Illinois Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

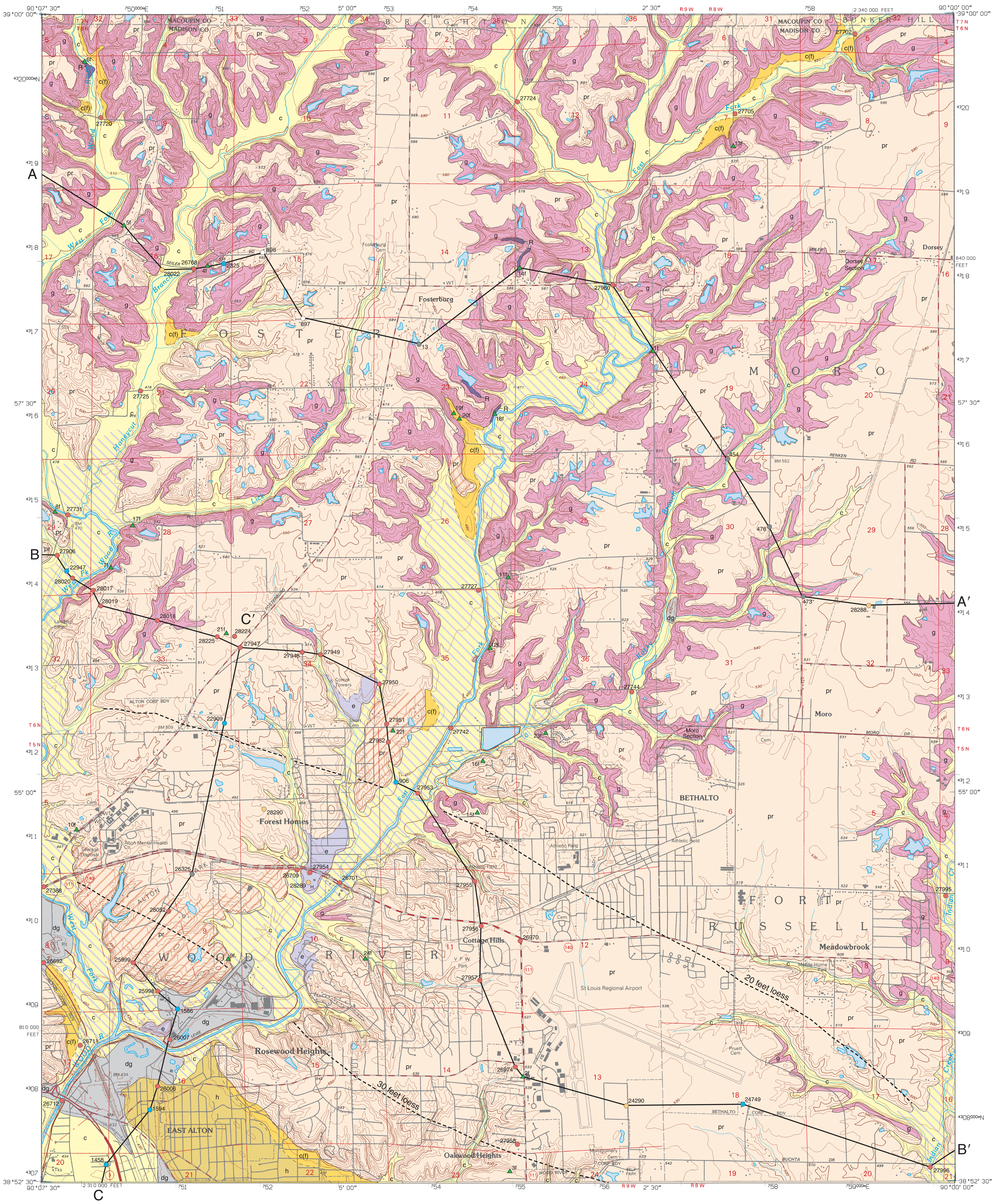
SURFICIAL GEOLOGY OF BETHALTO QUADRANGLE

