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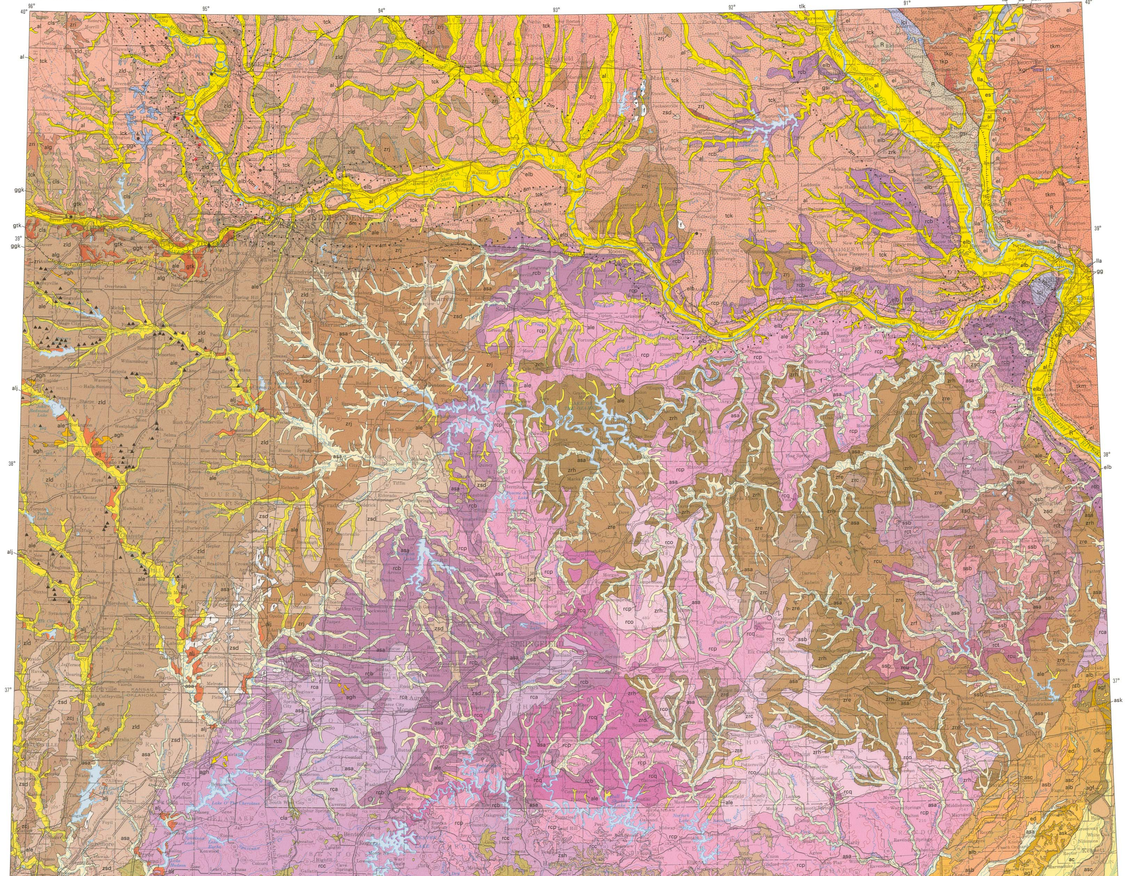
KANSAS GEOLOGICAL SURVEY, ARKANSAS GEOLOGICAL COMMISSION,
ILLINOIS STATE GEOLOGICAL SURVEY, AND OKLAHOMA GEOLOGICAL SURVEY

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
OZARK PLATEAU 4° × 6° QUADRANGLE
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1420 (NJ–15)



QUATERNARY GEOLOGIC MAP OF THE OZARK PLATEAU 4° × 6° QUADRANGLE, UNITED STATES

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1993
QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES

INDEX TO INTERNATIONAL MAP OF THE WORLD 1:1,000,000 TOPOGRAPHIC SERIES

Showing location of the Quaternary Geologic Map of the Ozark Plateau 4° × 6° Quadrangle as met [U.S. Geological Survey, Miscellaneous Investigations Series Map I–1420 (NJ–15)] and other published maps in the Quaternary Geologic Atlas of the United States in yellow.

NOTE: This map is the product of collaboration of State geological surveys 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 Quaternary deposits in each 1° × 2° quadrangle were prepared by the State compilers. Second, these maps were integrated and locally supplemented by the editors; map unit symbols were revised to a single, consistent classification; and map unit descriptions were prepared from information received from State compilers and from additional sources. Diagrams across the bottom 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 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 the management of resources associated with regions that have extensive slope and upland deposits (colluvium, residuum, and saprolite, 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 and unpublished and unpublished soil surveys, as an aid to the study and the distribution of bedrock parent materials. The classification is crude, but represents a first step toward a more refined and useful product.

