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

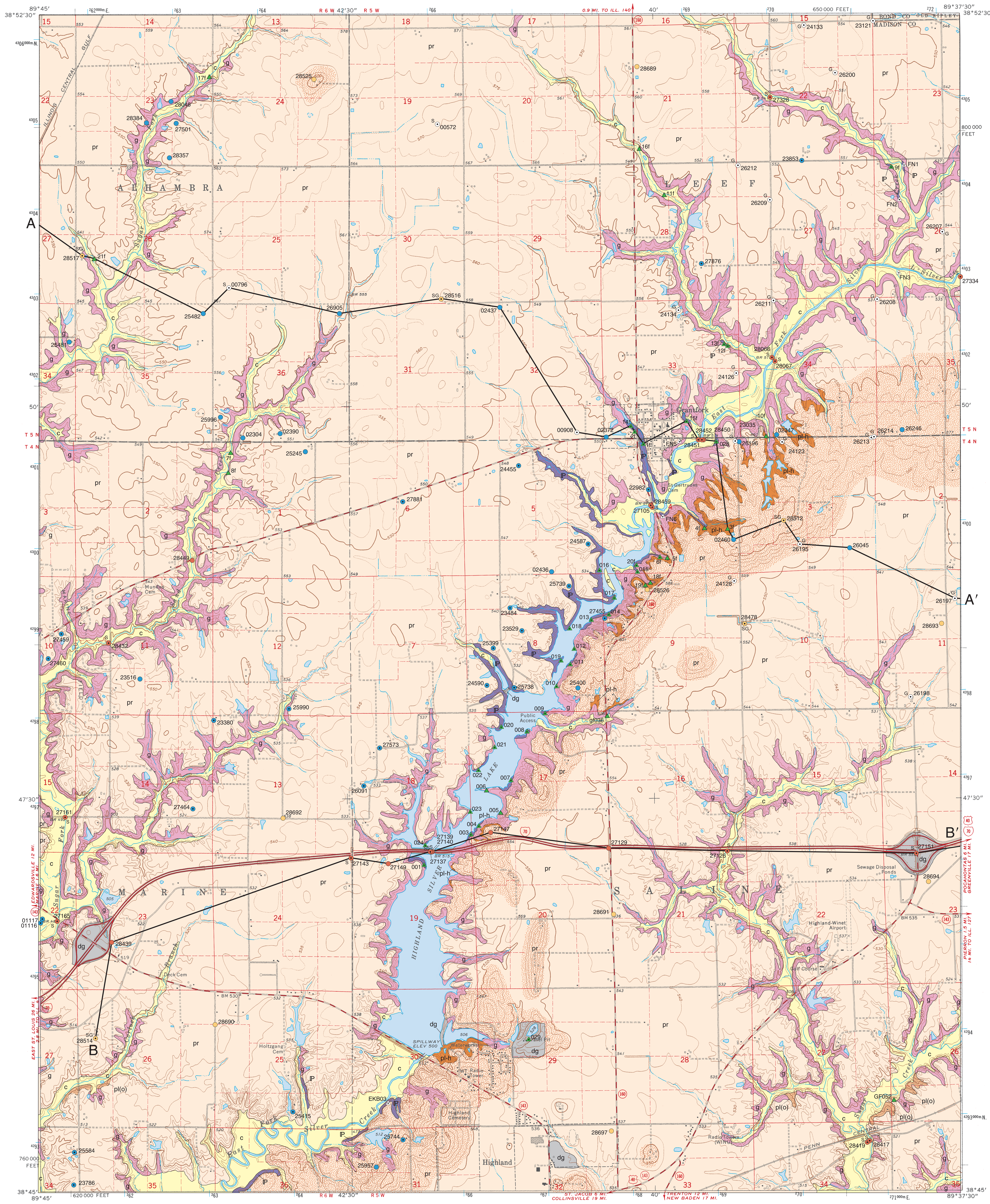
Surficial Geology of Grantfork Quadrangle