MADISON AND MACOUPIN COUNTIES, ILLINOIS

Illinois Geologic Quadrangle Map
IGQ Bethalto-SG

David A. Grimley

2005



QUATERNARY DEPOSITS

Description	Unit	Interpretation
HUDSON EPISODE (~12,000 years before present (B.P.) to today)		
Fill or removed earth; sediment of various types; up to 20 feet thick	Disturbed ground (dg)	**Man-made fill** or large areas of disturbed sediment such as industrial fill or quarry spoil piles
Silty clay to silt loam to sandy loam; may contain sand and gravel beds near base of unit; gray to brown; massive to well stratified; up to 30 feet thick	Cahokia Formation (c)	**Alluvium** (river deposits) in stream valley floodplains; contains much redeposited loess; coarser beds are most common where unit overlies till, outwash, or bedrock
Silt loam with scattered thin beds of sand and diamicton; brown; weakly stratified, soft; up to 15 feet thick	Cahokia Formation (fan facies) (c(f))	**Alluvium** deposited in toe slopes and fans; includes some colluvial fans and mudflows; sediment includes much redeposited loess
WISCONSIN EPISODE (~75,000–12,000 years B.P.)		
Silty clay to silt loam to fine sand; gray to yellowish brown to reddish brown, red hues more common at lower elevations; massive to stratified; stiff; leached to calcareous; up to 65 feet thick	Equality Formation (e) (hachures on map where buried)	**Lake deposits;** deposited by backflooding of Mississippi River tributaries during glacial times; occurs in terraces in East Fork Wood River valley, where covered by 3 to 8 feet of loess; buried below Cahokia Formation in valleys of East and West Fork Wood River and Indian Creek
Fine to medium sand near the surface, but mainly medium to coarse sand with gravel at depth; rare clayey beds up to 2 feet thick; light brown to gray to brown (in some places with pinkish hue); stratified; various pebble compositions; up to 95 feet thick	Henry Formation (h)	**Outwash** carried by the Mississippi River; occurs only in southwestern portion of map in the Wood River Terrace and under Cahokia alluvium
Silt to silt loam; yellowish brown to gray to brown (with pinkish hue); massive to blocky structure; friable; leached to calcareous; contains modern soil solum in upper 2 to 4 feet; up to 35 feet thick	Peoria and Roxana Silts (pr)	**Loess** (windblown silt); includes some slope deposits and redeposited loess; upper and thicker portion is Peoria Silt (yellowish brown to gray); lower portion is Roxana Silt (brown with pink hue to gray); total thickness greatest on uneroded uplands near Mississippi River valley bluffs
ILLINOIS EPISODE (~200,000–130,000 years B.P.)		
Fine to coarse sand (sand to sandy loam), with some silty or gravelly zones; generally coarser with depth; may include silty clay loam in its upper few feet; up to 45 feet thick	Pearl Formation (cross sections only) (pl) (hachures on map where buried)	**Outwash;** may contain Sangamon Geosol in upper portions; may include up to 8 feet of weathered Illinois Episode silt at top of unit; intertongues with Glasford Formation; buried by up to 30 feet of Peoria and Roxana Silts where hachured
Pebbly loam diamicton with many sand and silt lenses up to tens of feet wide and as much as 20 feet thick; light olive-brown to dark gray; upper few feet is weathered to brown, softer and more clayey (silty clay loam); lower portion is commonly more massive, stiff, and calcareous; up to 80 feet thick	Glasford Formation (<5 feet of loess cover) (g)	**Till and ice marginal sediment;** upper portion contains Sangamon Geosol; includes some sand and gravel lenses; lower portion is commonly more dense basal till; may be slightly more clayey at depth; commonly crops out along slopes
Silt loam, silty clay loam and loam; dark gray to grayish brown; some sandy layers; weakly laminated; leached to calcareous; up to 25 feet thick	Petersburg Silt (cross sections only) (pb)	**Lake deposits and slope deposits;** tends to occur in former lowlands or bedrock valleys
PRE-ILLINOIS EPISODE (~700,000–450,000 years B.P.)		
Pebbly silty clay loam diamicton, contains some sand lenses**;** yellowish brown (with orange hue) to dark gray, rarely olive or greenish gray; massive to weakly laminated; shale and coal fragments common; leached to calcareous; up to 35 feet thick	Omphghent member Banner Formation (cross sections only) (b-o)	**Till and ice marginal sediment;** may contain Yarmouth Geosol weathering profile in upper 10 feet (but commonly truncated)

