BEDROCK GEOLOGY OF VIENNA QUADRANGLE
JOHNSON COUNTY, ILLINOIS

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
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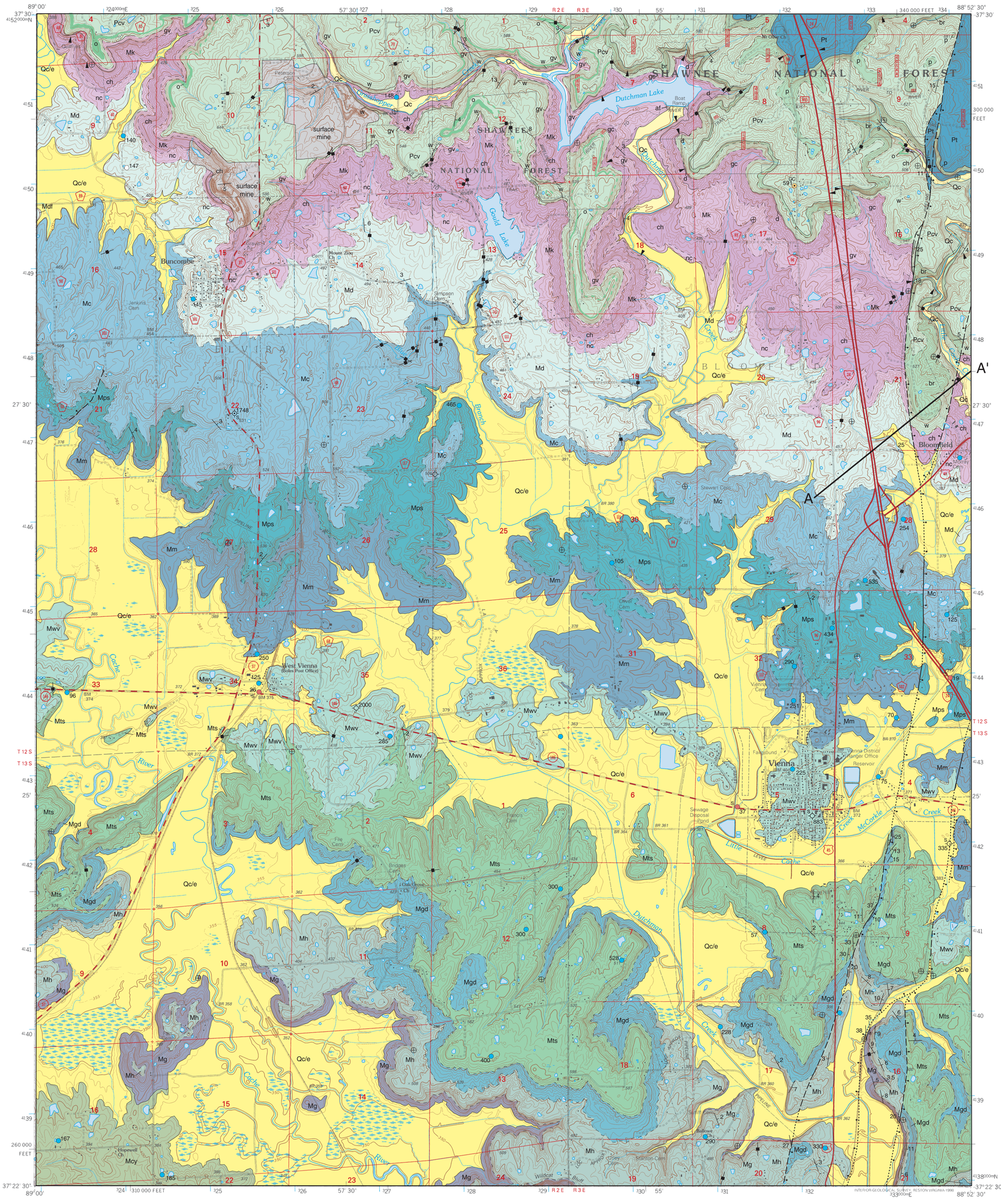
2004

