# QUATERNARY GEOLOGIC MAP OF THE LOUISVILLE 4° x 6° QUADRANGLE, UNITED STATES

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
MAP I-1420 (NJ-16)

**State compilations by**
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NOTE: This map is the product of collaboration between State geological surveys, universities, and the U.S. Geological Survey, and is designed for both scientific and practical purposes. It was prepared in two stages. First, separate maps and map explanations of the parts of States included in the quadrangle were prepared by the State compilers. Secondly, these maps were integrated and locally supplemented by the editors, map unit symbols were revised to a uniform system of classification, and the map unit descriptions were prepared from information received from the State compilers and from additional sources. The diagrams accompanying the map were prepared by the editors.

Differences in mapping or interpretation in different areas were resolved by correspondence to the extent possible. Most simply reflect differences in available information or in philosophies of mapping, and should encourage further investigation.

Less than forty percent of the surficial deposits of the United States have been mapped and described. Traditionally, mapping of surficial deposits has been focused on glacial, alluvial, eolian, lacustrine, marine, and landslide deposits. Slope and upland deposits have been mapped in detail only in restricted areas. However, an enormous amount of engineering construction and many important problems of land use and land management are associated with regions that have extensive slope and upland deposits (colluvium and residuum, for example). These materials have many different physical characteristics. Therefore, an effort has been made to classify, map, and describe these deposits, based in large part on unpublished interpretations, published and unpublished subsoil data, and the distribution of bedrock parent materials. The classification is crude, but represents a first step toward a more refined and useful product.

For scientific purposes, the map differentiates Quaternary surficial deposits on the basis of lithology, texture, genesis, stratigraphic relationships, and age, as shown on the correlation diagram and indicated in the map unit descriptions. Some geomorphic features, such as end moraines, are distinguished as map units. Erosional features, such as stream terraces, are not distinguished, and differentiation of sequences of alluvial deposits of different ages is rarely possible at a scale of 1:1,000,000. Landslide deposits are mostly too small to be shown at this scale, but areas in which landslides are present are distinguished locally as map units.

For practical purposes, the map is a surficial materials map. Materials are distinguished on the basis of texture, composition, and local specific characteristics such as swelling clay. It is not a map of soils as soils are recognized and classified in pedology or agronomy. Rather it is a generalized map of soils as recognized in engineering geology, or of subsoils or parent materials from which pedologic and agronomic soils are formed. As a materials map it serves as a base from which a wide variety of derivative maps for use in planning engineering, land use, or land management projects can be compiled. However, it does not replace detailed site study and analysis.

The map contains the following illustrations:

- An index map to the International Map of the World 1:100,000 topographic series showing the Quaternary geologic map of the Louisville 4°x 6° quadrangle and other published maps of the Miscellaneous Investigations Series (I-1420).
- An illustration of loess distribution and thickness in the map area.
- An illustration showing the responsibility for state compilations.
- A chart showing correlation of map units.

# LIST OF MAP UNITS

## HOLOCENE

| | |
|---|---|
| asa | ALLUVIAL GRAVELLY SAND |
| asl | ALLUVIAL SILT AND SAND |
| as | ALLUVIAL SAND |
| ala | ALLUVIAL SILT |
| ac | ALLUVIAL CLAY |
| ed | DUNE SAND |
| es | EOLIAN SHEET SAND |

## HOLOCENE AND LATE WISCONSIN

| | |
|---|---|
| al | ALLUVIUM |

## HOLOCENE AND WISCONSIN

| | |
|---|---|
| csa | SANDY SILTY COLLUVIUM |
| csb | COLLUVIUM WITH HUGE BLOCKS |
| csd | SILTY CLAYEY SAND COLLUVIUM |
| cla | SANDSTONE- AND SHALE-CLAST LOAMY COLLUVIUM |
| clb | STONY SILTY TO CLAYEY COLLUVIUM |
| clk | GRAVELLY CLAY LOAM COLLUVIUM |
| cca | SHALE-CHIP LOAMY COLLUVIUM |
| ccb | CARBONATE-CLAST LOAMY COLLUVIUM |
| ccc | STONY SILTY CLAYEY COLLUVIUM |
| cce | CHERTY CLAY COLLUVIUM |
| ccf | TERRA ROSSA |
| ccg | TERRA ROSSA |

## LATE WISCONSIN

| | |
|---|---|
| ask | ALLUVIAL SAND, SILT, AND CLAY |
| el | LOESS |
| lca | LAKE CLAY AND SILT |
| lla | SLACKWATER LAKE SILT, CLAY, SAND, AND GRAVEL |
| gg | OUTWASH SAND AND GRAVEL |
| gs | OUTWASH SAND |
| kg | ICE-CONTACT SAND AND GRAVEL |

Tills in Indiana and Ohio

| | |
|---|---|
| | LOAMY TILL |
| tl | Ground moraine |
| tl | End moraine |
| | LOAMY TILL |
| tld | Ground moraine |
| tld | End moraine |
| | LOAMY TILL |
| tlg | Ground moraine |
| tlg | End moraine |
| | LOAMY TILL |
| tlh | Ground moraine |
| tlh | End moraine |

Till members of the Wedron Formation in Illinois

| | |
|---|---|
| | LOAMY TILL |
| tkb | Ground moraine |
| tkb | End moraine |
| | LOAMY TILL |
| tkc | Ground moraine |
| tkc | End moraine |
| | LOAMY TILL |
| tkd | Ground moraine |
| tkd | End moraine |
| all | ALLUVIAL SILTY CLAYEY SAND |
| alb | SILTY ALLUVIUM |

## EARLY WISCONSIN

| | |
|---|---|
| asc | ALLUVIAL SILTY SAND |

**WISCONSIN AND ILLINOIAN**

ela LOESS AND LOESSIAL COLLUVIUM

**ILLINOIAN**

lci LAKE SILT AND CLAY
gsi OUTWASH SILT, SAND, AND GRAVEL
kgi ICE-CONTACT SAND AND GRAVEL
ksi ICE-CONTACT SAND

Till members of the Glasford Formation in Illinois

CLAYEY TILL
tal Ground moraine
tal End moraine
tkm LOAMY TILL

Till in Indiana and Ohio

tli LOAMY TILL

**PRE-ILLINOIAN MIDDLE PLEISTOCENE**

lld LAKE AND SLACKWATER CLAY AND SILT

**EARLY PLEISTOCENE AND PLIOCENE**

age CHERT-PEBBLE GRAVEL AND SAND
agf CHERT-PEBBLE GRAVEL AND SAND
agi UPLAND CHERT-PEBBLE GRAVEL AND SAND
agk PALEOCHANNEL GRAVEL IN LICKING RIVER DRAINAGE
agj HEADWATER UPLAND SAND AND GRAVEL

**EARLY PLEISTOCENE TO MIOCENE**

agh UPLAND CHERT-PEBBLE GRAVEL AND SAND

**QUATERNARY AND TERTIARY**

zsd SANDY DECOMPOSITION RESIDUUM
zsi CLAYEY FINE SAND DECOMPOSITION RESIDUUM
zsk FERRUGINOUS SAND DECOMPOSITION RESIDUUM
zsn SANDY SHALY DECOMPOSITION RESIDUUM
zce MASSIVE CLAY DECOMPOSITION RESIDUUM
zrb CHERTY CLAY SOLUTION RESIDUUM, SANDY CLAY DECOMPOSITION RESIDUUM, AND SILTY CLAY DECOMPOSITION RESIDUUM
zrc SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
zrd SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
rsa CHERT-FRAGMENT SOLUTION RESIDUUM
rsb PHOSPHATIC SANDY SOLUTION RESIDUUM
rcc CHERTY CLAY SOLUTION RESIDUUM
rca CHERTY CLAY SOLUTION RESIDUUM
rcb CHERTY CLAY SOLUTION RESIDUUM
rce THIN CLAYEY SOLUTION RESIDUUM
rcf CHERTY SILTY CLAY, LOCALLY PHOSPHATIC, SOLUTION RESIDUUM
rch CLAY LOAM SOLUTION RESIDUUM

**PRE-TERTIARY**

R BEDROCK

## LIST OF MAP SYMBOLS

CONTACT

MELTWATER CHANNEL

CONCENTRIC MINOR MORAINE FORMS

DIRECTION OF ICE MOVEMENT INDICATED BY STRIATIONS

OUTER LIMIT OF GLACIAL ADVANCE—Solid where marked by distal edge of end moraine or outer limit of till; dashed where inferred; dotted where buried; ticks on side of advance

BURIED PRE-ILLINOIAN STREAM CHANNEL

BOUNDARY BETWEEN DIFFERENT TERRAINS ON SAME MAP UNIT

BURIED PRE-ILLINOIAN TILL IN CHANNEL

BURIED PRE-ILLINOIAN OUTWASH GRAVEL IN CHANNEL

OUTER EDGE OF MISSISSIPPI RIVER FLOOD PLAIN

LOESS MANTLE—Peoria Loess and, in Illinois, underlying Roxana Silt, together 2-6 m thick. Commonly overlies a Sangamon paleosol developed on deposits of Illinoian age (**tal**, **tkm**, **tli**, **kgi**, **gsi**, **lci**)

MANMADE LAND—Fill, open-pit coal mines, and coal-mine waste

## DESCRIPTION OF MAP UNITS

### HOLOCENE

asa ALLUVIAL GRAVELLY SAND—Light-gray, yellowish-brown, dark-brown, or brownish-gray, coarse to fine sand and subangular to well-rounded pebble to cobble gravel; reddish orange to reddish brown in parts of Tennessee. Poorly to well sorted, poorly to well stratified, some interbedded or admixed silt and clay. Lenses of gravel in deposits along Cumberland River in Tennessee. Gravel is chiefly chert, limestone, dolomite, and minor amounts of quartz. Mapped areas include organic muck and swamp deposits on flood plains, and colluvium along margins of valley floors. Thickness generally 5–10 m, but in places as much as 30 m

asl ALLUVIAL SILT AND SAND—Grayish-tan to brown, locally clayey, silt and fine to very fine quartz sand; poorly sorted, irregularly bedded. Some interbedded or intermixed chert-pebble gravel, especially in headwaters. Silt is derived mainly from loess (**el**) and loessial colluvium. Mapped areas include organic muck and swamp deposits of flood plains. Thickness 3–8 m

as ALLUVIAL SAND—Gray to brown sand; local interbedded lenses of silt and clay. Poorly to well sorted, poorly to well stratified overbank deposit of Mississippi River. Mapped areas include swamp deposits and muck of oxbow lakes on flood plain. Overlies 10 m to more than 60 m of older alluvium consisting of intermixed and interbedded gravel, sand, silt, and clay that becomes coarser with depth. Thickness 1–2 m

ala ALLUVIAL SILT—Gray to yellowish-brown silt mixed with fine sand and some clay; poorly to well bedded overbank deposit of Mississippi River. Overlies 10 m to more than 60 m of intermixed and interbedded gravel, sand, silt, and clay that becomes coarser with depth. Mapped areas include local swamp and other organic-rich deposits. Thickness 1–2 m

ac ALLUVIAL CLAY—Gray to reddish-brown, poorly to well-bedded clay; contains some fine sand and silt; locally, layers and lenses of dark-brown to black organic clay. Overbank deposit of Mississippi River; mapped areas include swamp deposits and muck of flood-plain oxbow lakes. Overlies 10 m to more than 60 m of older intermixed and interbedded fluvioglacial gravel, sand, silt, and clay that becomes coarser with depth. Thickness 3–12 m

ed DUNE SAND (dune facies of Atherton Formation in Indiana; part of Parkland Sand in Illinois; unnamed elsewhere)—Pale-brown, crossbedded, well-sorted, weakly calcareous, medium to fine sand. Chiefly quartz and minor amounts of heavy minerals. Deposits are mostly along valleys of Wabash and White Rivers; stabilized by vegetation except for small blowouts; thickness 1–30 m. Deposits on plain of Mississippi River, north of Sikeston, Missouri, 1–2 m thick

es EOLIAN SHEET SAND (part of eolian sand facies of Atherton Formation in Indiana; part of Parkland Sand in Illinois; unnamed elsewhere)—Pale-brown, weakly calcareous, well-sorted, medium to fine sand, locally silty. Deposits are chiefly along valley of Wabash River, locally along other major drainages; commonly form blanketlike masses east of areas of outwash sand and gravel (**gs**, **gg**) or dune sand (**ed**). Thickness 1–3 m

