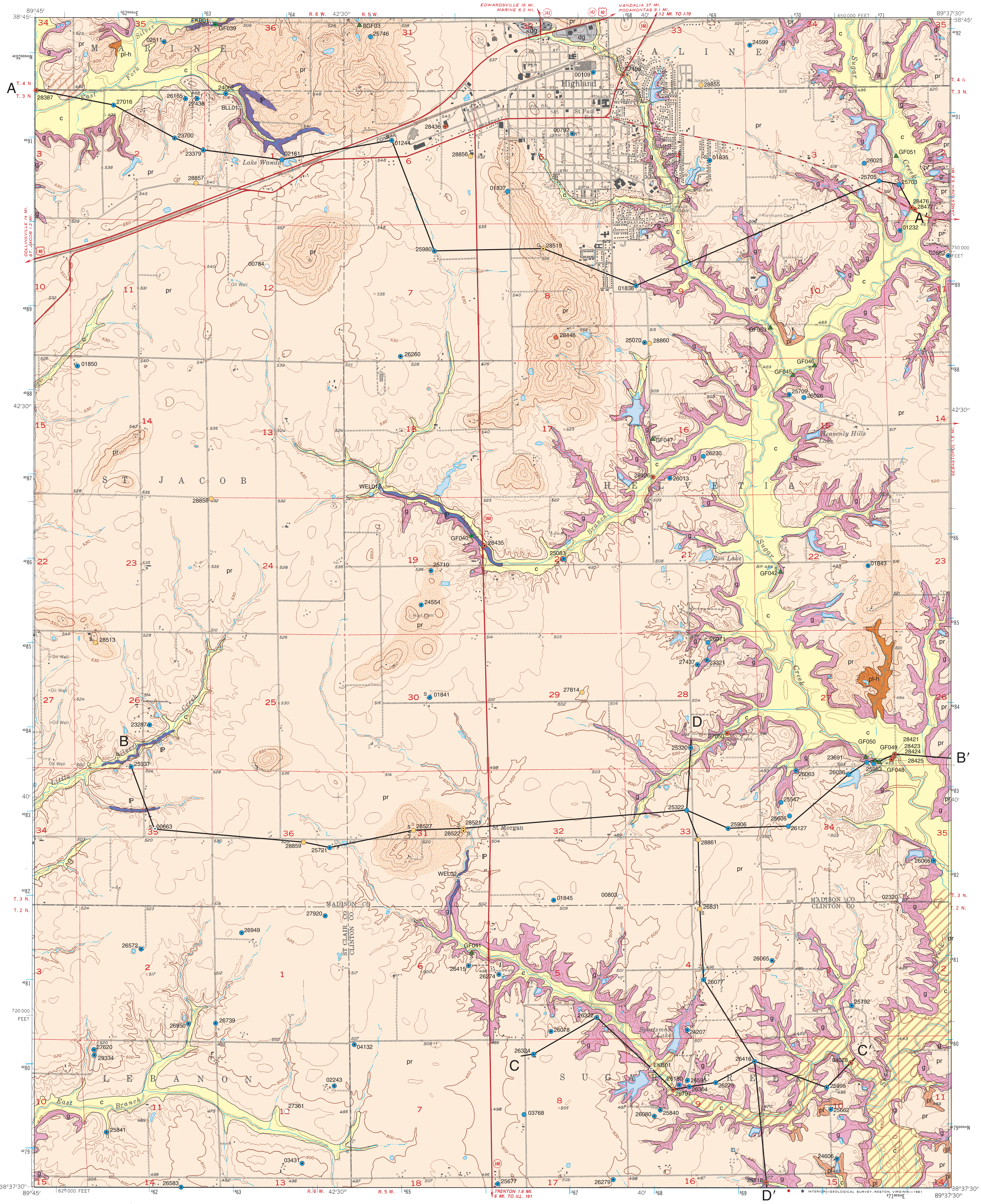
Illinois Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

