Illinois Geologic Quadrangle Map
IGQ Hampshire-SG

Surficial Geology of Hampshire Quadrangle

DeKalb and Kane Counties, Illinois

B. Brandon Curry

2008

Illinois Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief
Natural Resources Building
615 East Peabody Drive
Champaign, IL 61820-6964

http://www.isgs.uiuc.edu

Purpose and Background

The *Surficial Geology of Hampshire Quadrangle* is a map that describes and interprets Quaternary-age geologic materials that occur above bedrock. These unlithified sediments are relevant to many environmental, economic, and scientific issues. The surficial materials are primarily of glacial origin, including matrix-supported diamicton (mostly till), outwash sand and gravel, and lacustrine silt, clay, and very fine sand. These materials are mantled in most areas by about 3 feet of weathered, wind-deposited silt (loess). The primary land use in the area is agricultural. The two largest villages are Hampshire and Burlington with 2000 census populations of 2,900 and 452, respectively (Illinois Census 2000). The Village of Hampshire and areas east are categorized as a “Critical Growth Area” by the Kane County Regional Planning Commission (2004), whereas the remainder of the Hampshire Quadrangle is “Agricultural/Rural Village Area.” The population in the critical growth area is expected to grow considerably over the next few years. Hampshire’s population is projected to increase to about 23,800 and Burlington’s population to 15,000 by 2030 (Northern Illinois Planning Commission 2007). The growing population will likely impact groundwater availability and quality. Some private household wells pump water from sand and gravel aquifers in the glacial drift. The accompanying maps and cross sections indicate areas where aquifers are protected by a layer of fine-grained diamicton and other areas where such clayey barriers to groundwater flow are thin or missing.

Geologic Setting

The bedrock that underlies the Hampshire Quadrangle includes a discontinuous cap as much as 30 feet thick of cherty dolomite classified as the Silurian Elwood Formation, which overlies about 205 feet of shale, fossiliferous and vuggy grainstone (dolomite), and shaly dolomite of the Ordovician Maquoketa Group (Kempton et al. 1987). Drift thickness varies from about 250 feet thick to less than 30 feet. In northeastern Illinois, most surficial glacial sediment was deposited during the last glaciation (Wisconsin Episode) from about 24,000 to 15,000 radiocarbon years ago (^{14}C yr B.P.; Hansel and Johnson 1992, Curry et al. 1999). During this time, the Lake Michigan Lobe of the Laurentide Ice Sheet formed numerous subdued ridges with hummocky topography known as moraines (fig. 1). Meltwater carried and deposited outwash sand and gravel along streams and rivers (fig. 2). Laminated silt, clay, fine sand with some coarse sand, and gravel were deposited in lakes, primarily supraglacial ice-walled lakes and postglacial slackwater lakes.

Three moraines form the highest areas on the map, including parts of the Marengo Moraine, Bloomington Morainic System, and Burlington moraine (fig. 3). Originally mapped as part of the Elburn Complex (Willman and Frye 1970), the Burlington moraine forms a sinuous ridge rising as much as 50 feet from the adjacent ground moraine. The Village of Burlington is located atop the moraine. In the northeastern part of the map, the moraine terminates against the Marengo Moraine. To the south and west on the adjacent Maple Park and Sycamore Quadrangles, the Burlington moraine merges with low hummocky ground moraine peppered with ice-walled lake plains, known as the DeKalb mounds (Flemal et al. 1973).

Primary Findings

Aquifers

Private household wells utilize groundwater pumped from buried sand and gravel deposits mapped as the Ashmore Tongue of the Henry Formation and underlying Glasford Formation. Mapped as the Hampshire aquifer by Dey et al. (2007), the combined units are more than 100 feet thick. The Hampshire aquifer is covered by a layer of diamicton of the Tiskilwa Formation that is from about 20 feet to more than 110 feet thick (see the eastern side of cross section A–A′ on map sheet 2). This aquifer was recognized as part of the Bloomington aquifer by Curry and Seaber (1990).

Most municipal water supplies are pumped from bedrock aquifers. A recently completed municipal well in Hampshire (API 35829; Sec. 28, T42N, R6E) is pumping water from the St. Peter Sandstone starting at a depth of 614 feet (corresponding to an elevation of 270 feet above sea level).