Madison County, Illinois

David A. Grimley and Andrew C. Phillips

2006

Illinois Geologic Quadrangle Map
IGQ Grantfork-SG



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 30 feet thick	Disturbed ground: dg	**Man-made fill or excavations;** includes large areas of disturbed sediment and borrow areas such as near interstate highways or dams
Silty clay loam, silty clay, silt loam, and loam; occasional sand and gravel beds; dark brown to gray; massive to well stratified; noncalcareous; up to 25 feet thick	Cahokia Formation: c	**Alluvium** (river deposits) in stream valley floodplains; derived from reworking and sorting of loess, diamicton, and sand and gravel exposed in uplands and slopes; includes some historical deposition
WISCONSIN EPISODE (~75,000–12,000 years B.P.)		
Silt to silt loam; yellowish brown to gray to brown; massive to blocky structure; friable; noncalcareous; contains modern soil solum in upper 3 to 5 feet; up to 12 feet thick	Peoria and Roxana Silts (where > 5 feet thick): pr	**Loess** (windblown silt); includes redeposited loess in sloping areas; the Peoria and Roxana Silts are generally not easily differentiated due to similar physical properties, alteration, and thinness of units
ILLINOIS EPISODE (~200,000–130,000 years B.P.)		
Intermixed loam, sand and gravel, diamicton, and silty clay; high variability with zones of well-sorted sand and gravel in some areas; strong brown to yellowish brown to light olive-gray; upper 10 to 15 feet commonly more fine grained and weathered; soft to moderately stiff; fractured and faulted in places; noncalcareous to calcareous; up to 65 feet thick	Hagarstown Member, Pearl Formation (< 5 feet of loess cover): pl-h; (stipples where buried)	**Ice-contact sediment;** upper portion may contain Sangamon Geosol; includes debris flows, inclusions of older material, fractures or faults, and possible buried remnants of eskers or kames; intertongues with the Glasford Formation; contact lines are not shown on map where unit is buried
Sand with some gravel; may include silty or clayey beds; gray to yellowish brown; stratified; moderately to well sorted; up to 15 feet thick	Pearl Formation (outwash facies) (< 5 feet of loess cover): pl(o)	**Outwash** (proglacial sediment); occurs near surface along Sugar Creek in the southeast and Corlock Branch in the southwest; occurs underneath the Cahokia Formation in Sand Creek, Sugar Fork, and East Fork Silver Creek valleys
Pebbly loam diamicton; may contain sand and gravel lenses; light olive-brown to dark gray; main portion is generally massive, very stiff to hard, calcareous, and contains 5–10% pebbles (typically < 2-inch diameter); upper few feet weathered to brown or yellowish brown and softer with more clay (silty clay loam); up to 60 feet thick	Glasford Formation (< 5 feet of loess cover): g	**Till and ice-marginal sediment;** upper few feet of diamicton typically contains Sangamon Geosol solum; upper portion may include sand and gravel lenses and supraglacial deposits; lower portion is mainly basal till; crops out along steep slopes
PRE-ILLINOIS EPISODE (~700,000–450,000 years B.P.)		
Silty clay to silty clay loam; few pebbles; crudely to well stratified; moderately stiff; greenish gray to olive-gray to dark gray to yellowish brown; noncalcareous; up to 15 feet thick	Lierle Clay Member, Banner Formation (cross sections only): b-l	**Accretionary sediment** in former shallow depressions including shallow lake, stream, and slope deposits (colluvium); the Yarmouth Geosol is developed throughout the unit but may be truncated
Pebbly silty clay loam to loam diamicton; may contain thin sand and gravel lenses (up to 5 feet thick); light olive-brown to dark olive-gray to dark gray; massive to weakly laminated; moderately stiff to stiff; noncalcareous to calcareous; up to 45 feet thick	Omphghent member, Banner Formation (cross sections only): b-o	**Till and ice-marginal sediment;** generally contains evidence of Yarmouth Geosol weathering or oxidation in upper 10 feet; the alteration zone may or may not be truncated
Silty clay loam to pebbly clay loam diamicton; olive-gray to greenish gray to brown; massive, bedded, or laminated; contains subrounded, commonly platy chert pebbles; noncalcareous; oxidized in upper few feet	Canteen member, Banner Formation (cross sections only): b-c	**Alluvium and colluvium;** nonglacial; immediately underlain by bedrock, shale; may contain one or more paleosols, particularly in upper few feet

PRE-QUATERNARY DEPOSITS

Description	Unit	Interpretation
Shale, sandstone, and limestone; ranges from greenish gray to light gray to yellow-brown to black; laminated to bedded to massive; noncalcareous to calcareous; limestone beds ~3 feet thick (Carthage Limestone member, Bond Formation) underlain by black shale are common along northern Highland Silver Lake region	Pennsylvanian bedrock: ℙ	**Bedrock** or near-surface bedrock (within 5 feet of land surface); mapped in the northeastern and southwestern portions of quadrangle and in many areas along Highland Silver Lake

Data Type

- Outcrop
- Outcrop in field notes (ISGS archives)
- Stratigraphic boring
- Water well boring
- Engineering 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 or outcrop 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 at the ISGS Web site.

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Topography by photogrammetric methods from aerial photographs taken 1973. Field checked 1974.

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
SUPPLEMENTARY CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Released by the authority of the State of Illinois: 2006

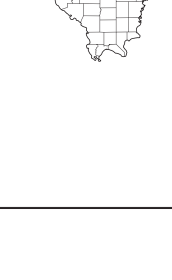
Geology based on field work and data compilation by D. Grimley and A. Phillips, 2004–2005.