Surficial Geology of Highland Quadrangle

Madison, St. Clair, and Clinton Counties, Illinois

Illinois Preliminary Geologic Map
IPGM Highland-SG

Andrew C. Phillips
2005



QUATERNARY DEPOSITS

Description	Unit	Interpretation
HUDSON EPISODE (~12,000 years before present (B. P.) to today)		
Fill or removed earth; mixed sediment of varied texture, including rubble, gravel, silt, and clay; typically 5 feet thick but up to 16 feet thick in bridge cones	Disturbed ground dg	**Graded land for commercial development as shown in soil report;** most areas disturbed for residential and commercial construction and transportation not shown
Silty clay to silt loam with loam to sandy loam, local sand and gravel lenses; massive to well stratified; gray to brown; leached, very soft to moderately stiff; typically moist to very moist but seasonally variable; up to 25 feet thick	Cahokia Formation c	**Stream sediment** in modern stream valley floodplains; mainly redeposited loess; may be coarser grained in lower portion where sediment is derived from till and buried glacial stream deposits
WISCONSIN EPISODE (~75,000 years–12,000 B.P.)		
Silt loam; massive to weakly stratified; dark yellow brown to gray, may have pink hue; noncalcareous; friable; contains modern soil solum in upper 2 to 5 feet (commonly weathered to silty clay loam); typically 10 feet on flat uplands but up to 15 feet thick	Peoria and Roxana Silts pr	**Loess** (wind blown sediment), also includes 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); thinnest where eroded on hilltops and upper slopes
ILLINOIS EPISODE (~200,000 years–130,000 B.P.)		
Sand, gravel, and diamicton; interbedded; reddish brown, brown to gray; noncalcareous to calcareous; up to 15 feet thick; where unit is buried, contacts are inferred	Hagarstown Member, Pearl Formation pl-h (stipples where buried)	**Ice marginal deposits** including debris flow, outwash, and till, characteristically variable; buried by up to 12 feet of loess in ridges and mounds on uplands with local outcrops in stream valleys; intertongues with Pearl or Glasford Formations; contains Sangamon Geosol in upper portions, some sand may have been weathered to diamicton in B horizon
Fine to coarse sand (sand to sandy loam) with gravel and silt lenses; may be clay-rich in upper few feet where a buried soil occurs; reddish brown, brown, gray; noncalcareous to calcareous; up to 15 feet thick; where unit is buried, contacts are inferred	Pearl Formation outwash facies pl (hachures where buried)	**Outwash** deposited by glacial meltwater streams; forms terraces along East Fork Silver Creek where it is buried by loess, crops out in Sugar Fork, apparently eroded from valley bottoms; contains Sangamon Geosol in upper portions but typically truncated; some sand may have been weathered to diamicton; exposed or within 5 feet of the land surface in surficial map units
Pebbly loam diamicton; massive; includes lenses of silt, sand and gravel, predominantly in upper part; olive brown to dark gray to dark grayish brown; upper few feet has pedogenic features, is brown, relatively soft, clay-rich, and moist, fractures extend through upper 15 feet; lower portion is typically more uniform, stiff to hard, low moisture, and calcareous; lowest 5 to 10 feet may be more clay-rich or has inclusions of older units; up to 80 feet thick	Glasford Formation g	**Till and ice marginal sediment;** weaker and more moist upper portion is supraglacial till, lower dense portion is basal till; pervasive below Peoria and Roxana Silts; underlies stream sediment (Cahokia Formation) in most valleys, crops out along valley slopes; Sangamon Geosol usually developed in upper few feet; exposed or within 5 feet of the land surface in surficial map units
Silt to clay with sand lenses and dispersed gravel clasts; massive; olive gray to gray; noncalcareous to calcareous; moderately to very stiff; low moisture content; up to 25 feet thick	Petersburg Silt (cross sections only) pb	**Proglacial or slackwater lake sediment;** may contain lower portion of Sangamon Geosol; underlies Glasford Formation in portions of the bedrock valley under Sugar Creek
PRE-ILLINOIS EPISODES (~700,000–400,000 years B.P.)		
Clay loam to silty clay to loam diamicton; upper part is relatively loamy, lower part is relatively clayey; few thin silt and sand lenses, wood fragments; crudely bedded to massive; very stiff; low to moderate moisture; upper part is olive brown to dark yellow brown, lower part is dark gray; noncalcareous to calcareous, up to 55 feet thick	Omphghent member, Banner Formation (cross sections only) b-o	**Till and ice marginal sediment;** Yarmouth Geosol may be developed in upper 10 feet but commonly truncated; mainly basal till; occurs within ridge features and fills bedrock valleys in eastern half of quadrangle
Pebbly silty clay loam to loam diamicton; thin lenses of sand and rounded gravel; very stiff; brown to gray; noncalcareous to calcareous; up to 15 feet thick	Banner Formation, unnamed unit (cross sections only) b-u	**Till;** paleosol developed in upper 4 feet; found mainly beneath ridge features; poorly known but correlates to diamictons below ridges units in adjacent quadrangles to northwest and west
Loam, silt loam, silty clay loam, and clay with fine sand to gravel near base of unit; weakly stratified to well stratified, fines upwards but variable; stiff to hard; moderately to very moist; olive gray to olive brown; leached; up to 25 feet thick	Banner Formation, Canteen member (cross sections only) b-c	**Stream and lake sediment;** nonglacial; contains one or more paleosols older than Yarmouth Geosol, may include residuum; overlies bedrock
Pebbly loam diamicton, silty clay, sand; diamicton is hard, brown; silty clay is olive, soft; sand is fine, brown to gray, thin bedded; up to 40 feet thick	Banner Formation, undifferentiated (cross sections only) b	**Predominantly till,** but may include any of differentiated Banner Formation units; shown where there is weak or incomplete borehole evidence of sediment with paleosol (probably Yarmouth Geosol) below Glasford Formation

