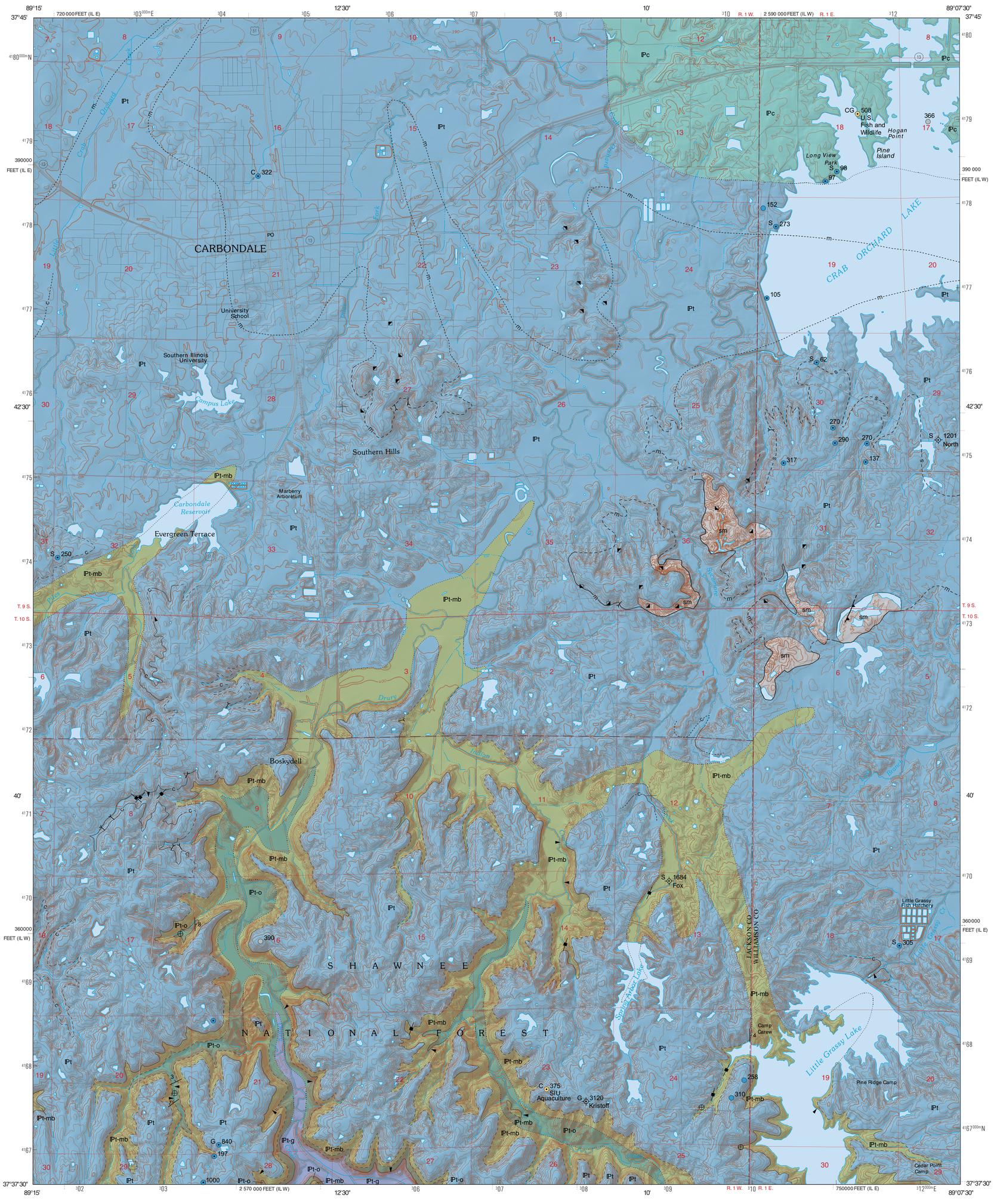
BEDROCK GEOLOGY OF CARBONDALE QUADRANGLE
JACKSON AND WILLIAMSON COUNTIES, ILLINOIS

Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

W. John Nelson
2013

Illinois Geologic Quadrangle Map
IGQ Carbondale-BG



EXPLANATION

- Holocene
  - sm — Surface mine
  - Pc — Carbondale Formation (Desmoinesian)
- Pennsylvanian
  - Pt — Tradewater Formation (Desmoinesian)
    - s, Stonefort Limestone Member
    - m, Murphysboro Coal Member
    - c, Curlew Member
  - Pt-mb — Murray Bluff Sandstone Member (Atokan)
  - Pt-o — olive shale member (Atokan)
  - Pt-g — Grindstaff Sandstone Member (Atokan)

Symbols

- 40 — Strike and dip of bedding; number indicates degree of dip
- Horizontal bedding
- Vertical joints
- Shaft mine
- Slope mine
- Drift mine
- Outcrop of special note, shown where contact or map unit was well exposed at time of mapping

Drill Holes
from which subsurface data were obtained

- Stratigraphic test boring, continuously cored
- Water-well boring
- Coal-test boring
- Dry oil-test hole

SGC 109 Fox — Labels indicate samples (s), geophysical log (g), or core (c). Numeric labels indicate total depth of boring in feet. Label name indicates well name. Dot indicates location accurate within 100 feet.

