Institute of Natural Resource Sustainability
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ILLINOIS STATE GEOLOGICAL SURVEY
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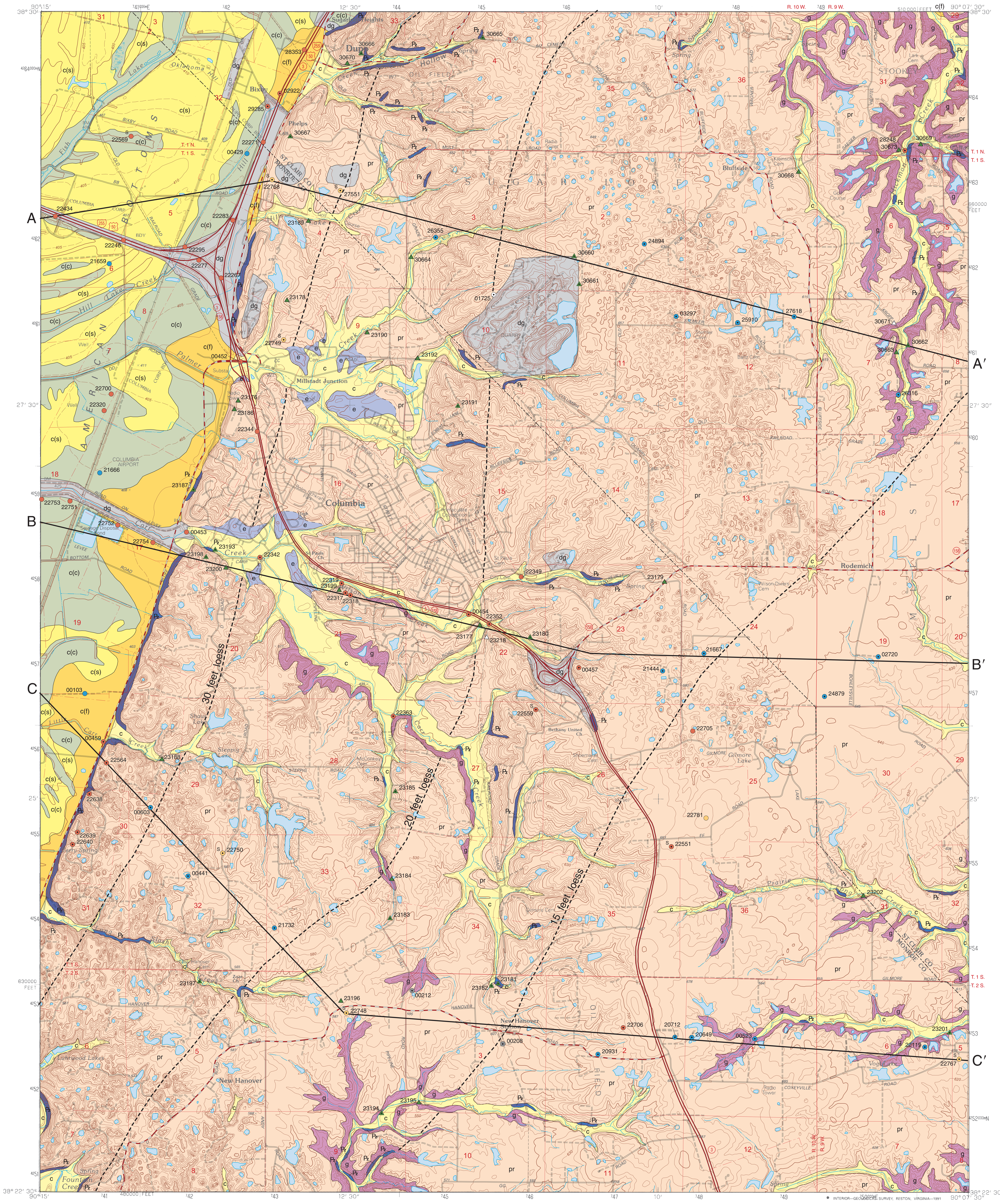
Surficial Geology of Columbia Quadrangle

