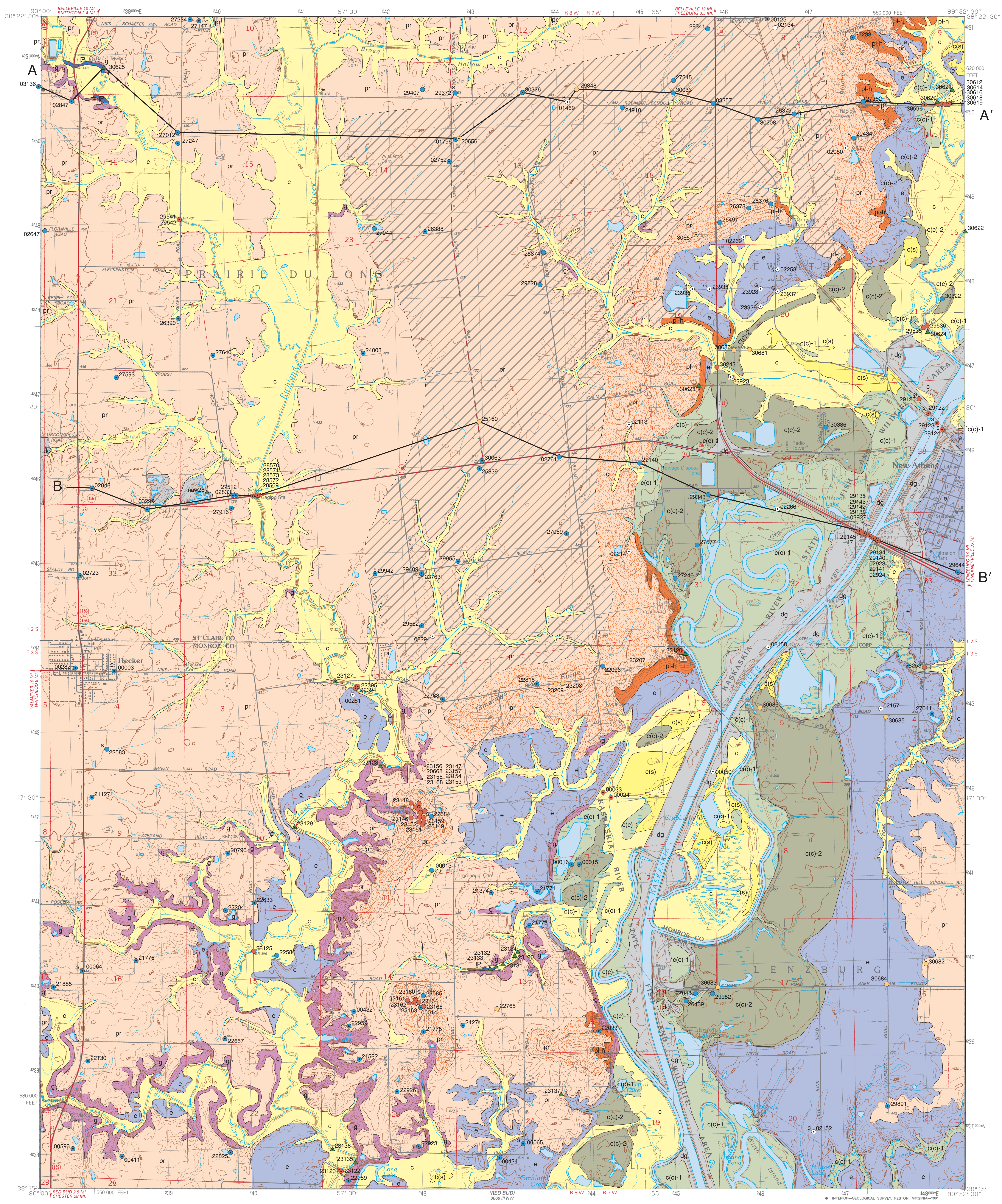
SURFICIAL GEOLOGY OF NEW ATHENS WEST QUADRANGLE

MONROE AND ST. CLAIR COUNTIES, ILLINOIS

ILLINOIS STATE GEOLOGICAL SURVEY
E. Donald McKay III, Interim Director

STATEMAP New Athens West-SG

Andrew C. Phillips
2008



QUATERNARY DEPOSITS

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

Description	Unit	Interpretation
Fill or removed earth; Filled areas are loam and fine diamicton up to 20 feet thick; surface mined areas contain heterogeneous diamicton and limestone and sandstone exposed above water level	Disturbed ground dg	**Anthropogenic fill or excavations;** Fill includes dredge spoil along Kaskaskia River and upper Richland Creek, bridge and trestle cones, and levees constructed around city of New Athens; excavations include borrow pits along Kaskaskia River and bedrock mines
Silty clay to silt loam to sandy loam; local sand and gravel lenses; massive to well stratified, gray to brown, non-calcareous, soft to moderately stiff; moist to very moist; up to 15 feet thick	Cahokia Formation c	**Stream sediment** deposited on floodplains and natural levees; mainly redeposited loess
Silty clay; grades to loam and sand with depth; massive to weakly stratified; brown to olive brown; non-calcareous, very soft to soft, moist to very moist; up to 15 feet thick	c(c)-1	**Floodplain and backswamp deposits;** mainly redeposited loess but also includes sediment related to historical settlement; differentiated in Kaskaskia River valley only
Loam to fine sand; massive to weakly stratified; brown to gray; non-calcareous; soft to moderately stiff; dry to very moist; up to 15 feet thick	c(s)	**Channel bar, point bar, natural levee, and crevasse splay deposits;** derived from glacial outwash; differentiated in Kaskaskia River valley only
Silty clay; grades to loam and sand with depth; massive to weakly stratified; brown to olive brown; non-calcareous, very soft to soft, moist to very moist; weak soil development in upper 5 feet; up to 9 feet thick	c(c)-2	**Floodplain deposits** from early Hudson Episode high river level; forms terrace below 400 foot elevations; grades with depth into glacial lake or stream sediment; differentiated in Kaskaskia River valley only

WISCONSIN EPISODE (~75,000 years–12,000 B.P.)