PRE-QUATERNARY (PALEOZOIC) DEPOSITS

Description	Unit	Interpretation
Sandstone, shale, coal, underclay, and limestone; various colors including olive-brown, greenish gray, light gray and black; laminated to bedded to massive; noncalcareous to calcareous	Near-surface bedrock (R)	**Bedrock exposures or bedrock** within 5 feet of land surface

Data Type

	Data type
▲ 5f	Natural outcrops and man-made exposure (author field notes)
△ Moro Section	Outcrop in field notes (ISGS archives)
● 28022	Stratigraphic boring (drilled by ISGS)
H ● 28289	Shallow stratigraphic boring (hand auger)
● 22947	Water well boring
● 27702	Engineering boring
● 454	Coal boring
○ 898	Other boring

Note: Numeric labels of borings indicate the county number, a portion of the 12-digit API number on file at the ISGS Geological Records Unit. Outcrop labels indicate author field number. Online well and boring records are available at the ISGS Web site.

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

Note: Loess contours (thick black dashed lines on map) show the combined thickness of Peoria and Roxana Silts on uneroded upland areas. The actual thickness at a given spot may be much less, especially along valley slopes where post-depositional erosion of loess has been significant (see cross sections).

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Topography compiled from imagery dated 1948. Revised and updated from imagery dated 1952 and 1993. Topographic base map edited 1996.

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
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Released by the authority of the State of Illinois: 2005

Geology based on field work by D. Grimley, 2002–2003.

Digital cartography by M. Barrett and J. Carrell, Illinois State Geological Survey.

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES

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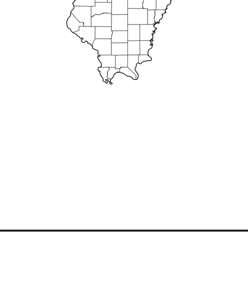

1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Brighton
2 Shipman
3 Bunker Hill
4 Alton
5 Prairietown
6 Columbia Bottom
7 Wood River
8 Edwardsville

APPROXIMATE MEAN DECLINATION, 2005

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

This surficial geology map of the Bethalto 7.5-minute Quadrangle, located in northwestern Madison County (fig. 1), provides an important framework for land and groundwater use, engineering assessment, economic development, and archeological and geological studies in the area. This study is part of a broader 1:24,000 scale geologic mapping program undertaken by the ISGS in developing areas of the St. Louis Metro East region (Grimley 1999, 2002), as part of the USGS-STATEMAP program.

Regional Setting

The Bethalto 7.5-minute Quadrangle, immediately east of the Alton 7.5-minute Quadrangle (Grimley 1999), is located within about 10 miles of the maximum Illinois and pre-Illinois episode ice margins (fig. 1). During both glacial episodes, ice generally advanced from the northeast (Willman and Frye 1970, Grimley et al. 2001). The mapped area can be divided geomorphically into the Mississippi River valley, tributary valleys and terraces, and upland areas (fig. 1). The sediments within these landforms differ due to varying geologic processes that acted on these areas.