Illinois Preliminary Geologic Map
IPGM Vienna-BG



EXPLANATION

Quaternary	Qc	Cahokia Formation	Holocene
	Qc/e	Cahokia Formation over Equality Formation	Pleistocene
		Unconformity	
	Pt	Tradewater Formation	Atokan
		Caseyville Formation	
Pennsylvanian	Pcv: p	Pounds Sandstone Member	
	Pcv: br	Battery Rock Sandstone Member	
	Pcv: w	Wayside Member	Morrowan
	Pcv: o	Omar sandstone lentil	
		Unconformity	
		Kinkaid Limestone	
	Mk: d	Dutchman Limestone Member	
	Mk: gc	Grove Church Shale Member	
	Mk: gv	Goreville Limestone Member	
	Mk: ch	Cave Hill Member	
	Mk: nc	Negli Creek Limestone Member	
	Md	Degonia Formation and Ford Station Member of Clore	
	Mc	Clore Formation, Tygett and Cora Members	
	Mps	Palestine Sandstone	
	Mm	Menard Limestone	Chesterian
	Mwv	Waltersburg Formation and Vienna Limestone	
Mississippian	Mts	Tar Springs Sandstone	
	Mgd	Glen Dean Limestone	
	Mh	Hardinsburg Sandstone	
	Mg	Golconda Formation	
	Mcy	Cypress Sandstone	
	Mlc	Lower Chesterian, undifferentiated (cross section only)	
	Msg	Ste. Genevieve Limestone (cross section only)	
	Mvu	Valmeyeran, undifferentiated (cross section only)	Valmeyeran

Symbols

- 40 — Strike and dip of bedding; number indicates degree of dip
- ⊕ — Horizontal bedding
- Vertical joints
- 80 — Dipping joints; number indicates degree of dip

Drill Holes
from which subsurface data were obtained. Numbers indicate total depth of boring in feet.

- 335 — Dry oil test hole
- 35 — Stratigraphic boring
- 210 — Water well
- 75 — Engineering boring
- SCG — Boring with samples (s), core(c), or geophysical log (G); dot indicates location accurate within 100 ft

Line Symbols
dashed where inferred, dotted where concealed

- Contact
- Normal fault: bar and ball on downthrown side
- A—A' — Line of cross section

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Topography compiled 1963. Planimetry derived from imagery taken 1993. Partial field check 1996.

North American Datum of 1983 (NAD 83)
Projection: Transverse Mercator
10,000-foot ticks: Illinois State Plane Coordinate system, east zone (Transverse Mercator)
1,000-meter ticks: Universal Transverse Mercator grid system, zone 16

Recommended citation:
Nelson, W. John, J. Hintz, F. B. Denny and J. A. Devera, 2004, Bedrock Geology of Vienna Quadrangle, Johnson County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Vienna-BG, 1:24,000.

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
SUPPLEMENTARY CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Released by the authority of the State of Illinois: 2004

Geology based on field work by W. J. Nelson, J. Hintz, F. B. Denny and J. A. Devera, 1997–2004.

Digital cartography by L. Verhelst, Illinois State Geological Survey.

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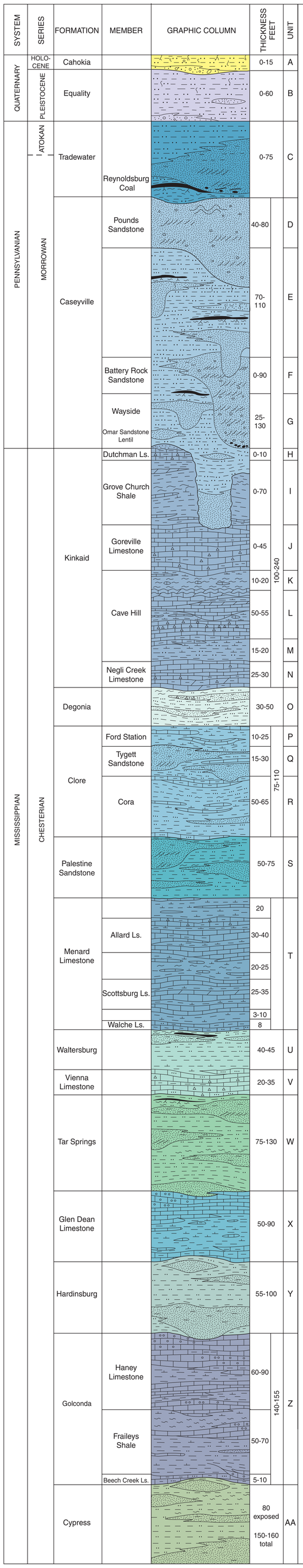
1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Lick Creek
2 Goreville
3 Creal Springs
4 Mount Pleasant
5 Bloomfield
6 Cypress
7 Karnak
8 Mermet

APPROXIMATE MEAN DECLINATION, 2004

ROAD CLASSIFICATION

- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Unimproved road
- 64 Interstate Route
- 161 U.S. Route
- 158 State Route
- 97 County Route



A Cahokia Formation Silt, sand, and gravel. In bottom lands the Cahokia is largely silt that is mottled in gray to brown and has indistinct bedding. Sand and gravel lenses are scattered, being more prominent at the base. In upland areas the Cahokia contains plentiful sand and fine gravel derived from weathered Pennsylvanian sandstone, angular chert fragments from Mississippian limestone, and blocks of sandstone derived from various bedrock units.