Description	Unit	Interpretation
Silt loam to silty clay loam; yellowish brown to gray to brown with pink hue; massive to blocky structure; friable; mainly non-calcareous but may be dolomitic; contains modern soil solum in upper 2 to 5 feet (commonly weathered to silty clay loam); up to 13 feet thick	Peoria and Roxana Silts pr	**Loess,** but including some slope deposits; upper and thicker portion is Peoria Silt (yellow brown to gray); lower portion is Roxana Silt (brown with pink hue to gray); thins from northwest to southeast
Silt loam to silty clay loam; massive to laminated; gray, may have pink hue, soft, moist, calcareous, may contain wood and shell fragments; up to 30 feet thick	Equality Formation e	**Backwater lakes** formed when mouth of Kaskaskia River was blocked by aggradation in Mississippi Valley; occurs in terraces at 410 foot elevations below about 5 feet loess
Fine to medium sand; massive to thin bedded; brown to gray; moist; non-calcareous to calcareous; up to 10 feet thick	Henry Formation (cross sections only) h	**Glacial stream sediment;** occurs directly below Cahokia or Equality Formations, in Kaskaskia Valley only; may grade into sandy Cahokia Formation above or fine Pearl Formation below

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

Description	Unit	Interpretation
Silt loam to silty clay loam, may contain thin fine sand beds; massive to well stratified; brown to pale brown; locally strong redox features; non-calcareous; up to 10 feet thick	Teneriffe Silt (cross sections only) tr (hatch lines where buried) ▨	**Loess and fine grained glacial stream sediment;** contains cumulic Sangamon Geosol; lies above and intertongues with Pearl Formation; occurs mainly on outwash plain east of Richland Creek;
Sand, gravel, and loam diamicton; portions are either dominantly diamicton with small coarse-grained lenses, or locally thick sand and gravel with few fine-grained interbeds; fining upwards; reddish brown, brown, gray; non-calcareous to calcareous; soft to very stiff; up to 100 feet thick, base typically level with surrounding plain	Pearl Formation, Hagarstown Member pl-h (stipple where buried) ▒	**Ice marginal deposits** including outwash, debris flow, and till, characteristically variable; contains Sangamon Geosol in upper portions; forms ridges and mounds on uplands but includes associated buried units; covered by up to 14 feet of loess, intertongues with Pearl Formation, overlies Glasford Formation
Fine to coarse sand and gravel, silt lenses; fines upward; may be clay-rich in upper few feet where a buried soil occurs; reddish brown, brown, gray; leached to calcareous; medium dense to dense; up to 30 feet thick in major valleys	Pearl Formation, outwash facies (cross sections only) pl	**Outwash;** 5-10 feet thick under Cahokia Formation in Richland Creek valley and underlies loess and fine grained alluvium at depths of 20-25 feet in low relief plain in north central areas; contains Sangamon Geosol in upper portions except where eroded; upper portion may be indistinguishable from lower Cahokia or Henry Formations; grades laterally into Hagarstown Member and may intercalate with Petersburg Silt
Pebbly loamy diamicton; massive to crudely stratified; may include lenses of silt, sand or gravel up to 10 feet thick and tens of feet wide in upper portion; brown and olive brown to gray; upper few feet is weathered, brown, softer, more clay rich, and relatively moist; lower portion is commonly more uniform, stiff to very hard, low moisture, and calcareous; more gravelly and stiffest where underlies Hagardstown Member; up to 60 feet thick; thinnest west of Richland Creek where bedrock is near surface	Glasford Formation g	**Till;** weaker and more moist upper portion is supraglacial till, lower denser portion is basal till; Sangamon Geosol developed in upper few feet; eroded out below portions of main stream valleys and terraces in south, crops out along steep stream valley slopes, especially lower RIchland and Prairie du Long Creeks
Silt loam to silt; massive to laminated, jointed; brown to gray; calcareous; very stiff; low moisture content; fossiliferous zones; up to 50 feet thick	Petersburg Silt (cross sections only) pb	**Proglacial or slackwater lake sediment,** may include nearshore facies; underlies or intercalates with Pearl Formation, or underlies Glasford Formation

PRE-ILLINOIS EPISODES (~700,000–400,000 years B.P.)

Description	Unit	Interpretation
Silty clay loam, silt loam, and clay loam diamicton; crudely bedded to massive; few thin silt and sand lenses; very stiff; low to moderate moisture; upper part is reddish brown to brown, lower part is olive brown to gray; non-calcareous to calcareous, up to 60 feet thick	Banner Formation, undifferentiated (cross sections only) b	**Till and ice marginal sediment;** mainly basal till, but may include lake or stream sediment with organic matter in upper or basal portions; truncated Yarmouth Geosol may be developed in upper few feet; eroded or not deposited in west half of map;
Silt loam and loam; laminated to bedded; stiff; low to moderate moisture; alternating beds of olive brown and reddish brown; calcareous; wood fragments, mollusk shell; up to 20 ft thick	Banner Formation, Harkness Silt Member (cross sections only) b-h	**Lake sediment,** but may interfinger with stream sediment; buried beneath till of Banner Formation in Richland Creek bedrock valley

PRE-QUATERNARY DEPOSITS

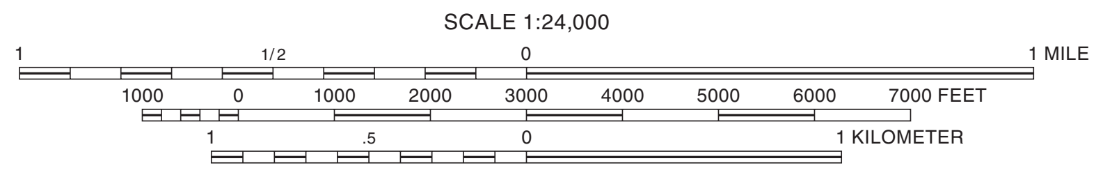
PALEOZOIC BEDROCK

Description	Unit	Interpretation
Sandstone, shale, limestone, and coal; upper few feet may be weathered to clay, or loam; some units fossiliferous	Near-surface bedrock ℙ	**Pennsylvanian and Mississippian bedrock;** crops out in Richland Creek and West Fork Richland Creek channel bed and along valley walls east of Richland Creek; limestone and sandstone mines in northwest quadrant

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Topography compiled from imagery dated 1986. Field checked 1988. Map edited 1990.

North American Datum of 1927 (NAD 27)
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 16

SCALE 1:24,000



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

Released by the authority of the State of Illinois: 2008

Geology based on field work by Andrew C. Phillips and Tim Hodson, 2007–2008.

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

This research was supported in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program (STATEMAP) under USGS award number 07HQAG0109. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

The Illinois State Geological Survey and the State of Illinois make no guarantee, expressed or implied, regarding the correctness of the interpretations presented in this document and accept no liability for the consequences of decisions made by others on the basis of the information presented here. The geologic interpretations are based on data that may vary with respect to accuracy of geographic location, the type and quantity of data available at each location, and the scientific and technical qualifications of the data sources. Maps or cross sections in this document are not meant to be enlarged.