For Missouri, Kansas, and Illinois, 32 geologic units are described 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. Most landslide deposits are too small to be shown at this scale.

For parts of Arkansas, 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 result, some soil types 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.

LIST OF MAP UNITS

HOLOCENE

- asa ALLUVIAL GRAVELLY SAND
- ac ALLUVIAL CLAY

HOLOCENE AND LATE WISCONSIN

- al ALLUVIUM
- ale ALLUVIAL SILT AND CLAY
- alg ALLUVIAL SILT AND CLAY
- ed DUNE SAND
- es EOLIAN SHEET SAND
- el LOESS

HOLOCENE AND WISCONSIN

- ask ALLUVIAL SAND, SILT, AND CLAY
- cla SANDSTONE AND SHALE CLAST LOAMY COLLUVIUM
- clk GRAVELLY SILTY CLAY COLLUVIUM
- cls CHERT-CLAST CLAYEY SILT TO SILTY CLAY LOAM COLLUVIUM

HOLOCENE, WISCONSIN, AND ILLINOIAN

- elb LOESS

LATE WISCONSIN

- gg OUTWASH SAND AND GRAVEL
- alb SILTY ALLUVIUM

WISCONSIN

- lla LAKE CLAY AND SILT

EARLY WISCONSIN

- asc ALLUVIAL SILTY SAND
- asb ALLUVIAL SAND

WISCONSIN, ILLINOIAN, AND PRE-ILLINOIAN

- agch ALLUVIAL CHERT GRAVEL AND SAND

ILLINOIAN

- lci LAKE SILT AND CLAY
- gai OUTWASH SILT, SAND, AND GRAVEL
- ggk ICE-CONTACT SAND AND GRAVEL
- tkm LOAMY TILL
- tkg LOAMY TILL
  Ground moraine
  End moraine
- ats ALLUVIAL SILTY CLAY, SAND, AND GRAVEL
- ggk ALLUVIAL SILTY CLAY, SAND, AND GRAVEL

PRE-ILLINOIAN

- lck LAKE CLAY
- gnk OUTWASH SANDY GRAVEL AND TILL
- tlk LOAMY TILL
- tck CLAY LOAM TILL

EARLY PLEISTOCENE TO PLIOCENE(?)

- agf CHERT PEBBLE GRAVEL AND SAND
- agch UPLAND CHERT GRAVEL

QUATERNARY AND TERTIARY

- zsd SANDY DECOMPOSITION RESIDUUM
- zsh SILTY SAND AND SANDY SILT DECOMPOSITION RESIDUUM
- zld CLAYEY SILT TO SILTY CLAY DECOMPOSITION RESIDUUM
- zcj CLAY AND SILTY CLAY DECOMPOSITION RESIDUUM
- zrc THICK SAND AND SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zrd THICK SAND AND SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zre THICK CHERTY SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zrf VERY THICK CHERTY SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zrh THIN CHERTY SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zrg SHALY CLAY AND CHERTY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zri SILTY CLAY AND CHERTY CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zrj SANDY CLAY, SILTY CLAY, AND CLAY DECOMPOSITION AND SOLUTION RESIDUUM
- zrk CHERTY SILTY TO SILTY CLAY LOAM DECOMPOSITION AND SOLUTION RESIDUUM
- zrl SILTY CLAY LOAM DECOMPOSITION AND SOLUTION RESIDUUM
- rcc CHERTY CLAY SOLUTION RESIDUUM
- rca THICK CHERTY CLAY SOLUTION RESIDUUM
- rce CHERTY CLAY SOLUTION RESIDUUM
- rco THICK CHERTY SILTY TO SANDY CLAY SOLUTION RESIDUUM
- rcq THIN CHERTY SILTY TO SANDY CLAY SOLUTION RESIDUUM
- rcq VERY THIN CHERTY SILTY TO SANDY CLAY SOLUTION RESIDUUM
- rca VERY THICK CHERTY SILTY CLAY AND CLAYEY SILT SOLUTION RESIDUUM
- rct THICK CHERTY SILTY CLAY AND CLAYEY SILT SOLUTION RESIDUUM
- rcu THIN CHERTY SILTY CLAY AND CLAYEY SILT SOLUTION RESIDUUM
- ssb SANDY SILTY SAPROLITE