PRE-QUATERNARY (PALEOZOIC) DEPOSITS

Description	Unit	Interpretation
Predominantly shale, black and gray, brown to greenish where weathered; noncalcareous, also includes fossiliferous limestone and sandstone; mainly buried but shale is within 5 feet of the surface of some tributary valley bottoms in northwest areas, and limestone crops out in tributary valley bottoms in south	Near-surface Pennsylvanian bedrock ℙ	**Bedrock** exposed or within 5 feet of land surface

Data Type

GF039	Outcrop
EKB01	Outcrop in field notes (ISGS archives)
28522	Stratigraphic boring
24606	Water well
26797	Engineering boring
00784	Other boring, including oil and gas
SG	Boring with samples (S) or geophysical log (G); dot indicates to bedrock.

Note: Numeric labels 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

A—A′ Line of cross section

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Topography from aerial photographs taken 1955. Field checked 1957. Revisions from aerial photographs taken 1979. Map edited 1981.

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

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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 A. Phillips, 2004–2005.

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

This Illinois Preliminary Geologic Map (IPGM) is a lightly edited product, subject to less scientific and cartographic review than our Illinois Geological Quadrangle (IGQ) series. It will not necessarily correspond to the format of IGQ series maps, or to those of other IPGM series maps. Whether or when this map will be upgraded depends on the resources and priorities of the ISGS.

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

1905-2005 ISGS Illinois State Geological Survey

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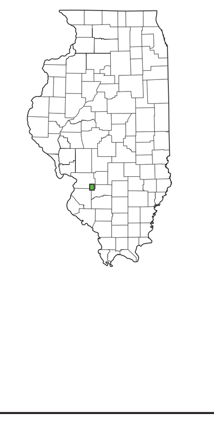

1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Marine
2 Grantfork
3 Pocahontas
4 St. Jacob
5 St. Rose
6 Lebanon
7 Trenton
8 Breese

1°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2005

ROAD CLASSIFICATION

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

Introduction

This map depicts geologic materials found within 5 feet of the ground surface in the Highland 7.5-minute quadrangle, Madison and St. Clair Counties, southwestern Illinois (fig. 1). The cross sections show the extent of surficial and buried units down to bedrock. Previously published maps of the area have been at 1:500,000 scale (Lineback 1979; Stiff 2000), although there has been mapping at larger scales. This project builds upon earlier work, especially Fox et al. (unpublished) by adding new observations of the surface and subsurface, incorporating them into a digital database, and interpreting them at a larger scale. Sediments forming prominent upland ridges were distinguished, 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 as a preliminary geologic model for construction site, geologic hazard, groundwater resource, and other assessments. The work is part of the ISGS Metro-East mapping program, intended to provide critical geologic data in this rapidly developing area.

Regional Setting

The Highland 7.5-minute quadrangle is located about 15 miles east of bluffs that overlook the Mississippi River valley, and near the margins of the Illinois and pre-Illinois Episode glaciations (fig. 1). The landscape is comprised of three geomorphic regions: 1) river valleys, 2) low relief uplands and valley slopes, and 3) ridged or hummocky uplands. River valleys, including some terraces and small fans on valley sidewalls, are mainly comprised of waterlaid sediments. The larger north to south trending stream valleys in the region, such as Sugar, Silver, and Cahokia creeks were conduits of meltwater from the last glacier to cover this region. The Silver and Sugar creek drainages are tributary to the Kaskaskia River valley to the south (not shown).