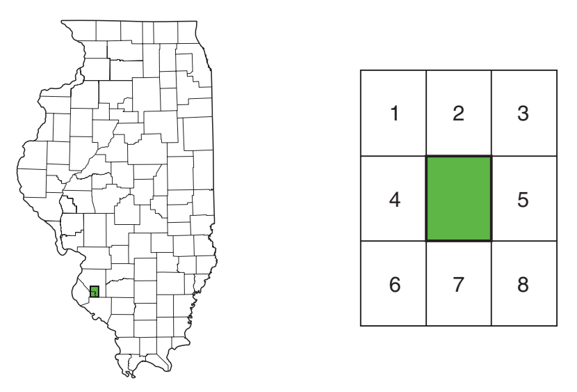
Data Type

▲	Outcrop
●	Stratigraphic boring
●	Water well boring
●	Engineering boring
●	Coal boring
○	Other boring, including oil and gas
SG ⊙ 26211	Labels indicate samples (S) or geophysical log (G). Boring and outcrop labels indicate the county number. Dot indicates boring is to bedrock
——	Contact
– – – – –	Inferred contact
A — A′	Line of cross section

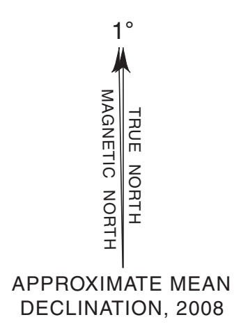
Note: The county number is a portion of the 12-digit API number on file at the ISGS Geological Records Unit. Most well and boring records are available online from the ISGS Web site.

Illinois State Geological Survey

For more information contact:
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 244-2414
http://www.isgs.uiuc.edu



ADJOINING QUADRANGLES
1 Millstadt
2 Freeburg
3 Mascoutah
4 Paderborn
5 New Athens East
6 Ames
7 Red Bud
8 Baldwin



APPROXIMATE MEAN DECLINATION, 2008

ROAD CLASSIFICATION

Primary highway, hard surface	Light-duty road, hard or improved surface
Secondary highway, hard surface	Unimproved road
○ State Route	

Introduction

The New Athens West 7.5-minute quadrangle is located about 12 miles east of bluffs that overlook the Mississippi River valley, and includes a portion of the Kaskaskia River Valley, a major tributary to the Mississippi (fig. 1). Richland Creek, which has its headwaters in Belleville and flows into the Kaskaskia, traverses the entire western half of the quadrangle; it is joined by Prairie du Long Creek, its largest tributary, near the southern boundary of the map and its confluence with the Kaskaskia River. Silver Creek, which heads in northern Madison County, joins the Kaskaskia in the northwest corner of the map. The margins of the Illinois and pre-Illinois Episode glaciations lie only a few miles west. The city of New Athens (pop. 1981;State of Illinois 2000) lies on the east bank of the Kaskaskia River. Its economy is now primarily recreational, but at one time supported significant river and rail shipping, especially of coal from the mines immediately to the east (Walton 1928). A coal port still exists south of New Athens. The village of Hecker (pop. 475; State of Illinois 2000) is mainly residential. Land use is dominantly agricultural, but the Kaskaskia State Fish and Wildlife Refuge in the Kaskaskia River floodplain provides significant recreational opportunities to the region. Future residential and commercial development may follow the recent trends of Waterloo and Freeburg which benefit from a rural setting immediately upon the outskirts of Belleville, and access to St. Louis by highway and light rail (fig. 1). An interchange of the Gateway Connector, a proposed partial beltway linking Columbia with O'Fallon and points north, is platted about 10 miles north and could be a significant driver of development. Several geologic and hydrologic features are of concern within the quadrangle and surrounding area:

- Many rural residences rely on shallow wells developed in drift where distribution of groundwater yield and quality are patchy. [Tally?] Shallow wells are relatively susceptible to contamination.
- The quadrangle contains 24% of the Richland Creek watershed. Surface water quality is important because Richland Creek flows into the Kaskaskia River State Fish and Wildlife Area, and communities downstream of the confluence rely on the Kaskaskia River for drinking water. Surface water quality can be quickly compromised by chemical and sediment constituents in runoff.
- The quadrangle is adjacent to the United States Geological Survey Urban Hazards Mapping Project target area (Williams et al. 2007). Patches of buried saturated fine sands across the quadrangle may be susceptible to liquefaction under ground shaking by earthquakes emanating from the New Madrid Fault, about 140 miles to the south.
- Ridges trending northeast to southwest across the quadrangle including Belcher and Tamarawa Ridges constitute an Illinois Episode morainic complex. Regionally, some of these ridges are important groundwater and aggregate sources.