PRE-TERTIARY

- R BEDROCK

- CONTACT
- STRIATIONS—Showing direction of glacier movement
- ICE-PUSH STRUCTURE
- ICE-THRUST STRUCTURE AND INFERRED DIRECTION OF GLACIER MOVEMENT
- OUTER LIMIT OF GLACIAL ADVANCE—Solid where marked by distal edge of end moraine; dashed where inferred; dotted where buried
- BURIED OUTER LIMIT OF OLDEST KNOWN PRE-ILLINOIAN GLACIAL ADVANCE IN MISSOURI
- BURIED PLEISTOCENE RIVER CHANNEL
- PEARLETTE FAMILY TEPHRA—Not identified individually
- DEPOSIT OF UPLAND CHERT GRAVEL (agh) TOO SMALL TO MAP SEPARATELY
- • • 10m · LOESS THICKNESS—Thickness in meters
  - LOESS—Peoria Loess, 2–6 m thick, overlying "Yarmouth-Sangamon" to late Sangamon paleosol developed in one or more pre-Illinoian till and, locally, in accompanying residuum (zsd, zrj, zrk, zrl) north of the Missouri River
  - LOESS—Peoria Loess, 6–10 m thick, overlying Sangamon paleosol developed in Loveland Loess, 2–6 m thick. The loesses overlie Yarmouth paleosol developed in one or more pre-Illinoian tills (tck, tlk), and, locally, in accompanying residuum (zsd) north of the Missouri River
  - LOESS—Peoria Loess and underlying Roxana Silt, together less than 6 m thick. Commonly overlies Sangamon paleosol developed in deposits of Illinoian age (tkm, tkg, kgi, gai, lci)
  - LOESS—Peoria Loess (Wisconsin) less than 2 m thick and eolian or loamy residuum (zsd, zrj) generally absent
- f MAN-MADE LAND—Chiefly mine pits and spoil piles
- LOCATION OF IMPORTANT STRATIGRAPHIC SECTION—Stratigraphic sequences listed from oldest to youngest
  - a1 Type locality, NE1/4SE1/4 sec. 6, T. 2 S., R. 20 E., Doniphan County, Kansas (from quarry face and auger holes; exposure now destroyed) (modified from Frye and Leonard, 1952)—Pre-Illinoian David City Formation, gravel, cobbles, and boulders of limestone, igneous rocks, and quartzite in silty sand matrix, upper part well-sorted sand; pre-Illinoian Iowa Point Till, fossiliferous at base, paleosol (not stratigraphically equivalent to type Afton paleosol) developed in uppermost part; pre-Illinoian "Kansan" till, fossiliferous at base, Yarmouth paleosol (not stratigraphically equivalent to type Afton paleosol) developed in uppermost part; Illinoian Loveland Loess; and Sangamon paleosol developed in uppermost part; Holocene Peoria Loess, with Brady paleosol developed in uppermost part; Holocene Bignell Loess
  - a2 Hutchens Tooth No. 2 section, SW1/4NE1/4 sec. 33, T. 3 S., R. 22 E., Doniphan County, Kansas (modified from Bayne and others, 1971)—Fluvial gravel and sand containing a few cobbles, overlain by fine-grained silt, sand, and clay; paleosol (not stratigraphically equivalent to type Afton paleosol) developed in upper part; overlain by loess less than 6 m thick; pre-Illinoian Cedar Bluffs Till, sandy, pebbly, and bouldery, paleosol developed in upper part; Illinoian Loveland Loess
  - a3 Type locality of Atchison Formation, SE1/4SW1/4 sec. 2, T. 6 S., R. 20 E., Atchison County, Kansas (modified from Frye and Leonard, 1952)—Pre-Illinoian Atchison Formation, clasts mostly limestone, in a very fine grained, well-sorted, thin-bedded, crossbedded, locally cemented with calcium carbonate, sandy to gravelly loam; pre-Illinoian "Kansan" till, clasts of limestone, igneous rock types, and pink quartzite
  - a4 Type locality, Nortonville Clay, NE1/4NW1/4 sec. 12, T. 7 N., R. 18 E., Nortonville quadrangle, Atchison County, Kansas (modified from Frye and Leonard, 1952, and James Thorp and H.G. O'Connor, Kansas Geological Survey, unpublished data, 1966)—Pre-Illinoian till, oxidized, calcareous; pre-Illinoian Nortonville Clay, light-gray to pink, mottled, plastic clay including some silt, fine sand, and a few erratic pebbles; calcareous except for widely scattered carbonate concretions; Wisconsin Loess. The Nortonville Clay is an important stratigraphic marker; it is correlative with the Fertrelview Formation (stratigraphic section 6) in Missouri (Howe and Heim, 1986)
  - a5 Missouri Power section, center SW1/4 sec. 9, T. 11 S., R. 15 E., Shawnee County, Kansas (modified from Davis and Carlson, 1952, p. 275)—Pre-Illinoian Atchison Formation, clasts mostly limestone, a very few of granite and metamorphic rock types; "Kansan" till, fluvial pebbly sand (formerly Grand Island Member of Meade Formation)
  - a6 Type locality of Fertrelview Formation, SE1/4SE1/4NE1/4 sec. 5, T. 52 N., R. 34 W., Platte County, Missouri (modified from unpublished log of Missouri Geological Survey Drill Hole No. 984 recorded by G.E. Heim, Jr., and R.B. McMillan, 1956)—Pre-Illinoian till, Fertrelview Formation, brown-gray clay including some silt and fine to coarse sand; Illinoian Loveland Loess, Sangamon paleosol developed in uppermost part; Wisconsin Peoria Loess. The Fertrelview Formation is an important stratigraphic marker; correlative with the Nortonville Clay in Kansas (Howe and Heim, 1968)
  - a7 Mt. Hope Church section, SW1/4SE1/4 sec. 14, T. 49 N., R. 12 W., Boone County, Missouri (modified from Allen and Guccione, 1973)—Pre-Illinoian sandy clay till, highly contorted, manganese stained, weakly calcareous; contorted clayey silt; sandy gravel, mostly of limestone, chert, and very scarce northern erratics; till, bedded, locally contorted, leached, manganese stained, reworked paleomagnetism; clayey till, bedded, sand, yellowish brown, noncalcareous; till, manganese stained, leached, gravel of rotted granite, gabbro, greenstone and some chert; manganese stained sand, brown, leached; clayey sand, locally till-like, with stone line at surface; paleosol; Illinoian(?) sandy silt; manganese stained; Wisconsin loess