Line Symbols
dashed where inferred, dotted where concealed

- Contact
- Thrust or reverse fault, sawteeth on upthrown side

Note: Well and boring records are on file at the ISGS Geological Records Unit and are available online from the ISGS website.

Base map compiled by Illinois State Geological Survey from digital data (Raster Feature Separates) provided by the United States Geological Survey. Topography compiled 1963. Planimetry derived from imagery taken 1993. PLSS and survey control current as of 1996.

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

Recommended citation:
Nelson, W.J., 2013, Bedrock Geology of Carbondale Quadrangle, Jackson and Williamson Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Carbondale-BG, 2 sheets, 1:24,000.

SCALE 1:24,000

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. John Nelson, 2000–2001.

Digital cartography by Jane E. Johnshoy Domier and Trisha S. Rentschler, Illinois State Geological Survey.

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1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Murphysboro
2 De Soto
3 Herrin
4 Pomona
5 Crab Orchard Lake
6 Cobden
7 Makanda
8 Lick Creek

APPROXIMATE MEAN DECLINATION, 2013

ROAD CLASSIFICATION

- U.S. Route
- State Route
- Local road

Introduction

This map portrays the distribution of bedrock formations and members in the Carbondale Quadrangle as they would appear if all of the unlithified Quaternary sediments were removed. It is a companion to the map of surficial geology of the Carbondale Quadrangle (Nelson 2013b). Because glacial deposits cover much of the map area, much of the bedrock geology had to be deduced from borehole records or inferred and projected on the basis of information from scattered outcrops. This is particularly true in the northern part of the map area, where Quaternary deposits are thickest and several deep, buried preglacial valleys have been delineated.

Sources of Information
During the winter of 2000 and 2001, the author extensively traversed the Carbondale Quadrangle by automobile and on foot, focusing on areas most likely to yield rock outcroppings, such as river bluffs, ravines, and human-made excavations. Field notes of previous geologists, on public file at the Illinois State Geological Survey (ISGS), yielded much additional valuable information on rock exposures that no longer are accessible, including abandoned mines and areas not submerged by Crab Orchard and Little Grassy Lakes. Also housed at the ISGS are logs and samples from more than 200 boreholes, all of which were considered in making this map. Most useful were the sample studies and electric logs from oil and gas test holes and the detailed drillers' logs from more than 50 coal-test borings. Some water wells also have sample logs made by the author and other geologists. Other water-well and engineering logs provide little information on the bedrock beyond its depth, but this information is essential for an accurate projection of bedrock geology beneath the surface.

Finally, two stratigraphic test holes were continuously cored into bedrock. These are the U.S. Fish & Wildlife Service boring near the northeast corner of the map area and the Southern Illinois University (SIU) Center for Fisheries, Aquaculture, & Aquatic Sciences boring in the south-central part.

Previous Investigations
Shaw and Savage (1912) mapped the bedrock and surficial geology of the area that directly adjoins the Carbondale Quadrangle to the north. Lamar (1925) mapped the Carbondale 15′ Quadrangle, of which the present map is the northwest quarter. Desborough (1961) produced a geologic map and report on the Pomona 7.5′ Quadrangle adjacent to the west. Bedrock geologic maps of all surrounding 7.5′ quadrangles have been published or are in production.

Preglacial Valleys

Before southern Illinois was glaciated, several streams in the Carbondale area followed courses different from those of today. Many of these valleys were completely filled with glacial deposits. As the glaciers receded, streams in the area re-established themselves but, in many cases, could not find their former channels. Thus, they cut new ones—in some cases, cutting deep rock gorges through former ridges. Among the more significant buried preglacial valleys are these:

- A valley more than 150 feet deep beneath present Little Crab Orchard Creek is the former course of the Big Muddy River.
- The buried valley along Piles Fork was a southwest-flowing tributary of the Big Muddy. Present-day Piles Fork flows northeast.
- Drury Creek formerly joined Crab Orchard Creek at the site of Dogwood Road, and the combined streams turned northeast through the area of Lakewood School.
- Little Grassy Creek formerly flowed due north along the county line, and then turned west to join Indian Creek.
- Drury and Indian Creeks formerly meandered more strongly than they do at present.

A more complete discussion of preglacial drainages accompanies the map of Carbondale drift thickness (Nelson 2013a).