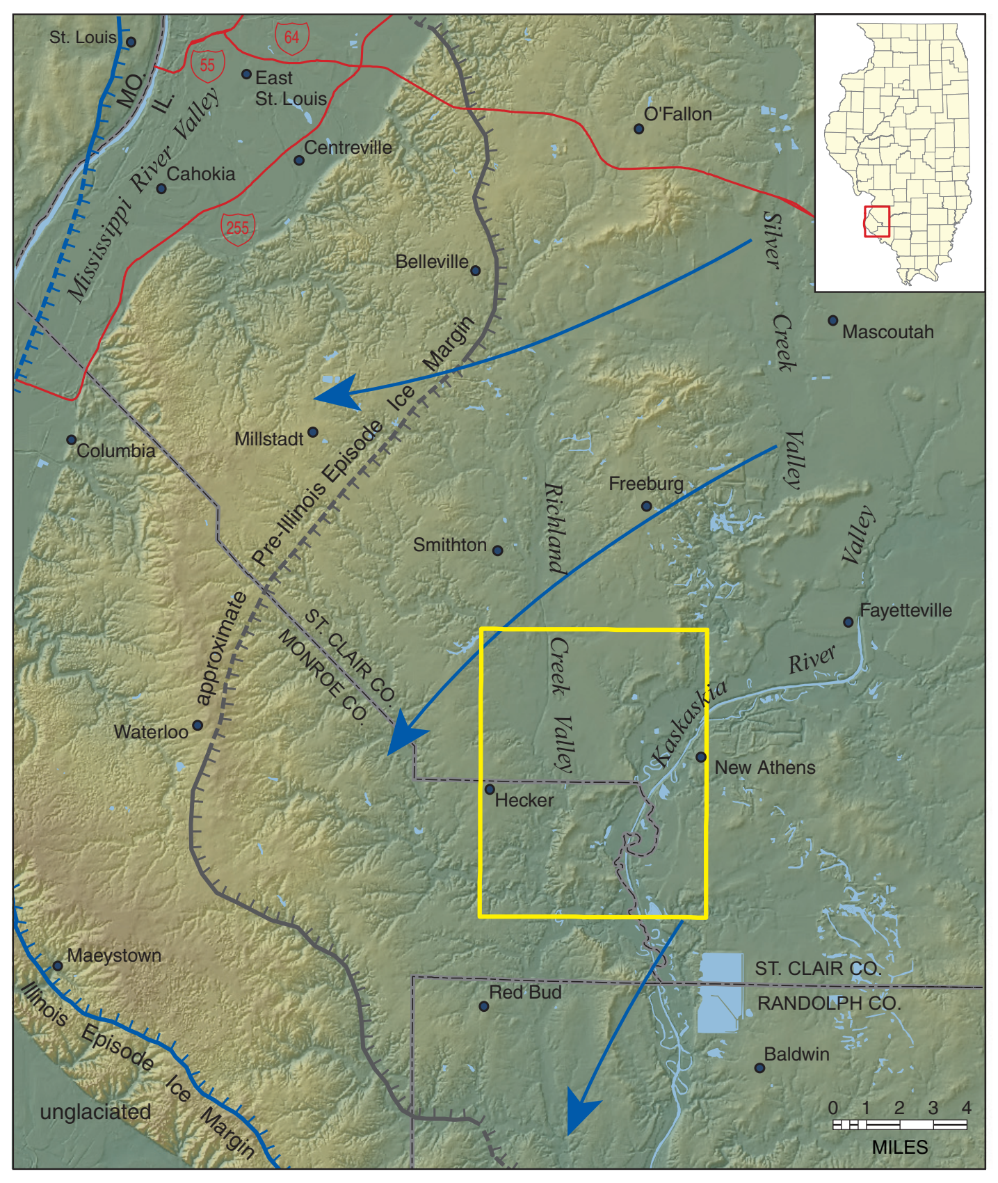


Figure 1 Shaded relief map of the St. Louis Metro East area (southern portion). The New Athens West Quadrangle is outlined in yellow. Blue arrows indicate approximate ice flow direction during the Illinois Episode.

This map depicts geologic materials found within 5 feet of the ground surface. The cross sections provide 2-dimensional views of the extent of surficial and buried units down to bedrock. Previously published geologic maps of the area have been at 1:500,000 (Lineback 1979; Stiff 2000) and 1:250,000 (Jacobs 1971) scale. Devera and Jacobsen (2004) focused on the bedrock geology, though did provide some interpretations of the Quaternary deposits. Unpublished 1:24,000 work maps compiled by E.D. McKay for McKay (1986) were especially helpful. This project builds upon this earlier work by adding new observations of the surface and subsurface, incorporating them into a digital database, and interpreting them at large scale. Sediments forming prominent upland ridges were distinguished, buried fine sands across some upland areas were delineated, the variability of units was characterized, and areas with relatively good and relatively poor geologic control were identified. Prediction of the occurrence of buried units far from the lines of cross section should be made with care; additional studies are necessary if greater detail is desired. This product can be used for preliminary geologic assessments of construction siting issues, geologic hazards, groundwater and materials resources, environmental protection, and other activities. The work is part of the Illinois State Geological Survey (ISGS) Metro-East mapping project, intended to provide critical geologic data in this rapidly developing area.

Methods

The surficial map depicts geologic units that occur within 5 ft of the surface. The map was constructed by interpretations of parent materials from soil surveys (NRCS 1999) that were validated with outcrop observations and modified to conform to topography, interpretations of borehole data, and compilation of field notes and groundwater reports from previous ISGS research. Some landforms were interpreted by airphoto analysis. Borehole data sources included new borings acquired for this project, and stratigraphic-, geotechnical-, water-, gas-, and coal-boring records stored in the ISGS Geological Records Unit and the ISGS Geological Samples Library. The quality of the geologic and locational descriptions of archived data vary considerably in detail and accuracy. Stratigraphic boring descriptions and geotechnical logs typically provided the most detail and could be located most accurately. Except for two companies, descriptions provided by water-well drillers were generally of low value because few lithologic boundaries were distinguished, typically only larger sand and gravel bodies or the drift/bedrock interface could be determined, and locations tend to be imprecise. Outcrops described in this study provide critical two-dimensional perspectives of map unit variability and contact characteristics, but exposures are limited to near-surface units. Positions of well and outcrop locations shown on the map are based upon the best available information for each point.

Two geophysical methods were used for this study, downhole natural gamma logging, and electrical earth resistivity surveying. Slow logging natural gamma (nγ) radiation in stratigraphic boreholes distinguishes clay-rich (high nγ) and clay-poor (low nγ) units (Bleuer 2004). The instrument is sensitive to both the grain size and mineralogy of geologic materials. Each of the magnitude, downhole frequency, and downhole trend of the signal can be distinctive for a given stratigraphic unit. The logs provide a more continuous record of a stratigraphic borehole than might the core itself. Loose, granular materials are particularly hard to sample when coring, but show up clearly on nγlogs.

Electrical earth resistivity surveying is a geophysical technique that takes advantage of the contrast in electrical properties of natural materials. The electrical resistance of the materials is measured by injecting an electric current into the ground through two metal stakes (the current dipole) and measuring the resulting electrical potential with two other stakes (the potential dipole). According to Ohm's Law, resistance is the potential divided by the current. But resistance of earth materials depends on the volume of the material being measured. Resistivity, the resistance of a unit area of material divided by a unit length and reported as ohm-meters, is the same regardless of the volume of the material. For this test, we used the dipole-dipole configuration: the two electrodes forming the potential dipole are next to the two electrodes forming the current dipole. The length of the two dipoles are always the same as each other, but increase in length to increase the depth penetration. The distance between the two dipoles is a multiple of the length, with increasing multiples also providing for increased depth penetration. For the High Resolution Electrical Earth Resistivity (HREER) tests conducted in this survey, up to 60 metal stakes were pushed into the ground at intervals of 5 meters along the survey line. The stakes were connected through multi-core cable to a computer-controlled resistivity meter (ABEM Terrameter 1000) and switching system (LUND imaging system). A control program sequentially switched various combinations of electrodes, operated the instrument, and stored the data. After a set of readings was completed, the survey line was moved incrementally and more data were acquired. Profiles of continuous resistivity measurements were obtained at 5 m spaces and up to as much as 60 m (200 ft) deep. A two-dimensional resistivity model was calculated from the electrical data using a finite element inversion program (RES2DINV; Loke and Barker 1996). This program can partially compensate for the effects of topography and lateral resistivity changes.

The cross sections depict the thickness, horizontal extent, and relationships of subsurface geologic units down to bedrock. Units thinner than 5 feet are not shown. Horizontal and vertical accuracy of data used in the cross sections range between approximately 5 to 200 ft and 1 to 5 ft, respectively. Surficial contacts were correlated between observation points by interpreting landform-sediment relationships on topographic maps. Buried unit boundaries are assumed to be well known within 1000 ft of each observation point. Buried unit boundaries extending further than 1000 ft from well-known observation points are dashed. Stratigraphic nomenclature follows Hansel and Johnson (1996) and Willman and Frye (1970), as appropriate.

The bedrock topography was constructed by computer modeling. The 236 borehole records with reliable bedrock observations and 7 field observations. These were supplemented with inferred elevations from 6 borehole records that did not reach bedrock yet were intersected by preliminary surface models. Inferred point elevations and contours were used where preliminary bedrock surfaces rose above the surface topographic model. The model also uses streamlines based upon geologic judgment to guide a hydrologically correct surface.