### HOLOCENE AND LATE WISCONSIN

al ALLUVIUM (Cahokia Alluvium in Illinois; alluvial facies of Martinsville Formation in Indiana; unnamed elsewhere)—Brown to gray clay, silt, sand, and gravel. Noncalcareous to calcareous, moderately to well sorted, stratified. Textures vary laterally and vertically; may be mixed or interbedded. Upper part commonly silt and fine sand; lower part commonly sand and rounded gravel. Lithologies mixed and variable, reflecting composition of bedrock and older surficial deposits upstream. Comprises overbank and stream-channel deposits; also underlies flood plains, low stream terraces, and alluvial fans. Along Ohio and Mississippi Rivers, and in glaciated areas, commonly overlies glacial outwash sand and gravel (**gg**, **gs**). Mapped areas include local fine-grained sheetwash deposits and swamp deposits. Thickness 1–5 m

**HOLOCENE AND WISCONSIN**

csa SANDY SILTY COLLUVIUM[1]—Yellowish-brown to brownish-gray sandy silt and silty sand, mixed with loess. Contains angular to subround clasts of sandstone, siltstone, and shale. Mantled by about 1 m of younger loess. Mapped areas include bedrock outcrops and large areas of strip-coal-mine waste that are mapped separately (**f**) in Indiana. Thickness 1–2 m

csb COLLUVIUM[1] WITH HUGE BLOCKS—Light-gray to pale-yellowish-brown, poorly sorted, sandy, silty clay loam; contains chips of siltstone and shale, and angular to slabby clasts of sandstone ranging from a few centimeters to 10–15 m in diameter. Occurs on steep slopes at west margins of flat to gently sloping uplands of the Cumberland Plateau in Tennessee. Mapped areas include some cherty clay solution residuum (**rcc**). Thickness commonly 3–15 m; may be as much as 30 m

csd SILTY CLAYEY SAND COLLUVIUM[1]—Orange to light-reddish-brown, silty, clayey, fine to medium quartz sand, mixed with loess; includes scattered small to medium, angular to subangular, slabby clasts of limestone and sandstone, and slabs or chips of shale. On steep slopes, may include landslides and slumps. Lower part commonly characterized by creep and downslope warping of the bedrock structure. Mapped areas include bedrock exposures, abundant to east but rare to west; also some karst terrain on limestone, and small alluvial deposits in valley bottoms. Mantle of younger loess on undissected uplands about 1 m thick to east, 2–6 m thick to west. Thickness of colluvium about 3 m; locally as much as 25 m to east

cla SANDSTONE- AND SHALE-CLAST LOAMY COLLUVIUM[1]—Light-, brownish-, or yellowish-gray sandy loam to clay loam; poorly sorted; unstratified. Contains angular to subround, or slabby, pebble- to boulder-size fragments of sandstone, conglomeratic sandstone, and chips of shale. Locally overlies sandy decomposition residuum (**zsd**). On steep slopes, clayey material tends to be unstable, and commonly is associated with soil creep and landslides. Locally includes areas of scattered to abundant landslide deposits. Mapped areas include rare rock exposures on steep slopes, minor sandy decomposition residuum, and local alluvium along streams. Thickness 2–7 m; as much as 25 m at foot of some steep slopes

clb STONY SILTY TO CLAYEY COLLUVIUM[1]—Pale-yellow, yellow-brown, or orange-brown silt loam to clay loam containing angular to subangular fragments of siltstone and dark-gray shale. Lower part commonly characterized by downslope folding and creep of bedrock strata. Covered by about 1 m of loess on uplands and moderate slopes, less on steep slopes. Mapped areas include numerous bedrock outcrops. Thickness as much as 2 m

clk GRAVELLY CLAY LOAM COLLUVIUM[1]—Yellowish-gray to reddish-brown, silty clay loam and, locally, fine sandy loam; contains scattered clasts of well-rounded chert gravel and shale chips. Large landslide blocks of shale, fine-grained sandstone, and gravel occur locally along base of steep slopes. Mantled by clay-rich loess 4–6 m thick. Restricted to areas known as Crowleys Ridge and Benton Hills along Mississippi River flood plain in Missouri. Irregular thickness 0.5–10 m

cca SHALE-CHIP LOAMY COLLUVIUM[1]—Greenish- to pale-yellowish-gray, silty clay loam; locally blocks and chips of shale and siltstone in a matrix of disintegrated shale. Formed on steeply dissected terrain; slumped masses and creep structures common. Thickness 3–6 m; locally as much as 12 m

ccb CARBONATE-CLAST LOAMY COLLUVIUM[1]—Yellowish-brown to orange silty clay, containing scattered to numerous cobble- to boulder-size, subangular to subround limestone slabs and, locally, shale chips. Local karst features where overlying limestone. Mapped areas include local alluvium and bedrock exposures along streams. Thickness 1–2.5 m

ccc STONY SILTY CLAYEY COLLUVIUM[1]—Yellowish-, orange-, or reddish-brown, calcareous, silty clay loam. Contains abundant angular to subangular pebble- to boulder-size fragments of limestone and angular chips to slabs of shale; also contains scattered subangular to well-rounded erratics of limestone, dolomite, chert, quartz, and Precambrian igneous and metamorphic rocks, a colluvial lag from a former mantle of Illinoian till now extensively eroded, and preserved only locally in undissected areas. Upper part includes admixed loess; loess generally less than 1 m thick locally mantles the colluvium on uplands and undissected gentle to moderate slopes. Mapped areas include numerous bedrock outcrops, especially on steep slopes. Isolated sinkholes where limestone is at the surface. Thickness as much as 2 m

cce CHERTY CLAY COLLUVIUM[1]—Reddish- to dark-yellowish-brown clay to clay loam; contains irregular fragments of chert and chips of shale. Slump and landslide deposits abundant on moderate to steep slopes; areas of swelling clays common. Mapped areas include numerous bedrock outcrops on steep slopes. Thickness 1–3 m; locally as much as 10 m at base of slopes

ccf TERRA ROSSA (mapped only in Indiana)—Red clay, locally containing abundant angular chert clasts. Characterized by heavy clay texture and strong angular blocky structure throughout. Sharp contact with underlying limestone. Considered to be derived from topographically higher clastic sedimentary rocks and transported laterally onto limestone surface. Subsequently weathered to form terra rossa. Insufficient volume of limestone available to have formed as a residuum (Olson and others, 1980; Ruhe and Olson, 1980). East of dashed line, mapped areas include sparse bedrock outcrops and few sinkholes; thickness 2–5 m. West of dashed line, mapped areas include extensive bedrock outcrops and abundant sinkholes;

thickness 1–3 m

ccg TERRA ROSSA (mapped only in Indiana) —Material same as unit **ccf**, but bedrock outcrops and sinkholes very rare. Thickness 3–15 m

**LATE WISCONSIN**

ask ALLUVIAL SAND, SILT, AND CLAY—Sand, silt, and clay, intermixed and interbedded, gravelly near base. Poorly to well stratified, poorly to well sorted. Clasts chiefly of chert and limestone, locally derived from older chert-pebble gravel and sand (**agf**); fine-grained component chiefly reworked loess. Material becomes coarser and more uniformly gravelly in headwater areas. Underlies flood plains and adjacent stream terraces. Mapped areas include local colluvium and slopewash deposits. Thickness as much as 10 m in upland valleys; thickness in lower parts of valleys 10 m to more than 30 m

el LOESS (Peoria Loess in Illinois, Indiana, and Kentucky)—Gray to yellowish-brown, windblown silt and silt loam. Calcareous where thick; weakly compacted and jointed. Occurs chiefly on uplands adjacent to major outwash deposits. Peoria Loess commonly overlies Farmdale soil developed on brown to reddish-brown or dark-gray leached, strongly compacted Roxana Silt. Mapped only where total thickness of all loess exceeds 6 m; thinner, unmapped deposits of Peoria Loess and younger loess are widespread elsewhere

lca LAKE CLAY AND SILT (part of Carmi Member of Equality Formation in Illinois; lacustrine facies of the Atherton Formation in Indiana; unnamed elsewhere)—Yellowish-brown to brown or bluish-gray to gray clay and silt. Well bedded, soft, commonly thinly laminated, and locally varved. Silt component resembles massive loess in places. Locally, thin and discontinuous. Mapped areas include lacustrine sand and fine gravel deposits and wave-washed or current-scoured till. Commonly overlain by loess of Holocene age, thin eolian sheet sand (**es**), swamp deposits, or alluvium (**al**). Thickness 1–10 m

lla SLACKWATER LAKE SILT, CLAY, SAND, AND GRAVEL (part of Carmi Member of Equality Formation in Illinois; lacustrine facies of Atherton Formation in Indiana; unnamed elsewhere; includes sandy alluvial deposits that are interstratified and intergradational with lake deposits in Kentucky)—Yellowish-brown to brown, becoming medium to dark gray downward, massive to thinly laminated material that probably is water-deposited loess. Partly calcareous and locally includes carbonate concretions. Shells of pelecypods and gastropods locally abundant. In some places, lake silt and clay intercalated with near-shore lake sand and pebble gravel; elsewhere, interbedded with outwash sand and gravel. Lake deposits formed in slackwater lakes impounded by aggradating outwash along the Ohio and Wabash Rivers, and other rivers flowing from glacier margins in late Wisconsin time. Crops out chiefly in terrace fronts bordering flood plains; commonly capped by alluvium (**al**) or loess (**el**). Locally in Kentucky, underlain by older, dark-, olive-, or greenish-gray calcareous lake silt and clay averaging about 10 m thick. Drilling records indicate thickness as much as 40 m