DESCRIPTION OF MAP UNITS

HOLOCENE

- asa ALLUVIAL GRAVELLY SAND—Light-brown, gray, or grayish-brown sand, silt, and gravel intermixed and interbedded; local lenses of clay. Gravel component consists of pebbles less than 3 cm in diameter; pebbles chiefly chert and quartz, a few sandstone. Underlies flood plains and low terraces of Black River and its tributaries in northeastern Arkansas. On flood plains in northeastern Oklahoma and western Missouri, mostly sand with very minor gravel. Mapped areas include some locally derived colluvium and organic-rich swamp deposits. Thickness 3–30 m; in western Missouri, averages 6 m
- ac ALLUVIAL CLAY—Gray, brown to reddish-brown, poorly to well-bedded clay, silt, and fine sand; represents overbank deposits of Mississippi River. Locally includes deposits of dark-brown to black organic clay in swamps and oxbow lakes. Overlies older fluviolacustrine and alluvial deposits; 1.0 m to more than 70 m thick, of gravel, sand, silt, and clay that becomes coarser with depth. Thickness 3–12 m

HOLOCENE AND LATE WISCONSIN

- al ALLUVIUM (Cahokia Alluvium in Illinois; unnamed elsewhere)—Brown to gray silt, clay, sand, and gravel. Noncalcareous to calcareous, moderately to well sorted, stratified; upper part commonly silt and fine sand, lower part chiefly sand and, locally, rounded pebble gravel. Clasts primarily limestone, chert, and erratic igneous and metamorphic rock types derived from glacial deposits. Overlies older thick fluvial and fluviolacustrial sand and gravel. Total thickness of both alluvium and older deposits is more than 60 m in Missouri and Mississippi River valleys, less than 30 m in Kansas River valley, and 5–10 m in tributary valleys
- ale ALLUVIAL SILT AND CLAY—Black to dark-gray or dark- to light-brown silt, clay, and fine sand; includes local lenses of sand and pebbly sand gravel; clasts 2–4 cm in diameter. Silt and clay commonly organic-rich and highly plastic. Underlies flood plains and low terraces. Thickness 0.5–10 m; locally as thick as 20 m in Kansas
- alg ALLUVIAL SILT AND CLAY—Brown to dark-gray silt, clay, and sand with local lenses of gravel. Underlies terraces along Kansas River and its tributaries. Clasts chiefly chert, limestone, and erratic igneous and metamorphic rock types derived from older glacial deposits. Thickness 10–30 m
- ed DUNE SAND—Pale-brown, crossbedded, well-sorted, weakly calcareous, medium to fine sand. Chiefly quartz and minor heavy minerals. Underlies low terraces along valley of Black River and Crowley's Ridge; stabilized by vegetation except for small blowouts. Thickness 3–10 m
- es EOLIAN SHEET SAND (included in Parkland Sand in Illinois)—Pale-brown, weakly calcareous, well-sorted, medium to fine sand; locally silty. Generally downwind from areas of alluvial sand and gravel (gg). Commonly overlies lake deposits (lla). Mapped only in Illinois. Thickness 1–3 m
- el LOESS (Peoria Loess in Illinois)—Gray to yellowish-brown, windblown silt and silt loam; calcareous where thick, weakly compacted and jointed. Mapped only where more than 6 m thick. Occurs chiefly on uplands adjacent to major outwash deposits. Commonly overlies a Farmdale paleosol developed in brown or reddish-brown to dark-gray, compact, leached, Roxana Silt, which in turn overlies lake deposits (lla) or bedrock. Elsewhere in Illinois, Peoria Loess and Roxana Silt overlie a Sangamon paleosol developed in tills of Illinoian age (tkm, tkg). (See loess distribution and thickness map.) Thickness 6–10 m