Geologic Setting

The landscape in the New Athens region was constructed over at least three episodes of glaciation (the pre-Illinois-, Illinois-, and Wisconsin Episodes), which were separated by relatively warm interglacial episodes, including an initial pre-glacial and the present-day postglacial episodes. Four landform-sediment assemblages can be distinguished: 1) bedrock-controlled uplands mainly west of Richland Creek; (2) a series of elongate hills trending NNE-SSW and known collectively as the "ridged drift", 3) low relief uplands, and 4) river valleys. In addition, there are concealed deposits, whose occurrence is partly controlled by the bedrock topography (fig. 2).

Geologic History

Before the earliest known Quaternary glaciation, erosion had exposed much of the land surface to bedrock. Regional drainage led to a large valley central to the quadrangle (fig. 2). Valley walls, composed of sandstone, limestone, shale, and coal were incised, probably deeply incised to the east, by tributary streams. Overall, the landscape was perhaps similar to present-day northeastern Kentucky. Stream and lake sediments may have accumulated in valley bottoms. During the pre-Illinois and the Illinois glacial episodes, glaciers flowed over the region from the northeast to the southwest, eventually extending into to the edge of the Mississippi Valley due west of Hecker (Goodfield 1965; McKay 1986; Grimley et al. 2001; fig. 1). The glaciers sculpted the pre-existing landscape and left deposits of diamicton (a poorly sorted mixture of rocks, sand, silt, and clay) as till at the glacier bed or as debris flows sloughed off of glacier margins or in crevasses. Sorted silt, sand, and gravel were deposited from meltwater streams as outwash. The Richland, Silver Creek, and Kaskaskia Valleys were each outwash channels, either under the ice or beyond the ice margins. Other outwash was deposited by low relief braided stream systems across broad plains. Upon deglaciation, although regional drainage patterns remained similar, some pre-existing valleys were completely buried or only partly re-occupied. For example, the proto-Richland Creek bedrock valley lies east of the modern Richland Creek valley and turns east towards the Kaskaskia Valley in the north central portion of the map (fig. 2). During the last (Wisconsin Episode) glaciation, ice only advanced into the northeastern quadrant of Illinois, reaching to about 100 miles to the northeast of New Athens. However, the outwash had significant effects. Large volumes of sediment were discharged into the Mississippi and Kaskaskia rivers. As well, high sediment aggradation in the Mississippi and Kaskaskia Rivers created slackwater conditions in tributary valleys such as the Kaskaskia River and Richland Creek, respectively. Thick deposits of fine sediment accumulated in these temporary lakes. During glaciation, silt was eroded by westerly winds off the unvegetated, extensive, sandy floodplains in the Mississippi Valley, then deposited across the upland landscape as blankets of loess. Between glaciations, streams continued to erode some sediment out of their valleys, and soils developed on the fresh land surface.

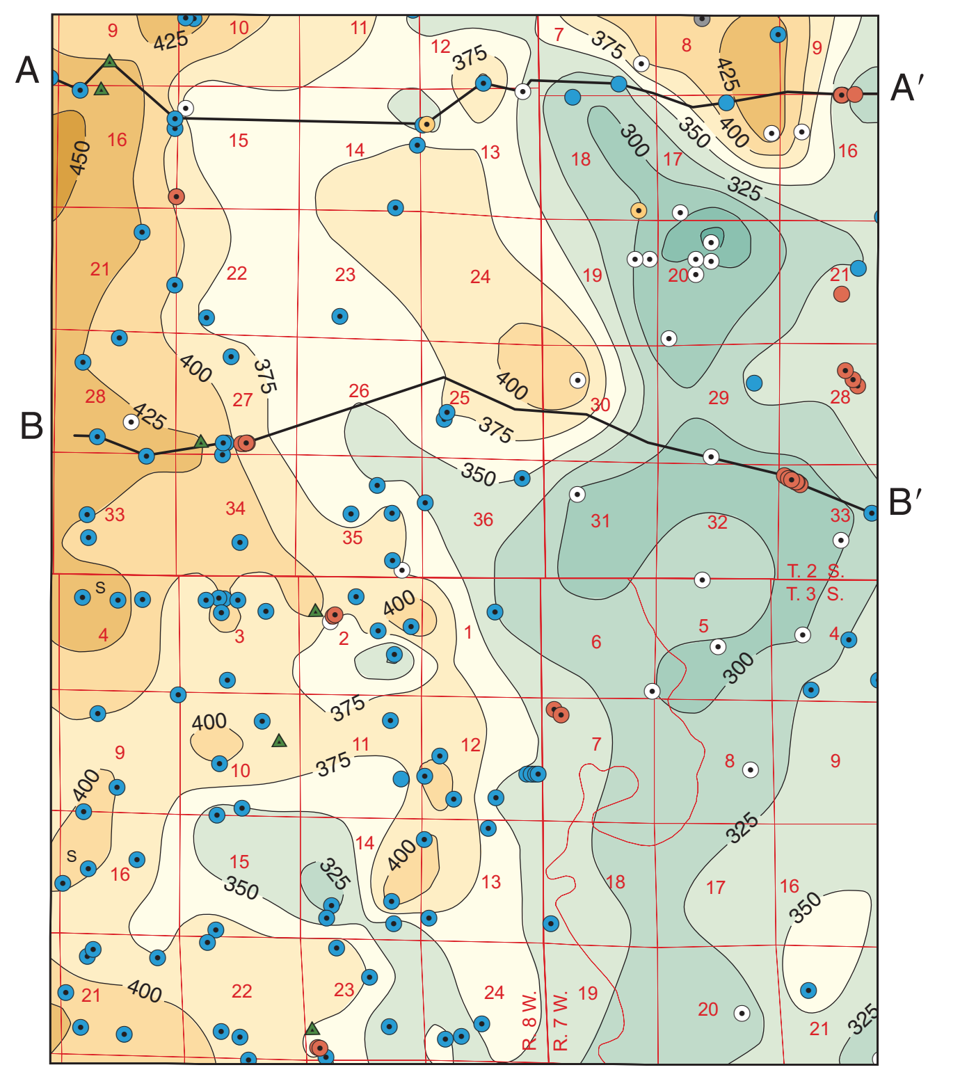


Figure 2 Bedrock topography of the New Athens West Quadrangle. Localities of all data that reliably indicate the bedrock surface are shown (many data are not shown on surficial map). Scale is 1:100,000.

The elevations of the channel bottoms were probably at their highest just after glaciation. With the cessation of the large sediment supply, there has since been general incision of the valleys into older sediments and lowering of land surface. Postglacial stream sediment is derived mainly from erosion of the loess covering the uplands. Erosion has also exposed older Quaternary sediments and bedrock. Clearing of forests during early European colonization, and possibly earlier during Amerindian civilization centered at the Cahokia Site in the Mississippi Valley, led to a period extensive upland erosion and sediment accumulation in creek valleys. Relatively recent stream incision into these sediments and older deposits is attributed to large water discharges with initially low sediment loads brought about by recent climate changes, land use changes, or both. Straightening of the Richland and Kaskaskia channels in the mid-20th century increased flow rates and may thus have changed channel migration or incision rates locally.