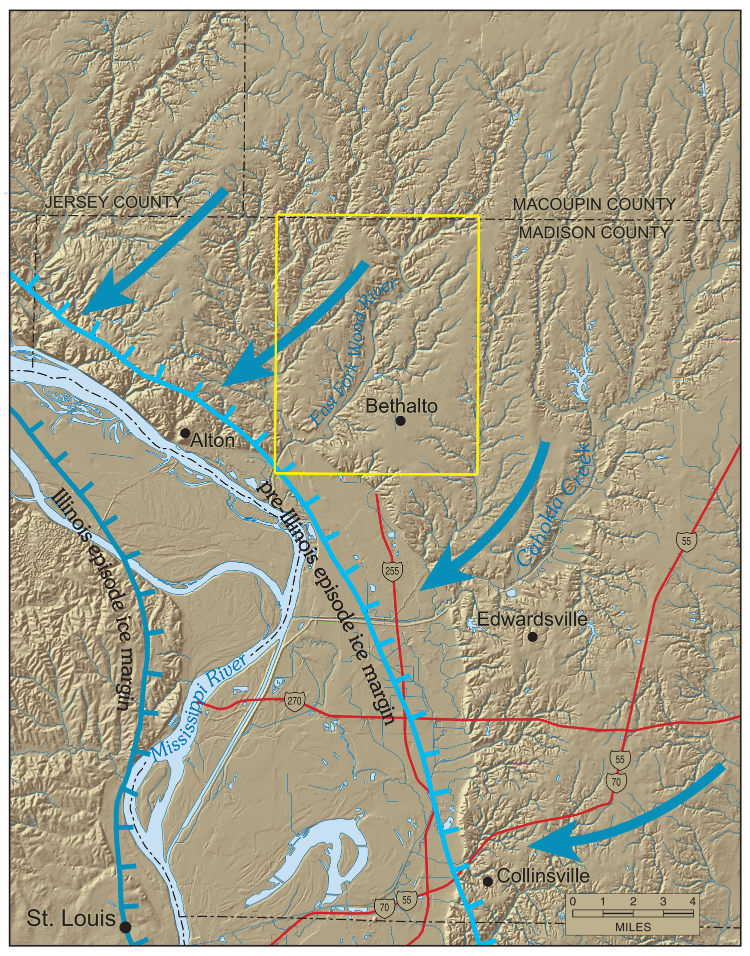

Figure 1 Shaded relief map of the St. Louis Metro East area (northern portion). The Bethalto Quadrangle is outlined in yellow. The quadrangle lies within the ice margins of both the Illinois and pre-Illinois episode glaciations. Arrows indicate the direction of ice flow for the Illinois Episode glaciation.

Uplands, underlain at depth by glacial till and ice-marginal deposits, are blanketed by thick loess (windblown silt) that has been studied extensively in this region (McKay 1977, 1979; Wang et al. 2000). The loess was deposited by strong westerly windstorms that periodically swept across the broad Mississippi River valley during the most recent glaciation, the Wisconsin Episode. Large tributary valleys such as East Fork Wood River, West Fork Wood River, and Honeycut Branch contain postglacial stream deposits, which in some areas overlie lake deposits and/or sand and gravel (outwash). A small portion of the broad Mississippi River valley shown in the southwest corner of the map features postglacial terraces, fans, and river deposits.

Methods

Surficial Geology Map

This map is based in part upon data for soil and parent materials (Goddard and Sabata 1982) that were modified based upon field investigations of outcrops, soil probings, and drill cores obtained for this STATEMAP project. Data from Illinois Department of Transportation (IDOT) borings, other engineering borings, and water-well borings were used to test and modify map unit contacts. Data from borings shown on the map and cross sections are on file at the ISGS Geological Records Unit. Material descriptions in stratigraphic borings and outcrops are in an unpublished manuscript in the ISGS Library (Grimley 2005). Supporting data and text, as well as this map, are available on the ISGS Web site (http://www.isgs.uiuc.edu/online-maps/ipgm/ipgm.htm).

Cross Sections

The cross sections portray the near-surface deposits as if viewed in a slice through the earth down to bedrock. The vertical dimension has been exaggerated 20 times to show the geologic details more clearly. The lines of cross section are indicated on the surficial map. Data used for subsurface unit contacts (in approximate order of quality) are from studied outcrops, archived geological field notes (ISGS library), stratigraphic borings, engineering borings (primarily from IDOT and Madison County Highway Department), coal borings, and water-well borings. Units less than 5 feet in maximum thickness are not shown on the cross sections. The full depth of borings that penetrated below the bedrock surface is not shown.

Surficial Deposits

Uplands

Uplands, including most sloping areas, constitute most of the quadrangle. The uplands are blanketed by silty loess deposits (Peoria and Roxana Silts), which typically range from 10 to 30 feet thick on uneroded uplands, thinning to the northeast. Thicker loess occurs on uplands adjacent to the Mississippi River valley (i.e., southwestern portion of quadrangle). During the last glaciation (Wisconsin Episode), silt-size particles from Mississippi River valley meltwater deposits were periodically windswept and carried in dust clouds eastward to upland areas, where the particles gradually settled out across the landscape. The loess deposits are typically silt loam, but are altered to a heavy silt loam to silty clay loam in the upper 3 to 5 feet, which contains the modern soil solum (Goddard and Sabata 1982). The Peoria Silt is the upper (younger) loess unit, and the Roxana Silt, which tends to have a slight pinkish hue, is the lower loess unit (Hansel and Johnson 1996). The units are mapped together because their physical properties are similar. Loess may be as thick as 35 feet in isolated areas near the bluffs.