B Equality Formation Silt, clay, minor sand and gravel. Silt and silty clay, the prevalent lithologies, are largely mottled gray and brown, but some beds are orange to pink. These materials are partly calcareous and contain organic matter (largely plant material) and limonite spherules. Silt and clay may be laminated or massive. Sand and gravel occur as lenses and thin interbeds, mainly at the base of the unit. Description entirely from well records; there are no outcrops.

C Tradewater Formation Sandstone, shale, claystone, coal. Sandstone is white to light gray, very fine to fine-grained quartz arenite to sublitharenite, thin to thick-bedded, with trough crossbedding and lenses of shale and siltstone. Coal stringers and shale rip-up clasts occur near base; lower contact is erosional. Reynoldsburg Coal Member is 0 to 1.9 feet thick, bright banded with shale laminae and sandstone dikes. Below coal is claystone, gray and rooted; grading downward to laminated gray silty shale, total thickness 10 to 12 feet. The roadcuts along I-24 near the north edge of the map provide the only good exposure. In the graben near northeast corner of quadrangle, Tradewater is represented by float and small outcrops of sandstone; generally a sublitharenite containing more mica and interstitial clay than Caseyville sandstones.

D Caseyville Formation, Pounds Sandstone Member Sandstone is white to light gray, friable, sugary-textured quartz arenite having sparkly quartz overgrowth on sand grains. It is fine to coarse-grained and contains scattered granules and small pebbles (less than ½ inch) of well-rounded clear to white quartz. Bedding is thick to very thick and commonly obscure; the sandstone commonly appears massive. Trough and planar crossbedding occurs in sets a few inches to about 3 feet thick, mostly dipping southwest, south, and southeast. Planar lamination and ripple marks are present. In the graben at northeast corner of map area the Pounds displays slumped bedding and healed listric fractures, suggesting tectonic disturbance before the sand was lithified. The Pounds forms cliffs and low rounded ledges that exhibit pock-marked or honeycomb weathering and Liesegang banding. Lower contact was not observed, but is probably erosional.

E Caseyville Formation, unnamed interval. Shale, siltstone, sandstone, coal, claystone. Shale and siltstone are medium to dark gray, laminated, micaceous, partly carbonaceous, and sideritic. Well preserved plant fossils occur in shale overlying coal near middle of interval. They include abundant *Desmopteris longifolia and Alethopteris* cf. *davreuxii* along with *Senftenbergia pennaeformis*, *Sphenophyllum cuniefolium*, *Neuropteris* sp., and ?*Eremopteris* sp. (William A. DiMichele, Smithsonian Institution, written communication, 2004). Sandstone is white to light gray, weathering buff, very fine to fine quartz arenite, thin to thick-bedded, showing ripple marks and crossbedding and in places alternating with shale and siltstone. Burrows and trace fossils, including Eoina, are locally present. Coal in roadcut on I-24 is 0.9 feet thick, bright banded, and rests on rooted claystone. A coal bed at least 1.5 feet thick reportedly was mined near the SE corner of Sec. 9, T12S, R3E at the east edge of the map area (H.R. Wanless, 1932, ISGS field notes). Along old railroad (now a bicycle trail) near east edge of map area this unit is largely sandstone having thin, flaggy bedding but several thicker layers are highly lenticular and display contorted lamination, suggesting tectonic disturbance before the sand was lithified. Also found in this area is a local cliff-forming sandstone up to 30 feet thick lithologically resembling the overlying Pounds Sandstone. Near Dutchman Lake and Interstate 24 is a discontinuous ledge-forming sandstone 5 to 15 feet thick, the top of which is 20 to 25 feet above the Battery Rock Sandstone. In the roadcut on I-24, this sandstone thickens abruptly, filling a channel scoured into the Battery Rock. The I-24 roadcuts provide by far the best exposures of this interval; elsewhere it is largely covered on slopes below the Pounds.