Structural Geology

The Carbondale Quadrangle is situated near the southwestern margin of the Illinois Basin, adjacent to the northeast flank of the Ozark Dome. Strata dip regionally northeast, from dome to basin. Limited data indicate that the Murphysboro Coal dips northeast at about 60 feet per mile in the northeast part of the present map area. In the southwestern part, the Murray Bluff Sandstone dips 65 to 70 feet per mile in the same direction. These dips amount to a little greater than a 1% gradient, or a dip of one half of a degree. Such a dip would be barely perceptible in the field, even in an area of continuous bedrock exposure such as the Grand Canyon.

Small and subtle folds were observed in a few areas of the Carbondale Quadrangle. For example, a small anticline or dome occurs along a ravine west of Drury Creek in the SE¼ NE¼, Sec. 17, T10S, R1W. This upward fold locally brings the olive shale member above drainage. Bedding dips of about 8° east were measured at the east line of Sec. 17. Bedding in the olive shale member dips as steeply as 7° northwest along a ravine in the NE¼ SE¼, Sec. 20. However, the overlying Murray Bluff Sandstone does not appear to share this structure. Minor folds such as these may be products of differential compaction or other nontectonic processes.

In May of 1977, the author observed a small reverse fault in the then-active Tab/Simco coal strip mine in the SW¼ SW¼ SE¼, Sec. 31, T9S, R1E. The fault appeared to strike north-northeast, dip 45°, and have about 6 feet of throw. Tim Gognat, then a student at SIU, observed another fault at the same mine. This was a normal fault striking northeast, dipping 60° northwest, and having a throw of 10 feet (Gognat, letter to Nelson 1977).

Both faults displaced strata overlying the Murphysboro Coal and did not affect the glacial sediments. Heinz Damberger of the ISGS (field notes 1970) mentioned small thrust faults repeating the coal in a pit located in the NE¼ SE¼ SW¼, Sec. 31, T9S, R1W. No details were provided.

A larger, concealed fault may lie near the eastern border of the Carbondale Quadrangle. The elevation of the Murray Bluff Sandstone is 50 to 100 feet higher in the southwestern part of the Crab Orchard Lake Quadrangle (Nelson 2007) than in the adjacent part of the Carbondale Quadrangle. The regional strike and dip of the sandstone is approximately the same in the two quadrangles. A fault running north and south, having the west side downthrown 50 to 100 feet, could account for the mismatch. Two north-trending faults of such magnitude occur in the Makanda Quadrangle, south of the present map area (Jacobson and Weibel 1993).

Joints are fairly common in bedrock throughout the map area. The most common trends are N 15°E to N 40°E with dips close to vertical. Spacing varies from less than an inch to many feet; joints tend to occur in swarms or clusters. Jointing locally influences topography, as in the linear north-northeasterly trending ravine west of Little Grassy Lake in the E½, Sec. 24. Several linear preglacial valley segments, including lower Drury Creek, Piles Fork, and the ancestral Big Muddy, parallel the prevalent joint trend.

Mineral Resources

Coal
Carbondale owes its name to coal, and mining was an important early industry. The first commercial mining in Illinois took place at Murphysboro, where barge loads of coal were sent downriver as early as 1810. In the Carbondale Quadrangle, mining was underway by 1890 and continued until 1977. Data on all the known mines have been compiled (Myers 2008).