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

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

ISGS 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



1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Worden
2 New Douglas
3 Sorento South
4 Marine
5 Pocahontas
6 St. Jacob
7 Highland
8 St. Rose

APPROXIMATE MEAN DECLINATION, 2006

ROAD CLASSIFICATION

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

Introduction

The surficial geology map of the Grantfork 7.5-minute Quadrangle, located in Illinois about 30 miles northeast of St. Louis, Missouri, provides an important framework for land and groundwater use, engineering assessments, environmental hazard predictions, and geological studies. This investigation was prepared as part of a broader geologic mapping program undertaken by the ISGS in developing areas of the St. Louis Metro East region (Grimley 2004, Phillips and Grimley 2004, Phillips 2004).

The Grantfork Quadrangle is located in east-central Madison County, about 20 to 25 miles east of the Mississippi River valley and about the same distance east of the maximum extent of glacial ice during the Illinois and pre-Illinois episodes (fig. 1; Grimley et al. 2001). Glacial ice in southwestern Illinois generally advanced from the northeast, originating from the Lake Michigan basin during the Illinois Episode and from the Lake Michigan basin and/or the more eastern Great Lakes Region during pre-Illinois episodes (Willman and Frye 1970). Deposits of both glacial episodes have also been reported by McKay (1979), Stohr et al. (1987), and Phillips (2004) within 15 miles of this area. Glacial ice did not reach the study area during the Wisconsin Episode; however, glacial meltwaters from the upper Mississippi River drainage basin deposited outwash throughout the middle Mississippi Valley. This outwash was the source for loess deposits (windblown silt) that blanket uplands in southwestern Illinois.

Methods

Surficial Map
The surficial geology map is based in part upon soil parent material data (Goddard and Sabata 1982) and supplemented by data from outcrops, stratigraphic test holes obtained for this STATEMAP project, engineering borings from Illinois Department of Transportation (IDOT) and Madison County Highway Department, coal borings, and water wells. Map contacts were also adjusted according to the surface topography, geomorphology, and observed landform-sediment associations. Important data points used for the surficial geology map, cross sections, or landform-sediment associations are shown on the map.

Cross Sections
The cross sections portray unconsolidated deposits as would be seen in a vertical slice through the earth down to bedrock (vertically exaggerated 20×). The lines of cross section are indicated on the surficial map and figure 2. Data used for subsurface unit contacts (in approximate order of quality) are from studied outcrops, stratigraphic test holes, engineering boring records, coal test borings (many with geophysical logs), water-well records, and oil-well records. Units less than 5 feet in maximum thickness are not shown on the cross sections. Dashed contacts are used to indicate where data are less reliable or not present. The full lengths of borings that penetrated deeply into bedrock are not shown.

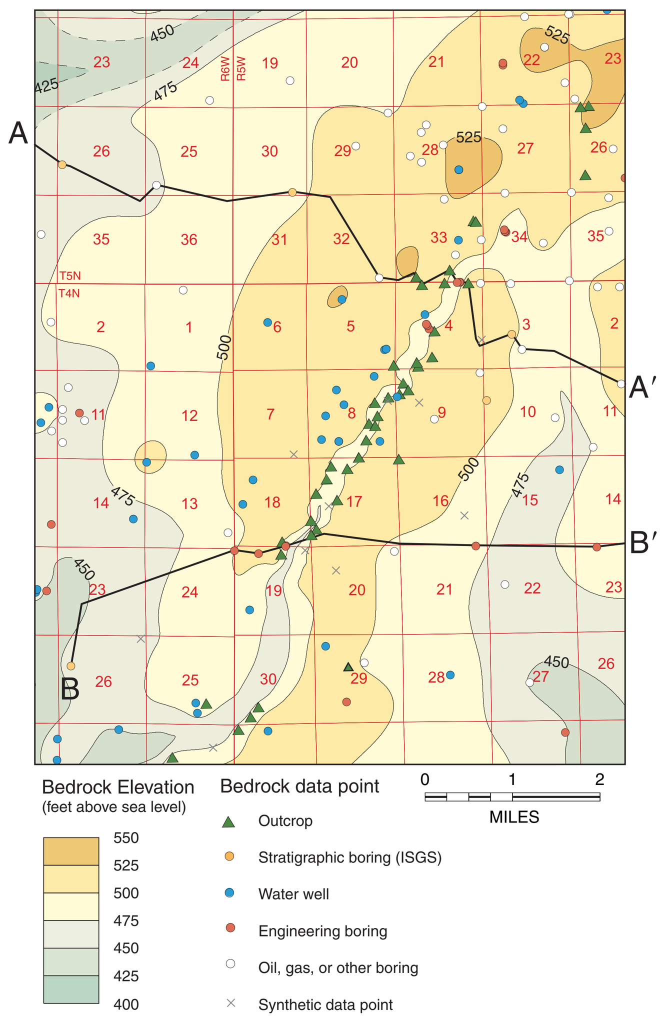


Figure 2 Bedrock topography of the Grantfork Quadrangle. Section boundaries are shown in red, and cross section lines are shown in black. All reliable data to bedrock are shown (some data are not shown on surficial map). Scale is 1:100,000.