gg OUTWASH SAND AND GRAVEL (Batavia and Mackinaw Members of Henry Formation in Illinois; outwash facies of Atherton Formation in Indiana; unnamed elsewhere)—Pale-brown to gray, fine to coarse sand or pebbly sand alternating with layers or beds of locally bouldery, granule- to cobble-gravel, and minor beds of silt. Clasts rounded. Textures variable laterally and vertically; interlayered thick and thin beds; poorly sorted, poorly to well stratified, locally crossbedded. Clasts chiefly dolomite, limestone, and sandstone; some are hard, crystalline or metamorphic rock and, locally, some are shale. Deposits underlie terraces, outwash plains, valley trains, outwash fans, deltas, and meltwater channels near Wisconsin ice-front positions. Surface locally pitted by ice-block depressions and commonly covered by thin Peoria Loess (**el**) in Illinois or windblown sand (**ed**, **es**); locally overlain by swamp deposits. Thickness 1–20 m

gs OUTWASH SAND (outwash facies of Atherton Formation in Indiana; included in Henry Formation in Illinois; unnamed elsewhere)—Pale-brown to gray, fine to coarse sand or pebbly sand, locally with beds or lenses of granule- to pebble-gravel, silt, or silty clay. Clasts rounded. Well sorted and poorly to well stratified. Composition similar to that of outwash sand and gravel (**gg**). Occurs principally as outwash plains; overlain locally by thin Peoria Loess (**el**) in Illinois, windblown sand (**ed**, **es**), swamp deposits, or alluvial fill (**al**). Thickness 1-20 m

kg ICE-CONTACT SAND AND GRAVEL (kame facies of Atherton Formation in Indiana; unnamed in Ohio)—Pale-brown to gray, fine to coarse sand and gravel; includes minor silt and local lenses of till. Textures vary laterally and vertically. Gravel ranges from granules to boulders; clasts are subangular to rounded. Poorly sorted, poorly to well stratified, and commonly exhibits faults, folds, and slump or collapse structures. Composition similar to that of outwash sand and gravel (**gg**, **gs**). Forms ice-contact ridges, mounds, hummocks, terraces, deltas, eskers, and ice-fracture fillings; surface locally pitted with ice-block depressions. Mapped areas locally include small deposits of outwash sand and gravel (**gg**, **gs**), swamp deposits, peat, and alluvial sand (**as**). In Illinois, ice-contact deposits of the Wasco Member of the Henry Formation are too small to map at this scale and are included with the underlying till member of the Wedron Formation (**tkb**, **tkc**, **tkd**). Thickness 5–20 m

LOAMY TILL (Trafalgar Formation in Indiana)—Yellowish-brown or brown to light- or dark-gray loam, silt loam, silty clay loam, and clay loam. Calcareous, nonsorted to very poorly sorted. Generally pebbly. Pebbles, cobbles, and small boulders chiefly limestone and dolomite; large boulders chiefly granite, gneiss, and quartzite. Abundance of garnet and high magnetic susceptibility of till in Indiana indicate material was transported from north-northeast. Mapped areas include small deposits of outwash or ice-contact sand and gravel (**gg**, **gs**, **kg**). Commonly, but not everywhere, covered by loess (**el**) as thick as 1 m

tl Ground moraine—Thickness 2–30 m

tl End moraine—Forms broad, low ridges, commonly having hummocky topography. In Ohio, pebbles, cobbles, and boulders are much more abundant than in till of ground moraine. In Indiana, boulder accumulations appear to be only a surface or near-surface phenomenon. Thickness 5–35 m

LOAMY TILL (Boston and Caesar Tills in Ohio)—Yellowish-brown, brown, dark-brown, or grayish-brown to gray, generally noncalcareous silt loam and loam; nonsorted; lenses and interbeds of silt, sand, and gravel common. Compact. Sparsely pebbly to pebbly; rare cobbles; boulders uncommon. Clasts chiefly dolomite and limestone; some sandstone, shale, and erratic igneous and metamorphic rocks. Mapped area includes small deposits of outwash and ice-contact sand and gravel (**gg**, **gs**, **kg**). Locally overlain by alluvium, peat, or swamp deposits

tld Ground moraine—Thickness less than 1.5 m on uplands, 3–6 m in valleys

tld End moraine—Low ridges, generally having subdued constructional topography. Thickness 5–10 m; locally more than 15 m

LOAMY TILL (part of Trafalgar Formation in Indiana; unnamed in Ohio)—Pale-yellow, yellowish-brown, brown, dark-brown to light-gray, gray, or bluish-gray, calcareous loam, silt loam, clay loam, and silty clay loam; nonsorted to poorly sorted. Typically has irregular horizontal platy structure and is well jointed. Calcium carbonate joint fillings. Till is sparingly pebbly to pebbly; cobbles and boulders locally common, particularly in end moraines. Pebbles, cobbles, and small boulders chiefly dolomite, limestone, sandstone, siltstone, and shale; large boulders chiefly erratic crystalline igneous and metamorphic rocks and quartzite. Mapped areas locally include bedrock outcrops and small deposits of outwash and ice-contact sand and gravel (**gg**, **kg**), lake clay and silt (**lca**), and alluvium (**al**). Till locally overlain by loess 15-23 cm thick, or by alluvium, peat, or swamp deposits

tlg Ground moraine—Thickness 1–3 m, rarely 6 m

tlg End moraine—Broad, low ridges or complex areas of narrow, concentric, or anastomosing ridges having knob-and-kettle topography or irregular hummocks and shallow undrained depressions. Thickness 4–15 m

LOAMY TILL (part of Trafalgar Formation in Indiana; unnamed in Ohio)—Yellowish-brown, reddish-brown, grayish-brown, or bluish-gray, locally mottled, calcareous loam, silt loam, and clay loam; in places sandy loam or loamy sand. Nonsorted to poorly sorted; loose to compact, friable. Blocky structure. Calcium carbonate joint fillings. Moderately pebbly; cobbles and boulders locally abundant. Clasts chiefly limestone and dolomite; some shale, sandstone, chert, and erratics of granite, gneiss, and quartzite. Limestone clasts less abundant, chert clasts more abundant, and matrix more sandy and less clayey than in unit **tlg**. Mapped areas include bedrock outcrops and small deposits of outwash and alluvium. Commonly overlain by loess 20–40 cm thick, rarely 90 cm

tlh Ground moraine—Thickness 2–3 m, rarely 6 m

tlh End moraine—Broad low ridges, narrow, sharply defined ridges or complex of concentric or anastomosing ridges having knob-and-kettle topography and shallow undrained depressions. Thickness 4–15 m

Till members of the Wedron Formation in Illinois

[Chiefly till containing lenses and beds of sand, gravel, and silt. Mapped areas include small deposits of outwash sand and gravel (**gg**), ice-contact sand and gravel (**kg**), peat, and alluvium (**al**). All units have a thin to thick (less than 6 m) cover of Peoria Loess (**el**). Total thickness of formation averages about 20 m; maximum thickness may exceed 100 m]

LOAMY TILL (Batestown and Malden Till Members)—Olive-brown to gray clay loam and silty clay loam, dolomitic, nonsorted to very poorly sorted. Clasts chiefly dolomite; clay primarily illite

tkb Ground moraine—Thickness averages 6 m

tkb End moraine—Approximate thickness 15 m; thinner in places where till overlies older moraines and ridges

LOAMY TILL (Piatt Till Member)—Gray, weathering olive brown loam to silty clay loam; nonsorted to poorly sorted. Clasts chiefly dolomite; clay primarily illite

tkc Ground moraine—Thickness 1–6 m

tkc End moraine—Commonly overlies older moraines or ridges. Approximate thickness 6 m

LOAMY TILL (Fairgrange Till Member in Illinois and Indiana)—Pink, pinkish-gray, or gray clay loam, silty clay loam, and loam. Calcareous, clay dominantly illite; clasts predominantly dolomite. Low proportion of garnets in matrix and low magnetic susceptibility indicate a source far to north

tkd Ground moraine—Thickness averages 10 m; may be as much as 30 m in places

tkd End moraine—Thickness 30–100 m

all ALLUVIAL SILTY CLAYEY SAND (Prospect Formation of Indiana)—Yellowish-brown to brown sand, silt, and clay, intermixed and interbedded; local pebbly gravel lenses, especially at base; poorly sorted, poorly stratified; locally oxidized. Present in low terraces bordering modern alluvium. Although initially considered Illinoian in age, now thought to be of early late Wisconsin age. Derived from Illinoian till (**tli**), terra rossa (**ccf**), or sandy silty colluvium (**csa**). Thickness 2–10 m

alb SILTY ALLUVIUM—Yellowish-gray to brown silt and minor clay; poorly to well sorted, to well stratified; intermixed and interbedded. Underlies lowest of three terraces along northern part of Mississippi River flood plain. Overlies 10 m to more than 60 m of older fluvioglacial gravel, sand, silt, and clay that become coarser and increase in gravel content with depth. Thickness 8–9 m

**EARLY WISCONSIN**

asc ALLUVIAL SILTY SAND (deposits of "braided stream terraces" of Saucier, 1974)—Light-yellowish-gray to yellowish-brown, silty, fine to coarse quartz sand. Poorly to well sorted, poorly to well stratified. Underlies two successively higher terraces in northern part of Mississippi River plain. Overlies 10 m to more than 60 m of older fluvioglacial gravel, sand, silt, and clay that becomes coarser and increases in gravel content with depth. Mapped areas include some relict channels filled with silt and clay, and flood-plain swamp deposits. Thickness 5–6 m

**WISCONSIN AND ILLINOIAN**

ela LOESS AND LOESSIAL COLLUVIUM[1] (includes loess stratigraphically equivalent to the Peoria Loess and Roxana Silt in Illinois and, locally, to the Loveland Loess of Illinoian age in Iowa)—Grayish-brown to yellowish-brown, locally light reddish brown, silt loam. In places, contains three lenses of very fine to fine quartz sand. Massive to bedded; deeply dissected. Buried Sangamon soil locally preserved on Loveland Loess in lower part. Rests on thin oxidized colluvium derived from underlying "Lafayette Gravel" (**agh**) or bedrock. Thickness ranges from about 20 m in bluffs of Mississippi River to about 1–2 m to the east along Kentucky Lake

**ILLINOIAN**

lci LAKE SILT AND CLAY (Teneriffe Silt in Illinois)—Yellowish-brown to brown or gray, massive silt and clayey silt with beds of sand and clay. Generally leached; calcareous in lower part only where thick. Mapped areas locally include small deposits of outwash silt, sand, and gravel (**gsi**), windblown sand (**es**), and sheetwash colluvium. Sangamon paleosol developed in upper part. Commonly covered by as much as 6 m of loess (Peoria Loess and Roxana Silt in Illinois). Thickness less than 1 m to more than 10 m

gsi OUTWASH SILT, SAND, AND GRAVEL (Pearl Formation in Illinois)—Yellowish-brown to gray silt and pebbly sand. Generally more oxidized and cemented than younger outwash sand and gravel (**gg**), but similar in composition and bedding. Locally includes ice-contact sand and gravel (**kgi**). Underlies terraces and outwash plains. Sangamon paleosol developed in upper part. Commonly covered by as much as 6 m of loess (Peoria Loess and Roxana Silt). Thickness averages less than 12 m; in major valleys may be much thicker

kgi ICE-CONTACT SAND AND GRAVEL (Hagarstown Member of Glasford Formation in Illinois)—Chiefly well sorted, bedded sand and gravel; displays slump structures; includes some gravelly till. Occurs as kames, eskers, and crevasse fillings. Overlies till of Glasford Formation. Sangamon paleosol developed in upper part. Generally covered by as much as 6 m of loess (Peoria Loess and Roxana Silt in Illinois). Thickness probably greater than 30 m in places

ksi ICE-CONTACT SAND—Yellowish-gray to yellowish-brown, evenly to lenticularly bedded sand; poorly to well sorted; local marked contrasts in texture, especially where channel-and-fill bedding predominates. Includes lenses and layers of sandy to gravelly till. Occurs as kames, eskers, or crevasse fillings, chiefly in Indiana. Overlies Illinoian till. Sangamon paleosol developed in upper part. Generally covered by 1–4 m of loess (**el**). Thickness as much as 30 m