F Caseyville Formation, Battery Rock Sandstone Member Sandstone is white to light gray, medium to very coarse quartz arenite having a sugary texture and sparkly quartz overgrowths on the sand grains. Quartz granules and pebbles (typically 1/4 to ½ inch; some reach 1 inch) are generally abundant and occur as lenses and bands that follow bedding and the foreset layers of crossbedding. Lenses of quartz-pebble conglomerate occur in the lower part of the unit. Crossbedding is conspicuous and mostly wedge- and tabular-planar style is sets a few inches to 6 feet thick, the foreset beds dipping northwest, west, southwest, and south. Bidirectional crossbedding was observed locally. Planar lamination, ripple marks, small-scale cross lamination, and slumped lamination also are present. The Battery Rock forms steep ledges and overhanging cliffs in many places; the sandstone commonly displays honeycomb or boxwork weathering and Liesegang banding. The upper contact is sharp in some places; elsewhere it is marked by gradual upward decrease in grain size and bed thickness. The lower contact is erosional and marked in places by conglomerate of large quartz, ironstone, and coal pebbles. The unit fills channels or valleys incised into the Wayside Member. An angular unconformity between horizontal, unfractured Battery Rock and tilted, strongly jointed Wayside strata was observed near the large stream junction in the SW 1/4 of Sec. 9, T12S, R3E. Channel margins are abrupt, showing rapid pinch-out of the sandstone, and in some cases may be fault-controlled. The Battery Rock is absent west of Dutchman Lake.

G Caseyville Formation, Wayside Member Sandstone, siltstone, shale, local coal. The unit consists largely of thinly bedded or laminated strata, with lenses of ledge-forming sandstone. Sandstone is white to light gray, weathering brown, dominantly very fine to fine-grained and tightly cemented quartz arenite, commonly intercalated with dark gray shale and siltstone producing "zebra rock". Thin flaggy, planar bedding and planar, lenticular, and cross-lamination are common; some outcrops display tidal rhythmites. Small load casts and ball-and-pillow structures are common, as are casts of fossil wood and stems including lycopods and Calamites. Trace fossils include horizontal trails, burrows, and Cochlichnus. Siltstone of the Wayside is commonly light to medium gray and has wavy or ripple lamination and load casts. Shale varies from light gray to nearly black; well preserved fossil plant foliage was found in blocks fallen from the highwall of the quarry near the northwest corner of the map area. Also seen on the quarry walls are small channel deposits of sandstone, less than 15 feet thick and 300 feet wide, sharply incised into thin-bedded strata and having slump structures along the margins. The Omar sandstone lentil of Jacobson (1992) is a ledge-forming unit that is normally 10 feet or thinner but reaches 35 feet near the northwest corner of the quadrangle. Shaly coal and carbonaceous shale containing abundant fossil plants occurs within 10 feet above the Omar in the Goreville Quadrangle just outside the present map area (Jacobson, 1992). Ledge-forming sandstone at the base of the Wayside is highly lenticular. Along Grasshopper Creek in the north part of Sec. 12, T12 S, R3E, basal Wayside sandstone at least 35 feet thick. This sandstone is at the bottom of a southwest-trending paleochannel eroded into the Mississippian Kinkaid Limestone. The channel, 60 to 80 feet deep and about 1/4 mile wide, is directly in line with the highly linear Harco valley mapped by Bristol and Howard (1971) from northern Saline County, a distance of 40 miles away. Crossbedding indicates southwestward paleocurrent; the southeast channel margin is abrupt and the northwest border is gradual. Coal and shale containing well preserved fossil plants occur in the upper part of the Wayside near the southwest corner of the adjacent Goreville Quadrangle (Jacobson, 1993).

The base of the Wayside is a major, regional unconformity. In the Jones core there is 12 feet of basal conglomerate composed of Mississippian limestone and chert clasts, along with shale, siltstone, ironstone, and quartz pebbles in a matrix of sandstone. Beneath this is 4 ½ feet of limestone-pebble conglomerate having a clay matrix.

H Kinkaid Formation, Dutchman Limestone Member Limestone is light to medium gray crinoidal wackestone and packstone, with lesser amounts of crossbedded crinoidal grainstone and lime mudstone. Bedding undulates, most beds are 1 to 12 inches thick. The limestone is argillaceous and exhibits scaly weathering and has dark gray, ragged to wavy shaly partings. Lenses of dull, dark gray to black, fractures chert 3 to 6 inches in diameter constitute as much as 10% of the rock. Fossils other than echinoderm fragments are scarce; a few bryozoans were noted. Contact to overlying Pennsylvanian well exposed just below old road near SE corner of Sec. 7, T12S, R3E. In places a layer of nodular, brecciated chert as thick as 2 feet is at the top of the limestone; it may represent an ancient weathering profile. More good exposures, including the type section, are on hillsides south and east of Dutchman Lake dam. In the Jones core there is 3.7 feet of interbedded shale and limestone at the base of the Dutchman Member. These rocks contain diverse marine fossils in the upper part and only pectenoid pelecypods in the lower part. The contact to the Grove Church is sharp.