Surficial Deposits

The surficial deposits can be divided into three geomorphic terrains: (1) upland flats and eroded slopes, containing predominantly glacial and windblown sediments at or near the surface; (2) upland hills and ridges, containing ice-contact sediment; and (3) valleys, containing predominantly postglacial waterlain sediments near the surface. There are also older concealed deposits; their occurrence and thickness are closely related to the bedrock surface topography (fig. 2). Areas of disturbed ground are mapped along interstate highways, at sand and gravel pits, and at borrow pits mined for fill material.

Upland Flats and Eroded Slopes
Upland flats and eroded slopes constitute about 84% of the quadrangle's area. Uneroded uplands are blanketed by up to 12 feet of loess (windblown silt) that is underlain by thick glacial till and ice-marginal deposits. The loess (Peoria and Roxana Silts) is typically 7 to 12 feet thick where not eroded, but is thinner on the many steeper slopes (see map and cross sections). The thickest loess occurs on uplands in southwestern areas of the map, closer to the source of this windblown deposit. The loess was deposited during the last glaciation (Wisconsin Episode) when silt-size particles, from Mississippi Valley glacial meltwater, were periodically windswept and carried in dust clouds eastward to vegetated upland areas, where they gradually settled across the landscape. The loess deposits are typically a silt loam to heavy silt loam where unweathered. In the modern soil solum (generally the upper 3 to 4 feet), the loess is altered to a heavy silt loam or silty clay loam (Goddard and Sabata 1982). The Peoria Silt is the upper and younger loess unit. The Roxana Silt, with a slight pinkish hue, is the lower loess unit (Hansel and Johnson 1996). Since both loess units here are relatively thin, slightly to moderately weathered, leached of carbonates, and similar in physical properties, they were not mapped separately.

On many side slopes and ravines, where the loess has been eroded to less than 5 feet thick, the underlying diamicton (a massive, poorly sorted mixture of clay, silt, sand, and gravel), weathered diamicton, and/or associated sorted sediment are mapped as the surficial unit (Glasford Formation). Compared to overlying loess deposits, the Glasford diamicton is considerably more pebbly and dense. Furthermore, the diamicton has a lower moisture content (8–19%), greater unconfined compressive strength (Q_u), and higher average blow counts than loess deposits (table 1). Near-surface Glasford Formation is especially common in slopes along Highland Silver Lake and East Fork Silver Creek and in slopes adjacent to other valleys where postglacial loess erosion has been significant. The Glasford Formation, predominantly pebbly loam diamicton (interpreted as till) up to 60 feet thick, was deposited during the Illinois Episode. The diamicton is interspersed with sand and gravel lenses that can be tens to hundreds of feet wide and up to 20 feet thick. The sand and gravel lenses tend to be more common within upper portions of the unit, but also occur near the base (see cross sections). The upper 10 to 14 feet of the Glasford Formation, where uneroded, is generally more weathered, has a higher water content and is less stiff than the majority of the unit. This upper portion is interpreted as supraglacial till with a thin cap of late Illinois Episode loess. The lower and main portion of Glasford till, interpreted as subglacial, is very stiff to hard (table 1), likely due to compaction by overriding glacial ice. No physical evidence, such as tills separated by minor paleosols or proglacial outwash, was observed that would indicate two separate Illinois Episode ice advances as was noted to the east near Vandalia, Illinois (Jacobs and Lineback 1969).

In its uppermost portion, the Glasford Formation contains a buried interglacial soil known as the Sangamon Geosol. Alteration features prevalent in the upper 4 to 6 feet of this soil, including root traces, fractures, carbonate leaching, oxidation or color mottling, strong soil structure, clay accumulation, and/or clay skins, further help to delineate the contact below loess deposits. Oxidation (to light olive-brown) and fracturing may extend 15 to 25 feet into the Glasford diamicton before completely unaltered gray till is encountered.

Pennsylvanian bedrock was mapped along much of the northern half of Highland Silver Lake and in minor areas to the northeast, based on observed outcrops and soil survey reports of bedrock within 5 feet (Goddard and Sabata 1982). In the northeast portion of the map, north of East Fork Silver Creek, bedrock occurs at relatively shallow depths (< 40 feet of glacial drift cover). In such areas of high bedrock topography (fig. 2) and generally thin drift, Illinois Episode till rests directly on bedrock (see cross section A–A′ near Grantfork); the pre-Illinois episode deposits having been eroded. Near-surface bedrock consists of limestone, fissile black shale, blue-gray shale, and fine-grained sandstone. In the early 20th century, small quarries near the town of Grantfork, such as site 14f, utilized the exposed limestone (Carthage Limestone; formerly Shoal Creek) that is 3 feet thick below the creek bed.