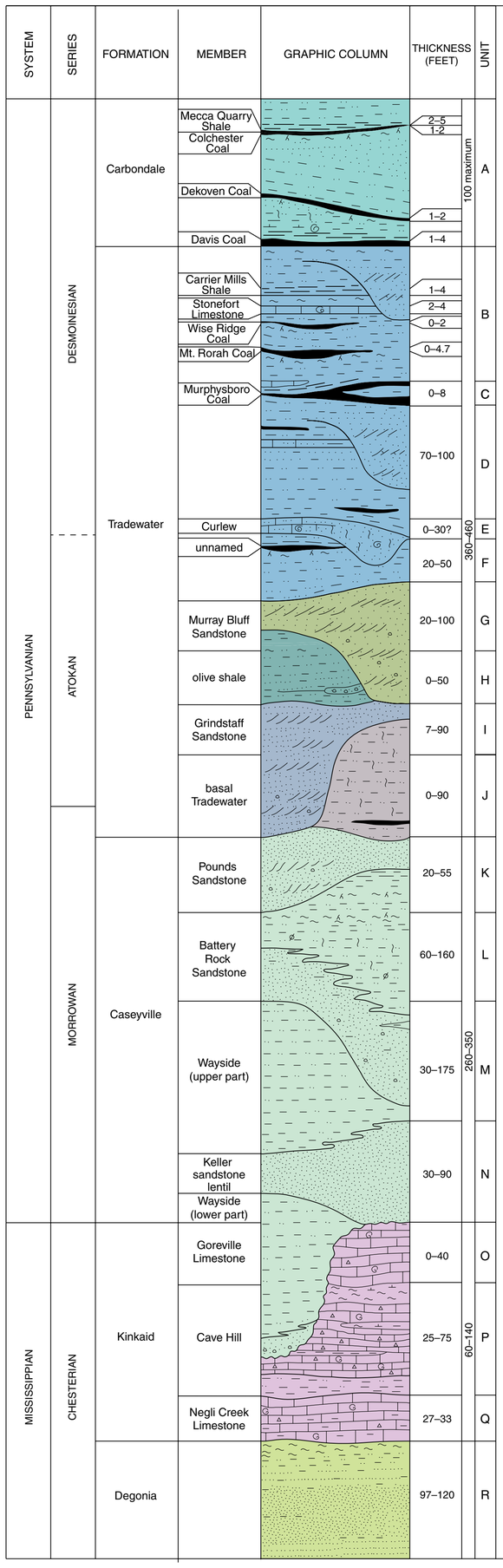
The main belt of mining extended through the hills east and southeast of the city. The Murphysboro Coal was the main target; some operations also worked the Mt. Rorah Coal. Until 1949, all mining took place underground via drifts, slopes, and shallow shafts. All of these were small operations, producing a few hundred to a few thousand tons of coal per year. Many operated intermittently, mostly during the winter months to serve local trade. The Murphysboro Coal undergoes abrupt changes in thickness and is commonly split by wedges of shale or mudstone. In many of the mines, the topography of the coal rolled strongly, which hampered underground haulage. In addition, the shale overlying the Murphysboro Coal was generally incompetent, so holding the mine roof in place was difficult. All these factors inhibited the development of large mines. The large operators gravitated to Murphysboro, Carterville, Herrin, Marion, and other locales where the coal deposits were consistently thicker and more predictable.

Surface mining displaced underground operations after World War II, but these also were small mines by Illinois standards. Using bulldozers, scrapers, and small shovels and draglines, the coal companies worked around the contours of hills and removed the Mt. Rorah and Murphysboro Coals. Most of this activity took place before the advent of reclamation laws.

Coal mining also took place on a very small scale in the vicinity of Boskydell, mostly in Sec. 8, T10S, R1W. These mines worked a coal bed approximately correlative with the Rock Island Coal, underlying the Curlew (Boskydell) Member. So far as is known, this bed does not exceed a thickness of 2½ feet. These mines were simply drifts or tunnels opened at the outcrop. It is likely that some were simply places where families dug coal for their own use during the Depression.

The likelihood of coal mining resuming in the Carbondale area is slight. All the known coal deposits are patchy, most of the easily mined coal has been taken, and rural areas are much more heavily populated today than they were during the early 20th century. Homeowners who buy or build in areas of past underground mining need to be aware of the hazards of surface subsidence. All mines for which data are available were mapped by Meyers (2008).

Oil and Gas
Eight test holes for oil and gas have been drilled in the Carbondale Quadrangle or within one mile of its borders (table 1). None of these achieved commercial production, although shows of oil were reported in three. The deepest test was the Kristoff in Sec. 27, T10S, R1W, which bottomed in the Lower Mississippian Fort Payne Formation at 3,120 feet.



A Carbondale Formation Shale, siltstone, sandstone, and coal. Confined to the northeast corner of the quadrangle, the Carbondale is known only from well logs. The only detailed record is that of the ISGS #1 U.S. Fish & Wildlife Service boring, which was cored continuously. The Carbondale Formation is 62 feet thick in this core and contains two named members, the Dekoven and Davis Coals. The Dekoven is 1.3 feet thick and consists of brightly banded coal having laminae of dark gray shale. The coal grades upward to carbonaceous shale that contains abundant fossil plants; this in turn grades upward to gray siltstone without fossils. The Davis Coal in the core is 3.7 feet thick and largely dully banded to canneloid. Overlying the coal is black shale 3.7 feet thick, which is calcareous and contains pelecypods near the top. The remaining interval between the coal beds coarsens upward from gray, silty shale to fine-grained sandstone that contains *Teichichnus* and other trace fossils. On the basis of projection from adjacent areas, the Carbondale Formation may reach 100 feet thick at the northern edge of the Carbondale Quadrangle and include the Colchester Coal and Mecca Quarry Shale Members.