Till members of the Glasford Formation in Illinois

[All till members are locally covered by small deposits of outwash silt, sand, and gravel (**gsi**, **gg**), lake silt and clay (**lci**, **lca**), slackwater lake silt, clay, sand, and gravel (**lla**), windblown sand (**es**), alluvium (**al**), or younger till, and commonly are covered by as much as 6 m of loess (**el**) (Peoria Loess and Roxana Silt in Illinois). Sangamon paleosol locally developed beneath the loess in the upper part of each till member. Average thickness of Glasford Formation about 15 m; maximum thickness probably greater than 30 m]

CLAYEY TILL (Radnor Till Member)—Yellowish-brown or brown to dark-gray clay loam, silty clay

loam, and loam. Illitic and dolomitic; commonly interbedded with sand and silt. Compact, locally massive and jointed. Thickness more than 6 m; locally may exceed 15 m

tal Ground moraine—Thickness 2–30 m

tal End moraine—Forms very broad low ridges having gently undulating topography

tkm LOAMY TILL (Hulick and Vandalia Till Members)—Yellowish-brown, reddish-brown, brownish-gray, or gray loam, silt loam, and clay loam. Illitic to intermediate illitic, dolomitic. Nonsorted to poorly sorted; locally interbedded with sand and gravel. Compact to moderately compact, locally jointed. Mapped areas include many small bedrock outcrops. Commonly covered by as much as 2 m of loess (**el**). Thickness 15 m in southwestern and south-central Illinois, 4–6 m in southeastern Illinois

Till in Indiana and Ohio

tli LOAMY TILL (Butlerville Till Member of Jessup Formation in western and central Indiana; Richmond Till in eastern Indiana and western Ohio)—Light-olive-brown, yellowish-brown to reddish-brown, or brownish-gray to bluish-gray, locally mottled, calcareous loam and clay loam; contains local thin lenses of gravel, sand, and silt. Pebbles and cobbles common in till; local calcium carbonate concretions in lower part. Clasts subangular to well rounded, chiefly of limestone, dolomite, and chert, but a few of sandstone, siltstone, shale, quartzite, quartz, and Precambrian igneous and metamorphic rocks. Till very compact, leached to depths of as much as 3 m; displays secondary iron oxide accumulations on joint surfaces. In Ohio, till locally includes two depositional units; it may include two units in Indiana. In some areas, especially near its outer limit, till is thin, discontinuous and patchy. Sangamon soil developed in uppermost part in places, overlain by Peoria Loess (**el**) as thick as 3 m. Thickness less than 3 m; more than 10 m in buried valleys

## PRE-ILLINOIAN MIDDLE PLEISTOCENE

lld LAKE AND SLACKWATER CLAY AND SILT (Claryville Clay in Kentucky)—Light-bluish- to greenish-gray, oxidized brownish-gray, yellowish-brown, or brown, finely laminated to thin-bedded clay shale with thin interbeds of limonite-cemented siltstone. Local thin lenses of limonite, siltstone, and limestone pebbles and chips. To north, contains 20 percent calcium carbonate from glacial flour, but no erratics of northern derivation; noncalcareous to south. Commonly leached about 2 m, locally as much as 5 m. Formerly correlated with Minford Silt in Kentucky and Ohio, which has reversed magnetic polarity (Hoyer, 1977; Bonnett and others, 1978) and thus is at least 740,000 years old, but Claryville Clay apparently has normal magnetic polarity (Teller and Last, 1981) and, if so, is less than 740,000 years old and pre-Illinoian in age. However, some samples analyzed were oxidized and the normal polarity may be induced. Thickness as much as 12 m

## EARLY PLEISTOCENE AND PLIOCENE

age CHERT-PEBBLE GRAVEL AND SAND (Mounds Gravel in Illinois)—Pale-buff to brown or reddish-brown pebbles, cobbles, and a few boulders. Locally stained or cemented with iron or manganese oxide; mostly unconsolidated, poorly sorted, weakly bedded. Matrix predominantly fine sand admixed with minor amounts of silt and clay. Clay abundant in uppermost part. Clasts well rounded to angular, chiefly chert but some of nonmetamorphic quartzite and a few of sandstone or clay. Clasts of clay and of sandstone, especially boulders, locally derived from underlying bedrock. Sand mostly quartz; heavy-mineral content higher in zircon and tourmaline and lower in kyanite, sillimanite, and staurolite than upland chert-pebble gravel and sand (**agh**); lower in staurolite and topaz than unit **agf**. Foreset beds of local channel-and-fill structures dip predominantly southwest; gravel surface slopes southwest from 180 m to 115 m altitude. Material in large part derived from ancestral drainage flowing from northeast. Overlain disconformably by Loveland Loess of Illinoian age. Thickness as much as 25 m

agf CHERT-PEBBLE GRAVEL AND SAND (gravel of Crowleys Ridge in Missouri)—Pale-buff to dark-brown unconsolidated pebbles, some cobbles, and a few boulders, locally stained with iron or manganese oxide. Matrix predominantly fine sand mixed with minor amounts of silt and clay that increase in abundance in upper part. Clasts range from well rounded to angular; rounded clasts more abundant than in units **age** or **agh**. Clasts chiefly chert; some are nonmetamorphic quartzite, a few sandstone or clay. Sand mostly quartz. Heavy-mineral content higher in zircon and tourmaline and lower in kyanite, sillimanite, and staurolite than unit **agh**; higher in staurolite and topaz than unit **age**. Poorly sorted deposit characterized by channel-and-fill crossbedding; foreset beds dip predominantly west or south. Source probably from many areas in ancestral headward drainage of Mississippi River. Thickness as much as 20 m

agi UPLAND CHERT-PEBBLE GRAVEL AND SAND (gravel on upland adjacent to Cumberland River)—Light-brown, mostly unconsolidated, well-rounded, discoidal pebble gravel in a sandy matrix. Includes some cobbles and lenses of sand. Well sorted, locally well bedded. Pebbles, mostly chert and quartz, as much as 2 cm in diameter; chert pebbles deeply iron stained. Basal part of deposit commonly cemented with hematite and limonite. Caps ridges and extends irregularly into valleys. May be equivalent to upper part of "Lafayette Gravel" (**agh**). Thickness ranges from a veneer to 7 m on ridges; locally as much as 30 m in valleys

agk PALEOCHANNEL GRAVEL IN LICKING RIVER DRAINAGE—Yellowish-orange to light- or moderate-brown gravel, sand, silt, and clay, intermixed and interbedded; deeply weathered; locally limonite cemented. Contains subround to angular, cobble- to pebble-size slabs and chips of limestone and siltstone, pebbles and granules of limonite and limonite-cemented siltstone, exotic cobbles and pebbles of reddish or yellowish chert, silicified limestone, dolomite, pink or yellow quartz, and coal. Occurs in remnant channel segments of high-level ancestral course of Licking River and its tributaries (near east margin of quadrangle between lat 38° and 39°), but below level of upland gravel of unit **agj**. Thickness ranges from as much as 8 m in upstream deposits to 22 m in downstream deposits

agj HEADWATER UPLAND SAND AND GRAVEL—Light- to reddish-brown sand, gravel, silt, and clay intermixed and interbedded; poorly consolidated, weakly bedded, poorly sorted. Clasts mostly granule to pebble, locally cobble size; well rounded, mostly quartz, quartzite, and chert; generally concentrated as a lag at surface. Sand very fine to medium; commonly crossbedded. Occurs as abandoned channel and terrace deposits on ridgetops or in high-level, abandoned valleys. Thickness chiefly less than 3 m; locally as much as 15 m

**EARLY PLEISTOCENE TO MIOCENE**

agh UPLAND CHERT-PEBBLE GRAVEL AND SAND ("Lafayette Gravel" or "Lafayette Formation")—Light-tan, yellowish-orange, or reddish-brown pebble gravel with some cobbles and a few boulders in abundant fine sand matrix. For stratigraphic purposes, lower of two parts is described first. In lower part, matrix admixed with minor silt and clay that becomes abundant in upper part. Poorly sorted, massive to weakly bedded. Clasts well rounded to angular, chiefly chert but some of quartz and metamorphic quartzite, and a few of sandstone. Sand mostly quartz; heavy-mineral content higher in kyanite, sillimanite, and staurolite, and lower in zircon and tourmaline than units **age** and **agf**. Characterized also by relatively high amounts of epidote, spinel, and tremolite from metamorphic-rock sources and zircon, sphene, monazite, tourmaline, and topaz from igneous-rock sources, both probably in the Blue Ridge Mountains to east. Deposit is channel-and-fill crossbedded; dip of foreset beds ranges from northwest in the eastern part of area, to southwest in the western part. Lower part of unit forms a buried valley fill as much as 30 m thick that is commonly uncemented but contains zones cemented with iron and manganese oxide, especially near its base. Pollen assemblages from a single locality suggest that the lower part is no older than Miocene and no younger than Pliocene (Olive, 1980). Upper part is lithologically similar but more sandy than the lower part and contains clasts of iron-cemented gravel derived from the lower part. In upland areas, the upper part forms a sheetlike deposit that is only a few meters thick and disconformably overlies the lower part. However, below an altitude of 120 m the upper part is as thick as 30 m along major drainages. Pollen assemblages from a single locality suggest that the upper part of the deposit is of Pleistocene age. Mapped area includes both stratigraphic units. Covered in most places by 2-8 m of colluvially and alluvially reworked loess. Thickness 5–30 m