Other units are mapped on side slopes and in ravines, where the loess has been eroded to less than 5 feet thick. On many such slopes, the underlying diamicton (a massive, poorly sorted mixture of clay, silt, sand, and gravel) is exposed or is near land surface. The diamicton, mapped as the Glasford Formation, is interpreted mainly as till that was deposited during the Illinois Episode. Near-surface Glasford Formation deposits are much more common to the northeast because the loess cover thins in that direction. The Glasford Formation includes many discontinuous sand and gravel lenses that can be tens of feet wide and up to 15 feet thick. In its uppermost portion, the Glasford Formation contains a buried interglacial soil (known as the Sangamon Geosol) that exhibits alteration features such as root pores, fractures, krotovina, oxidation or color mottling, strong soil structure, clay accumulation, and/or clay skins. Such alteration features, especially common in its upper few feet, help to distinguish the Glasford Formation from overlying Wisconsin Episode loess deposits. Additionally, the Glasford Formation is stiffer (higher unconfined compressive strength, higher blow counts) and has a lower moisture content than do the Peoria and Roxana Silts (table 1). The upper 10 to 15 feet of the Glasford till is typically softer and more weathered and may have a higher water content than lower portions, which were deposited subglacially and compacted by the full weight of glacial ice.

Table 1 Physical and chemical properties of selected map units (typical ranges listed).

	Geotechnical properties[1]			Particle size data[2]			Compositional data[3]	
	w (%)	Qu (tons/ft^2)	Blow count (N)	Sand (%)	Silt (%)	Clay (%)	Clay mineralogy	Magnetic susceptibility (x 10^{-5} SI units)
Cahokia Fm.	7–25	0.5–2.0	1–9	variable texture			ND[4]	ND
Equality Fm.	24–31	0.3–1.0	0–3	variable texture; typically silty loam to silty clay loam			high expandables	ND
Peoria and Roxana Silts	20–28	0.75–1.75	1–9	0–5	65–90	10–30	high expandables	5–80
Glasford till[5]	11–22	1.5–9.5	3–50	37–40	38–45	18–22	45–55% illite	5–40
Banner till[5]	19–29	1.2–4.5	2–32	26–32	40–49	23–30	38–45% illite	5–40

[1] Geotechnical properties: based on hundreds of data measurements from tens of engineering borings w = moisture content = 100% × (mass of water / mass of solids (dry)). Qu = unconfined compressive strength (load a sample can hold before failure); generally estimated with a hand penetrometer. N = blows per foot (Standard Penetration Test); number of blows necessary to penetrate one foot of material.

[2] Particle size data: based on <20 samples from stratigraphic borings and outcrops Sand = % >63 μm; silt = % 4–63 μm; clay = % <4 μm (proportions in the <2-mm fraction).

[3] Compositional data: based on <20 samples from stratigraphic borings and outcrops Clay mineralogy = proportions of expandables, illite, and kaolinite/chlorite (in <4 μm clay mineral fraction); calculations are based on results of H.D. Glass using a General Electric X-ray diffractometer. Magnetic susceptibility is of bulk sample in outcrop or in core (measured with Bartington MSF probe and MS2 meter).

[4] ND = no data available.

[5] Properties for the Glasford Formation and Banner Formation are for calcareous till only (excludes sand and gravel lenses and strongly weathered zones).

In a few areas between the lower reaches of the East and West Fork Wood River valleys, sandy deposits directly underlie loess deposits. These sandy deposits contain the Sangamon Geosol in their upper portion and are underlain by the Glasford Formation; the deposits are therefore included in the Pearl Formation (Willman and Frye 1970). The Pearl Formation may include up to 8 feet of weathered Illinois Episode loess in its upper portion and may intertongue with Glasford diamicton (cross section C–C′). The Pearl Formation occurs on high terraces that are rather nondescript because of a cover of 15 to 35 feet of Wisconsin Episode loess. The source of the Pearl Formation was likely meltwater from Illinois Episode glacial ice during its retreat to the northeast. In western Madison County, both the Pearl and Glasford sand and gravel deposits seem to be most common near and below the larger northeast-southwest-trending river valleys that may have served as proglacial or subglacial meltwater outlets during the Illinois Episode.