HOLOCENE AND WISCONSIN

- ask ALLUVIAL SAND, SILT, AND CLAY—Grayish- to yellowish-brown sand, silt, and clay, intermixed and interbedded, gravelly near base. Poorly to well stratified; poorly to well sorted. Clasts chiefly chert, locally derived rocks; alluvial gravel (agf); fine component chiefly reworked loess. Material becomes coarser and more gravelly in headwater areas. Underlies both flood plains and terraces. Mapped areas include local colluvium and slope-wash deposits. Thickness as 10 m in upland valleys; 10 to more than 20 m in lower parts of valleys
- cla SANDSTONE AND SHALE CLAST LOAMY COLLUVIUM"—Very dark grayish brown to yellowish-brown silt loam, silty clay loam, and fine sandy loam containing angular to subangular, pebble- to boulder-size fragments of sandstone and shale. Mapped only in Arkansas and Oklahoma. Mapped areas include a few bedrock exposures on steep slopes, local patches of eolian sand, and minor alluvium along streams. Thickness 0.5–1.5 m
- clk GRAVELLY SILTY CLAY COLLUVIUM"—Grayish- to yellowish-brown, poorly consolidated, fine sandy, silty clay containing chips and fragments of shale and sandstone, and pebbles to cobbles of locally reworked chert gravel derived from older alluvial deposits (agf) upslope. Mapped only in southeastern Missouri. Thickness 0.5–2 m
- cls CHERT-CLAST CLAYEY SILT TO SILTY CLAY LOAM COLLUVIUM"—Reddish-, dark- or grayish-brown, or gray silt loam, silty clay, or clay; contains abundant angular fragments of chert and some of limestone, sandstone, and shale. Derived from decomposition residuum (unit zld) or bedrock upslope. Also contains erratics of igneous and metamorphic rocks derived from till (unit tck) upslope. Mapped only in northwestmost part of quadrangle. Distribution based on extent of till dissection and slope. Mapped areas may include local eroded remnants of decomposition residuum (unit zld), especially on gentle upland slopes, minor local alluvium, and bedrock outcrops. Thickness 0.25–2 m

HOLOCENE, LATE WISCONSIN, AND ILLINOIAN

- elb LOESS (Bignell Loess, Peoria Loess, and Loveland Loess; Bignell, Peoria, and Loveland Formation of Kansas Geological Survey, Missouri) Loess not recognized in Missouri)—Grayish-, yellowish-, or reddish-brown silt loam; locally calcareous; locally includes sand lenses in low-lying areas of dark-gray silty clay (Gilman Canyon Formation in Kansas). A Sangamon paleosol commonly developed in uppermost Loveland Loess beneath Peoria Loess in Kansas and Missouri. Loess thickest near major rivers, thins away from them in a short distance. Thin Peoria Loess widespread on pre-Illinoian till in northern Missouri. South of the Kansas and Missouri Rivers, thin patchy loess commonly intermixed and interbedded with locally partly-weathered alluvial, residual, or alluvial deposits. Thickness 2–40 m along the Missouri River in Kansas, 3–23 m along the Missouri and Mississippi Rivers in Missouri

LATE WISCONSIN

- gg OUTWASH SAND AND GRAVEL (Mackinaw Member of Henry Formation in Illinois)—Pale-brown to gray, fine to coarse sand or pebbly sand alternating with minor beds of silt and seams or beds of granule to cobble, locally bouldery, gravel. Mapped only in Illinois, east of confluence of Mississippi and Missouri Rivers. Clasts rounded. Texture varies laterally and vertically. Interlayered thick and thin beds commonly are well sorted and poorly to well stratified; locally crossbedded. Clasts chiefly limestone, limestone, and sandstone with minor amounts of hard crystalline or metamorphic rock; locally, moderate amounts of shale. Deposit underlies terraces and extends beneath flood-plain alluvium. Commonly covered by thin, unmapped loess or windblown sand; locally by unmapped swamp deposits. Thickness 1–20 m
- alb SILTY ALLUVIUM—Yellowish-gray to brown, poorly to well-sorted, poorly to well-stratified silt and minor clay intermixed and interbedded. Underlies terrace 3 of Saucier (1974) in northern part of Mississippi River plain; overlies older Wisconsin fluviolacustrine gravel, sand, silt, and clay that become coarser and increase in gravel content with depth. Total thickness of both deposits 10 to more than 60 m; thickness 5–9 m