Upland Hills and Ridges
In many portions of southwestern Illinois, curvilinear hills and knolls, of glacial origin, occur in a general northeast to southwest orientation, approximately parallel to regional ice flow during the Illinois Episode (fig. 1; Grimley et al. 2001). A prominent ridge-system in the east-central portion of this quadrangle (on the east side of Highland Silver Lake) is up to 100 feet in relief and covers about 8% of the quadrangle. Such areas, historically termed the "ridged drift," tend to contain a higher proportion of loamy to sandy deposits than in surrounding areas. The lithologically complex deposits in the ridges, classified as the Hagarstown Member of the Pearl Formation, are here covered by up to 10 feet of loess. Small outcrops of the Hagarstown Member (mapped solid reddish brown) occur in steep ravines on the northwest side of the ridge where the loess has been eroded. Where 5 to 10 feet of loess blankets the Hagarstown Member, a stippled pattern on the map indicates this unit in the subsurface. Although previous studies in south-central Illinois have noted significant sand and gravel in these ridges (Jacobs and Lineback 1969), some ridges contain a high proportion of intermixed diamicton and fine-grained sediment (Phillips 2004). In the Grantfork area, the Hagarstown Member may be up to 70 feet thick, but it is mostly much thinner (cross section A–A′) and includes a mixture of sand and gravel, irregularly bedded and fractured diamicton, loam, and ice-thrusted inclusions. The upper 10 to 15 feet of the Hagarstown Member is typically weathered due to Sangamon Geosol development (cross section A–A′). Secondary alteration such as clay infiltration into originally sandy zones has resulted in finer textures, such as clay loam to sandy clay loam diamicton. The Hagarstown Member was originally classified as a member of the Glasford Formation since it generally overlies glacial till (Willman and Frye 1970), but was later redefined as a member of the Pearl Formation (Killey and Lineback 1983) due to its closer association with glacial stream deposits and for consistency with Wisconsin Episode classifications.

In many areas of southwestern Illinois, the ridged-drift systems appear to have been affected by the topography of the bedrock surface. In the northeastern portion of this quadrangle, a bedrock high (fig. 2) may have caused divergent flow of relatively thin glacial ice during the waning phase of Illinois Episode glaciation. On a more regional scale, the sharp change in direction in the large ridge system on this quadrangle from east-west to northeast-southwest (fig.1) could have resulted from a deflection of general ice flow to the southwest by the bedrock high northeast of the town of Grantfork. Regionally, as thinning ice flowed to the southwest over such bedrock highs, small elongated cavities may have developed underneath glacial ice possibly leading to development of a subglacial channel and/or a crevasse system. During the final melting phase, subglacial channels may have converted to open-air channels in reentrant areas between local sublobes that developed near and in the lee of bedrock high obstacles. Furthermore, supraglacial channels, common to interlobate areas, may also have developed, perhaps leading to sediment accumulation (e.g. debris flows) on the ice surface adjacent to bedrock highs (such as east of Highland Silver Lake). Such channels on the ice surface would have connected to subglacial drainage in some areas. Thus, the origin of the ridged-drift landscape and deposits may be quite complex and similar to that in the kettle-moraine area of southeastern Wisconsin (Carlson et al. 2005). Upon melting of glacial ice, the sediment in supraglacial, subglacial, and ice-marginal channels would begin to form the observed ridges. The sediment in such channels would normally include sorted sediment as well as debris flows and inclusions of till. The observed Hagarstown Member in the Grantfork Quadrangle does include considerable amounts of debris flow deposits and fractured fine-grained inclusions mixed with sorted sediments. The high variability of material in these ridges and knolls is consistent with deposition in an ice-marginal environment (including subglacial, supraglacial, and subaerial channels).

Valleys
Valleys, occupying about 8% of the quadrangle's area, are mainly filled with fine-grained, weakly stratified, postglacial stream deposits (Cahokia Formation). The Cahokia Formation may be as much as 25 feet thick (e.g., East Fork Silver Creek valley south of Highland Silver Lake), but is more typically 5 to 15 feet thick in smaller valleys. Although mostly silty clay loam, silt loam, and loam in texture, this map unit can include beds of fine- to medium-grained sand at depth and includes channel sand in modern streams. The deposits are mostly derived from erosion of loess and till exposed on uplands and sloping areas. The Cahokia Formation may contain buried organic-rich paleosols and layers of historically eroded sediment. Due to periodic flooding during postglacial times, areas mapped as the Cahokia Formation have relatively youthful modern soil profiles that generally lack B horizons compared with profiles for upland soil (Goddard and Sabata 1982).

Thin deposits of sand and gravel (generally < 5 feet) are present underneath the Cahokia Formation and immediately above bedrock in engineering borings in East Fork Silver Creek (cross section A–A′) and Sand Creek valleys. Such coarse-grained deposits are interpreted as outwash or ice-marginal sorted sediment deposited during the Illinois Episode glaciation and are correlated to the Pearl Formation (Willman and Frye 1970). Up to 15 feet of Pearl Formation sand and gravel could be present underneath the Cahokia Formation in East Fork Silver Creek valley south of Highland Silver Lake, based on studies southwest of the map area (Phillips 2004).