In some areas below the Glasford Formation, an older pre-Illinois Episode unit is preserved in the subsurface. This unit, included in the Banner Formation, consists of clayey diamicton (mainly till) that contains relatively few sand and gravel bodies. Overall, compared to Glasford till, the Banner till is consistently more clayey, less sandy, has higher moisture content, and is slightly less stiff (table 1). Such distinctions were used to help differentiate the two units in engineering boring data. Much of this difference may be due to the incorporation of significant amounts of shale and clayey bedrock residuum into pre-Illinois Episode glacial ice, as this was the first ice of the Quaternary Period to cross this area. In some places, particularly bedrock valleys, the Banner Formation may contain a buried interglacial soil (the Yarmouth Geosol) preserved in its upper portion, but elsewhere, the upper horizons of this soil have been truncated or eroded by stream or glacial processes. Despite the Yarmouth Soil's typical truncation, the effect of interglacial weathering is generally exhibited in the upper portion of the Banner Formation, which is typically more fractured and oxidized than lower portions.

Near-surface bedrock in the quadrangle consists predominantly of Pennsylvanian shale, sandstone, coal, and limestone. Some small (typically <10 feet high) bedrock exposures occur in areas of high elevations on the bedrock surface, particularly in the northwestern and central portions of the quadrangle. Many small areas of vertical bedrock exposures were not mappable and are not shown. An underground limestone (Mississippian) mine occurs in the southwestern portion of the quadrangle (Sec. 8, T5N, R9W; mapped as disturbed ground). Although many areas of the quadrangle have been undermined for coal (Treworgy and Hindman 1991), no active coal mines exist today.

Valleys and Low Terraces

Valleys and low terraces (<5 feet loess cover) occupy <25 % of the map area (fig. 1), but they are important and complex features with respect to geologic deposits and history. Fine-grained postglacial stream deposits (Cahokia Formation) fill most valleys with up to 30 feet of sediment. Although mostly silty clay to silt loam in texture, the Cahokia Formation includes layers of fine to medium sand at depth and in existing river channels. In some areas, particularly where directly underlain by till, the lowermost 1 to 2 feet of the Cahokia Formation is stratified sand and gravel. Sediment in the Cahokia Formation is mostly derived from erosion of loess and the Glasford Formation exposed on uplands and sloping areas.

On some higher areas of the stream floodplains and on the footslopes adjacent to steeply sloping areas, silty fan deposits are mapped (Cahokia fan facies). These areas of silty sediment contain well-developed modern soils (containing B horizons; Goddard and Sabata 1982) and are at slightly higher elevations than typical floodplain areas. The fan facies is thus less prone to flooding than the remainder of the Cahokia Formation. Sediment in these fans was deposited either by tributary streams carrying silty material from the uplands or by slope processes (colluvial fans). Some of this unit may include low Holocene terraces or remnants of older terraces covered by colluvium-alluvium.

Several low terraces along the lower reaches of the East Fork Wood River valley were mapped as Equality Formation where fine-grained, stratified sediments were observed. The elevation of the top of these terraces is typically ~ 455 to 480 feet above sea level (asl), and the loess cover ranges from about 3 to 8 feet thick. The Equality Formation, which ranges from silty clay to fine sand, is interpreted as slackwater lake deposits that formed when high levels of glacial meltwater in the Mississippi River valley caused sediment-laden water to back up into the Wood River valley. These lake deposits are distinctively soft and have low unconfined compressive strength and high moisture contents (table 1). In some places in the subsurface, the Equality Formation (up to 65 feet thick) underlies the Cahokia Formation, but the elevation of the top of the Equality Formation never exceeds about 480 feet asl (see cross sections). Such areas with Equality sediments in the subsurface are shown as hachured on the map. Although similar to the fine-grained facies of the Cahokia Formation, the Equality Formation is more texturally uniform, softer, higher in moisture content, and calcareous. In some places, the basal Cahokia Formation contains sandy beds, which allows easier differentiation of the two units.

In places along the East Fork Wood River valley, sandy deposits are present below both the Cahokia and Equality Formations. These subsurface deposits, thought to be outwash or ice-marginal sorted sediment related to Illinois Episode glaciation, are assigned either to the Pearl Formation (if overlying till) or to sand lenses within the Glasford Formation (if within or below till). The presence of this unit is based on subsurface boring log descriptions. The Pearl Formation also occurs underneath high, loess-covered terraces (see Uplands section).