B Unnamed interval Shale, mudstone, siltstone, sandstone, coal, limestone. At the top is unnamed sandstone that is commonly 20 to 40 feet thick. The sandstone is brownish gray in fresh exposures, weathering dark brown; it is fine- to medium-grained lithic arenite that contains abundant mica and interstitial clay. Planar and trough cross-bedding indicates paleocurrents toward the south and southeast. This sandstone has an erosive base that truncates underlying strata. Outcrops occur between Dogwood Road and the south shore of Crab Orchard Lake. The Carrier Mills Shale Member is black, hard, and thinly fissile or "slaty." Two to 8 feet below the Carrier Mills is the Stonefort Limestone Member, which is 1 to 4 feet thick. It is generally argillaceous lime mudstone to wackestone with brachiopods and echinoderm fragments. Outcrops were found in ravines between Spillway and Dogwood Roads, south of the lake. A short distance below the limestone is the Wise Ridge Coal Member, which varies from a streak to about 2 feet of brightly banded coal. The Mt. Rorah Coal Member is another 15 to 20 feet lower. This seam is less than 2 feet thick in most places, but it reaches 4 feet and was mined. The Mt. Rorah is brightly banded coal that commonly contains a thin interbed of shale or claystone near the middle. Distinguishing between the Mt. Rorah and the upper "bench" of split Murphysboro Coal can be problematic.

C Murphysboro Coal Member Coal with interbedded shale and mudstone. In most of the area southeast of Carbondale, the coal (as mined) was 4 to 6 feet thick and largely brightly banded, bituminous coal containing layers of carbonaceous shale and claystone. In some mines and boreholes, the seam is split into two "benches" by shale as thick as 10 feet. Data on the coal and enclosing rocks came from drilling records, mine maps, and extensive notes made by ISGS geologists while the mines were active.

D Unnamed interval Shale, siltstone, sandstone, thin coal, and limestone. This poorly exposed interval is largely known from well logs and samples, including the U.S. Fish & Wildlife Service core. In that core, the interval is largely sandstone that has a basal conglomerate layer and erosive lower contact. Contorted bedding reflects soft-sediment deformation. Other logs indicate an upward-coarsening succession that grades from gray, silty shale in the lower part to siltstone or shaly sandstone in the upper part. Two coal beds less than 2 feet thick are present, one near the base of the interval and the other about 20 feet below the top. Neither crops out, and there is no evidence of past mining. Several well logs and sample sets examined by the author indicate thin limestone or glauconitic, calcareous sandstone 20 to 30 feet beneath the Murphysboro Coal.

E Curlew (Boskydell) Member Hematitic sandstone to sandy and silty limestone. The sandstone typically is dark red to purplish brown, fine to coarse grained and poorly sorted, containing quartz granules and angular chips of shale and ironstone. It is more or less calcareous, in places grading to sandy limestone. Small crinoid stem segments are common; brachiopods, bryozoans, and rugose corals are less numerous. Other geologists (in ISGS field notes) reported gastropods, pelecypods, and a trilobite. Diverse trace fossils, many having marine affinities, are best exposed in the spillway of Little Grassy Lake (Devera 1989). Logs and samples of several wells in the northeastern Carbondale Quadrangle and adjacent Crab Orchard Lake Quadrangle indicate the member consists of limestone or sandy limestone. The U.S. Fish & Wildlife Service core revealed 6.1 feet of calcareous siltstone and sandstone, grading to silty limestone in the lower part. These rocks are thoroughly burrowed and contain scattered brachiopods and crinoid fragments. This unit was widely, but informally, known as the Boskydell sandstone or marine zone, based on excellent exposures along ravines west of that village. Seid et al. (2007) found that the Curlew Member fills channels eroded into underlying strata. Channels cannot be demonstrated in the Carbondale Quadrangle, but the Curlew Member is discontinuous. Correlation with the Curlew Limestone of western Kentucky is based on conodonts (Rexroad et al. 1998) and palynology of adjacent coal beds (Peppers 1993).

F Unnamed interval Shale, mudstone, siltstone, thin-bedded sandstone, coal. Shale and siltstone are light to dark gray and commonly interlaminated, showing rhythmic tidal lamination in places. Mudstone is gray to olive gray, is nonfissile, and exhibits root traces. Sandstone is light to medium gray, very fine to fine grained, and laminated to thinly bedded. Fossils include plant foliage and stems, large casts of lycopods and calamites, the trace fossil *Lockeia*, and simple horizontal burrows. An unnamed coal seam as thick as 3 feet was mined from numerous shallow drifts near Boskydell during the late 19th and early 20th centuries. Palynology indicates that this bed is approximately equivalent to the Rock Island Coal Member of late Atokan age (Peppers 1993). This interval erodes to gentle slopes and is poorly exposed; the U.S. Fish & Wildlife Service core provides a complete record.

