrock units that underlie Quaternary surficial deposits in the De Soto Quadrangle. Rock outcrops are few and small, found mostly in the southern part of the map area. Quaternary sediments are thicker than 120 feet in places along the preglacial valley of the Big Muddy River. This buried valley enters the quadrangle in the same area as the present river. Near the center of the map area, the buried valley turns sharply to the south, exiting near Glendale School and passing beneath the western outskirts of Carbondale.

Boreholes were the primary source of information on geology of the De Soto Quadrangle. Coal-test borings are heavily concentrated in the northern and eastern parts of the quadrangle, where the Herrin and Springfield Coals were mined. Some of these records include cores described by Illinois State Geological Survey (ISGS) geologists. Some of the oil and gas test holes have geophysical and sample logs that provide information on deeper strata. Borehole information is sparse in the southern half of the quadrangle. Maps of underground coal mines are another useful source of data, as are field notes made by ISGS geologists who visited the mines while they were active.

Splits and Channels in the Herrin Coal

Features that have a major impact on mining the Herrin Coal occur in the De Soto Quadrangle. These are the Walshville channel, a belt of split coal, and the Gimlet channel. All three are indicated on the map and illustrated in Figure 1.

The Walshville channel is the course of a river that existed prior to and during accumulation of the Herrin peat (Johnson 1972; Allgaier and Hopkins 1975). Within the channel, the Herrin Coal is largely replaced by shale, siltstone, and sandstone. The channel follows a sinuous course more than 200 miles from south of Champaign, Illinois to the De Soto Quadrangle, where it reaches the outcrop. In the De Soto Quadrangle, the belt of thin or absent coal varies from about 6,000 to 9,000 feet wide. Arbitrarily, the border of the channel has been drawn where the coal is less than 3 feet thick, but in many places the coal is entirely absent. In places, the deeper part of the Walshville cuts out the Springfield Coal. The Herrin Coal may be intact above eroded Springfield, signifying lateral migration of the channel (Fig. 1).

Bordering both sides of the Walshville channel are belts of coal that are "split" with layers of shale and mudstone. A prominent and extremely widespread mudstone layer in the Herrin Coal is the "blue band," which is commonly found about 2 feet above the base of the seam and throughout the map area. Away from the channel, the blue band is less than 3 inches thick. Approaching the channel, it gradually thickens to one foot or more. This thickening of the blue band recently was observed underground in the Royal Falcon Mine, less than a mile north of the map area. Close to the channel margins, additional shale and mudstone layers appear above and below the blue band. In some cases, more than half the thickness of the seam is shale and mudstone. Isolated pods of coal found within the Walshville channel may represent floating mats of peat (Fig. 1).

The Gimlet channel is the course of a younger river that eroded through the Herrin Coal long after the parent peat was buried. The channel runs north–south and is 2,000 to 3,000 feet wide. As shown by data from wells north of the De Soto Quadrangle, the Gimlet eroded down from the level of the underclay of the Rock Branch Coal, which lies 30 to 45 feet above the Piasa Limestone. The fact that the Gimlet channel is superimposed on the Walshville suggests structural control by faults at depth.

Geologic Structure and Faults

The De Soto Quadrangle lies near the southwestern margin of the Illinois Basin, bordering the northeast flank of the Ozark Dome. Regionally, strata dip toward the northeast, toward the deepest part of the basin. Structure on the map is portrayed by elevation contours on the top of the Herrin Coal. These show that the coal dips generally northeast at an average rate of 30 to 40 feet per mile, which is a fraction of one degree of dip. Unfortunately, not enough data are available to draw accurate contours on any horizon below the Herrin in the southern part of the quadrangle.

The Cottage Grove Fault System crosses the northeastern part of the De Soto Quadrangle. The system comprises a "master fault" trending slightly north of west and many "subsidiary faults" that strike north-northwest (Nelson and Krausse 1981). The fault system is mapped on the basis of observations in underground coal mines and, in a few places, by closely spaced borehole data. The master fault crosses the northeast corner of the map area. The coal is downthrown northeast of the master fault, but the dominant movement is believed to have been strike-slip, in a right-lateral sense (Nelson and Krausse 1981). Several subsidiary faults of the Cottage Grove Fault System have been traced from maps of underground mines. Although details are lacking, most such faults are high-angle normal faults, and displacements are in the range of 10 to 20 feet.