Uplands are composed of glacial, stream, lake, and windblown sediment (loess). Prominent ridges and isolated mounds mainly west and south of Highland break the otherwise subdued topography of the upland surface. These features are part of a regional train of ridges that trend northeast-southwest (fig. 1). In addition to these geomorphic regions, there are concealed deposits whose occurrence is partly related to surficial landforms and partly by the bedrock topography (fig. 2).

The Quaternary sediment overlying bedrock was deposited during at least three episodes of glaciation that were separated by relatively warm, interglacial episodes, including the present-day postglacial episode. Before the earliest Quaternary glaciation, erosion had exposed much of the land surface to bedrock. Streams flowed in valleys that underlie present-day East Fork Silver and Sugar Creeks (fig. 2). Bedrock valley walls were probably deeply incised by tributary streams such as are seen today in west-central Kentucky. During the pre-Illinois and the Illinois glacial episodes, glaciers flowed over the region from the northeast to the southwest, extending across the Mississippi Valley to the St. Louis area (McKay 1979; 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 base of the glacier or as sediment piles sloughed off of glacier margins or into crevasses. Sorted silt, sand, and gravel were deposited from meltwater streams. During the last (Wisconsin Episode) glaciation, ice only advanced into the northeastern quadrant of Illinois, about 80 miles to the northeast of Highland. The main influence of the glacier in this area was to discharge large volumes of sediment into the Mississippi River valley, where extensive plains of meltwater sediment were deposited. During glaciation, silt was eroded by westerly winds off the unvegetated sandy floodplains in the Mississippi Valley, and 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.

Postglacial stream sediment is derived mainly from erosion of the loess covering the uplands, but erosion has also exposed older Quaternary sediments and bedrock. Clearing of forests during early European colonization, and possibly earlier during Amerindian settlement centered at the Cahokia site in the Mississippi Valley, led to 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.

Methods

The surficial map was constructed by interpretations of parent materials from soils surveys (NRCS 1999, NRCS 2002) that were validated with outcrop observations and modified to conform to topography, interpretations of borehole data, and compilation of field notes from previous ISGS research. Some landforms were interpreted by airphoto analysis. Computer modeling was used to assist in the construction of the bedrock topography. Borehole data sources included new borings acquired for this project, and stratigraphic, geotechnical, water, and coal boring records stored in the ISGS Geological Records Unit. 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 a few select companies, descriptions provided by water-well drillers were generally of low value because few lithological boundaries were distinguished, except for the drift/bedrock interface, and locations tend to be imprecise. Outcrops described in this study provide critical two-dimensional perspectives of map unit variability and contact characteristics of near-surface units. Well and outcrop locations shown on the map are based upon the best available information for each point. The horizontal and vertical accuracies of data used in the cross sections range between approximately 5 to 200 feet and 1 to 20 feet, respectively. Surficial contacts were correlated between observation points by interpreting landform-sediment relationships on topographic maps. Buried unit boundaries are assumed to extend out to 1000 feet from each observation point. Boundaries extending further than that in the cross sections are dashed. Stratigraphic nomenclature follows Hansel and Johnson (1996) and Willman and Frye (1970), as appropriate.

Sediment Assemblages and Properties

Uplands

Most of the upland surface is comprised of a blanket of loess, covering thick glacial, ice-marginal, and deeply buried non-glacial stream deposits. The Peoria Silt and the underlying Roxana Silt loess units are not differentiated here because their geotechnical properties are very similar (table I), but 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, NRCS 2002). The loess is thickest (typically 12 feet) closest to its Mississippi Valley source area in the west and thins to about 10 feet on uneroded uplands in the east. The loess is over-thickened to about 15 feet in the central part of the quadrangle, where it probably contains undifferentiated slope wash and stream sediment.