**QUATERNARY AND TERTIARY**

zsd SANDY DECOMPOSITION RESIDUUM[2]—Light-gray, tan, pinkish-tan, or light-brown, coarse to fine sand to sandy clay. Developed chiefly on flat to gently sloping plateau uplands and broad ridge crests of Cumberland Plateau. On slopes and floors of secondary valleys too small to delineate on map the residuum is reworked to colluvium (**cla**), characterized by numerous landslides that increase in extent northward to become a widespread mappable unit on slopes and uplands. Residuum grades irregularly downward into sandstone or shale; lower part may contain angular slabs of rotted sandstone or chips of shale. Collapse into underlying mines common. Mapped areas include many bedrock exposures. Thickness less than 1.5 m, but locally is as much as 5 m

zsi CLAYEY FINE SAND DECOMPOSITION RESIDUUM[2]—White, buff, or gray, poorly sorted, clayey fine sand, fine sand, and, locally, fine sandy clay; in places may contain admixed loess. Grades down into bedrock. Mapped areas include bedrock outcrops and some locally derived colluvium. Thickness less than 1 m to 2 m

zsk FERRUGINOUS SAND DECOMPOSITION RESIDUUM[2]—Yellowish- to reddish-brown, ferruginous, well-sorted, fine quartz sand, locally cemented by iron oxide to produce highly irregular tubules, boxwork structures, and corrugated masses. Grades imperceptibly down into similarly oxidized parent sand. In

places, sand is slightly clayey and upper part contains admixed loess. Mapped areas include some locally derived colluvium and bedrock outcrops. Thickness indeterminate

zsn SANDY SHALY DECOMPOSITION RESIDUUM[2]—Grayish-, yellowish-, or reddish-brown sandy loam to clay loam. Lower part characterized by shale chips or fragments of sandstone. Mapped areas include thin, stony loam colluvium on steep slopes, and bedrock outcrops along ridge crests. Thickness less than 3 m; locally as much as 6 m

zce MASSIVE CLAY DECOMPOSITION RESIDUUM[2]—Yellowish-gray, brownish-gray, or brownish-black, massive, plastic, smectitic clay. Subject to shrinkage and swelling with changes in moisture content that involve large changes in volume. Locally includes some areas of light-gray or buff fine sandy clay or fine sand. Grades downward into dark-gray clay or, locally, soft, clayey, fine-grained sandstone. Commonly overlain by thin loess and contains some admixed loess in places. Mapped areas include locally derived colluvium and bedrock outcrops. Thickness less than 1 m to 2 m

zrb CHERTY CLAY SOLUTION RESIDUUM[3], SANDY CLAY DECOMPOSITION RESIDUUM[2], AND SILTY CLAY DECOMPOSITION RESIDUUM[2]-Comprises three residua that cannot be shown separately at scale of map. Cherty clay solution residuum is yellowish brown to dark reddish brown, contains subangular slabs of limestone in lower part, and is developed on limestone characterized by sinkholes and other karst features. Sandy clay decomposition residuum is yellowish brown, porous, ferruginous or calcareous, includes slabby sandstone fragments, and is developed on sandstone. Silty clay decomposition residuum is pale yellowish brown to grayish brown, contains shale chips, is characterized by creep structures on slopes, and is developed on shale. Locally admixed with or covered by loess in northern part of mapped area. Mapped areas include bedrock outcrops and some locally derived colluvium, as thick as 8 m, on steep slopes. Thickness 1–3 m

zrc SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[2,3]—Reddish-orange to reddish-brown sandy clay; grades down into sandstone or sandy carbonate rock through zone of subangular, partly decomposed rock fragments. Mantled by more than 6 m of clay-rich loess. Mapped areas include local bedrock outcrops on steep slopes and minor alluvium along streams. Thickness 10 m to more than 60 m

zrd SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[2,3]—Material same as unit zrc. Thickness 2–10 m

rsa CHERT-FRAGMENT SOLUTION RESIDUUM[3]—Yellowish-orange, yellowish-gray, yellowish-brown, or light-reddish-brown sandy loam to sandy clay loam; contains numerous chalcedonic chert fragments, shale chips, and a few quartz geodes. Sharp, very irregular contact with underlying limestone, into which residuum extends along fractures. Residuum grades downward through a zone of rock fragments into shale or sandstone. Mapped areas include bedrock outcrops, locally derived sheetwash deposits, and colluvium at base of steeper slopes. Thickness 3–10 m; locally as much as 40 m

rsb PHOSPHATIC SANDY SOLUTION RESIDUUM[3]—Reddish- to grayish-brown, clayey, silty sand to sandy clay loam. Phosphatic in western half of central basin in Tennessee, nonphosphatic in eastern half. Upper part tends to be less sandy and silty than lower part. Lower part contains shale chips and grades downward into arenaceous limestone with shale interbeds. Mapped areas locally include a mantle of stony clay colluvium and bedrock outcrops. Thickness less than 5 m; locally as much as 15 m where residuum fills solution fissures in limestone

rcc CHERTY CLAY SOLUTION RESIDUUM[3]—Moderate-orange to moderate-brown or tan to reddish-tan, commonly mottled, cherty clay to cherty sandy or silty clay. Chert is gray, yellowish brown or yellowish orange, locally light green or black, and occurs as angular to subround chunks and boulders. Contains slabs of sandstone, siltstone, and, locally, limestone and dolomite at or near the surface. Slabs suggest that deposit may represent, in part, colluvially reworked residuum rather than residuum in place. Contains considerable admixed loess in northern Kentucky. Contact with underlying bedrock abrupt and pinnacled. Mapped areas include some locally derived colluvium as well as bedrock outcrops. Where colluvium overlies residuum on steep slopes, both deposits tend to be unstable. Thickness 5–15 m; locally more than 30 m

rca CHERTY CLAY SOLUTION RESIDUUM[3]—Material same as unit **rcc**, but thicker. Mantled with clay-rich loess that is locally more than 6 m thick. Thickness 10 m to more than 60 m

rcb CHERTY CLAY SOLUTION RESIDUUM[3]—Material same as unit **rcc**, but thinner. Mantled with clay-rich loess that is locally more than 6 m thick. Thickness 2–10 m

rce THIN CLAYEY SOLUTION RESIDUUM[3]—Brown to reddish-brown, clayey residuum containing small amounts of chert and normally in abrupt contact with underlying bedrock. Characteristic of limestone glades of Tennessee. Mapped areas include some locally derived colluvium and extensive areas of barren limestone. Thickness less than 1.5 m, but may be as much as 3 m

rcf CHERTY SILTY CLAY, LOCALLY PHOSPHATIC, SOLUTION RESIDUUM[3]—Yellowish-brown, orange-red, reddish-brown, silty clay containing variable quantities of chert fragments.

Irregular, sharp, solution contact with underlying limestone; gradational through zone of partly weathered rock into local argillaceous limestone and shale. On steeper slopes in central western Tennessee deposit may contain considerable admixed loess. In western part of mapped area some deposits are phosphatic. At periphery of the central basin and on higher outlying hills and ridges, mapped areas include locally derived cherty colluvium as thick as 8 m, and numerous bedrock outcrops. Thickness less than 3 m, but locally as much as 15 m

rch CLAY LOAM SOLUTION RESIDUUM[3]—Reddish-brown clay to clay loam; contains subangular slabs of solution-surfaced limestone in places. Contact with bedrock irregular, locally pinnacled. Sinks and other karst features scattered to abundant. Mapped areas include sparse bedrock outcrops. Thickness 1–7 m

**PRE-TERTIARY**

R BEDROCK

[1]COLLUVIUM is a general term applied, for purposes of this map, to material transported and deposited by mass-wasting processes. In this quadrangle the processes are chiefly creep, solifluction, mudflow, landslide, and frost heave.

[2]DECOMPOSITION RESIDUUM is a general term applied, for purposes of this map, to the residual products of weathering that result primarily from the chemical decay of clastic sedimentary rocks, without appreciable lateral transport.

[3]SOLUTON RESIDUUM is a general term, applied for purposes of this map, to the insoluble residues remaining after solution of carbonate rocks, without appreciable lateral transport.

## SOURCES OF INFORMATION

### ILLINOIS


Follmer, L.R., 1979, A historical review of the Sangamon Soil, *in* Wisconsinan, Sangamonian, and Illinoian stratigraphy in central Illinois: Illinois State Geological Survey Guidebook 13, p. 79–91.

Frye, J.C., and Willman, H.B., 1963, Loess stratigraphy, Wisconsinan classification, and accretion-gleys in west-central Illinois, Midwestern Section Friends of the Pleistocene, 14th Annual Meeting: Illinois State Geological Survey Guidebook Series 5, 37 p.

Frye, J.C., and Willman, H.B., 1965, Illinois, *in* Guidebook for Field Conference G, Great Lakes-Ohio River Valley: International Association for Quaternary Research (INQUA), 7th Congress, U.S.A., p. 5–27.

Jacobs, A.M., and Lineback, J.A., 1969, Glacial geology of the Vandalia, Illinois, region: Illinois State Geological Survey Circular 442, 23 p.

Johnson, W.H., Follmer, L.R., Gross, D.L., and Jacobs, A.M., 1972, Pleistocene stratigraphy of east-central Illinois: Illinois State Geological Survey Guidebook 9, 97 p.

Johnson, W.H., Glass, H.D., Gross, D.L., and Moran, S.R., 1971, Glacial drift of the Shelbyville moraine at Shelbyville, Illinois: Illinois State Geological Survey Circular 459, 22 p.

Johnson, W.H., Gross, D.L., and Moran, S.R., 1971, Till stratigraphy of the Danville region, east-central Illinois, *in* Goldthwait, R.P., Forsyth, J.L., Gross, D.L., and Pessl, Fred, Jr., editors, Till—A Symposium: Columbus, Ohio State University Press, p. 184–216.

McKay, E.D., 1979, Stratigraphy of Wisconsinan and older loesses in southwestern Illinois, *in* Geology of western Illinois: Illinois State Geological Survey Guidebook 14, Trip 2, p. 37–67.

Willman, H.B., Atherton, Elwood, Buschbach, T.C., Collinson, Charles, Frye, J.C., Hopkins, M.E., Lineback, J.A., and Simon, J.A., 1975, Handbook of Illinois stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Willman, H.B., and Frye, J.C., 1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.


### INDIANA


Bleuer, N.K., 1975, The Stone Creek section, a historical key to the glacial stratigraphy of west-central Indiana: Indiana Geological Survey Occasional Paper 11, 9 p.

Bleuer, N.K., 1976, Remnant magnetism of Pleistocene sediments of Indiana: Indiana Academy of Science Proceedings for 1975, v. 85, p. 277–294.

Burger, A.M., Rexroad, C.B., Schneider, A.F., and Shaver, R.H., 1966, Excursions in Indiana geology: Indiana Geological Survey Guidebook 12, 71 p.

Gooding, A.M., 1963, Illinoian and Wisconsin glaciations in the Whitewater Basin, southeastern Indiana and adjacent areas: Journal of Geology, v. 71, p. 665–682.