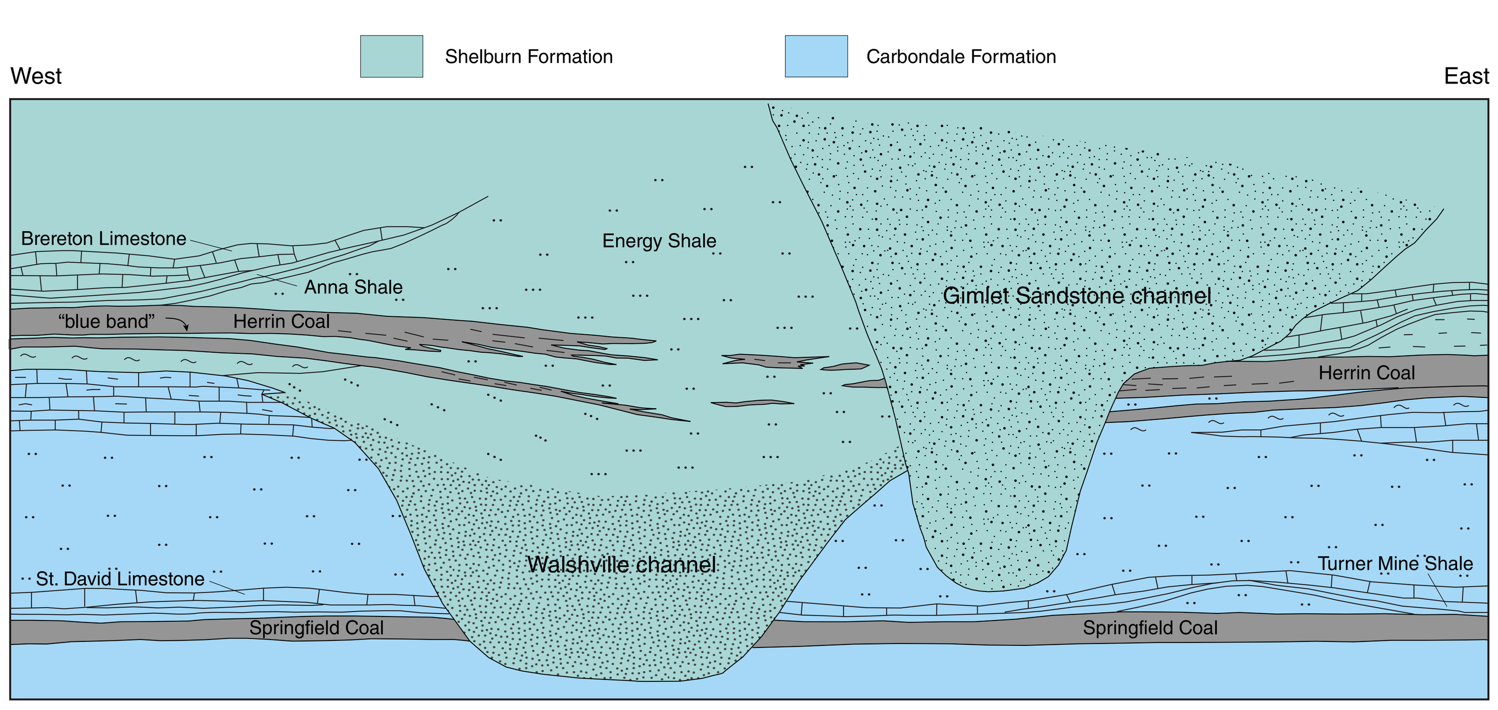


Figure 1. Generalized diagram showing splitting of the Herrin Coal, Walshville, and Gimlet channels.

Economic Geology

Coal

A major economic activity for more than a century, coal mining in the De Soto Quadrangle has wound down because the easily mined reserves are largely exhausted. The earliest mining on record took place beginning in 1881 at the Big Muddy Coal and Coke Company, a shaft mine 2 miles north of De Soto. Underground mining continued until 1965, when the Truax-Traer Coal Company's Burning Star underground mine closed. Virtually all these mines extracted the Herrin Coal, which ranged from 6.5 feet to more than 12 feet thick. Surface mining began in 1925 and continued through 1989; one small mine operated from 2001 to 2004. The largest surface mine was Consolidation Coal Company's Burning Star No. 5 mine, which worked both the Herrin and Springfield Coals from four separate pits (Palmer and Dutcher 1979; Obrad and Chenoweth 2008).

The Herrin Coal is essentially mined out in the De Soto Quadrangle. Thick "splits" of shale and mudstone along with channels that partially or completely remove the Herrin inhibited mining in the north-central part of the map area. Other areas of coal have been left unmined because thick, water-saturated overburden along the Big Muddy and Little Muddy Rivers precludes surface mining, and cover of competent bedrock is too thin for underground operations.

Although most of the shallow, strippable Springfield Coal has been taken, this seam could be mined underground beneath many square miles in the northern and eastern part of the quadrangle. Coal thickness ranges from 3 to nearly 5 feet; sulfur content is relatively high, at 3% to 5%. As in other areas of the basin, the black, fissile Turner Mine Shale and St. David Limestone provide a moderately competent roof for underground mining. Lenses of gray Dykersburg Shale tend to be less competent roof rock than the black shale.