I Kinkaid Formation, Grove Church Shale Member Shale, claystone, thin dolomite and limestone beds. The lower 40 feet is dominantly dark gray, thinly fissile clay shale and silty shale that is partly mottled greenish, olive, and dark red. Some of the shale is calcareous and contains bryozoans, pectenoid pelecypods, and other fossils. Much of the upper 20 feet of the Grove Church in the Jones core is claystone that is mottled dark red and greenish gray, massive and slickensided, containing brecciated carbonate and chert nodules. Limestone occurs as lenses and interbeds ranging from less than an inch to about three feet thick. Dense, sublithographic dolomite and dolomitic limestone, weathering yellowish brown to orange, crops out below the claystone. This rock contains scattered algae and whole productid brachiopods. Other Grove Church fossils include *Archimedes* and other fenestrate and trepostome bryozoans, the brachiopods Composita elongata, Spirifer sp., Derbyia sp., and Diaphragmus sp., Pterotocrinus sp. and other pelmatozoans, and conodonts. The unit forms slopes and is poorly exposed; the Jones core provides the only complete record. The best outcrops were found near the head of a ravine south of Dutchman Lake 300' from SL, 1300' from WL, Sec. 7, T12S, R3E. Lower contact in the Jones core is sharp.

J Kinkaid Formation, Goreville Limestone Member Limestone is light to medium gray and crinoidal; it is largely packstone and grainstone with lesser wackestone and lime mudstone. In most outcrops the limestone becomes coarser and more granular upward, with oolites and rounded, coated fossil grains near the top. However, the Jones core shows the Goreville composed of numerous upward-fining sequences each 2 to 7 feet thick. Each sequence has argillaceous wackestone in the upper part, grading downward to purer packstone and grainstone and having sharp basal contacts. On the outcrop, beds are planar to wavy and most are 6 to 18 inches thick. Some layers are argillaceous and exhibit scaly weathering, but discrete shale interbeds are absent. Lenses of dark gray to black, dull-textured chert 3 to 12 inches across are plentiful in the lower to middle part of the Goreville. These exhibit the same crinoidal texture as the limestone. Orange-weathering dolomitic wackestone and packstone that contains numerous unbroken brachiopods is found at the top of the member. Characteristic Goreville fossils are very large (up to 12 inches long) *Archimedes* corkscrews and shell-crusher sharks' teeth. Also present are fenestrate, trepostome, and fistuliporid bryozoans, spiriferids and other brachiopods, rugose corals (common), *Pentremites*, and trilobites (rare). Trace fossils believed to be *Zoophycos* sp. occur near the top. The Goreville is exposed as stepped ledges in many places, especially near Dutchman Lake and Dutchman Creek, where springs and sinkholes are common. The best outcrops are in the active and abandoned quarries north of Buncombe. The lower contact us sharp and may be a minor disconformity.

K Kinkaid Formation, Cave Hill Member (upper shale). Mudstone, shale, limestone. At the top is 0 to 6 feet of shale with thin limestone interbeds; the shale is dark gray, soft, laminated, and calcareous; it contains abundant pelecypods such as *Myalina*. Limestone beds 1 to 10 inches thick are dense, micritic, and argillaceous; they contain pelecypods and echinoderms, including edrioasteroids. The remainder of the interval, 10 to 13 feet thick, is massive to weakly bedded, slickensided mudstone that is mottled in gray and greenish gray, the middle part being dark red. The red part contains knobby, brecciated nodules and lenses of ochre-colored shaly dolomite or limestone. This unit is exposed in the quarries near Buncombe. The lower contact is either sharp and irregular or gradational.

L Kinkaid Formation, Cave Hill Member (middle limestone) Limestone; minor shale, dolomite, and chert. At the top is light gray, dense, lithographic dolomite or dolomitic limestone that has nodular bedding. In places it consists of carbonate nodules in a green clay matrix. Below is an interval of diverse types of limestone, but argillaceous lime mudstone predominates. Some beds display fine planar to gently undulating laminations. Intervals of shale are common; shale is mostly dark gray, fissile, calcareous, and contains nodules and interbeds of limestone. Quarry exposures show that shale intervals grade laterally to limestone and reveal several minor disconformities and hardgrounds in the middle to upper part of the unit. The lower 20 feet of the unit is dark gray, sublithographic lime mudstone having a few thin shale interbeds and tabular bedding a few inches to several feet thick. Bands of fossil debris and whole brachiopods are present. Near the top of the lower 20 feet are prominent bands and elongate lenses as thick as 12 inches of black, closely fractured, slightly vitreous chert. The lower contact is gradational.

M Kinkaid Formation, Cave Hill Member (lower shale) Shale is dark gray to dark olive and greenish gray, partly silty, weakly fissile, and calcareous. The upper part is calcareous and highly fossiliferous, grading to argillaceous limestone; downward the shale becomes darker and less fossil-rich. Fenestrate bryozoans and brachiopods such as *Spirifer increbescens*, *Mucrospirifer* sp., Diaphragmus sp., and Composita sp.; as well as the pelecypod Dunbarella are abundant. Gutschick (1965, 1968) reports a variety of crinoids, blastoids, horn corals, gastropods, trilobites, conularids, fish teeth, and microfossils from quarries near Buncombe. The lower contact is sharp.