Monroe and St. Clair Counties, Illinois

David A. Grimley

2009

Illinois Geologic Quadrangle Map
IGQ Columbia-SG



QUATERNARY DEPOSITS

HUDSON EPISODE (~12,000 years before present [B.P.] to today)

Description	Unit	Interpretation
Fill or removed earth; significant areas of earth material additions or disruptions by human activity; generally up to 40 feet thick (locally thicker at quarry)	Disturbed ground dg	**Anthropogenic fill** in highway interchanges, levees, limestone quarries. Includes some areas of severely stripped land in construction areas, golf courses, and a large limestone quarry.
Silt loam to silty clay loam, with some sand or gravel beds, especially near unit base; yellowish brown to grayish brown; noncalcareous to weakly calcareous; crudely to well stratified; thickest near the mouth of large creek valleys (Carr and Palmer Creeks); 5 to 30 feet thick	Cahokia Formation (east of Mississippi bluffs) c	**Alluvium;** in creek valleys tributary to the Mississippi River valley; generally silt-rich due to incorporation of loess deposits from surrounding uplands
Silt loam to silty clay loam to sandy loam, with some silty clay interbeds; dark brown to grayish brown to very dark gray; massive to crudely stratified; 5 to 30 feet thick	Cahokia Formation (silty fan deposits) c(f)	**Alluvial fan deposits** in the Mississippi Valley; mainly redeposited silty loess transported by streams in adjacent uplands (especially Carr and Palmer Creeks); weakly developed buried soils may occur within fan deposits; underlain by 0 to 30 feet of Henry Formation sand and gravel
Silt, silty clay, and clay; olive-gray to very dark gray with brown mottles; firm; may contain slickensides; massive to stratified; 5 to 50 feet thick	Cahokia Formation (clayey facies) (Mississippi River valley only) c(c)	**Backswamp or abandoned channel deposits;** infillings in former channels of the Mississippi River; underlain by Cahokia Formation sand (up to 40 feet thick) and Henry Formation (0 to 40 feet thick)
Fine sand with some medium to coarse sand and silt; yellowish brown to gray; medium to coarse sand becomes more common at depth; includes interbeds (<5 feet) of silty clay or silt in some areas; overlain by 0–4 feet of silty clay; typically 40 to 70 feet thick	Cahokia Formation (sandy facies) (Mississippi River valley only) c(s)	**Point bar and channel deposits** in the Mississippi River Valley; underlain by Henry Formation sand and gravel; may have a thin cover of fine-grained overbank deposits (<5 feet)

WISCONSIN EPISODE (~55,000–12,000 years B.P.)

Description	Unit	Interpretation
Silt and silty clay with some fine sand; yellowish brown to gray; massive to stratified; mapped on terraces generally below 470 feet elevation; leached to calcareous; 5 to 80 feet thick (unverified estimate)	Equality Formation e	**Slackwater lake deposits,** in backwater tributaries of the Mississippi River valley, aggraded during glacial times; occurs beneath terraces along Carr and Palmer Creek valleys; may have a loess cover of a few to several feet
Medium to coarse sand with fine gravel, yellowish brown to brownish gray; well sorted, contains common erratic pebbles; subrounded to subangular; leached to calcareous; up to 50 feet thick	Henry Formation (cross sections only) h	**Outwash** deposited in the Mississippi River valley, related to aggradation resulting from glaciation in upper Midwest; overlain by 50 to 80 feet of postglacial alluvium (Cahokia Formation)
Silt loam, light yellowish brown to grayish brown (Peoria Silt; upper unit) to slightly pinkish brown (Roxana Silt; lower unit); massive with weak soil structure; modern soil (typically Alfisol) developed in upper 3 to 4 feet has more clay and blocky structure; Roxana Silt ~30 to 75% as thick as Peoria Silt in uneroded areas; leached to dolomitic; total loess thickness 5 to 60 feet	Peoria and Roxana Silts pr	**Windblown silt (loess);** includes some colluvial or redeposited loess along steep slopes; loess thickness on uneroded uplands shown by contours lines on map (dashed lines); thickest on stable landscapes proximal to Mississippi River valley bluffs

ILLINOIS EPISODE (~200,000–130,000 years B.P.)