The Houchin Creek Coal is at or near the surface along a northwest-trending line from McKinney Hill to Indian Hill. Consistently close to 2 feet thick, this seam was worked from three small drift mines during or prior to the 1930s (H.R. Wanless, 1931 ISGS field notes). Potentially, the Houchin Creek could be mined at the surface along with the Survant Coal, which also averages about 2 feet thick and is 20 to 30 feet below the Houchin Creek.

The Murphysboro Coal underlies the entire map area, except for a small area to the southwest where the coal was eroded by the ancestral Big Muddy River. This seam ranges up to 8 feet thick and formerly was mined extensively in the vicinity of Murphysboro (Jacobson 1983; Jacobson et al. 2007) and Carbondale (Nelson 2013). So far as is known, the Murphysboro has not been prospected or mined in the De Soto Quadrangle. Electric logs of oil-test holes indicate that in the northern half of the map area, the Murphysboro is less than 3 feet thick and may be absent. Two records in the southern part of the quadrangle show the coal to be 6 to 7 feet thick, ample for underground mining. These holes are the Ervin Sullivan #1 Halliday in Sec. 2, T9S, R1W and the Monjeb Minerals #1 Morris hole in Sec. 25, T8S, R1W. The Halliday well has an electric log and a sample log made by the author, showing coal about 7 feet thick at a depth of 301 feet. In the Morris hole, the density log unequivocally identifies a coal bed 6 to 7 feet thick at a depth of 432 feet.

Palmer and Dutcher (1979, p. 96–104) described many features of the Herrin Coal, Walshville channel, and Gimlet Sandstone as formerly exposed in the Burning Star No. 5 surface coal mine. However, these authors misidentified the Gimlet Sandstone as the older Anvil Rock Sandstone.

Oil and Gas

Eighteen test holes for oil and gas have been drilled in the De Soto Quadrangle (Table 1). All were dry and were abandoned. The deepest formation tested was the Mississippian St. Louis Limestone. Shows of oil were reported in five wells. Formations that yielded shows of oil insufficient for commercial production were the Tar Springs, Cypress, Aux Vases, and Ste. Genevieve, all of Mississippian age.

The nearest oil production is from Middle Devonian limestone in the Vergennes oil field, about 3 miles northwest of the De Soto Quadrangle. The trap at Vergennes is an anticline immediately south of the Cottage Grove master fault (Nelson and Krausse 1981; Jacobson and Denny 2007). Several producing fields are east of the De Soto Quadrangle in Williamson County. The Cypress, Aux Vases, Ste. Genevieve, and other Mississippian units serve as reservoirs in those fields (Nelson 2007a, 2007b).

Table 1. Petroleum tests in the map area

County number	Operator	Lease	Sec.	Total depth (feet)	Formation at bottom	Logs
Jackson County, T7S, R1W						
860	L & W Drilling	#1 Martha Williams	33	2,319	Ste. Genevieve?	Driller's
Jackson County, T8S, R1W						
1472	J.L. Lester	#1 Western Coal	1	2,527	St. Louis	Electric
1056	Charles Mercer	#1 Williams	9	2,300	Waltersburg	Driller's
1381	Warren & Potsch	#1 Harris	10	2,127	Aux Vases	Electric
1057	Calvert	#1 Heiple	10	2,382	Ste. Genevieve	Electric
1058	Nash Redwine	#1 Heiple	10	2,352	Ste. Genevieve	Electric
1387	Calvert	#1 Shirley	10	2,180	Aux Vases	Electric
1533	Kuzmich	#2 Missouri Imp.	11	2,331	Aux Vases	Electric
1522	Kuzmich	#1 Missouri Imp.	12	2,423	Ste. Genevieve	Electric
1535	Jack Stapp	#1 Levy Estate	13	2,920	No data	None
1518	Jack Stapp	#2 Wilfong	13	2,503	Ste. Genevieve	None
1479	Jack Stapp	#1 Wilfong	24	2,505	Ste. Genevieve	Composite
22748	Monjeb Minerals	#1 Morris	25	2,400	Ste. Genevieve	Electric and gamma ray-density
Jackson County, T9S, R1W						
1172	Ervin Sullivan	#1 Holliday	2	2,299	St. Louis	Electric and sample
1181	Barton & Shipman	#1 Hall	8	2,055	Ste. Genevieve	Driller's
Williamson County, T8S, R1E						
2225	D.T. Drilling	#1 Western Coal	6	2,493	Ste. Genevieve	Electric
2293	Jack Stapp	#1 Missouri Imp.	7	2,468	Ste. Genevieve	Electric (partial)
1947	Cities Service	#1 Western Coal	7	2,514	St. Louis	Electric

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