Two distinctive relatively coarse-grained units, the Hagarstown Member and the outwash facies of the Pearl Formation are buried beneath 5–12 feet of loess. The Hagarstown Member is associated with northeast-southwest trending ridges and irregular to conical mounds. The sediments may have been deposited in ice-contact environments such as end moraines, kames, eskers, or meltwater streams, or 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). Borehole 28519 through the high ridge south of Highland (cross section A–A′) recovered 12 feet of sand (partly altered to diamicton by Sangamon Geosol development) mixed with diamicton directly below loess. Similarly, borehole 28527 through an isolated mound near St. Morgan (cross section B–B′) recovered only 2 feet of sand and gravel mixed with weakly consolidated diamicton below loess. The upper few feet of the Hagarstown Member typically contain truncated Sangamon Geosol, which can be used to distinguish Illinois from Wisconsin Episode sediment.

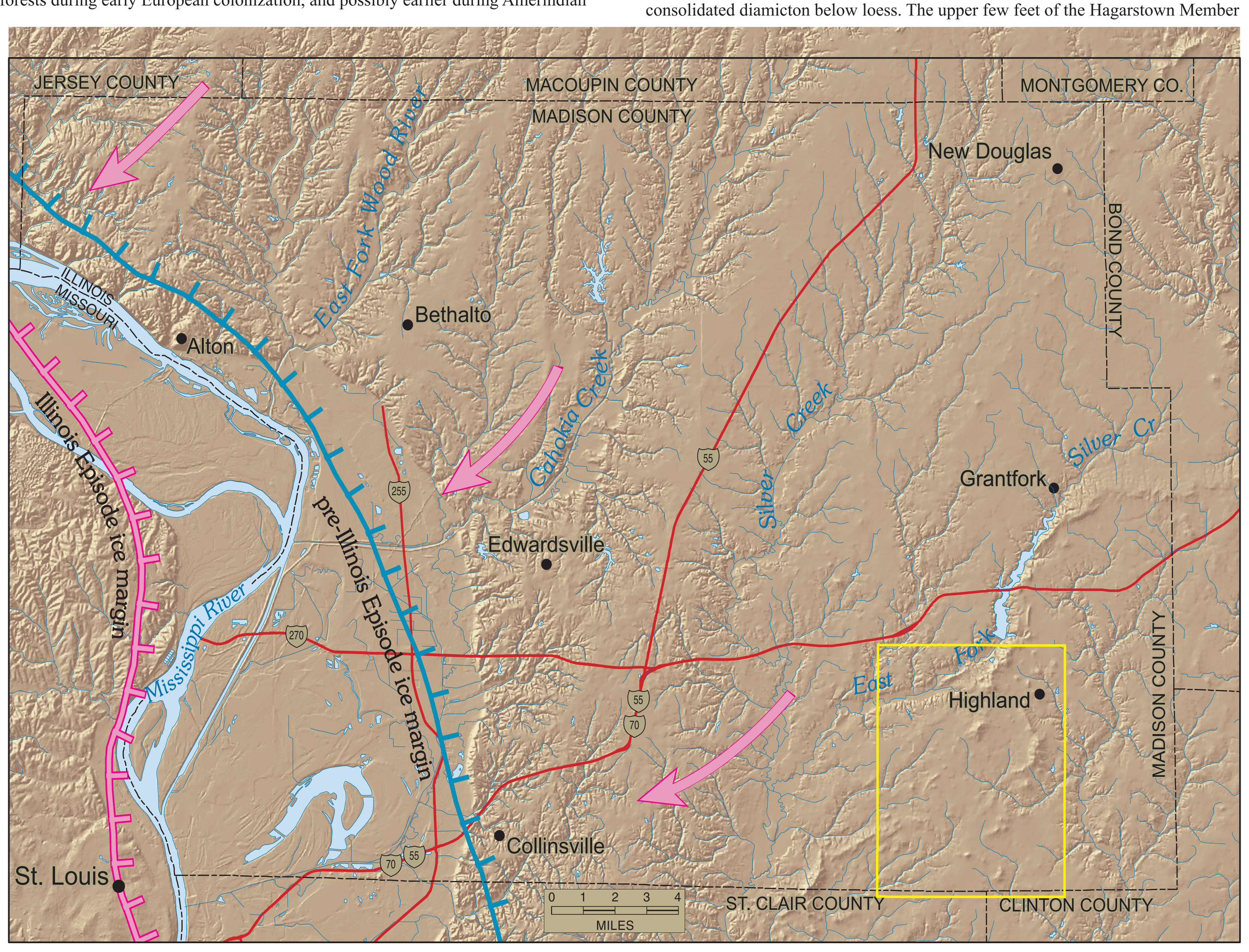

Figure 1 This map depicts the landscape of the region around the Highland 7.5-minute Quadrangle (yellow outline) with a simulated light source from the northwest. The quadrangle lies in the Kaskaskia River watershed. The Illinois Episode glacier constructed the relatively smooth surface of the uplands at the base of the glacier, but left trains of ridges and mounds along stagnating margins or in crevasses. Sugar Creek and East Fork Silver Creek were Illinois Episode meltwater channels, whereas smaller valleys are mainly more recent features. Stream incision of the upland surface within the Highland Quadrangle is not as advanced as it is to the west of the quadrangle.