Gooding, A.M., 1965, Southeastern Indiana, *in* Guidebook for Field Conference G, Great Lakes-Ohio River Valley: International Association for Quaternary Research (INQUA), 7th Congress, U.S.A., p. 43–53.
Gooding, A.M., 1966, The Kansan glaciation in southeastern Indiana: Ohio Journal of Science, v. 66, p. 426–433.
Gooding, A.M., 1973, Character of late Wisconsin tills in eastern Indiana: Indiana Geological Survey Bulletin 49, 28 p.
Gooding, A.M., 1975, The Sidney interstadial and late Wisconsin history in Indiana and Ohio: American Journal of Science, v. 275, p. 993–1011.
Gray, H.H., Bleuer, N.K., Hill, J.R., and Lineback, J.A., 1979, Geologic map of the 1° x 2° Indianapolis quadrangle, Indiana and Illinois, showing bedrock and unconsolidated deposits: Indiana Geological Survey Regional Geologic Map 1 [revised], scale 1:250,000.
Gray, H.H., Forsyth, J.L., Schneider, A.F., and Gooding, A.M., 1972, Geologic map of the 1° x 2° Cincinnati quadrangle, Indiana and Ohio, showing bedrock and unconsolidated deposits: Indiana Geological Survey Regional Geologic Map 7, scale 1:250,000.
Gray, H.H., Wayne, W.J., and Wier, C.E., 1970, Geologic map of the 1° x 2° Vincennes quadrangle and parts of adjoining quadrangles, Indiana and Illinois, showing bedrock and unconsolidated deposits: Indiana Geological Survey Regional Geological Map 3, scale 1:250,000.
Gray, H.H., Wayne, W.J., and Wier, C.E., 1972, Geologic map of the 1° x 2° Louisville quadrangle, Indiana, showing bedrock and unconsolidated deposits: Indiana Geological Survey Regional Geological Map 6, scale 1:250,000.
Harrison, W., and Terasmae, J., 1961, Remnant magnetism in silts of Pleistocene age from North America: Journal of Sedimentary Petrology, v. 31, p. 448–452.
Johnson, W.H., and Bleuer, N.K., 1980, Quaternary geology of east-central Illinois and west-central Indiana, *in* Fraser, G.S., editor, Sediments of the modern meander belt of the Vermillion River near Eugene, Indiana, and sedimentology of the late Wisconsinan terrace deposits along the Big Bend area of the Wabash River: Society of Economic Paleontologists and Mineralogists, Great Lakes Section, Field Trip Guidebook, Trip A, p. 45–58.
Johnson, W.H., Gross, D.L., and Moran, S.R., 1971, Till stratigraphy of the Danville region, east-central Illinois, *in* Goldthwait, R.P., Forsyth, J.L., Gross, D.L., and Pessl, Fred, Jr., editors, Till—A symposium: Columbus, Ohio State University Press, p. 184–216.
Kapp, R.0., and Gooding, A.M., 1974, Stratigraphy and pollen analyses of Yarmouthian interglacial deposits in southeastern Indiana: Ohio Journal of Science, v. 74, p. 226–238.
Olson, C.G., Brunson, K.L., and Ruhe, R.V., 1978, Clay mineral weathering and Quaternary soil morphology, *in* Mahaney, W.C., editor, Quaternary soils: Norwich, England, Geo Abstracts, Ltd., p. 109–123.
Olson, C.G., Ruhe, R.V., and Mausbach, M.J., 1980, The Terra Rossa limestone contact phenomena in karst, southern Indiana: Soil Science Society of America Journal, v. 44, p. 1075–1079.
Ruhe, R.V., and Olson, C.G., 1978, Loess stratigraphy and paleosols in southwest Indiana: Friends of the Pleistocene, Midwest Section, 25th Field Conference Guidebook, 72 p.
Ruhe, R.V., and Olson, C.G., 1980, The origin of Terra Rossa in the karst of southern Indiana: Geological Society of America, North-central Section, 14th Annual Meeting Guidebook, Field Trip 4, p 84–122.
Schneider, A.F., and Wayne, W.J., 1967, Pleistocene stratigraphy of west-central Indiana, *in* Schneider, A.F., editor, Geologic tales along Hoosier trails: Geological Society of America, North-central Section, 1st Annual Meeting, Bloomington, Indiana, Guidebook, Field Trip 3, p. 77–103.
Teller, J.T., 1972, Significant multiple pre-Illinoian till exposure in southeastern Indiana: Geological Society of America Bulletin, v. 83, p. 2181–2188.
Thornbury, W.D., and Wayne, W.J., 1953, Wisconsin stratigraphy of the Wabash Valley and west-central Indiana: Illinois and Indiana Geological Surveys, Biennial Pleistocene Field Conference 4, Itinerary of Joint Geological Field Conference, June 10-17, 1953, p. 74–98.
Thornbury, W.D., and Wayne, W.J., 1957, Kansan, Illinoian, and early Tazewell tills, loesses, and associated faunas in south-central Indiana: Friends of the Pleistocene, Midwest Section, 8th Annual Field Conference, Guidebook, 27 p.
Wayne, W.J., 1958, Early Pleistocene sediments in Indiana: Journal of Geology, v. 66, p. 8–15.
Wayne, W.J., 1963, Pleistocene formations in Indiana: Indiana Geological Survey Bulletin 25, 85 p.
Wayne, W.J., 1965, Western and central Indiana, *in* Guidebook for Field Conference G, Great Lakes-Ohio River Valley: International Association for Quaternary Research (INQUA), 7th Congress, U.S.A., p. 27–42.
Unpublished information contributed by H.H. Gray, N.K. Bleuer, and John Bassett.

## KENTUCKY

Briggs, R.P., 1957, Coal resources of the Campton quadrangle, Kentucky-Tennessee: U.S. Geological Survey Geologic Quadrangle Map GQ-855, scale 1:24,000.
Cressman, E.R., 1968, Geologic map of the Salvisa quadrangle, central Kentucky: U.S. Geological Survey

Geologic Quadrangle Map GQ-760, scale 1:24,000.
Fairer, G.M., Norris, R.L., and Johnson, W.D., 1975, Geologic map of the Beech Grove quadrangle, western Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1230, scale 1:24,000.
Hansen, D.E., 1976, Geologic map of the Sacramento quadrangle, western Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1306, scale 1:24,000.
Jillson, W.R., 1945, The Kentucky River, an outline of drainage modification of a master stream during geologic time: Frankfurt, Kentucky, State Journal, 104 p.
Johnson, W.D., and Smith, A.E., 1975, Geologic map of the Calhoun quadrangle, western Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1239, scale 1:24,000.
Kepferle, R.C., 1967, Geologic map of the Colesburg quadrangle, Hardin and Bullitt Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-602, scale 1:24,000.
Kolata, D.R., Treworzy, J.D., and Masters, J.M., 1981, Structural framework of the Mississippi embayment of southern Illinois: Illinois State Geological Survey Circular 516, p. 115–132.
Leighton, M.M., and Ray, L.L., 1965, Glacial deposits of Nebraskan and Kansan age in northern Kentucky: U.S. Geological Survey Professional Paper 525-B, p.B126–B131.
Luft, S.J., 1980, Map showing the late preglacial (Teays-age) course and pre-Illinoian deposits of the Licking River in north-central Kentucky: U.S. Geological Survey Miscellaneous Field Studies Map MF-1194, scale 1:125,000.
McDowell, R.C., Grabowski, G.J., Jr., and Moore, S.L., 1981, Geologic map of Kentucky: U.S. Geological Survey, scale 1:250,000.
Olive, W.W., 1980 [1981], Geologic maps of the Jackson Purchase region, Kentucky: U.S. Geological Survey Miscellaneous Investigations Series Map 1-1217, scale 1:250,000.
Palmer, J.E., 1976, Geologic map of the Grove Center quadrangle, Kentucky-Illinois, and part of the Shawneetown quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1314, scale 1:24,000.
Potter, P.E., 1955, The petrology and origin of the Lafayette Gravel, part 1, Mineralogy and petrology: Journal of Geology, v. 63, no. 1, p. 1–37, no. 2, p. 115–132.
Ray, L.L., 1957, Two significant new exposures of Pleistocene deposits along the Ohio River in Kentucky: Journal of Geology, v. 65, p. 542–545.
Ray, L.L., 1965, Kentucky, *in* Guidebook for Field Conference G, Great Lakes-Ohio River Valley: International Association for Quaternary Research (INQUA), 7th Congress, U.S.A., p. 53–63.
Ray, L.L., 1974, Geomorphology and Quaternary geology of the glaciated Ohio River Valley—A reconnaissance study: U.S. Geological Survey Professional Paper 826, 77 p.
Russell, E.E., 1975, Stratigraphy of the outcropping Upper Cretaceous in western Tennessee, *in* Russell, E.E., and Parks, W.S., Stratigraphy of the outcropping Upper Cretaceous, Paleocene, and lower Eocene in western Tennessee (including descriptions of younger fluvial deposits): Tennessee Division of Geology Bulletin 75, p. A1–A65.
Swadley, W C, 1971, The preglacial Kentucky River of northern Kentucky: U.S. Geological Survey Professional Paper 750-D, p. D127–D131.
Teller, J.T., 1973, Preglacial (Teays) and early glacial drainage in the Cincinnati area, Ohio, Kentucky, and Indiana: Geological Society of America Bulletin, v. 84, p.3677–3688.
Teller, J.T., and Last, W.M., 1981, The Claryville Clay and early glacial drainage in the Cincinnati, Ohio, region: Palaeogeography, Palaeoclimatology, and Palaeoecology, v. 33, p. 347–367.

MISSOURI

Allgood, F.P, and Persinger, I.P., 1979, Missouri general soil map and soil association description: Columbia, Missouri, U.S. Soil Conservation Service, in cooperation with Missouri Agricultural Experiment Station, 74 p., scale 1:1,333,300.
Anderson, K.H., coordinator, 1979, Geologic map of Missouri: Missouri Geological Survey Division of Geology and Land Survey, scale 1:500,000.
Farrar, Willard, and McManamy, Lyle, 1937, The geology of Stoddard County, Missouri: Missouri Geological Survey and Water Resources, 59th Biennial Report, Appendix 6, 92 p.
Garrett, J.D., Allgood, F.P., Brown, B.L., Grossman, R.B., and Scrivner, C.L., 1978, Soils of the southeast Missouri lowlands: University of Missouri-Columbia, Extension Division, 27 p.
Grohskopf, J.G., 1955, Subsurface geology of the Mississippi embayment of southeast Missouri: Missouri Geological Survey and Water Resources, v. 37, 2nd Series, 133 p.
McCracken, M.H., 1961, Geologic map of Missouri: Missouri Geological Survey, scale 1:500,000.
Saucier, R.T., 1974, Quaternary geology of the lower Mississippi Valley: Arkansas Archeological Survey Research Series 6, 26 p.

OHIO

Blackman, M.J., 1970, A detailed study of the Pleistocene history of a portion of Preble County, Ohio: Oxford, Miami