G Murray Bluff Sandstone Member Sandstone. The rock is light gray to buff on fresh surfaces; weathered outcrops commonly are heavily encrusted with iron oxide. Generally, it is fine to medium grained and well sorted, having subrounded to subangular grains. Composition varies from sublitharenite to borderline quartz arenite and is predominantly quartz with roughly 5 to 25% weathered feldspar, lithic fragments, mica, and interstitial clay. Grain size commonly becomes finer upward and the bedding becomes thinner. Conspicuous in many outcrops is tabular cross-bedding in sets as thick as 8 feet, dipping mostly south to southwest. The upper Murray Bluff exhibits cross-bedding that is thinner and more variably oriented, along with ripple marks and small-scale cross-lamination. The lower contact is erosional and commonly marked by a basal conglomerate of quartz, shale, and siderite pebbles. The upper contact generally is gradational. This unit forms prominent cliffs and ledges, especially along Indian Creek and Drury Creek. The thickness is 80 to 100 feet across most of the outcrop belt, except near Giant City State Park, where the unit thins to 20 feet. The Murray Bluff is identified on the basis of lithology and the palynology of adjacent coal beds (Peppers 1993).

Geologic Features
- Fossil roots
- Marine fossils
- Siderite nodules
- Chert nodules
- Burrows
- Black fissile shale
- Nonfissile mudstone, underclay

H Olive shale member (informal) Shale, siltstone, thin-bedded sandstone, minor coal and conglomerate. Shale varies from medium gray to grayish black; most of it is silty (grading to siltstone) and well laminated. Siltstone is mostly light to medium gray and displays planar, wavy, and rippled lamination. Sandstone is light gray to buff, very fine to fine grained, and laminated to thinly bedded. It commonly shows ripple and cross-lamination. Lenses of conglomerate composed of quartz and ironstone pebbles in a sandstone matrix were observed in two or three places. The core from the U.S. Fish & Wildlife Service borehole contains a coal bed 0.8 foot thick believed to belong to this interval. A coal bed as thick as 2.5 feet was formerly mined within this interval immediately south of the Carbondale Quadrangle. This coal was correlated approximately with the Smith coal bed of western Kentucky on the basis of palynology (Jacobson and Weibel 1993). The olive shale member is poorly exposed; no continuous outcrops were found. The upper contact is erosional; the unit is absent in the SIU Center for Fisheries, Aquaculture, & Aquatic Sciences core. Nelson et al. (1991) named the olive shale member informally in southeastern Illinois. Devera (1989) described marine trace fossils attributed to this unit.

I Grindstaff Sandstone Member Sandstone. The rock is light gray, weathering light brown to yellowish gray, and largely fine to medium grained and well sorted. Scattered coarse sand grains and small quartz granules are present locally. The sandstone is, or approaches, quartz arenite, containing less than 10% mica and other lithic fragments and minor interstitial clay. The bedding is thin to thick, with prominent wedge-planar and tabular-planar cross-bedding that dips south to southwest. Grain size and bedding thickness tend to decrease upward. The lower contact is erosional, whereas the upper contact is gradational. The sandstone erodes to bold, rounded cliffs and steep ledges that are commonly honeycombed and encrusted with Liesegang bands. The scenic bluffs in Giant City State Park are composed of this sandstone. This unit appears to correspond to the lower part of the Makanda Sandstone of Lamar and was incorrectly mapped as Pounds Sandstone (Caseyville Formation) by Desborough (1961). In the Makanda Quadrangle, Jacobson and Weibel (1993) mapped this unit as an unnamed sandstone lentil in the lower part of the Tradewater Formation. Correlation with the Grindstaff Sandstone Member of southeastern Illinois is based on characteristic lithology and stratigraphic position; direct continuity cannot be demonstrated. The Grindstaff Sandstone Member appears to represent fluvial sediments deposited in incised valleys. The sandstone is less than 10 feet thick in the U.S. Fish & Wildlife Service core.

J Basal Tradewater interval Shale, siltstone, thin-bedded sandstone. This interval (and everything below) occurs entirely in the subsurface, cropping out just south of the study area in the Makanda Quadrangle. The only detailed record is in the U.S. Fish & Wildlife Service core, where the interval is 90 feet (27 m) thick and consists of interlaminated dark gray shale and light gray, very fine- to fine-grained sandstone. Lamination is planar to wavy and rippled, with possible tidal rhythmites. A variety of trace fossils are present, including simple horizontal burrows, *Teichichnus*, *Asterosoma*, and *Conostichus*. The latter three have marine affinities (Devera 1989). In the SIU Center for Fisheries, Aquaculture, & Aquatic Sciences core, the basal Tradewater shale is absent because the Grindstaff Sandstone directly overlies the Pounds Sandstone. Outcrops in Giant City State Park immediately south of the map area show interlaminated shale and sandstone, and a coal bed that locally reaches 2 feet thick.