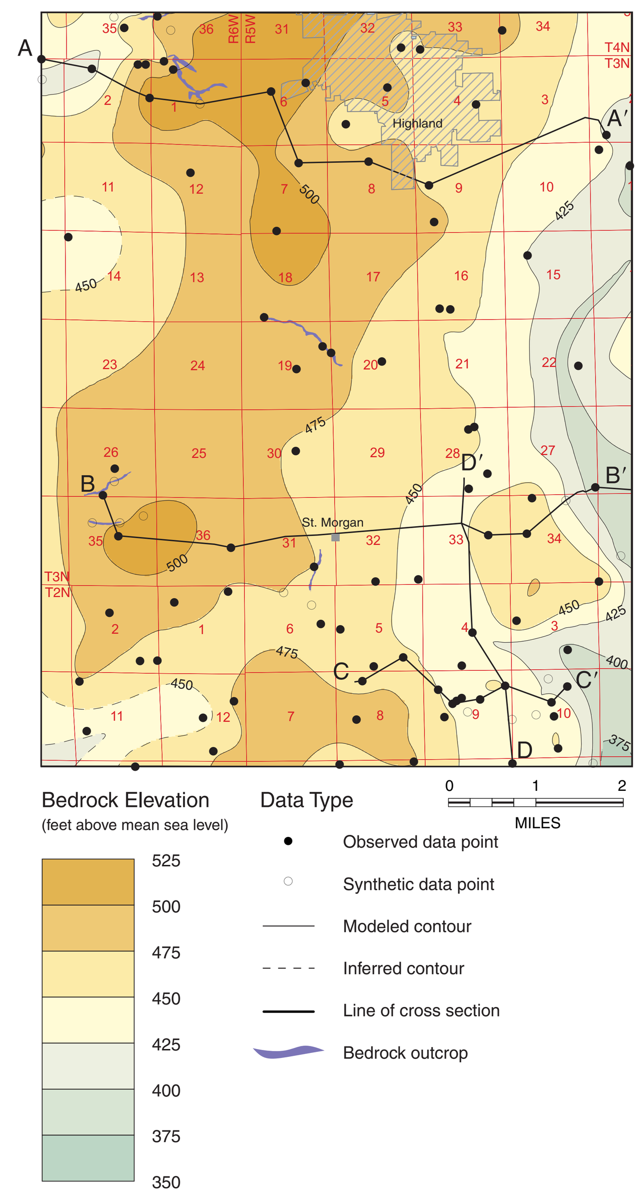

Figure 2 This map of the bedrock surface topography shows a high region trending from just west of the City of Highland towards the south southwest. A large valley underlies Sugar Creek along the eastern margin of the quadrangle, but is partly buried by Illinois Episode deposits. Small valleys along the western margin drain toward a wide valley system to the west of the quadrangle. Shale and sandstone crop out in upper tributary reaches in the west and north, and shale and limestone crop out in the central area of the quadrangle. Drift is thinnest below the main modern valleys and along their side slopes, and thickest below surficial ridges and mounds.

The outwash facies of the Pearl Formation is mainly meltwater stream sediment. In low terraces along East Fork Silver Creek with upper elevations of about 480 feet, this facies is covered by less than 10 feet of the Peoria and Roxana silts (cross section A–A′). The fine to medium sand and some gravel were deposited when Silver Creek was an outlet for meltwater from the Illinois Episode glacier. Where weathered during development of the Sangamon Geosol, the texture may have been altered to loam, or may even have sufficient clay to have a diamicton texture. Along Sugar Creek, outcrops of the Pearl Formation are generally too narrow to depict on the surficial map and have been included in the Glasford Formation (below).