University of Ohio, M.S. thesis, 160 p.
Bleuer, N.K., 1976, Remnant magnetism of Pleistocene sediments of Indiana: Indiana Academy of Science Proceedings for 1975, v. 85, p. 277–294.
Bonnett, R.B., Sanderson, D.D., and Noltimier, H.C., 1978, Paleomagnetic results from the Minford Silt, Teays Depot, West Virginia [abs.]: Transactions American Geophysical Union, v. 59, p. 224.
Brace, B.R., 1968, Pleistocene stratigraphy of the Hamilton quadrangle [Ohio]: Oxford, Miami University of Ohio, M.S. thesis, 138 p.
Brown, D. M., 1948, The Pleistocene geology of Clark County, Ohio: Columbus, Ohio State University, M.S. thesis, 73 p.
Durrell, R. H., 1961, The Pleistocene geology of the Cincinnati region [Kentucky, Ohio, and Indiana]: Geological Society of America, Guidebook, Field Trip 3, p. 47–57.
Franzi, D.A., 1980, The glacial geology of the Richmond-New Paris region of Indiana and Ohio: Oxford, Miami University of Ohio, M.S. thesis, 134 p.
Goldstein, F.R., 1968, The Pleistocene geology of a portion of Butler County of southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis, 102 p.
Goldthwait, R.P., 1948, Glacial geology, *in* Norris, S.E., Cross, W.P., and Goldthwait, R.P., The water resources of Montgomery County, Ohio: Ohio Water Resources Board Bulletin 12, p. 28–36.
Goldthwait, R.P., 1950, Wisconsin glacial deposits, *in* Norris, S.E., The water resources of Green County, Ohio: Ohio Division of Water Bulletin 19, p. 13–19.
Goldthwait, R.P., 1952, Glacial deposits, *in* Norris, S.E., Cross, W.P., Goldthwait, R.P., and Sanderson, E.E., The water resources of Clark County, Ohio: Ohio Water Research Board Bulletin 22, p. 44–46.
Goldthwait, R.P., Stewart, D.P., Franzi, D.A., and Quinn, M.J., 1981, Quaternary deposits of southwestern Ohio, *in* Roberts, T.G., editor, Geomorphology, hydrogeology, geoarcheology, engineering geology: Geological Society of America, Field Trip Guidebook, v. 3, p. 409–432.
Goldthwait, R.P., White, G.W., and Forsyth, J.L., 1961 [revised 1967], Glacial map of Ohio: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-316, scale 1:500,000.
Gooding, A.M., 1975, The Sidney interstadial and late Wisconsin history in Indiana and Ohio: American Journal of Science, v. 275, p. 993–1011.
Gray, H.H., Forsyth, J.L., Schneider, A.F., and Gooding, A.M., 1972, Geologic map of the $1^{\circ}$ x $2^{\circ}$ Cincinnati quadrangle, Indiana and Ohio, showing bedrock and unconsolidated deposits: Indiana Geological Survey Regional Geologic Map 7, scale 1:250,000.
Guccione, M.J., 1972, Differentiation of tills of the Miami lobe in southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis, 104 p.
Hoyer, M.C., 1977, Relationship of Laurentide ice sheets to valley fills along abandoned Teays drainage lines in southern Ohio: Geological Society of America Abstracts with Programs, v. 5, no. 5, p. 608.
Norris, S.E., and Spieker, A.M., 1966, Ground-water resources of the Dayton area, Ohio: U.S. Geological Survey Water-Supply Paper 1808, 167 p.
Ray, L.L., 1974, Geomorphology and Quaternary geology of the glaciated Ohio River Valley—A reconnaissance study: U.S. Geological Survey Professional Paper 826, 77 p.
Selby, A.C., 1978, The glacial geology of Darke County, Ohio: Columbus, Ohio State University, M.S. thesis, 171 p.
Smith, J.M., 1949, A study of the Wisconsin glaciation of southeastern Indiana and southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis, 74 p.
Steiger, J.R., 1967, Mechanical and carbonate analysis of soil parent material derived from glacial tills and lacustrine deposits in western Ohio: Columbus, Ohio State University, M.S. thesis, 127 p.
Steiger, J.R., and Holowaychuk, Nicholas, 1971, Particle-size and carbonate analysis of glacial till and lacustrine deposits in western Ohio. *in* Goldthwait, R.P., Forsyth, J.L., Gross, D.L., and Pessl, Fred, Jr., editors, Till—A symposium: Columbus, Ohio State University Press, p. 275–289.
Sun, K-H. D., 1975, The soil mechanics and clay mineralogy of glacial tills in a portion of southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis.
Teller, J.T., 1970, Early Pleistocene glaciation and drainage in southwestern Ohio, southeastern Indiana, and northern Kentucky: University of Cincinnati, Ph.D. dissertation, 115 p.
Teller, J.T., and Last, W.M., 1981, The Claryville Clay and early glacial drainage in the Cincinnati, Ohio, region: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 33, p. 347–367.
Thomas, J.B., 1965, A detailed study of the Pleistocene geology of a portion of Preble County, southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis, 119 p.
Thomas, J.B., 1970, Illinoian-Wisconsinan Pleistocene deposits at Eaton, Ohio: Geological Society of America Bulletin, v. 81, p. 3433–3436.
U.S. Soil Conservation Service, published and unpublished soil survey maps of individual counties.
Watson, R.L., 1972, Pleistocene stratigraphy across a portion of the Hartwell moraine in southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis, 133 p.
Wilding, L.P., Drees, L.R., Smeck, N.E., and Hall, G.E., 1971, Mineral and elemental composition of Wisconsin-age till deposits in west-central Ohio, *in* Goldthwait, R.P., Forsyth, J.L, Gross, D.L., and Pessl, Fred, Jr., editors, Till—

A symposium: Columbus, Ohio State University Press, p. 290–317.
Wright, F.M., III, 1970, The Pleistocene stratigraphy of the Farmersville and the northern part of the Middletown quadrangles, southwestern Ohio: Oxford, Miami University of Ohio, M.S. thesis, 189 p.
Unpublished information contributed by J.L. Forsyth, R.P. Goldthwait, Nicholas Holowaychuk, R.J. Larsen, and D.P. Stewart.

TENNESSEE

Elder, J.A., and Springer, M.E., 1978, General soil map of Tennessee: U.S. Soil Conservation Service, in cooperation with Tennessee Agricultural Experiment Station, scale 1:750,000.
Hardeman, W.D., Miller, R.A., and Swingle, G.D., 1966, Geologic map of Tennessee: Tennessee Department of Conservation, Division of Geology, scale 1:250,000.
Olive, W.W., 1980 [1981], Geologic maps of the Jackson Purchase region, Kentucky: U.S. Geological Survey Miscellaneous Investigations Map Series I-1217, scale 1:250,000.
Russell, E.E., and Parks, W.S., 1975, Stratigraphy of the outcropping Upper Cretaceous, Paleocene, and lower Eocene in western Tennessee (including descriptions of younger fluvial deposits): Tennessee Department of Conservation, Division of Geology, Report of Investigations 75, 61 p.
Schreurs, R.L, and Marcher, M.V., 1959, Geology and ground-water resources of the Dyersburg quadrangle, Tennessee: Tennessee Department of Conservation, Division of Geology, Report of Investigations 7, 61 p.

INDEX MAP OF LOESS DISTRIBUTION AND THICKNESS

Lineback, J.A., 1979, Quaternary deposits of Illinois: Illinois State Geological Survey, scale 1:500,000.
Ruhe, R.V., unpublished isopach map of total thickness of Wisconsinan loess in Indiana, scale 1:1,000,000.
Thorp, James, and Smith, H.T.U., 1952, Pleistocene eolian deposits of the United States, Alaska, and parts of Canada: National Research Council Committee for the Study of Eolian Deposits, Geological Society of America, scale 1:2,500,000.
Willman, H.B., and Frye, J.C., 1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, pl. 3, scale 1:2,500,000.

LOCATION OF IMPORTANT STRATIGRAPHIC SECTION—Stratigraphic sequences listed from oldest to youngest

1. Rochester section, Illinois—Illinoian Vandalia Till Member and Berry Clay Member (type section), both of Glasford Formation; Sangamon soil (reference section); sand; Roxana Silt; Farmdale soil; Peoria Loess (Willman and Frye, 1970; Frye and Willman, 1963, 1965; Follmer, 1979). Paratype section for informal Sangamon stage of Willman and Frye (1970)
2. Paddock Creek section, Illinois—Pre-Illinoian Omphghent till member[4] (type section) of Banner Formation; paleosol; Illinoian Fort Russell till member[4] (type section) of Glasford Formation; Sangamon soil; Roxana Silt; Farmdale soil; Peoria Loess (McKay, 1979)
3. Mulberry Grove section, Illinois—Illinoian Smithboro Till Member (type section), Mulberry Grove Silt Member (type section), and Vandalia Till Member, all of Glasford Formation; Pearl Formation; Sangamon soil; Roxana Silt; Farmdale soil; Peoria Loess (Jacobs and Lineback, 1969)
4. Vandalia Bridge section, Illinois—Pre-Illinoian till; "Yarmouth" paleosol[5]; Illinoian Smithboro Till Member and Vandalia Till Member, both of Glasford Formation; Pearl Formation (Jacobs and Lineback, 1969)
5. Shelbyville section, Illinois—Composite section: Illinoian Vandalia Till Member and Berry Clay Member, both of Glasford Formation, and Sangamon soil; Roxana Silt; Robein Silt and Farmdale soil (21,400±1,000 B.P., ISGS-46); Morton Loess; peat, stratigraphically equivalent to Robein Silt and Morton Loess (21,300±500 B.P., ISGS-32, and 20,000±200 B.P., ISGS-26); Piatt Till Member of Wedron Formation; Richland Loess (Johnson, Gross, and others, 1971)
6. Jewett section, Illinois—Pre-Illinoian Tilton Till Member of Banner Formation; "Yarmouth" paleosol[5]; Illinoian Smithboro Till Member and Vandalia Till Member, both of Glasford Formation; Sangamon soil; Roxana Silt; Farmdale soil; Peoria Loess (Jacobs and Lineback, 1969; Johnson and others, 1972)
7. Hutton section, Illinois—Illinoian Smithboro Till Member and Mulberry Grove Silt Member, both of Glasford Formation; Pike soil; Illinoian Vandalia Till Member of Glasford Formation; Sangamon soil; Roxana Silt; Farmdale soil; Peoria Loess (Johnson and others, 1972)
8. Center School section, Illinois—Illinoian Vandalia Till Member of Glasford Formation; Pearl Formation; Sangamon soil; Roxana Silt; Robein Silt and Farmdale soil (20,500±130 B.P., ISGS-89); Henry Formation; late Wisconsin Fairgrange Till Member of Wedron Formation; Henry Formation; Richland Loess (Johnson and others, 1972)
9. New Harmony section, Indiana—Illinoian till of Jessup Formation; "Sangamon" paleosol[6]; Farmdale Loess

Member and Peoria Loess Member, both of Atherton Formation (Olson and others, 1978)