Sediment Assemblages and Properties

Bedrock-Controlled Uplands

The bedrock surface rises from below 300 feet above sea level (asl) in the deepest part of the Kaskaskia Valley in the southeast corner of the map to 430 feet asl along the west margin (fig. 2). The surface undulates; the highs appear to be supported by Paleozoic limestones and relatively resistant sandstones, whereas the lows are underlain by shale and less resistant sandstone. The strata dip gently NNE. The data are too sparse to accurately delineate the lithologic boundaries, but the contact, subparallel and just west of the elongate ridges, between Mississipian and Pennsylvanian systems is clear (Devera and Jacobsen 2004).

West of Richland Creek, only a thin assemblage of till blanketed by loess covers the bedrock. The assemblage rarely exceeds 25 feet. The Peoria Silt and the underlying Roxana Silt loess units are not differentiated here because their geotechnical properties are very similar (table I). They have been studied extensively by McKay (1979), Wang et al. (2003), and others. Original textures of silt loam to heavy silt loam have been modified within the modern solum to heavy silt loam to silty clay loam (NRCS 1999). The loess is thickest (maximum 13 ft but typically 9 ft) closest to its Mississippi Valley source area in the west and thins to 9-10 ft on uneroded uplands in the east. The mapped area may include some loess-derived stream sediment in low-order stream valley bottoms.

Along side slopes and valley walls, where erosion has thinned the loess blanket to 5 ft or less, the Glasford Formation is shown on the surficial map. Sediments in the Glasford Formation include diamicton, weathered diamicton, and associated sorted sands and gravels. The sediment was deposited mainly as till and ice-contact sediment. The ice-contact sediment is distinguished from the diamicton facies of the Hagarstown Member (below) in that it lacks topographic expression of the deposit and sorted sediments are a more minor component. The Glasford Formation is typically pervasive under the uplands of the Metro-East region. Diamicton of the Glasford Formation is loamy, very stiff, with low water content (table 1). Lenses of sand and gravel, up to 10 ft thick and hundreds of feet wide, have been described in the upper part and base of the Glasford Formation in neighboring quadrangles in Madison County (Phillips 2004b; Phillips and Grimley 2004). The lower third of the Glasford Formation is slightly more clay-rich and softer, probably because of incorporation of underlying clayey units and shale. Sheared inclusions of pre-Illinois Episode diamicton and weathered shale were identified in several stratigraphic borings. Within the weathering profile of the Sangamon Geosol, as well, the Glasford Formation has relatively low strength and high moisture content, in part due to higher clay content.

Elongate Hills

Two relatively coarse-grained units, the Pearl Formation-Hagarstown Member and the Pearl Formation, undifferentiated, buried beneath 5 -15 ft of loess are depicted on the map by patterned areas. The Hagarstown Member of the Pearl Formation is associated with the northeast-southwest trending ridged drift and irregular to conical mounds. The sediments may have been deposited in ice-contact environments such as end moraines, eskers, meltwater streams, or deltas in proglacial lakes. The Hagarstown Member is characteristically variable. Although sand and gravel bodies tens of feet thick may occur, especially in the elongate landforms and even in inter-ridge areas, their lateral extent may be very restricted and some landforms may be primarily composed of diamicton (Jacobs and Lineback 1969; Heigold et al. 1985; Stiff 1996). For example, along Nike Road over Tamarawa Ridge, an EER survey suggested pervasive sand only east of borehole 23207. This is confirmed by sand and gravel cropping out along the steep hillside at observation 23126. However, 10's of feet were reported from generally reliable drillers for water wells parallel to the EER profile. Similarly, swarms of geotechnical borings at Beck Vocational School (11-3S-8W) and the Nike Site M (14-3S-8W) indicate patchy occurrences of sorted sediment. Further, diamicton crops out on the flanks of the ridges that border lower Richland Creek. By contrast, borehole evidence suggests that Belcher Ridge and the ridge immediately southwest (17, 18, 19 2S-7W; stratigraphic test 30657) contain relatively homogeneous bodies of fine sand to gravel that contact underlying till at about the level of the surrounding plain.

Thus, the Hagarstown Member is mapped where elongate landforms are likely to contain sorted sediment. We distinguish two sedimentary facies of the Hagarstown Member, one predominantly diamicton with common sand and gravel lenses ("morainic facies"), the other predominantly sand and gravel ("outwash facies"). The Hagarstown Member is not mapped on landforms where occurrences of sand and gravel is unlikely (e.g. near 23-3S-8W). The upper few feet of the Hagarstown Member typically contains truncated Sangamon Geosol, which can be used to distinguish Illinois- from Wisconsin Episode sediment. The Hagarstown Member interfingers with the Pearl Formation, undifferentiated, way from the ridges.

Low Relief Uplands

The gently undulating land surface east of Richland Creek and west of the elongate hills conceals a complex depositional history as a stream valley and outwash plain. Below the Wisconsin Episode loesses are 10-30 ft of Illinois Episode meltwater stream sediment. The uppermost unit, Teneriffe Silt, is mainly stratified very fine sand to silt loam and silty clay loam 5 to 10 feet thick. It blankets underlying units and fills in depressions. Regionally it has been mapped as the Berry Clay – Teneriffe Silt Complex where silty clay loam or clay are major components (c.f. Grimley 2006). Though dominantly stream sediment it may include some Illinois Episode loess and slopewash from the surrounding hills. A key distinguishing feature from the Peoria and Roxana Silts is the occurrence of a well-developed paleosol, the Sangamon Geosol, in the upper few feet. Characteristics include well-defined peds, large Fe-Mn concentrations, and a clear textural B horizon. The A horizon is usually truncated.

Below the Teneriffe Silt occurs outwash sands of the Pearl Formation, undifferentiated. The Pearl Formation here fines up from coarse sand with minor gravel to fine sand. The contact with the Teneriffe Silt may be gradational or distinct. Twenty (20) to 80 ft of sand are reported from waterwells over the outwash plain, although the wells are sparsely distributed. The Pearl Formation merges with or underlies the Hagarstown Member of the Pearl Formation (below) to the east and south, and appears to pinch out towards Richland Creek though it is likely contiguous somewhere along the reach. The origin of the Pearl Formation here is not clear. Some must be genetically related to an ice margin perched in the position of the elongate hills, but some must also be related to Pearl Formation sands buried in the Richland Creek valley. The valley upstream of IL 156 is relatively wide and contains 5-10 ft of Pearl Formation, whereas no sands are found downstream of IL 156. This suggests that Richland Creek was an Illinois Episode outwash channel, but fed into the Kaskaskia Valley across the outwash plain.