N Kinkaid Formation, Negli Creek Limestone Member Limestone is largely medium to dark gray and brownish gray lime mudstone and skeletal wackestone. The upper part commonly includes lighter gray crinoidal packstone and grainstone that may have rounded and coated fossil grains. Locally, orange-weathering dolomitic limestone is at the top of the member. The tabular beds range from 3 to 24 inches thick and are separated by wavy, discontinuous shaly partings. Chert nodules are common in the lower Negli Creek. Fossils include brachiopods, fenestrate bryozoans, blastoids, bellerophontid gastropods (common), *Girvanella* oncoids (common) and the sponge(?) *Chaetetella* (rare). The last three are well-known guide fossils to the Negli Creek (Gutschick, 1965; Trace and McGrain, 1985). The best exposures are in the quarries near Buncombe and natural outcrops along the west side of Dutchman Creek in Sec. 18, T12S, R3E. Sinkholes commonly mark the outcrop of this unit. The lower contact is sharp.

O Degonia Formation Shale, sandstone, siltstone, mudstone, chert. The Degonia is largely shale that is dark gray to greenish gray, partly silty and moderately to highly fissile. Greenish gray siltstone to silty mudstone in the middle Degonia is massive with a lumpy texture and exhibits roots and other features of soils. Some sandstone is light brown, very fine grained, clean quartz arenite with thin wavy bedding and ripple marks. More distinctive is very fine sandstone to siltstone that is dark olive to greenish gray, weathering rusty orange. This rock has fine, varve-like planar lamination and erodes out as long rectangular and wedge-shaped blocks bounded by joints. In the Jones core the upper Degonia contains thick intervals of maroon and greenish-gray variegated claystone and silty mudstone that is massive to blocky, slickensided, and contains angular, brecciated, septarian dolomite concretions. Brown chert was observed as float near the top of the unit. The Degonia forms low, rolling topography and in places makes a subtle cuesta. Exposures are fragmentary. The Jones core shows a sharp basal contact, but an outcrop showed a gradational contact.

P Clore Formation, Ford Station Member Limestone, shale, and siltstone. Limestone beds are at least 3 feet thick and medium-dark gray to olive gray, weathering light gray mottled with orange; lime mudstone to wackestone, partly dolomitic and argillaceous, massive to nodular. Whole spiriferid, productid, and compositid brachiopods are common. As seen in the Jones core, shale of the Ford Station is dark gray, calcareous, and fossiliferous, ranging from a platy clay shale to silty shale having laminae and thin interbeds of light gray siltstone. Only small, incomplete exposures were found. The lower contact was not observed.

Q Clore Formation, Tygett Sandstone Member. Sandstone, siltstone, and shale. Sandstone is light gray to light brown, very fine to medium-grained quartz arenite. It typically coarsens upward, being crossbedded in the upper part and bearing the horseshoe-shaped trace fossil *Rhizocorallium*. Downward the sandstone becomes thin-bedded with planar to wavy and ripple-marked bedding surfaces. Laminated sandstone in turn grades downward to siltstone and shale. Incomplete exposures suggest two or possibly three sandstone intervals are locally present, separated by shale and limestone similar to that of the Cora Member. Two Tygett sandstone sequences definitely are present both east and west of the Vienna Quadrangle (Devera, 1991; Nelson, 1993; Nelson and Weibel, 1996; Nelson, in press). The Jones core revealed four sandstone-shale intervals, each separated by limestone similar to that of the Ford Station. Sandstone intervals coarsen upward and in two cases were rooted at the top. The Tygett forms a well-defined cuesta, but good exposures are confined to ravines and stream beds. The lower contact is gradational.

R Clore Formation, Cora Member Shale, limestone, minor siltstone and sandstone. Shale, the dominant rock type, is mostly dark gray to nearly black, thinly fissile or platy clay shale containing ironstone nodules. Greenish gray, silty, and weakly fissile shale or mudstone also is present. Limestone bed at the top is 4 to 6 feet thick and dark gray, very argillaceous brachiopod-bryozoan lime mudstone to wackestone that weathers yellowish gray and forms smooth, rounded surfaces. Thin beds and lenses of highly fossiliferous limestone occur throughout the member; they contain brachiopods such as *Composita subquadrata*, *Spirifer increbescens*, and *Chonetes* sp. and trepostome and fenestrate bryozoans including *Archimedes* sp. A limestone bed near the base is 2 to 3 feet thick and weathers dark red. A measured section by Dial (1963) includes two upward-coarsening intervals each about 10 feet thick and grading from dark gray clay shale at the base to siltstone or very fine sandstone at the top. The lower contact is sharp.