Along side slopes and valley walls, where erosion has thinned the loess blanket to 5 feet 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 Hagarstown Member in that it lacks topographic expression and sorted sediments are a more minor component. The Glasford Formation is pervasive under the uplands, reaching thicknesses of 50–60 feet. Diamicton of the Glasford Formation is loamy, very stiff, with low water content (table 1). Lenses of sand and gravel, up to 10 feet 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 2004; 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.

Stream Valleys

The East Fork Silver Creek and Sugar Creek valleys are filled with up to 30 feet of postglacial stream sediment (Cahokia Formation) and floored mainly by glacial till (Glasford Formation). Terraces as well as buried deposits of glacial stream sediment (Pearl Formation, outwash facies) in the lower reaches of Sugar Creek show that these larger streams were meltwater outlets during the Illinois Episode. Most tributary valleys are filled with only the Cahokia Formation and are thus more recent features, or the meltwater features have been eroded. The Cahokia Formation 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 were concentrated by stream processes from older deposits (till or glacial stream sediment) may occur at the base of the unit.

Tributary streams are incised into upland sediments. The thickness of stream sediments (Cahokia Formation) in the upper reaches of tributary streams varies from a thin veneer to less than 10 feet, but thickens to ~25 feet near confluences with the trunk valleys. Tributary valleys are relatively narrow with steep walls where incision has progressed below the surficial loess into till (Glasford Formation), whereas valleys are wider and gentler where sandy deposits are the uppermost subsurface unit (Pearl Formation). In the upper reaches of several streams, bedrock is exposed in the channel bed or covered by a thin lag of recent sediment (fig. 2).

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

Unit	Geotechnical Properties[1] w(%)	Geotechnical Properties[1] Q_u (tsf)	Geotechnical Properties[1] N	Particle Size Data[2] Sand	Particle Size Data[2] Silt	Particle Size Data[2] Clay	Clay mineralogy	Geophysical Data[3] Natural gamma	Geophysical Data[3] MS
Cahokia Fm.	21–29	0.25–1.25	2–8		coarse sand to silt loam		ND[4]	ND	5–18
Peoria and Roxana Silts	19–25	1.0–2.25	4–8	1–8	70–78	19–23	very high expandables	30–50	ND
Pearl Fm., undivided	20–40	ND[4]	2–22		fine to medium sand with gravel		ND	low	ND
Hagarstown M.	ND		ND		loam, sand, gravel, loam diamicton		very high expandables	35–50	ND
Glasford Fm. [5]	16–24	0.8–4.5	3–25	26–43	37–54	20–29	50–78 % illite	30–60	ND
Petersburg Silt	11–19	0.5–2.0	13–24	ND	ND	ND	ND	ND	ND
Omphghent m. [5]	ND	3.0–>4.5	ND	22–52	19–50	28–30	~58% illite, ~16% expandables	30–50	ND
Banner Fm., unnamed unit	ND	3.0–>4.5	ND		silt to loam		high expandables	30–55	ND
Canteen m.	ND	>4.5	ND	3–40	35–60	10–45	ND	45–55	ND
Pennsylvanian shale (bedrock)	10–18	3.5–>4.5	>50	ND	ND	ND	high illite	very high	ND

[1] Geotechnical Properties: Compiled from 3–15 bridge borings and 1 stratigraphic boring from across the quadrangle
w = % moisture content = mass of water / mass of solids (dry)
Q_u = unconfined compressive strength, Pocket Penetrometer method
N = blows per foot (Standard Penetration Test)

[2] Particle size distribution and clay mineralogy: Compiled from discrete sampling of 3 stratigraphic borings
Sand = % > 63 μm; Silt = % 4–63 μm; Clay = % < 4 μm (proportions in the < 2 mm fraction)
clay mineralogy = proportions of expandables, illite, and kaolinite/chlorite (in < 4 μm clay mineral fraction); these calculations using Scintag diffractometer indicate about ¼ more illite than previous results by H.D. Glass with General Electric X-ray diffractometer.

[3] Geophysical Data:
Natural gamma radiation interpreted from continuous downhole logs of 1 stratigraphic boring
MS = magnetic susceptibility (x 10^{-5} SI units), determined from quasi-continuous sampling of 1 outcrop

[4] ND = no data available

[5] Properties for Glasford Fm. and Omphghent m., Banner Fm. are mainly for calcareous till (excludes sand and gravel lenses and strongly weathered zones).