River Valleys

The Richland Creek valley fill was introduced above. Upstream of IL 156, postglacial stream sediment (Cahokia Formation) which lies mainly on outwash and till of the Pearl and Glasford Formations, respectively. The Pearl Formation does not occur downstream of IL 156. The occurrence of the Pearl Formation in Richland Creek and also in Silver Creek shows that these larger tributary streams were meltwater outlets during the Illinois Episode. The Cahokia Formation is up to 40 ft thick. It is generally fine grained because the sediment source was primarily loess, but the texture varies from silty clay deposited in backwater environments and abandoned meanders, to loamy sediments associated with deposition near channels. Layers of sand occur at depth, and up to several feet of sand and gravel that was concentrated by stream processes from older deposits (till or outwash) may occur at the base of the unit.

Two terrace levels occur above the modern floodplain in the Kaskaskia Valley and lower Richland and Prairie du Long Creeks. During the Wisconsin Episode, aggradation in the Mississippi Valley cause slackwater conditions in the Kaskaskia and its tributaries. Lakes filled with fine sediment. Subsequent incision left Equality terraces (e) at elevations of about 400-430. Laminated to massive silt loam to silty clay is capped with about 3 ft of Peoria Silt (not Roxana Silt). A spectacular outcrop occurs just at the northeast map edge on the left bank of Silver Creek (observation 30622). Thirty feet of calcareous, stiff, silt and silty clay are exposed above the water. Borehole evidence suggests that the Equality Formation rests on Pearl Formation (outwash) in the Kaskaskia Valley and Glasford Formation in Prairie du Long and Richland Creeks.

A second terrace level is not well-constrained by age. It may be remnant of early postglacial river levels or post-settlement levels. Terraces mapped as c(c)-2 have up to 9 ft of massive silty clay, clay or clay loam and lie sharply over fine sands, probably of the Henry Formation. These terraces are mapped within the Kaskaskia Valley below 400 foot elevations. They represent overbank floodplain deposition during a period of high river levels.

The Kaskaskia clearly underwent a long period of meandering behavior in order to develop the strongly meandering channels left as backswamps after straightening of the main channel. It is not clear how long this occurred in part because of lack of borehole data, but also because the channel is rather narrow (though underfit) and so many older alluvial landforms have probably been reeroded. The other units mapped within the Kaskaskia reflect the diversity of environments of meandering stream systems. Clayey Cahokia Formation (c(c)-1) is backswamp fill; sandy Cahokia Formation (c(s)) occurs as natural levees, point bar, and crevasse splays, and Cahokia Formation (undifferentiated; (c)) comprises silty floodplain deposits. The Cahokia Formation has maximum thicknesses of about 15 feet, less than found in some tributary valleys like Silver Creek in northern St. Clair and in Madison Counties (Grimley and Phillips 2006). In tributary valleys within New Athens West quadrangle, the Cahokia Formation is undifferentiated because lithologic variability is relatively low and data are sparse. It is up to 10 feet thick.

Concealed Deposits

Filling the lowermost portions of bedrock valleys are deposits that are uncommonly or never seen in outcrop. Petersburg Silt includes slackwater lake sediment. In boring 30657 at an elevation of X, 30 ft of hard, jointed, calcareous silt loam was encountered. It was alternately laminated and massive, contained root traces, wood and unidentified shell fragments, and rip-up clasts. These features are evidence of a shallow lake to alluvial environment that temporarily filled Illinois Episode valleys. The damming mechanism could have been either ice crossing the Kaskaskia Valley or aggradation in the Mississippi Valley causing backwater effects.

Pre-Illinois Episode Quaternary deposits (Banner Formation) have only been found in outcrop in northern Madison County (c.f. Phillips 2004a; Mckay 1986) can only be identified in boreholes or with geophysical techniques. Banner Formation deposits are distinguished from the Glasford Formation by the weathering profile of an interglacial soil (Yarmouth Geosol) developed in the upper part, by selected physical and chemical properties (table 1), and by stratigraphic position. The Yarmouth Geosol was truncated by the Illinois Episode glacier and may only be recognized by a zone leached of carbonate. The top of the Yarmouth Geosol is interpreted from water well records by descriptions of "greenish", "yellow", or "brown" sediments below gray sediment of the lower Glasford Formation.

Three units of the Banner Formation are distinguished. They include 1) diamicton interpreted to be till, 2) bedded clay and silt deposited in glacial lakes (Harkness Silt Member), and 3) weathered, non-glacial, pebbly to loamy textured sorted sediments (the informal Canteen member; Phillips 2004b). Till of the Banner Formation is typically uniform in this region. Relative to the Glasford Formation, it has moderate strength, moisture content, and low pebble content. Regionally it has a silt loam texture, but here is predominantly loam to sandy clay loam, similar to the Glasford Formation (c.f. Phillips 2004b; Phillips and Grimley 2004). A 3 ft thick sand lense near the base of the till was interpreted from the nγlog in borehole 30530.

The Harkness Silt Member was found in borehole 30656. The clay to clay loam sediment was deposited in massive beds with distinctive alternating reddish and greenish hues. Gastropod and mussel shell fragments occur sparsely and in shell hash zones.

A weak paleosol (sediment leached of carbonate and olive color), variable textures, lack of erratic pebbles, and clay mineralogy similar to bedrock distinguish the Canteen member within the Banner Formation. The unit may contain stream, lake, and slope sediment, as well as additional paleosols. The sediments are interpreted to be non-glacial in origin and directly overlie bedrock. The Canteen member is restricted to bedrock valleys (cross sections, fig. 2). It has been found in boreholes penetrating buried bedrock valleys from St. Clair to northern Madison Counties (e.g., Phillips 2004b; Grimley 2006; Phillips and Grimley 2006).

Geologic Resources

Water Resources

There are few water wells with which to evaluate groundwater resources within the quadrangle relative to other areas. Although the Pearl Formation and sand and gravel lenses within the Glasford Formation are potentially productive, the bodies are generally restricted in extent, varied in location, and thus are difficult to target for drilling. West of Richland Creek there are very few wells completed in surficial materials; most go several hundreds of feet into bedrock. East of Richland Creek in the uplands, most domestically supplies also come from the bedrock. Over the low relief plain, however, about half of the existing wells are shallow (25-50 feet) and exploit the Pearl Formation. All municipal supplies are from bedrock or the Kaskaskia River.

Geologic Hazards

Seismic Hazard

Buried fine sands of the Pearl Formation on the terraces (hachured regions) along Richland and Kaskaskia Creek represent potential liquefaction hazards. Potential confining layers include the pedogenically-altered accretion and fine-grained stream deposits of the Teneriffe Silt. Tuttle (2005) identified paleoseismic features including sand blows in stream outcrops along the Kaskaskia River, as well as many other locations in the region. They were correlated to earthquake activity centered on the New Madrid Seismic Zone in southern Illinois.