10. Mount Vernon section, Indiana—Composite section: pre-Illinoian silt and sand; "pre-Loveland" or "Yarmouth" paleosol[5]; Loveland Loess Member of Atherton Formation; "Sangamon" paleosol'; Farmdale Loess Member and Peoria Loess Member, both of Atherton Formation (Ruhe and Olson, 1978; Olson and others, 1978)
11. Newburgh section, Indiana—Paleosol on pre-Quaternary bedrock; Loveland Loess Member of Atherton Formation; "Sangamon" paleosol[6]; Farmdale Loess Member and Peoria Loess Member, both of Atherton Formation (Ruhe and Olson, 1978)
12. Mill Creek section, Indiana—"Pre-glacial" gravel; intensely weathered clay (reversed magnetic polarity); silt (reversed magnetic polarity); clay (reversed magnetic polarity); pre-Illinoian West Lebanon till[4]; sand and gravel; undivided tills of Wisconsin age (Bleuer, 1976. unpub. data, 1983; W.H. Johnson, unpub. data, 1983)
13. Hillsdale section, Indiana—Pre-Illinoian Harmattan Till Member of Banner Formation; paleosol; pre-Illinoian till; pre-Illinoian Hillery Till Member of Banner Formation; silt (normal magnetic polarity); Hillery Till Member; loess; late Wisconsin till of Wedron Formation (Bleuer, 1976, unpub. data, 1983; W. H. Johnson, unpub. data, 1983)
14. Strangers Branch section, Indiana—Pre-Illinoian Hillery Till Member of Banner Formation; silt; pre-Illinoian till (possibly Tilton Till Member of Banner Formation); paleosol; silt; "Yarmouth" peaty silt[5] (>36,000 B.P., W-669); silt and sand; Illinoian Smithboro Till Member of Glasford Formation; silt; Illinoian Vandalia Till Member of Glasford Formation (Wayne, 1963; Schneider and Wayne, 1967; Johnson and Bleuer, 1980)
15. Liberty School section, Indiana—Composite section: pre-Illinoian Cloverdale Till Member of Jessup Formation; silt and sand; "Yarmouth" alluvium[5] (normal magnetic polarity); pre-Illinoian Hillery Till Member of Banner Formation; sand; pre-Illinoian Tilton Till Member of Banner Formation; "Sangamon" paleosol[6]; Farmdale Loess Member of Atherton Formation; late Wisconsin Center Grove Till Member of Trafalgar Formation; Peoria Loess Member of Atherton Formation (Thornbury and Wayne, 1953; Wayne, 1965; Burger and others, 1966; Schneider and Wayne, 1967; Johnson and others, 1971; Bleuer, 1976, unpub. data, 1983; W. H. Johnson, unpub. data, 1983)
16. Cagles Mill Reservoir section, Indiana—Cagle Loess Member (type section; normal magnetic polarity) of Atherton Formation; clay (normal magnetic polarity); pre-Illinoian Cloverdale Till Member (type section) of Jessup Formation; "Yarmouth" paleosol[5]; pre-Illinoian till; "Sangamon" paleosol[6]; Peoria Loess Member of Atherton Formation (Wayne, 1958, 1963, 1965; Harrison and Terasmae, 1961; Schneider and Wayne, 1967; Bleuer, 1976, unpub. data, 1983; W.H. Johnson, unpub. data, 1983)
17. Clayton section, Indiana—Composite section: late Wisconsin Center Grove Till Member of Trafalgar Formation (wood in till, 22,300±800 B.P., W-595); sand and gravel; fossiliferous silt; sand and gravel; silt; late Wisconsin Cartersburg Till Member (type section) of Trafalgar Formation; silt, sand, and gravel; Cartersburg Till Member (Thornbury and Wayne, 1953, 1957; Wayne, 1963)
18. Buckhart Creek section, Indiana—Illinoian Butlerville Till Member of Jessup Formation; "Sangamon" paleosol; late Wisconsin Center Grove Till Member of Trafalgar Formation (type section; wood in till, 20,900±900 B.P., W-580); gravel; silt (20,300±800 B.P., W-597, and 20,100±800 B.P., W-598); late Wisconsin Cartersburg Till Member of Trafalgar Formation (type section); silt, weathered profile in sand and silt; Cartersburg Till Member (Wayne, 1963, 1965; Burger and others, 1966)
19. Osgood section, Indiana—Clay; pre-Illinoian Columbia till[4]; sand; "Yarmouth" paleosol[5]; Illinoian till; sand and gravel; Illinoian till; silt (Gooding, 1966)
20. St. Maurice section, Indiana—Cherty clay and silt; pre-Illinoian till: silt and clay; pre-Illinoian till; sand and gravel; pre-Illinoian till; paleosol; silt; sand and gravel: "Yarmouth" paleosol[5]; Illinoian till (Teller, 1972; N. K. Bleuer, unpub. data, 1983)
21. Handley Farm section, Indiana—Pre-Illinoian till (Alpine till[4]?); clay (reversed magnetic polarity) having unconformable upper contact; clay (reversed magnetic polarity) containing "full interglacial" pollen; pre-Illinoian Columbia till[4] or colluvium derived from till; "Yarmouth" paleosol[5]; clay; sand and gravel: Illinoian till; loess (Gooding, 1965, 1966; Kapp and Gooding, 1974: Bleuer, 1976)
22. Townsend Farm section, Indiana—Pre-Illinoian Alpine till[4] (type section); sand; pre-Illinoian Columbia till[4] (type section); silt; "Yarmouth" paleosol[5]; clay; Illinoian till (Gooding, 1966)
23. Sefton Farm section, Indiana—Illinoian Richmond till[4]; clay; silt and "Sangamon" paleosol[6]; late Wisconsin Fayette till[4] (wood in till, 21,150±450 B.P., I-4345); peaty silt (stump in silt, 20,000±500 B.P., I-610): late Wisconsin Shelbyville till[4]; sand and gravel (Gooding, 1963, 1965, 1975)
24. Cummins Farm section, Indiana—Composite section: Illinoian Richmond till[4]; loess; "Sangamon" paleosol[6]; silt (stump on "Sangamon" paleosol surface and buried by silt, >40,000 B.P., I-677); early Wisconsin Whitewater till[4] or late Wisconsin Fayette till[4]; sand and gravel: late Wisconsin Shelbyville till[4]: loess (Gooding, 1963, 1965, 1975)
25. Darrah Farm section, Indiana—Illinoian Centerville till[4]; silt; Illinoian Richmond till[4]; sand; Richmond till: humus; silt; "Sangamon" paleosol[6]; early Wisconsin Whitewater till[4]; fossiliferous silt; Whitewater till[4]

(wood in till, >41,000 B.P., L-414-A); late Wisconsin Fayette till[4]; silt; late Wisconsin Shelbyville till[4]: silt; late Wisconsin Champaign till[4] (Gooding, 1963)

26. Smith Farm section, Indiana—Illinoian Centerville till[4]; silt and clay; Illinoian Richmond till[4]; sand; Richmond till; silt and sand; Sangamon paleosol; clay; early Wisconsin Whitewater till[4] (wood in till, >43,000 B.P., L-479-A); silt; late Wisconsin till (Fayette till[4]); sand; late Wisconsin Shelbyville till[4] (Gooding, 1963, 1965)
27. Wildman Farm section, Indiana—Illinoian Centerville till[4] (type section); silt; Illinoian Richmond till[4] (type section); silt; gravel; Richmond till (type section); sand and gravel; silt and clay; Richmond till (type section); sand and silt; silt and clay; gravel and sand; "Sangamon" paleosol[6] ; late Wisconsin Fayette till[4] or Shelbyville till[4] (Gooding, 1963)
28. American Aggregates section, Indiana—Illinoian Richmond till[4]; sand and gravel; Richmond till; silt and sand; early Wisconsin Whitewater till[4] (type section); silt and fine sand (>38,000 B.P., I-587, and >40,500 B.P., L-478-B); late Wisconsin Fayette till[4]; sand and gravel; late Wisconsin Shelbyville till[4]; sand and gravel; late Wisconsin Champaign till[4] (Gooding, 1963; Wayne, 1965)
29. New Paris Water Works section, Ohio—Early Wisconsin Whitewater till[4]; silt and clay (normal magnetic polarity); sand and gravel; early Wisconsin Fairhaven till[4]; sand; Fairhaven till; sand and gravel; colluvium(?) and Sidney paleosol; silt and clay (normal magnetic polarity; 23,450±500 B.P., I-8928, and 23,300±500 B.P., I-7345); paleosol (normal magnetic polarity); late Wisconsin Fayette fill[4]; sand; late Wisconsin "lower Shelbyville" till[4]; sand and gravel; late Wisconsin Crawfordsville till[4]; loess (Gooding, 1975; Bleuer, 1976; Goldthwait and others, 1981)
30. Bantas Fork No. 1 section, Ohio—Gravel, sand, silt, and clay (wood, 44,800±1700 B.P., ISGS-726, age suspect and should be treated as an infinite age); early Wisconsin Fairhaven till[4]; Sidney paleosol; late Wisconsin Fayette till[4] (wood in till, 20,500±420 B.P., I-10,184); sand and gravel; late Wisconsin "upper Shelbyville" till[4]; gravel; late Wisconsin Crawfordsville till[4]; sand and gravel; late Wisconsin Knightstown till[4]; loess (Goldthwait and others, 1981)
31. Eaton-Fredrick section, Ohio—Illinoian till; "Sangamon" paleosol[6]; early Wisconsin Whitewater till[4]; sand; late Wisconsin Fayette till[4] (wood in till, 22,230-430 to +415 B.P., DIC-41, and 21,940±130 B.P., ISGS-116); sand and gravel; undivided late Wisconsin tills; loess (Thomas, 1970)
32. Somers Farm North section, Ohio—Illinoian Richmond till[4]; sand; early Wisconsin Whitewater till[4] (wood in till, >45,160 B.P., ISGS-590); sand; early Wisconsin Fairhaven till[4] (type section); Sidney paleosol; late Wisconsin "lower Shelbyville" till[4]; loess (Goldthwait and others, 1981)
33. Doty's High Bank section, Ohio—Early Wisconsin Whitewater till[4]; silt (wood, 21,500±60 B.P., QL-1372, 21,350±60 B.P., QL-1373, and 21,070±100 B.P., ISGS-604); late Wisconsin "lower" Fayette till[4] (wood in till, 21,250±440 B.P., I-10,185); late Wisconsin "upper" Fayette till[4]; gravel, sand, and silt (stumps in lake sediments, 20,210±260 B.P., ISGS-761, and 20,100±800 B.P. and 19,400±250 B.P., laboratory numbers not listed); late Wisconsin "lower Shelbyville" till[4] (wood in till, 20,500±420 B.P., I-10,184, and 19,980±500 B.P., W-92); sand and silt; "upper Shelbyville" till[4]; loess (Durrell, 1961; Goldthwait and others, 1981)
34. Hamilton section, Ohio—Illinoian till; loess; "Sangamon" paleosol[6]; late Wisconsin Fayette till[4]; sand and gravel; silt (18,750±300 B.P., W-738, age suspect); paleosol; late Wisconsin Shelbyville till[4] (wood in till, 19,100±300 B.P., W-724); loess (Durrell, 1961)
35. Rack Sand and Gravel Co. section, Ohio—Deltaic clay and sand; pre-Illinoian or Illinoian till; sand; silt and clay; sand with paleosol; Illinoian till (Durrell, 1961; Goldthwait and others, 1981)
36. Backbone Creek section, Ohio—Gravel; "Yarmouth(?)" alluvium[5]; "Yarmouth(?)" paleosol[5]; sand and gravel; Illinoian till (Goldthwait and others, 1981)
37. Greater Cincinnati Airport section, Kentucky—Composite section: pre-Illinoian till; loess; "Afton" paleosol[7]; pre-Illinoian till; sand; loess; "Yarmouth" paleosol[5]; loess (Ray, 1965, 1974)
38. Pleasant Valley section, Kentucky—Composite section: sand, silt, and clay; pre-Illinoian till; accretion-gley and "Afton" paleosol[5]; pre-Illinoian till; accretion-gley and paleosol; loess and "Yarmouth" paleosol[5]; loess (Leighton and Ray, 1965; Ray, 1965, 1974)
39. Phillips Branch section, Kentucky—Pre-Illinoian till; "Yarmouth" paleosol[5]; Peoria Loess (Ray, 1957, 1974)

[4]Informal stratigraphic unit.

[5]"Yarmouth" paleosols, peaty silt, and alluvium in Illinois, Indiana, Ohio, and Kentucky are not necessarily the same age as the Yarmouth paleosol in its type area in Iowa.

[6]"Sangamon" paleosols in Indiana and Ohio are not necessarily the same age as the Sangamon soil in its type area in Illinois.

[7]The "Afton" paleosol in Kentucky is not necessarily the same age as the Afton paleosol in its type area in Iowa.