Description	Unit	Interpretation
Silt loam to silty clay loam to silty clay with some fine to medium sand beds; yellowish brown to grayish brown to dark gray; massive to stratified; mainly leached of carbonates; typically contains strong soil structure; 0 to 10 feet thick	Teneriffe Silt (cross sections only) tr	**Loess with some depressional or lake deposits;** may include areas with redeposited loess into lowlands; generally thickest proximal to Mississippi River valley bluffs; contains Sangamon Geosol (interglacial) weathering
Pebbly silt loam to silty clay loam diamicton with some sand and gravel or silt lenses; yellowish brown to light olive brown to dark gray; gray colors more common in lower unoxidized portions; common iron stains on joints and fractures; carbonate, chert, and shale pebbles of local source are common with erratics pebbles relatively scarce; leached to calcareous; 5 to 70 feet thick	Glasford Formation g	**Glacial till and ice-marginal sediment;** contains the solum of the Sangamon Geosol in upper 4 to 7 feet; covered by 0 to 4 feet of Peoria and Roxana Silts (loess); overlies thin silt, colluvium, residuum, or bedrock
Silt loam to silty clay loam; dark grey to yellowish brown; soft to medium consistency; weakly stratified to massive; minor silty clay or fine sandy beds with some pebbles; may contain spruce (*Picea*) wood fragments; calcareous; 0 to 10 feet thick (discontinuous)	Petersburg Silt (cross sections only) pb	**Slackwater lake deposits and loess;** lake deposits occur in former bedrock valleys or lows; eolian silt occurs on some upland areas; typically overlies colluvium or bedrock

PRE-ILLINOIS and YARMOUTH EPISODES (~450,000–200,000 years B.P.)

Description	Unit	Interpretation
Silt clay to silty clay loam to silt loam; rare pebbles; very dark greenish grey to dark gray; massive to weakly stratified; strong blocky to weak soil structure; noncalcareous; 0 to 10 feet thick (discontinuous)	Lierle Clay Member, Banner Formation (cross sections only) b-l	**Accretionary deposits** in former depressions or lowlands; contains Yarmouth Geosol (interglacial) soil development, which occurred during depositional period (cumulic soil)

PALEOZOIC BEDROCK

Description	Unit	Interpretation
Bedrock exposures or bedrock within about 5 feet of land surface; limestone, shale, siltstone, sandstone, and coal; limestone is predominant in north-central and southwestern areas of the map	Near-surface bedrock Pz	**Shallow marine, deltaic, and fluvial;** Mississippian limestone occurs near-surface where karst is visible; Pennsylvanian rocks with various lithologies occur within the Columbia syncline due south of the town of Columbia (between sinkholed areas) (Devera 2000)

Base map compiled by Illinois State Geological Survey from digital data (Digital Line Graphs) provided by the United States Geological Survey. Topography compiled by photogrammetric methods from aerial photographs taken 1986. PLSS current as of 1991. Planimetry derived from imagery taken 1998.

North American Datum of 1983 (NAD 83)
Projection: Transverse Mercator
10,000-foot ticks: Illinois State Plane Coordinate system, west zone (Transverse Mercator)
1,000-meter ticks: Universal Transverse Mercator grid system, zone 15

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

BASE MAP CONTOUR INTERVAL 10 FEET
SUPPLEMENTARY CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology based on field work by David A. Grimley, 1999–2000.

Digital cartography by Jennifer E. Carrell, Daniel R. Stevenson, and Jane E.J. Domier, Illinois State Geological Survey.

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Data Type

- Outcrop
- Outcrop in field notes (ISGS archives)
- Stratigraphic boring
- Water well boring
- Engineering boring
- Coal boring
- Other boring, including oil and gas

s 26211 — Labels indicate samples (s).
Boring and outcrop labels indicate the county number.
Dot indicates boring is to bedrock.

- Contact
- Inferred contact
- Loess thickness contour
- A — A′ Line of cross section

Note: The county number is a portion of the 12-digit API number on file at the ISGS Geological Records Unit. Most well and boring records are available online from the ISGS Web site.