In a few areas proximal to Corlock Branch and Sugar Creek, mappable sand and gravel deposits (Pearl Formation) are found near the surface, below about 2 to 5 feet of loess. Such deposits occur on small terraces or are exposed on slopes between about 490 and 510 feet elevation. In these areas, the Pearl Formation may contain the Sangamon Geosol in its upper portions and, in places, may be iron or clay cemented. Elsewhere in Madison County, Pearl sand and gravel is most common in terraces or in the subsurface along south- and southwest-trending valleys (e.g., East Fork Silver Creek, Sand Creek, Sugar Creek, and Corlock Branch Valleys) that likely served as meltwater outlets for Illinois Episode glacial ice.

Concealed Deposits
In much of the map area, pre-Illinois episode deposits (classified as the Banner Formation) are preserved between the overlying Glasford Formation and bedrock below (see cross sections). The Banner Formation is divisible into three units (two informal and one formal): 1) an olive-brown to greenish gray, weakly laminated silty clay with some beds of fine sand (Canteen member; lowest unit); 2) a silty clay loam to loam diamicton with sand and gravel bodies (Omphghent member; predominant unit); and 3) a greenish gray to dark gray, silty clay to silty clay loam with soil development features (Lierle Clay Member; uppermost unit). These members of the Banner Formation (described below from oldest to youngest) are thickest in preglacial bedrock valleys or lowlands in western and southeastern portions of the quadrangle (fig. 2 and cross sections). The Banner Formation is here not known to occur within 5 feet of the surface, having been eroded in areas of shallow bedrock. Much of the following information regarding the characteristics of the Banner Formation is based on continuous core samples from stratigraphic test holes to bedrock (county nos. 28512, 28514, 28516, 28517, or 28478). The predominant bedrock lithologies below the Banner Formation or other Quaternary deposits are shale and limestone with scattered beds of coal and underclay. Based on ISGS records to date, no surface or subsurface coal mines have yet been developed.

The Canteen member of the Banner Formation was found in only one stratigraphic test boring (no. 28514, cross section B–B′), below the Omphghent member, and includes mainly fine-grained sediment. In its uppermost 5 feet and also in zones at depth, the Canteen member exhibits weak to moderate soil structure, typical of a buried floodplain soil. In this boring, the deposit is interpreted as mainly preglacial Quaternary alluvium and colluvium because it lacks glacial erratics and is noncalcareous. Regionally, the Canteen Member tends to infill local bedrock lowlands (fig. 2) or regional preglacial valleys (Phillips and Grimley 2004). The unit can, in places, include slackwater lake deposits, coarse-grained alluvium (usually just above bedrock), and/or redeposited loess related to early Quaternary glaciations.

The Omphghent member is interpreted mainly as till, ice-marginal sediment, and outwash. In comparison to Glasford till, the Omphghent till is generally more clayey, less sandy, and not as stiff. Omphghent till also typically has less illite (in clay mineral fraction), less dolomite, greater moisture content, and slightly greater natural gamma radiation (table 1). In its lower unweathered portions, the Omphghent till may contain shale fragments and scattered fossil spruce wood fragments and exhibit a greenish gray color similar to the local shale bedrock. Such characteristics reflect incorporation of shale and clayey bedrock residuum into pre-Illinois episode glacial ice, likely during the earliest Quaternary ice advance in this region. In some places, the upper, but relatively unweathered, portion of Omphghent till contains more illite, calcite, and sand and has greater magnetic susceptibility than the remainder of the unit, suggesting a lower concentration of locally derived shale and residuum. Where weathered and oxidized, the Omphghent till has an olive-brown color. In eastern areas where the Omphghent till overlies carbonate bedrock rather than shale, the unit tends to have a lower clay content. Lenses of sand and gravel within the Omphghent member are typically less than 10 feet thick.

In some areas, a greenish gray to dark gray, silty clay to silty clay loam, known as the Lierle Clay Member of the Banner Formation (Willman and Frye 1970), overlies the Omphghent member. The Lierle Clay Member, containing abundant evidence of cumulic soil formation, iron reduction, and weathering, is primarily interpreted as sediment that accumulated in wetlands, small ponds, or lowlands. Alteration features, attributed to formation of the Yarmouth Geosol (a buried interglacial soil), include enhanced soil structure, root pores, clay accumulation, and carbonate leaching. Yarmouth Geosol development in the Lierle Clay Member, as well as in the uppermost Omphghent member, help to delineate the Banner Formation from the Glasford Formation. In some areas, such as in Omphghent Township, several miles to the west of this quadrangle, a truncated Yarmouth paleosol occurs at the Glasford-Banner contact (McKay 1979). Even where the Yarmouth Geosol is partially eroded, deep oxidation and fractures extending into the upper Omphghent till are typically preserved. Such evidence, as well as diagnostic physical properties and compositional data (table 1), can aid with correlations of the Banner Formation to sites that contain the complete Yarmouth Geosol. In one stratigraphic test hole (no. 28517), more than 10 feet of Lierle Clay Member appears to have been incorporated by Illinois Episode ice and thereby intertongued with basal Glasford Formation (cross section A–A′).