K Pounds Sandstone Member (Caseyville) Sandstone is white to light gray, very fine- to medium-grained quartz arenite with uncommon quartz granules. The SIU Center for Fisheries, Aquaculture, & Aquatic Sciences core shows thin to thick bedding and cross-bedding; a thin conglomerate of shale, siltstone, sandstone; and coal clasts in the lower part. The grain size and bedding thickness generally decrease upward from erosional lower contact.

L Battery Rock Sandstone Member (Caseyville) Shale, mudstone, siltstone, sandstone. Overall, an upward-fining sequence that grades from shale at the top to sandstone at the base. Dark gray to black, carbonaceous shale containing fossil plants occurs at the top. The SIU Center for Fisheries, Aquaculture, & Aquatic Sciences core shows two or three paleosols of nonfissile, slickensided mudstone that has a brecciated texture and contains root traces. Downward, the core reveals interlaminated dark gray shale and light gray sandstone with planar, ripple, and cross-lamination and well-defined tidal rhythmites. These rocks are borrowed and contain siderite nodules. The lower part of the sequence is sandstone, similar in lithology to the Pounds Sandstone. The lower contact is erosive.

M Wayside Member (Caseyville) Shale, siltstone, and sandstone. This unit is quite variable, but the upper part generally coarsens upward from dark gray shale in the lower part to very fine-grained, shaly sandstone in the upper part. Samples from the Holliday oil test, just north of the map area, record basal sandstone less than 5 feet (1.5 m) thick overlain by upward-coarsening shale and siltstone 170 feet (51 m) thick. This well was drilled into a sub-Pennsylvanian paleovalley.

N Keller sandstone lentil (Caseyville) Sandstone is similar in lithology to the Pounds and Battery Rock Sandstone Members. Quartz granules commonly are present. Shale interbeds occur in the upper part. The Keller is well developed on an outcrop in the Makanda Quadrangle (Jacobson and Weibel 1993) and is indicated by most well logs as being in the Carbondale Quadrangle. It is a lenticular unit within the Wayside Member, evidently filling incised valleys. The lower contact is unconformable on Mississippian limestone in many places.

O Goreville Limestone Member (Kinkaid) Limestone in well cuttings was described as mottled light to dark brownish gray, coarse grained, and fossiliferous. Typically in this part of Illinois, the Goreville Limestone Member is largely light gray, coarse crinoidal grainstone that contains little chert and few shale interbeds. The lower contact is sharp.

P Cave Hill Member (Kinkaid) Limestone, dolomite, shale, mudstone. The Cave Hill Member is subdivided into upper mudstone, middle carbonate, and lower shale. The upper mudstone is 8 to 15 feet (2.4 to 4.6 m) thick, nonfissile, and variegated in red, green, and gray. Calcareous shale and thin lenses of limestone may occur at the top. The middle interval, as thick as 55 feet (17 m), comprises limestone of varied texture along with lesser dolomite and shale interbeds. Much of the limestone is dense, sublithographic lime mudstone containing bands and lenses of dark gray vitreous chert. The lower shale of the Cave Hill Member is gray to greenish gray, silty, laminated, and calcareous. The contacts are sharp.

Q Negli Creek Limestone Member (Kinkaid) Limestone is mostly medium to dark gray to brownish gray, fossiliferous lime mudstone and wackestone. It is argillaceous and moderately cherty. The upper part may include lighter colored packstone and grainstone. Brachiopods, gastropods, and echinoderm fragments are plentiful. This is a highly consistent marker unit. Both contacts are sharp.

R Degonia Formation Sandstone, siltstone, shale, and mudstone. The upper 10 to 20 feet (3 to 6 m) normally include variegated red, green, and gray nonfissile mudstone that changes downward to gray, laminated silty shale and siltstone. The remainder of the Degonia Formation is sandstone that is white to light yellowish and brownish gray, very fine to fine-grained, well-sorted quartz arenite with subrounded to subangular grains. The cement is silica and calcite. The lower contact is sharp and, in some cases, erosional.

Carbondale lies south of established oil and gas production. The closest producing wells are 10 to 15 miles north at Elkville, Vergennes, and Campbell Hill in Jackson County and 10 miles northeast near Energy in Williamson County.

On the one hand, the Carbondale area has not been properly tested for petroleum. Three of the eight holes stopped short of the Cypress Formation, which is the shallowest unit that commonly produces in southern Illinois. None reached the Devonian and older rocks that have yielded oil in many areas of the state. All were drilled more than 40 years ago, when exploratory and producing technology was far less advanced than it is today.

On the other hand, there is little to encourage further exploration. No surface indications are known of faults, anticlines, or other potential traps. Unless concealed traps are present, hydrocarbons likely have escaped updip to the surface along the Ste. Genevieve Fault Zone and flank of the Ozark Dome, about 12 miles southwest of Carbondale.