WISCONSIN

- lla LAKE CLAY AND SILT (Member of Equality Formation in Illinois)—Yellowish-brown to brown or bluish-gray to gray clay and silt. Mapped only in Illinois. Deposits well bedded, soft, commonly thin bedded, and locally varved. Silt component resembles massive loess in places. Most deposits underlie extensive, flat, low-lying areas formerly occupied by glacial lakes dammed by aggrading glacial outwash deposits in the principal meltwater stream valleys. Deposits locally thin and discontinuous. Mapped areas include some undifferentiated lake and fine gravel, and wave-washed or current-scoured till. Commonly covered by thin unmapped loess, eolian sheet sand, loamy residuum, or alluvium. Thickness 1–10 m.

EARLY WISCONSIN

- asc ALLUVIAL SILTY SAND—Yellowish-gray to yellowish-brown, poorly to well-sorted, poorly to well-stratified sand intermixed and interbedded with silt. Underlies terrace 2 of Saucier (1974) in northern part of Mississippi River plain; overlies older Wisconsin fluviolacustrine gravel, sand, silt, and clay that become coarser and increase in gravel content with depth and are 5 m to more than 60 m thick. Thickness of both deposits 5–9 m
- asb ALLUVIAL SAND (deposits of "Braided Stream Terraces" of Saucier, 1974)—White to gray or brown, poorly to well-sorted, fine to coarse quartz sand and minor silt and clay; locally contains some relict channels filled with interbedded silt and clay. Underlies uppermost terraces along Black River and Crowley's Ridge; commonly overlain locally by dune sand (ed). Mapped areas include both glacial outwash and nonglacial alluvium. Thickness 3–8 m

WISCONSIN, ILLINOIAN, AND PRE-ILLINOIAN

- agch ALLUVIAL CHERT GRAVEL AND SAND—Light-brown, yellowish- to reddish-brown, fine- and medium- to coarse sand containing abundant pebbles and cobbles of chert; massive to crossbedded. Some chert clasts mantled by white rind, indicating a source area to the west in north-central Oklahoma. Terraces 10–12 m above present flood plains. Mapped only along Arkansas River in Oklahoma (southwest corner of quadrangle). Thickness 2–5 m

ILLINOIAN

- lci LAKE SILT AND CLAY (Tenerife Silt in Illinois)—Yellowish-brown to brown, massive silt and clay; silt containing interbeds of sand and clay. Mapped only in Illinois and near St. Louis, Missouri. Generally leached, but calcareous in lower part where thick. Locally, mapped areas include some outwash silt, sand, and gravel (gai) and sheet-wash alluvium. Sangamon paleosol developed in upper part. Commonly covered by loess (Peoria Loess and Roxana Silt, shown by overprint pattern) less than 6 m thick. Thickness less than 1 m to more than 10 m
- gai OUTWASH SILT, SAND, AND GRAVEL (Pearl Formation in Illinois; gravel at Oakwood, in Missouri)—Yellowish-brown to gray silt and pebbly sand. Weakly to well bedded. Mapped only west of Illinois River near Pearl, Illinois, and west of Mississippi River south of Hannibal, Missouri. Deposits in Illinois similar in composition to younger outwash sand and gravel (gg), but more oxidized and more cemented. Sangamon paleosol developed in uppermost part. Covered by less than 6 m of loess (Peoria Loess and Roxana Silt, shown by overprint pattern). In Missouri, consists of poorly stratified sand, gravel, cobbles, and boulders, probably eroded from pre-Illinoian till (tlk) on adjacent uplands in Illinoian time. Thickness about 12 m, locally thicker
- kgi ICE-CONTACT SAND AND GRAVEL (Hagarstown Member of Glasford Formation in Illinois)—Chiefly well sorted, bedded sand and gravel, includes some gravelly till. Mapped only in Illinois; forms kames, eskers, and crevasse fillings. Overlies Vandalia Till Member of Glasford Formation (tkm). Sangamon paleosol developed in uppermost part. Generally covered by less than 6 m thick (Peoria Loess and Roxana Silt, shown by overprint pattern). Thickness commonly 10–15 m; probably greater than 30 m in places
- tkm LOAMY TILL (Vandalia Till Member of Glasford Formation in Illinois)—Brown or brownish-gray to gray, calcareous, pebbly to cobbly, loamy till containing numerous thin lenticular beds of silt, sand, and gravel. Mapped only in Illinois. Clasts chiefly limestone and dolomite, with a few of sandstone, siltstone, shale, or chert; scattered erratic clasts of igneous and metamorphic rocks. Till compact and jointed; secondary iron oxide accumulations present on joint surfaces. Sangamon paleosol developed in upper part of till; overlain by loess less than 6 m thick (Roxana Silt and Peoria Loess, shown by overprint pattern). Thickness 2–15 m
- tkg LOAMY TILL (Kellerville Till Member of Glasford Formation in Illinois)—Reddish- to yellowish-brown, brownish-yellow, olive-green, or gray, calcareous clay loam and loam. Texture highly variable; ranges from sandy loam to clay loam. Nonsorted to poorly sorted; locally exhibits faint pseudostratification. Commonly contains intercalated or interstratified pods or zones of silt, sand, or gravel; locally very sandy or gravelly in lower part. Generally massive and compact; jointed; crude horizontal partings common. Generally sparsely pebbly; locally very pebbly. Clasts chiefly shale and dolomite, with a few of limestone or sandstone; coal fragments abundant locally. A Sangamon paleosol commonly developed in upper part; overlain by less than 6 m thick (Peoria Loess and Roxana Silt, shown by overprint pattern)
- tkg Ground moraine—Thickness 1–7 m; locally more than 20 m in buried valleys eroded in bedrock
- tkg End moraine—Forms broad, deeply eroded ridges; includes some unmapped ice-contact sand and gravel. Thickness locally more than 20 m