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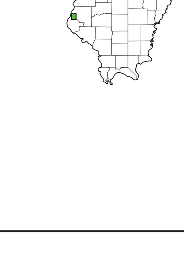

1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Webster Groves
2 Cahokia
3 French Village
4 Oakville
5 Millstadt
6 Valmeyer
7 Waterloo
8 Paderborn

1°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2009

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

Introduction

The Columbia Quadrangle, located in southwestern Illinois about 15 miles south of St. Louis, contains predominantly glaciated and loess-covered uplands, as well as an area of the Mississippi River valley in the western quarter of the map. Near-surface deposits on the uplands are dominated by thick loess (15 to 50 feet on uneroded uplands) deposited during the last glaciation (Wisconsin Episode) and underlain by glacial till of the penultimate glaciation (Illinois Episode). In the Mississippi River valley, up to about 110 feet of waterlain clay, silt, sand, and gravel (Wisconsin Episode and postglacial) is found above bedrock.

Methods

This surficial geologic map is based in part upon soil series parent materials compiled from the St. Clair County (Wallace 1978) and Monroe County (Higgins 1984) soil surveys, but was considerably modified based upon field observations, Illinois State Geological Survey (ISGS) field notes, and subsurface data obtained from well log data, coal test boring data, Illinois Department of Transportation boring records, boring logs from local consulting companies (particularly Shively Geotechnical, Inc. and Philip Services Corporation), E.D. McKay's thesis (1977), and drilling operations performed as part of this STATEMAP project. Areas of near-surface till and postglacial alluvium are based in part on soil parent material data of Wallace (1978) and Higgins (1984). Subsurface boring data on file at the ISGS and new outcrop studies were utilized for drafting of the three cross sections.

Quaternary Geology

Uplands

The underlying bedrock in the Columbia Quadrangle is predominantly Mississippian limestone with some Pennsylvanian shale, limestone, sandstone, and coal in the Columbia syncline (Devera 2000). Bedrock outcrops occur along much of the Mississippi River valley bluffs and also along many high-gradient streams that have eroded through surficial deposits. Some of the Herrin Coal in this area has been mined from outcrops and in the subsurface during the past century (Damberger et al. 1997). Bedrock residuum is occasionally preserved in the subsurface at the interface between bedrock and Quaternary sediments. Pre-Illinois Episode till was not found in outcrop or reliably in core samples. Some thin deposits of pre-Illinois alluvium, loess, colluvium, and/or lacustrine deposits appear to be present in a few cores, but the age of these sediments is not entirely clear due to erosional truncation of the Yarmouth Geosol, an interglacial paleosol that separates pre-Illinois Episode from Illinois Episode sediments. In one core (no. 22768; Sec. 4, T1S, R10W), 6 feet or more of noncalcareous, silt loam to silty clay with rare pebbles (probable Yarmouth or pre-Illinois Episode accretionary deposits) is present below calcareous Illinois Episode deposits. This unit, classified as the Lierle Clay Member of the Banner Formation (b-l, Willman and Frye 1970), is shown only in cross section A–A′, but is likely found locally in other areas as well. The Lierle may have originated from resedimented loess and thin till deposits in surrounding uplands.