Groundwater
The Carbondale area is not well endowed with subsurface water. Originally, Carbondale obtained its water supply from drilled wells 400 to 600 feet deep. Lamar (1925, p. 163) wrote, "The water has a distinct taste, which is due to its mineralized character . . . from 1,205 to 2,472 parts per million of mineral matter, over half of which is common salt." Production rates of old city wells are not on record, but no well in the quadrangle is known to have yielded more than 50 gallons per minute. Carbondale long ago changed its municipal water supply from deep wells to a reservoir.

Drilled wells in the quadrangle generally produce enough water for domestic use. Most are completed in sandstone of the lower Tradewater and Caseyville Formations, at depths of 100 to 500 feet below the surface. Such wells typically yield 10 to 35 gallons per minute through 6-inch casing. Because the thickness, porosity, and permeability of Pennsylvanian sandstone are so variable, predicting where and how deep to drill is nearly impossible. One house may have a good well at 150 feet and the neighboring house may have a meager well at 400 feet. Drillers' logs do not provide enough information to map bedrock aquifers.

Table 1 Oil and gas test holes in and near the Carbondale Quadrangle.

County no.	Operator	Lease	Location	Depth in ft	Formation at T.D.[1]	Type of log(s)
Jackson County						
1172	Ervin Sullivan	#1 Holliday	2-9S-1W	2,299	St. Louis	Electric, sample
1181	Barton & Shipman	#1 Hall	8-9S-1W	2,055	Ste. Genevieve	Drillers'
1329	Big 4 Oil Co.	#1 Otis Fox	13-10S-1W	2,690	Salem?	Sample
1441	National Assoc.	#1 Kristoff	23-10S-1W	3,120	Fort Payne	Electric
1332	Wrightsman	#1 Bradley	27-10S-1W	1,264	Golconda	Drillers'
1335	Ohio Oil Co.	#1 Rendleman	27-10S-1W	852	Menard	Sample
Williamson County						
244	Wiswell et al.	#1 John North	29-9S-1E	1,320	Tar Springs	Drillers', sample
2000	Browning	#1 Hayton	32-9S-1E	2,060	Ste. Genevieve	Sample

[1]T.D., total depth.

Several landowners interviewed by the author complained of high iron content, which imparts rusty stains to laundry and plumbing, and of hydrogen sulfide, which smells of rotten eggs and corrodes pumps. Such problems seem to be most pronounced in wells that draw water from Murray Bluff and other middle Tradewater sandstone. These sandstone units are heavily impregnated with iron oxide where they crop out. Another problem is iron sulfide contamination from water flowing through coal seams and old mines. The Murphysboro Coal itself is an aquifer and contains water having a high salt content (Zehner 1966). Wells completed in the lower Tradewater and Caseyville sandstone seem to produce better quality water. The rocks themselves contain fewer contaminants and the recharge area is largely in the Shawnee National Forest.

Attempts to obtain quantities of water from drilled wells beyond the needs of a single household have generally been unsuccessful. A golf course, a church camp, the Little Grassy Fish Hatchery, and the SIU Center for Fisheries, Aquaculture, & Aquatic Sciences all were forced to give up on wells and use reservoir water. At the golf course, a well was drilled as deep as 1,350 feet without finding adequate supplies.

The Illinois State Water Survey in Champaign maintains records on groundwater quality throughout the state. As a free service to homeowners, the Water Survey conducts analyses for mineral content of well water. County health departments often offer free testing for bacterial contamination. For a fee, commercial laboratories carry out a wide range of water analyses.

Boskydell Sandstone Informal Name
An important building stone known as "Carbondale brown stone" was commercially quarried from about the 1850s to the 1920s. Quarry operations were located four miles south of Carbondale in the village of Boskeydell, Illinois, where sandstone from the Tradewater Formation was quarried for gravestones and dimension building stone. Boskeydell became an important stop on the Illinois Central Railroad, which shipped the sandstone to distant markets. Peak years of production at the quarries were between the 1870s and 1910, when John Rowle, building stone agent and broker in Chicago, promoted the sale of the sandstone. Many of the brownstone houses in Chicago come from Rowle's Carbondale Brown Stone Company. The sandstone product varied from reddish shades of brown to tan. Red and purple were favored for gravestones, whereas varying shades of brown made attractive patterns for commercial buildings, churches, and schools.

Acknowledgments

Brandon B. Curry, Joseph A. Devera, and David A. Grimley helped the author interpret outcrops in the field, described and sampled drill cores, and carried out laboratory analyses of samples from outcrops and boreholes. B. Brandon Curry reviewed an early draft of this report and provided many helpful comments, as well as adding information and references. Reviews by Scott D. Elrick, Joseph A. Devera, and Richard C. Berg further improved this document. Cartography was carried out by Jane E. Johnshoy Domier and Trisha S. Rentschler.

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