S Palestine Formation Sandstone, siltstone shale, mudstone, coal. Sandstone is light gray to buff, very fine to fine quartz arenite. In most places it coarsens upward, the upper part being crossbedded and the lower portion having thin, flaggy and ripple-marked bedding. Some siltstone is dark olive gray, thinly laminated, and erodes in long rhomboidal blocks. Shaly coal or carbonaceous about 1 inch thick, overlying gray, rooted mudstone, was observed in several places in the middle part of the unit. Below the coal is mostly siltstone and shale, poorly exposed. The Jones core showed carbonaceous black shale at the top of the Palestine, overlying rooted siltstone grading to rhythmically laminated shale sandstone. A section measured by Dial (1963) includes almost the entire Palestine; it portrays three or four upward-coarsening intervals each 10 to 20 feet thick. Sandstone is moderately resistant and tends to form a low cuesta; other lithologies form slopes. The lower contact was not observed.

T Menard Limestone Limestone and shale. At the top is about 20 feet of unnamed shale that is medium to dark gray, partly calcareous, and contains thin interbeds of fossiliferous limestone. Below is the Allard Limestone Member, 35 to 40 feet of light to medium brown to gray lime mudstone and fine to coarse skeletal wackestone and packstone with thin shale interbeds and scattered chert nodules. In the middle is 20 to 25 feet of shale with thin limestone layers. Waxy bright green shale occurs within this unit. Next downward is the Scottsburg Limestone Member, which is about 30 feet of light to dark gray limestone, largely dense, sublithographic lime mudstone in hummocky beds, separated by thin shale layers. Below the Scottsburg is 3 to 5 feet of shale and finally, the Walche Limestone Member, about 8 feet of argillaceous and silty, drab micritic limestone. Common fossils of the Menard include the brachiopods *Composita subquadrata* and Spirifer increbescens, wing plates of the crinoid *Pterotocrinus menardensis*, and a variety of bryozoans. Outcrops are few; information is drawn mainly from well records and outcrops in adjacent quadrangles. A good exposure of the Allard Member is just east of the map area in the northbound on-ramp to Interstate 24 from S.R. 146. The lower contact is sharp.

U Waltersburg Formation Shale, siltstone, and sandstone. The formation is largely dark gray, thinly fissile clay shale that becomes silty upward, grading to siltstone and sandstone at the top of the formation. Sandstone is olive gray to brownish gray, very fine grained, shaly, and thinly bedded. Locally a thin, impure coal overlies the sandstone. The Waltersburg is largely covered by Quaternary deposits within the map area.

V Vienna Limestone Limestone is largely dark gray to brownish gray, siliceous lime mudstone and wackestone, with some crinoidal packstone and grainstone. Some beds are sandy; laminae and thin interbeds of dark gray shale are present. Dark brown chert nodules are numerous. The type locality (Weller, 1920), a quarry just west of Vienna in the SE SW NW of Sec. 5, T13S, R3E, has been backfilled; few other limestone outcrops exist in the mapped area. The Vienna is mapped mostly on the basis of distinctive white to brown weathered, porous blocks of fossiliferous chert found as float.

W Tar Springs Formation Sandstone, siltstone, shale, thin coal. Sandstone is white to light gray and greenish gray, very fine to medium-grained quartz arenite that is slightly micaceous and iron-stained. It varies from thinly bedded to massive and displays ripple marks, crossbedding, small load casts, indistinct burrows, and shale rip-up clasts. Shale and siltstone are medium to dark gray, micaceous, and thinly laminated. The Tar Springs appears to consist of several upward-fining and upward-coarsening sequences each 15 to 30 feet thick. Thin coal commonly occurs near the top; it rests on dark gray, rooted mudstone. Dark gray claystone also occurs in the lower Tar Springs. Sandstone of the Tar Springs forms ledges and caps many ridges in the southern part of the map area. The lower contact is sharp in some localities but may intertongue with the Glen Dean in others.