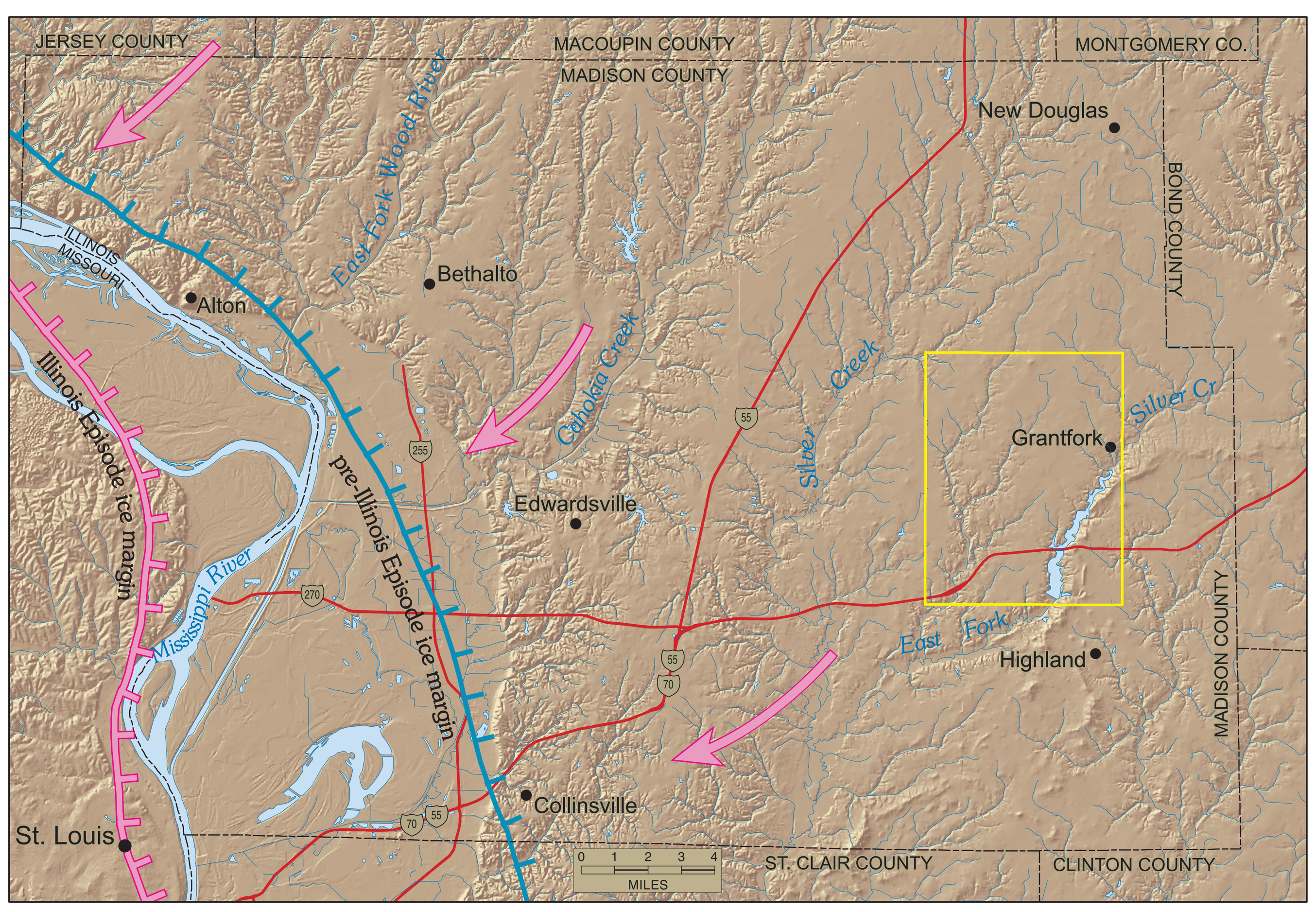


Figure 1 Shaded relief map of the St. Louis Metro East area (northern portion). The Grantfork Quadrangle is outlined in yellow. The quadrangle lies within the ice margins of both the Illinois and pre-Illinois episode glaciations. Arrows indicate the direction of ice flow for the Illinois Episode glaciation.