ILLINOIAN TO PRE-ILLINOIAN

- ats ALLUVIAL SILTY CLAY, SAND, AND GRAVEL—Reddish-brown to dark-gray silty clay, locally including lenses of sand and gravel at base. Gravel mostly chert and limestone. Mapped only in Kansas and Oklahoma where underlies a sequence of terraces along drainages south of the Kansas River. Contains Pleistocene vertebrate fossils in places. Thickness 3–15 m
- ggk ALLUVIAL SILTY CLAY, SAND, AND GRAVEL—Reddish-brown to dark-gray silty clay, locally including lenses of sand and gravel at base. Clasts mostly chert and limestone from local sources but some erratics of igneous and metamorphic rocks reworked from older glacial deposits. Mapped north of and in drainage of the Kansas River in Kansas. Locally contains Pleistocene vertebrate fossils and, at least at one locality, a lens of undifferentiated Pearlette family volcanic ash. Thickness 3–20 m

PRE-ILLINOIAN

- lck LAKE CLAY (Nortonville Clay in Kansas)—Dark- to pinkish-gray noncalcareous lake clay; overlies clay loam till (tck) on uplands. Mapped only in Kansas. Locally covered by thin, unmapped loess. Thickness less than 12 m
- gnk OUTWASH SANDY GRAVEL AND TILL—Reddish- and yellowish-brown, clayey to loamy till containing pebble- to boulder-size clasts of chert, limestone, dolomite and erratic igneous and metamorphic rock types; may include deposits of more than one glaciation. Mapped only in Kansas on uplands and in terrace deposits along the Kansas River and its tributaries; included in unit tck elsewhere. Commonly intermixed and interbedded with stratified drift—sand, gravel, and clay that is moderately well sorted and locally cemented with calcium carbonate. Contains local lenses of varved lacustrine silt and fine sand. Thickness generally 9–16 m; locally 33 m
- tlk LOAMY TILL—Light-yellowish-brown to dark-greenish-gray, calcareous loamy till containing pebbles of limestone, chert, and quartzite. Occurs only in a small area of Missouri along Mississippi River plain at northern edge of quadrangle. A fine-textured "Yarmouth-Sangamon" paleosol developed in the till overlain locally by 1–3 m of Peoria Loess (shown by overprint pattern). Thickness 3–10 m
- tck CLAY LOAM TILL—Red to brown or dark-gray clay loam till; poorly sorted, unstratified, and locally jointed. Contains pebble- to boulder-size clasts of limestone, chert, shale, and erratic igneous and metamorphic rocks. Locally includes glaciofluvial deposits of sand and silt, lenses of gravel, and glaciolacustrine medium to fine sand and silt. Probably represents more than one pre-Illinoian glaciation. In northwest Missouri and Kansas, a Yarmouth paleosol developed in the till is overlain by loess (shown by overprint pattern) consisting successively of Loveland Loess (in upper part of which a clay-rich Sangamon paleosol is developed), Peoria Loess, and, in addition, Bignell Loess in Kansas. In north-central and northeast Missouri, a "Yarmouth-Sangamon" paleosol developed in the till is overlain by Peoria Loess (shown by overprint pattern). Thickness 3–33 m; locally as much as 110 m where till fills buried valleys in underlying bedrock

EARLY PLEISTOCENE TO PLIOCENE(?)