X Glen Dean Limestone Limestone and shale. The unit comprises an upper limestone 30 to 50 feet thick, a lower shale of about the same thickness, and a thin basal limestone. The upper limestone is medium to dark gray, weathering to rough surfaces that are gray with orange mottling. It is largely crinoid-bryozoan packstone and grainstone with oolites, with lesser amounts of wackestone and lime mudstone. Bedding is thin to massive; some grainstone is crossbedded; small mounds or bioherms were observed at an abandoned quarry in the NE NE Sec. 17, T13S, R3E (C.A. Ross, 1963, ISGS field notes). Fossils include *Archimedes*, *Fenestella*, and other fenestrate bryozoans; *Spirifer* sp. and other brachiopods, blastoids, and corals. Many sinkholes mark the outcrop belt; a sinkhole more than 30 feet deep covers 15 to 20 acres in the SW 1/4 of Sec. 12, T13S, R2E. The lower shale is medium to dark gray and greenish gray, platy, fossiliferous, and calcareous; and it contains thin interbeds and lenses of limestone. The lower contact appears to be gradational.

Y Hardinsburg Formation Sandstone, siltstone, and shale. Sandstone is light gray to buff, very fine to medium-grained quartz arenite that is thinly bedded to massive. Ripple marks and trough crossbedding are common. Siltstone and shale are medium to dark gray or greenish gray, ripple marked and laminated. In general, the upper Hardinsburg is interbedded shale and thin-bedded sandstone; the lower part is mostly thinly bedded sandstone with occasional thick beds. The Hardinsburg forms a cuesta; its sandstone produces ledges and low cliffs near the southern edge of the map area, especially along Wildcat Bluff. The lower contact is sharp and may be erosional.

Z Golconda Formation. Limestone, shale, mudstone. The Haney Limestone Member at the top is largely light to dark brownish gray, fine to very coarse crinoidal wackestone to crossbedded grainstone, some of which is oolitic. Bedding is hummocky, separated by dark, shaly partings. Chert nodules are scattered. Brachiopods, bryozoans, and rugose corals are common along with abundant echinoderm fragments. The lower part of the Haney comprises limestone and shale interbedded in roughly equal proportions. The Fraileys Shale Member is largely olive to greenish-gray to dark gray, calcareous, thinly fissile clay shale, with limestone beds of varied texture as thick as several feet. Red shale or mudstone occurs at the top; a little siltstone to fine sandstone in the lower part. The Beech Creek Limestone Member at the base of the Golconda is dark gray to brown, partly dolomitic, argillaceous to silty limestone. An outcrop in the bank of Cache River below Wildcat Bluff, just south of the map area, shows conglomeratic limestone containing mudstone clasts and filling a channel scoured into the Beech Creek. The lower contact is sharp.

AA Cypress Formation Sandstone, siltstone, and shale. The upper 50 to 80 feet consists of poorly exposed gray shale and siltstone having interbeds or lenses of white to greenish gray, very fine sandstone. Red shale or mudstone is locally present. The lower Cypress is largely sandstone that is white to light gray, fine to medium-grained quartz arenite, containing a few shale and coaly laminae in the lower part. Only the upper Cypress is at the surface in the map area at the southwestern corner. The lower contact is erosional.

Subsurface (cross section only)

BB Ridenhower Shale Shale, limestone, and sandstone. Shale, the dominant lithology, is medium to dark gray, thinly fissile, and calcareous. Limestone 6 to 12 feet thick is at the top; thin sandstone at the base represents the feather-edge of the Bethel Sandstone. The lower contact is sharp.

CC Paoli Limestone Limestone, shale, and mudstone. The sample log of the Albright well differentiates four members. The Downeys Bluff Limestone Member at the top is 13 feet of light olive-gray, fossiliferous and oolitic limestone. The Yankeetown Member is 49 feet thick and has red, purple and green variegated mudstone at the top, overlying interbedded dark gray, calcareous, fossiliferous shale and light olive to brownish gray, oolitic and bioclastic limestone. The Shetlerville Limestone Member is 45 feet thick and consists of drab brownish gray, bioclastic to obscurely oolitic limestone and dolomite. The Levias Limestone Member, at the base, is 28 feet of light olive gray to brownish gray limestone having pink to reddish brown, hematitic oolites. The lower contact is sharp.

DD Aux Vases Formation Sandstone is light gray, greenish gray, and reddish gray, very fine grained, calcareous, and it contains thin layers of gray shale. Lower contact is sharp.

EE Ste. Genevieve Limestone Limestone and sandstone. Limestone is largely light gray and light brownish gray oolitic and skeletal packstone and grainstone, some of which is sandy. Intervals of dark gray, micritic, cherty limestone similar to the underlying St. Louis are present. In the Albright well, two intervals of sandstone were logged: one 25 feet thick with its top 50 feet below the top of the formation and the other 8 feet thick and 103 feet from the formation top. The lower contact is based on the lowest occurrence of distinctly oolitic limestone.

FF St. Louis Limestone Limestone and dolomite. Light to dark brown and brownish gray, dolomitic limestone and dolomite are micritic to obscurely oolitic and bioclastic. Portions are silty, chert is plentiful. Only the upper 220 feet has been drilled within the map area.