Illinois Episode deposits commonly include till, lacustrine sediment, waterlain sand, and loess. Such deposits have remained largely intact in relatively flat landscapes because the Illinois Episode was the last (and perhaps only) glaciation in this area. However, in the high-relief western areas, these units were more apt to have been eroded and were likely initially thinner due to thin glacial ice or a limited duration of glaciation near the Illinoian ice margin. The Glasford Formation till, typically a pebbly silt loam to silty clay loam diamicton, is as much as 65 feet thick in the eastern areas of the map. However, the Glasford thins to 5 to 10 feet thick in some western areas. Striations (N 77º W) in a sandstone at site 23198, southwest of the town of Columbia, indicate ice directional advance from slightly south of east. Spruce or larch wood fragments were found in lacustrine silt below unoxidized till and above the Lierle Clay Member in a stratigraphic test core (no. 22768). This core was drilled into a preglacial lowland or ancestral bedrock valley (Panno et al. 2008a) near Hill Creek. This silt (Petersburg Silt) was also found immediately underlying the Glasford Formation in many outcrops and boreholes in bedrock valleys and lowlands several miles northeast of this quadrangle (Grimley and McKay 2004). The Petersburg Silt and Glasford Formation are not separated by a buried interglacial-quality soil (no evidence of B horizon or leaching zone). Thus, ice advance into shallow proglacial or slackwater lakes is interpreted to have immediately followed deposition of the lake deposits, which occur up to ~450 to 475 feet elevation in ancestral bedrock valleys or lowlands. Silty lake deposits or loess above the Glasford Formation, classified as the Teneriffe Silt, are also present in many areas, but such deposits are relatively thin (<10 feet). The Teneriffe Silt, principally a weathered loess but containing waterlain beds in places, was found to be 5 to 10 feet thick in a few stratigraphic test holes and is thus shown as a blanketing layer above the Glasford Formation in cross sections A–A′ and C–C′. The Sangamon Geosol, which is ubiquitous over uneroded upland areas of the quadrangle, was developed into the Glasford Formation and/or Teneriffe Silt subsequent to deposition of these units. Soil development, resulting in increased soil structure and clay content, continued until loess deposition was initiated during the following ice age.

Loess deposits (windblown silt, Wisconsin Episode) are up to 50 feet thick on upland crests along the Mississippi River valley bluffs but thin dramatically to the southeast to less than 15 feet on uplands. The source of the loess was eolian deflation from outwash sediment in the broad American Bottoms in the Mississippi River valley in the western part of this quadrangle and further west. Loess deposits consist of Peoria and Roxana Silts; the Peoria Silt is between ~30 to 100% thicker than the Roxana Silt (McKay 1977). Both units are predominantly silt, typically with less than 5% sand and less than 20% clay when relatively unweathered. Roxana Silt was deposited between about 55,000 and 28,000 radiocarbon (^{14}C) years before present, whereas Peoria Silt was deposited between about 25,000 and 12,000 ^{14}C years before present (McKay 1977, Grimley et al. 1998). In areas of numerous sinkholes in the north-central and southwestern portion of the map (Panno et al. 2008b), loess deposits drape thin till and limestone bedrock; loess in the sinkhole fills has been remobilized and resedimented by colluvial and fluvial processes.

Mississippi River Valley

Deposits in the Mississippi River valley (locally known as the American Bottoms) consist of several sequences of waterlain deposits with a general fining-upward sequence. The oldest and coarsest Mississippi River deposit is a basal sand and gravel (Henry Formation, Hansel and Johnson 1996), which is as much as 50 feet thick and deposited during the last glaciation (Wisconsin Episode). Fluvial sediment associated with Illinois and pre-Illinois Episode glaciations were presumably eroded prior to or concurrent with Henry Formation deposition, although unmappable remnants may remain. Above the Henry Formation is a well-sorted medium to fine sand unit with little gravel. This middle layer is interpreted to be Cahokia Formation (postglacial river deposits), based on textural changes and previous studies of the valley sediments (Bergstrom and Walker 1956, Willman and Frye 1970). The upper third of deposits in the valley (cross section A–A′) consists of a mixture of sandy point bar deposits and silty clay swale fills (backswamp and abandoned channel deposits of the Mississippi River). Channel abandonment occurred between about 6,000 and 2,500 ^{14}C years before present based on the regional stratigraphy and radiocarbon dates on material in the younger Goose Lake meander (White et al. 1984, Booth and Koldehoff 1999). Young alluvial fan deposits, containing silty redeposited loess, reach out onto the valley adjacent to the major creeks emanating from the bluffs (Carr Creek, Little Carr Creek, and Palmer Creek). The fan deposits appear to overlie backswamp deposits and thus are presumably less than 2,500 ^{14}C years old, based on ages determined for abandoned channels in the American Bottoms (White et al. 1984, Booth and Koldehoff 1999). As much as 6 feet of silt in fan deposits near Edgemont originated during historical times as a result of upland erosion by deforestation, farming, and construction of suburban subdivisions (Booth and Koldehoff 1999). In most of the stream valleys east of the Mississippi River valley, a mainly silty and sandy fluvial sediment (Cahokia Formation) is found to be generally 5 to 30 feet thick. The Cahokia Formation in small tributary valleys has a large component of redeposited Peoria and Roxana Silts. Erosion of these loess units from uplands and redeposition in lowlands has been accelerated due to human activity in historical times.