- agf CHERT PEBBLE GRAVEL AND SAND (gravel of Crowleys Ridge in Arkansas and Missouri)—Pale-buff, light- to dark-brown pebbles, cobbles, and a few boulders; locally stained with iron or manganese oxide. Matrix unconsolidated fine sand and minor amounts of silt and clay that increase in abundance in upper part of deposit. Clasts mostly well rounded, some are angular. Chiefly chert and sedimentary, metamorphic quartzite, sandstone, and claystone. Sand mostly quartz; includes heavy minerals indicative source in headwater drainage of Mississippi River. Poorly sorted and characterized by channel cut-and-fill crossbedding; forest beds (fig. preliminarily to west of south. Deposit covered by 4–6 m of loess (Peoria Loess and Loveland Loess). Thickness as much as 20 m
- agch UPLAND CHERT GRAVEL—Brown chert gravel in reddish-brown leached and oxidized clay matrix; chert reworked from widespread decomposition residuum (zrg, zrd). Mapped only in Kansas, chiefly in drainage of Neosho River and on uplands near west edge of quadrangle. Small deposits shown by symbol. Thickness 1–6 m

QUATERNARY AND TERTIARY

- zsd SANDY DECOMPOSITION RESIDUUM[1]—Brown to dark-grayish-brown, medium to fine sand to silty clay; contains angular fragments of sandstone and limestone and chips of shale in lower part; occurs principally on flat to gently sloping uplands. In southeastern Kansas and Missouri, locally covered with thin loess. North of the pre-Illinoian glacial advance limit, commonly mantled with thin till (tok) or scattered erratics. Mapped areas include some locally derived colluvium and, in southeastern Kansas, many strip mines and spoil piles too small to map separately. Thickness generally 0.5–2 m, locally as much as 5 m
- zsh SILTY SAND AND SILTY SAND DECOMPOSITION RESIDUUM[1]—Tan to light-brown silty fine sand, locally reddish brown silty to sandy clay; sand chiefly quartz. Mapped only in northern Arkansas. Thickness 0.5–2 m
- zld CLAYEY SILT TO SILTY CLAY DECOMPOSITION RESIDUUM[1]—Reddish-, dark-, olive-, or gray-brown, very plastic clay, fine sandy silt to silty clay or clay. Contains small chips of shale and fragments of limestone, chert, and sandstone; local iron-manganese concretions in Oklahoma. Mapped areas include locally derived colluvium and bedrock exposures on steep slopes and on uplands in Kansas, small zones of residual chert clasts. In northeast Kansas and north of the Missouri River in Missouri, locally overlain by unmapped thin till and thin loess. Thickness, from Missouri southward, as thick as 5 m where developed from shale on gentle slopes in Kansas
- zcj CLAY AND SILTY CLAY DECOMPOSITION RESIDUUM—Grayish- to yellowish-brown, or brown clay to silty loam, locally mottled yellowish brown or gray; in places, fine sandy loam; grades down into soft shale or fractured fine-grained sandstone. Mapped areas include bedrock outcrops and colluvium. Colluvium, as much as 2 m in lower slopes, contains as much as 15 percent fragments of sandstone and shale less than 25 cm in long dimension. Thickness 0.5–1 m
- zrc THICK SAND AND SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[1]—Red to reddish-brown sand and sandy clay containing abundant fragments of sandstone, sandy dolomite, and chert. Locally includes relict layers of sandstone or chert. Mapped only on sandstone, in a sandy decomposition residuum developed from shale on bedrock through a zone of partly decomposed fragments. Where developed on dolomite, is a sandy, silty, or clayey residuum containing chert fragments that is residual after solution of dolomite. Mapped only in southeastern and central southern Missouri. Mapped areas include local bedrock outcrops, chiefly sandstone and dolomite on steep slopes, and minor alluvium along streams. Thickness 10–60 m
- zrd THICK SAND AND SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[1]—Material same as unit zrc. Mapped only in central Missouri. Thickness 2–10 m
- zre THICK CHERTY SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[1]—Red to yellowish-red and gray sandy clay containing abundant clasts of angular to subangular, gray to grayish-black chert and quartzite. Mapped only in Missouri. Decomposition residuum developed from sandstone, cherty dolomite, and solution residuum from cherty dolomite. In central and southern Missouri, solution residuum consists mostly of chert fragments in a blocky-structured red clay matrix; locally chert boulders in the clay are more than 1 m in diameter. In eastern Missouri, residuum contains fewer rock fragments and is chiefly clay. Mapped areas commonly include coarse cherty colluvium and, on steep slopes, local bedrock outcrops. Thickness 10–55 m
- zrf VERY THICK CHERTY SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[1]—Material same as unit zre. Thickness greater than 55 m
- zrh THIN CHERTY SANDY CLAY DECOMPOSITION AND SOLUTION RESIDUUM[1]—Material same as unit zre. Thickness 2–10 m
- zrg SHALY