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

	Geotechnical properties[1]			Particle size data[2]				Geophysical data[3]	
	w (%)	Q_u (tons/ft^2)	N	Sand (%)	Silt (%)	Clay (%)	Clay mineralogy	Natural gamma	MS
Cahokia Formation	17–29	0.1–1.25	1–10		variable texture		high expandables	variable	5–25
Peoria and Roxana Silts	20–32	1.1–2.1	5–10	2–15	55–83	17–35	20–30% illite (high expandables)	mod.	10–50
Pearl Formation	ND[4]	0.1–4.5	3–80		generally > 50% sand; some gravel		ND	low	20–40
Hagarstown Member	ND	ND	8–15		variable texture; sometimes > 50% sand		ND	low–mod.	5–40
Glasford Formation[5]	8–19	2.0–8.3	10–45	30–54	24–40	14–30	59–75% illite	mod.–high	8–40
Lierle Clay Member	19–29	1.5–3.5	ND	11–33	36–50	24–52	27–35% illite (high expandables)	high	10–30
Omphghent member[5]	12–21	1.5–5.7	11–30	25–46	29–39	25–39	54–61% illite	high	10–50
Shale bedrock	8–17	3.5 to > 4.5	50–100	ND	ND	ND	ND	very high	2–12

[1]Geotechnical properties: based on hundreds of measurements (total for all units) from about 25 engineering (bridge) borings and 3 stratigraphic test borings in the quadrangle. w, moisture content = mass of water/mass of solids (dry). Q_u, unconfined compressive strength. N, blows per foot (standard penetration test).

[2]Particle size and compositional data: based on a more limited dataset (~ 20 samples) from 4 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 diffractomet calculations indicate about one-fourth more illite than previous results by H.D. Glass with General Electric X-ray diffractometer.

[3]Geophysical data: natural gamma, relative intensity of natural gamma radiation (data from 4 stratigraphic borings and 15 other borings). MS, magnetic susceptibility (x 10^{-5} SI units) (detailed data from 4 stratigraphic borings).

[4]ND, no data available.

[5]Properties for Glasford Formation and Omphghent member are mainly for calcareous till (excludes sand and gravel lenses and strongly weathered zones); weathered upper portions can be less stiff and more clayey and have higher water contents.

Economic Resources

Sand and Gravel
Sand and gravel in the Grantfork Quadrangle is actively being mined at one pit (Sec. 29, T4N, R5W) on an as needed basis. Minable deposits here consist primarily of sand with some gravel and are mapped as Hagarstown Member of Pearl Formation (beneath 5 to 10 feet of loess). Other portions of these ridges may contain economically usable deposits, but, in many places, the sand is poorly sorted, intermixed with diamicton, limited in thickness, unpredictable in extent, or absent. In other areas (county no. 28512; Sec. 3, T4N, R5W), up to 70 feet of poorly sorted to well-sorted sand with gravel is present. It is suspected that most well-sorted sand may occur within former glaciofluvial channels near the crests of the ridges, but data are limited. Additional drill hole and geophysical data will be necessary to define the extent of these deposits locally.

Groundwater
Groundwater is extensively used for household, public, and industrial water supplies in southwestern Illinois. Surface water resources such as Highland Silver Lake are also present in this quadrangle. Sand and gravel lenses in the Glasford and Pearl Formations, including the Hagarstown Member, constitute the predominant glacial aquifers in the Grantfork Quadrangle. Known sand and gravel lenses are stippled in the cross sections (water table may be at greater than 30 feet depth in some ridges). Undoubtedly, sand and gravel lenses are more numerous than shown. Due to their relatively limited thickness and extent, aquifers in the map area are typically only suitable for low-yield water wells. In upland areas, sand and gravel bodies within the upper Glasford Formation or Hagarstown Member are commonly utilized for low-yield household water supply from large-diameter bored wells. In such wells, the dense, lower portion of Glasford till is often utilized as a natural storage area for well water below the screened interval. Sand and gravel lenses in the Banner Formation are relatively uncommon. Sand and gravel in the Pearl Formation is limited in thickness and extent but may provide low-yield water supplies in southern portions of Sugar Fork or East Fork Silver Creek valleys.

Environmental Hazards

Groundwater Contamination
Surface contaminants pose a potential threat to groundwater supplies in near-surface aquifers that are not overlain by a confining (clay-rich and unfractured) deposit. Near-surface sand and gravel aquifers, such as in the Hagarstown Member, are most vulnerable to agricultural or industrial contaminants. Confining materials, such as clayey till or lake sediment, can serve to protect buried aquifers (Berg 2001). The potential for groundwater contamination depends on the thickness and character of fine-grained alluvium, loess, or till deposits that overlie the aquifer. Deeper glacial aquifers near the base of the Glasford Formation or within the Banner Formation generally have a lower contamination potential than shallower aquifers because the groundwater is protected by the considerable thickness of clay-rich till. Field studies of hydraulic conductivity at a nearby waste disposal site at Wilsonville, Illinois (Herzog and Morse 1990) have shown that the lower portion of Glasford Formation (more dense, uniform, and unfractured) can be much less permeable than the upper portion (more fractured and with more sand lenses). Minor aquifers within the Pearl Formation in creek valleys are only somewhat protected by the mainly fine-grained, but relatively thin, Cahokia Formation.

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