Material Resources

Sand and Gravel

As much as 120 feet of sand and gravel (but mostly sand) occurs in the Mississippi River valley (cross section A–A′). Dredging for sand and gravel is currently in operation in the American Bottoms several miles northeast of this quadrangle (Grimley and McKay 2004). Sand is obtained from about 60 to 90 feet depth (below clayey or fine sand alluvium) and is used for fill and construction uses. However, the gravel content is low, somewhat limiting the use of this sediment by the construction industry. As indicated by data from water wells located in the floodplain (see cross sections), more desirable coarse river sand (Henry Formation) is commonly buried by 50 feet of clay, silt, dirty sand, or fine to medium sand (Cahokia Formation).

Groundwater

Henry Formation sand and gravel and Cahokia Formation sand in the Mississippi River floodplain constitute the most significant Quaternary aquifer of this quadrangle (cross sections and Bergstrom and Walker 1956). Yields from this aquifer are high; however, the potential for contamination is generally high because of the relatively thin and discontinuous covering of silt and clay (0–50 feet). The potential for contamination also depends on hydraulic gradients and overall position in the three-dimensional groundwater flow system. In upland areas, groundwater supplies are primarily from bedrock aquifers (Panno et al. 1997). Sand and gravel lenses within the local till are not sufficiently thick or extensive for more than a low-yield water supply and, in some cases, may be unsaturated due to high relief and lower water levels.

Environmental Hazards

Karst (Sinkhole and Cavern Development)

Karst topography is evident at the surface in many areas of the quadrangle where limestone bedrock is within ~25 feet of land surface. In such areas, where thin loess and residuum overlie pure limestone, such as the Salem or St. Louis Formations (Devera 2000), sinkhole and underground cavern development is most prevalent (Panno et al. 1997, Panno et al. 2008b). Underground drainage in karstic areas, such as near Alton, Illinois, can be rapid (>0.5 mile/day) and commonly follows joint sets toward the Mississippi River valley (Lamar 1928). Bedrock aquifers underlying karstic regions are thus highly susceptible to contamination because groundwater recharge flows quickly into cavernous bedrock and is not filtered through soil, clay, or slowly permeable bedrock (Panno et al. 1997, Panno and Weibel 1998). Karstic regions also pose a hazard to building structures because of the danger of sinkhole collapse and widening.

Mass Wasting

Erosion, undercutting, and slumping of thick loess deposits at bluff edges are a potential hazard (Killey et al. 1985). Slumping commonly occurs in this area when water collects at the base of relatively permeable loess on top of the clayey Sangamon Geosol/Glasford Formation, at the Peoria/Roxana Silt contact, or at other permeability contrasts. Higher-pore water pressures in such perched water tables increase the likelihood of slumping or failure along steep slopes. Natural slumps in glacial materials have been noted along several creek cutbanks, such as at outcrop sites 23182 (upper Carr Creek Valley), 23189 (Hill Lake Creek valley), 23190 (Palmer Creek valley), and 23201 (Prairie du Long Creek valley).

Soil Erosion

Steep slopes along ravines and bluffs are subject to severe soil erosion due to the nature of loessal soils. Areas mapped as Peoria and Roxana Silt have loose, windblown, near-surface silt deposits that are soft and weakly cohesive and thus have a low shear resistance. These loess deposits are easily eroded by running water during heavy rainfalls. Runoff during rainstorms can quickly erode into and enlarge rills and gullies, thereby accelerating the process of erosion, as water is channeled into the growing drainage system. Mass wasting processes (slumping) and agricultural practices also greatly contribute to the amount of sediment eroded into creek watersheds.

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