Mississippi River Valley

The southwestern area of the quadrangle contains a small portion of the Mississippi River valley (fig. 1). This area contains variable thicknesses of postglacial river sediments, deposited by the Mississippi River and Wood River. These near-surface deposits are mainly fine-grained Cahokia Formation deposits. Underneath them, fine to coarse sand with some gravel is found that correlates to the Henry Formation, glacial outwash from the last glaciation (Wisconsin Episode). The Henry Formation also occurs in a large terrace, the Wood River Terrace, which has <0.5 feet of loess cover and is late Wisconsin Episode in age (Hajic 1993). The Henry Formation in this terrace tends to coarsen with depth from generally finer sands to coarser sands with gravel occurring below depths of 50 feet. Some interbedding of fine and coarse deposits occurs. Glacial ice did not reach the study area during the Wisconsin Episode; however, glacial meltwater in the upper Mississippi River drainage basin was responsible for this outwash and, indirectly, for the outwash-derived loess in southwestern Illinois.

Some colluvial and alluvial fans (Cahokia fan facies) exist on the flanks of the valley between the terrace surface and the loess-covered uplands. The colluvial/alluvial fans adjacent to the Wood River Terrace near East Alton likely overlie sandy terrace deposits of the Henry Formation. Other fans occur on the edge of the floodplain and may overlie Equality Formation terrace deposits in more protected or backwater areas of the Mississippi River valley. Some fan deposits are interpreted to occur in the subsurface, buried by younger alluvium (see western end of A–A′ cross section).

Areas of disturbed ground are mainly limited to the southwestern portion of the quadrangle. Most areas of disturbed soil are less than 10 feet in thickness, and some are less than 5 feet. Nearly all of the mapped area of disturbed ground is in the Wood River valley (East or West Forks) and is underlain by silty or clayey Cahokia Formation alluvium.

Economic Resources

Sand and Gravel

Sources of economically minable sand and gravel in the Bethalto Quadrangle are likely limited to the Henry Formation and Pearl Formation because sand and gravel bodies within till units (e.g., Glasford Formation) are limited in thickness and are unpredictable in their dimensions. Henry Formation sands are up to 95 feet thick in the Wood River Terrace; however, alternating beds of fine and coarse sand and the presence of some lignite may complicate the use of this product. Most areas mapped as Henry Formation are also already developed. Sand and gravel is commonly used by the construction industry for concrete, asphalt, fill, and road base (Goldman 1994).

Groundwater

Groundwater is extensively used for household, public, and industrial water supplies. Sand and gravel bodies in the Glasford, Pearl, and Henry Formations are the most important Quaternary aquifers (see stippled areas of cross sections). In upland areas, sand and gravel bodies within the Glasford Formation are commonly used for low-yield household water supplies. The Pearl Formation is not widely distributed, is relatively thin, and occurs in sparsely populated areas; thus, it is not yet widely used as an aquifer. The Henry Formation comprises a significant (but unprotected) aquifer in the Mississippi River valley near the southwest corner of this quadrangle.

Environmental Hazards

Groundwater Contamination

Surface contaminants pose a potential threat to groundwater supplies in near-surface aquifers that are not overlain by a confining (clayey, unfractured) unit. Shallow sand and gravel aquifers exposed at the surface are the most vulnerable to agricultural or industrial contaminants. Confining units, such as clayey till units or lake deposits, can help protect aquifers. The typically fine-grained Cahokia and Equality Formations may help protect some of the Pearl Formation aquifers in valleys. The Glasford Formation (where unfractured and lacking sand lenses) can help protect deeper aquifers in upland areas. A summary of the factors used to determine the potential for contamination in shallow aquifers in Illinois is provided by Berg et al. (1984).

Subsidence

As much as 10% of the area of this quadrangle has been undermined for extraction of coal between 1850 and 1960 (Chenoweth and Borino 2001). Coal mining was primarily from the Herrin (No. 6) Coal Member of the Carbondale Formation. Coal was extracted using the room-and-pillar method. Land subsidence in mined-out areas is a serious potential problem for developers and construction projects in this area (Treworgy and Hindman 1991).

Acknowledgments

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