Concealed Deposits

Hard, massive silt loam with low moisture content below the Glasford Formation and filling the buried bedrock valley under lower Sugar Creek is interpreted from boring data as the Petersburg Silt (cross section B–B′). In other parts of Madison County, the Petersburg Silt was interpreted as backwater lake and stream sediment that filled pre-Illinois Episode valleys (Phillips 2004; Grimley 2004). This finding is tentative and should be confirmed with additional borehole investigations.

Pre-Illinois Episode Quaternary deposits (Banner Formation) are distinguished from the Glasford Formation by selected physical and chemical properties (table 1) and by the weathering profile of an interglacial soil (Yarmouth Geosol) developed in the upper part. The Yarmouth Geosol was typically truncated by the Illinois Episode glacier and may only be recognized by a zone leached of carbonate. Within the Highland quadrangle, three units of the Banner Formation are distinguished. They include 1) diamicton interpreted to be till with the Yarmouth Geosol developed in the upper part (the informal Omphghent member; McKay 1986), 2) older glacial diamictons with unnamed paleosols, and 3) weathered, non-glacial, fine to medium textured sorted sediments (the informal Canteen member; Phillips 2004). The Omphghent member is thickest where pre-Illinois Episode deposits fill bedrock valleys (fig. 2). It also underlies some of the larger surface ridges (cross sections). My interpretation is that either the ridges were first formed by the pre-Illinois Episode glacier(-s?) or that the ridges were areas of mainly glacial deposition rather than erosion during the Illinois Episode. By contrast, pre-Illinois Episode deposits appear to have been eroded by the Illinois Episode glacier on the west half of the quadrangle. The Omphghent member within Highland quadrangle is harder and loamier than it is further west (McKay 1986; Phillips 2005; table 1), perhaps because the bedrock has relatively less shale. There are few thin sand and gravel lenses.

In borehole 28519, sediments from an even earlier pre-Illinois Episode glaciation were distinguished from the overlying Omphghent member by occurrence of a weak paleosol (sediment leached of carbonate and brown color) developed in sand and gravel with an illuviated clay matrix. The sorted sediments rest on a hard, pebbly loam diamicton, probably till, that becomes less loamy downwards. A similar unit was found under a surface ridge 7 miles to the southwest (Phillips 2005), but whether or not the two observations indicate the occurrence of a minor or major glacial event is not yet known.

A weak paleosol, variable textures, lack of erratic pebbles, and a clay mineralogy similar to bedrock distinguish the Canteen member within the Banner Formation. The unit may contain stream, lake, and slope sediments, as well as additional paleosols. The sediments are intepreted to be non-glacial in origin and directly overlie bedrock. The Canteen member is restricted to bedrock valleys (cross sections, fig. 2), and has been found in boreholes penetrating buried bedrock valleys from northern St. Clair to northern Madison Counties (fig. 1).

Geologic Resources

Groundwater Resources

There are limited groundwater resources in the drift of Highland quadrangle. 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. Nonetheless, there is anecdotal evidence that reliable water for private wells can be obtained from ridges and mounds. From study of the data in the ISGS Geological Records Unit, most wells developed within drift are between 25 and 50 feet deep with large diameters. Only about one fourth are screened in gravel or sand lenses 2–10 feet thick; the rest are screened in till and probably capture water from thinner sand lenses and fractures. 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 feet thick, that could substantially retard downward groundwater flow (Herzog et al. 1989). However, soil structure, fractures, and the many small lenses of sand within the upper part of the Glasford Formation may provide pathways for contaminants to underlying layers.

Acknowledgments

I thank the private landowners who graciously permitted us to drill on their properties. The Departments of Transportation of Madison County, St. Clair County, and Illinois provided drilling records. The city of Highland was helpful in investigating old records and siting drill holes. G. Berning, Natural Resources Conservation Service, helped with landowner contacts. Kohnen Concrete Products helped to confirm the locations of several of the water wells they drilled. Stratigraphic borings and gamma logs were obtained by the ISGS drill team. The mapping was supported by United States Geological Survey STATEMAP Contract 04HQAG0046. 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 U.S. government.

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