Groundwater Contamination

Contamination potential for shallow aquifers in uneroded uplands is low to moderate (Berg et al. 1984). Although potential confining layers of loess and till are sufficiently thick over much of the quadrangle, sand and gravel lenses in shallowly buried Hagarstown Member, Pearl Formation, and Glasford Formation provide potential subsurface pathways for contaminants (c.f. Berg et al. 1984). The Sangamon Geosol likewise provides a clay-rich horizon, up to 3 ft thick, that could substantially retard downward groundwater flow (c.f. Herzog et al. 1989). However, soil structure, fractures, as well as the many small lenses of sand within the upper part of the Glasford Formation may provide pathways for contaminants to underlying layers.

Acknowledgments

We would like to thank the private and public landowners who graciously permitted us to drill on their properties. Core and gamma logs were obtained by the ISGS drill team. Tim Hodson helped with the field and work. Clay mineral analyses were completed by Nicole Fox; particle size analyses were overseen by Hue-Hwa Hwang. Zeno at Beck Vocational Institute knew a lot about the Nike installation. John Nelson described the bedrock portions of the new stratigraphic test holes. The mapping was supported by United States Geological Survey STATEMAP Contract 07HQAG0109. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the United States Government or the State of Illinois. This map is based on the most reliable information available at the time mapping was completed, but, because of project objectives and the scale of the map, interpretations from it should not preclude more detailed site investigations specific to any other project.

References

Berg, R.C., J.P. Kempton, and K. Cartwright, 1984, Potential for contamination of shallow aquifers in Illinois: Illinois State Geological Survey, Circular 532, 30 p.

Bleuer, N.K., 2004, Slow Logging Subtle Sequences: Indiana Geological Survey Special Report 65, 39 p.

Devera, J., and R. Jacobsen, 2004, Geology of New Athens West, St. Clair and Monroe Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geological Map, IPGM New Athens West – G, 1:24,000.

Goodfield, A.G., 1965, Pleistocene and surficial geology of the city of St. Louis and the adjacent St. Louis County [Ph.D. dissertation]: University of Illinois at Urbana-Champaign, 207 p.

Grimley, D.A, 2006, Surficial geology of Mascoutah Quadrangle, St. Clair County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Mascoutah-SG, 1:24,000.

Grimley, D.A., and Phillips, A.C., 2006, Surficial Geology of Madison County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Marine-SG, 1:100,000.

Grimley, D.A., A.C. Philips, L.R. Follmer, H. Wang, and R.S. Nelson, 2001, Quaternary and environmental geology of the St. Louis Metro East Area, in D. Malone, editor, Guidebook for Fieldtrips for the Thirty-Fifth Annual Meeting of the North-Central Section of the Geological Society of America: Illinois State Geological Survey Guidebook 33, p. 21–61.

Hansel, A.K., and Johnson, W.H., 1996, Wedron and Mason Groups: Lithostratigraphic reclassification of deposits of the Wisconsin Episode, Lake Michigan Lobe Area: Illinois State Geological Survey Bulletin 104, 116 p.

Heigold, P.C., Poole, V.L., Cartwright, K., and Gilkeson, R.H., 1985, An electrical earth resistivity survey of the Macon-Taylorville Ridged-Drift Aquifer: Illinois State Geological Survey Circular 533, 23 p.

Herzog, B.L., R.A. Griffin, C.J. Stohr, L.R. Follmer, W.J. Morse, and W.J. Su., 1989, Investigation of failure mechanisms and migration of organic chemicals at Wilsonville, Illinois: Ground Water Monitoring Review, v. 9, p. 82–89.

Jacobs, A.M., compiler, 1971, Geology for Planning in St. Clair County, Illinois: Illinois State Geological Survey Circular 465, 35 p.

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

Lineback, J.A., 1979, Quaternary deposits of Illinois: Illinois State Geological Survey, 1:500,000.

Loke, M. H. and R. D. Barker, 1996. Rapid least-squares inversion of apparent resistivity pseudosections by a quasi-Newton method. Geophysical Prospecting, Vol. 44, p. 131-152.

McKay, E.D.,1979, Stratigraphy of Wisconsinan and older loesses in southwestern Illinois, in Geology of Western Illinois, 43rd Annual Tri-State Geological Field Conference: Illinois State Geological Survey Guidebook 15, p. 37–67.

McKay, E.D., 1986, Illinoian and older loesses and tills at the Maryville section, in R.W. Graham, editor, Quaternary records of southwestern Illinois and adjacent Missouri: Illinois State Geological Survey Guidebook 23, p. 37–68.

NRCS, 1999, Soil Survey Geographic (SSURGO) database for St. Clair County, Illinois: U.S. Department of Agriculture, Natural Resources Conservation Service, http://www.ftw.nrcs.usda.gov/ssur_data.html.

Phillips, A.C., 2004a, Surficial geology of Collinsville Quadrangle, Madison and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Collinsville-SG, 1:24,000.

Phillips, A.C., 2004b, Surficial geology of St. Jacob Quadrangle, Madison and St. Clair Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM St. Jacob-SG, 1:24,000.

Phillips, A.C. and D.A. Grimley, 2004, Surficial geology of Marine Quadrangle, Madison County, Illinois: Illinois State Geological Survey Illinois Preliminary Geologic Map, IPGM Marine-SG, 1:24,000.

State of Illinois, 2000, Illinois Census 2000, http://illinoisgis.ito.state.il.us/census2000/. (Accessed August 27, 2007.)

Stiff, B.B., 1996, Morphometric analyses of ridges and subsurface coarse, water-laid deposits in a portion of the Ridged Drift of the Kaskaskia Valley, south-central Illinois: M.S. Thesis, University of Illinois at Urbana-Champaign, 156 p.

Stiff, B.B., 2000, Surficial deposits of Illinois: Illinois State Geological Survey Open File Series 2000-7.

Tuttle, M.P., 2005, Paleoseismological Study in the St. Louis Region: Collaborative Research: Final Technical Report, U.S. Geological Survey, Contract Award 1434-99HQGR0032, 29 p.

Walton, W.C., 1928, Centennial history of McKendree College: Ch. 5, Early American settlers of St. Clair County, USGenWeb Project Web site: A brief history of St. Clair County, Illinois, http://www.rootsweb.ancestry.com/~ilstclai/chap5.htm. (Accessed August 29, 2008)

Wang, H., R.E. Hughes, J.D. Steele, S.M. Lepley, J. Tian, 2003, Correlation of climate cycles of Middle Mississippi Valley loess and Greenland ice: Geology v. 31, p. 179–182.

Williams, R.A., P. Steckel, and E. Schweig, 2007, The St. Louis Area Earthquake Hazards Mapping Project: U.S. Geological Survey Fact Sheet 2007-3073.

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