Sand and Gravel Aggregate

Exposures in abandoned pits indicate that shallow, discontinuous sand and gravel deposits were mined for local aggregate. Currently, large sand and gravel pits are operated just north of the Hampshire Quadrangle, and it is possible that pits will open later in the mapping area where sand and gravel is as much as 70 feet thick (see cross section A–A′ on map sheet 2).

Ice-walled Lake Plains

Numerous circular to semicircular flat-topped hills from 100 to 30,000 feet across occur throughout DeKalb and Kane Counties. The hills are subtle features, rising from about 5 to 30 feet above adjacent glacial deposits. Known as the DeKalb mounds (Flemal et al. 1973), this investigation found them to be composed of a succession of four layers, including (1) basal sand and gravel, (2) fossiliferous, laminated lake sediment, (3) weathered sand and gravel, or sandy diamicton, and (4) weathered silty loess. Fossil ostracodes (aquatic microcrustaceans) identified from the laminated deposits indicate the water was at least 30 feet deep. The fossiliferous lake sediment extends laterally to below the edge of the mounds, which is held to be primary evidence that ice buttressed the sides of the lake sediment. Fossil leaves of tundra plants in the ice-walled lake sediment date from about 17,250 to 15,125 ^{14}C yr B.P.

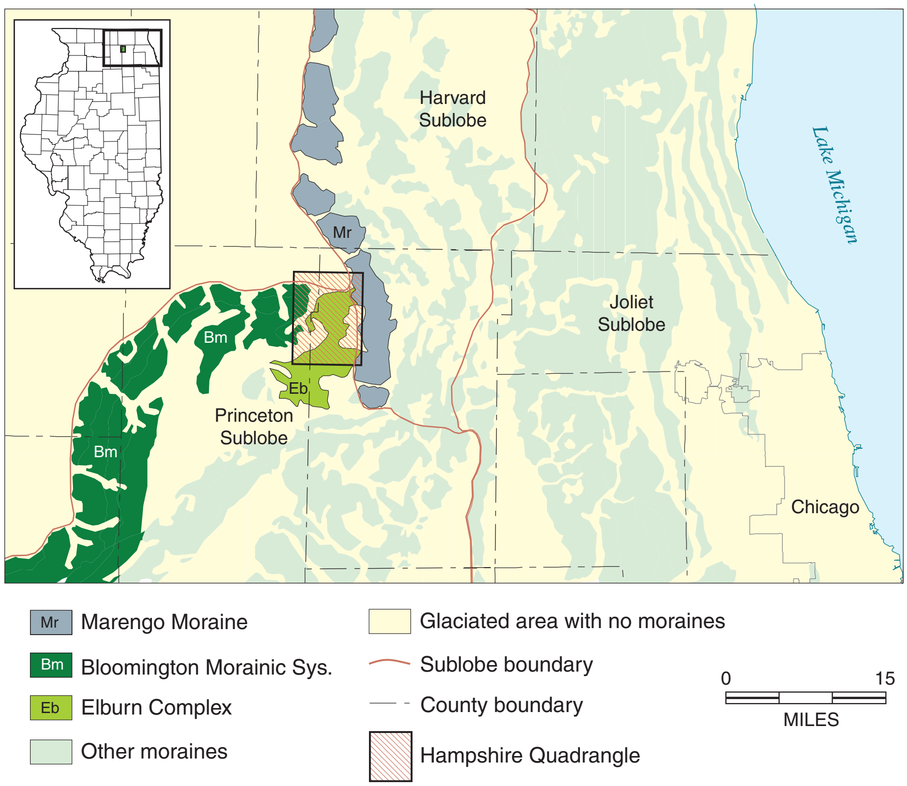


Figure 1 Wisconsin Episode moraines in northeastern Illinois. Moraines, shown in gray and green, were formed near the terminus of glacial ice at various positions of the Lake Michigan Lobe. Glaciers advanced in a westerly and southwesterly direction into Illinois from the Lake Michigan basin. The oldest moraines occur generally to the west and the younger moraines to the east. In the area of the last glaciation, the yellow areas are typically drainageways or plains of outwash, lake sediment, or till. This map is adapted from Willman and Frye (1970) and Hansel and Johnson (1996). The Hampshire Quadrangle is hachured in red.

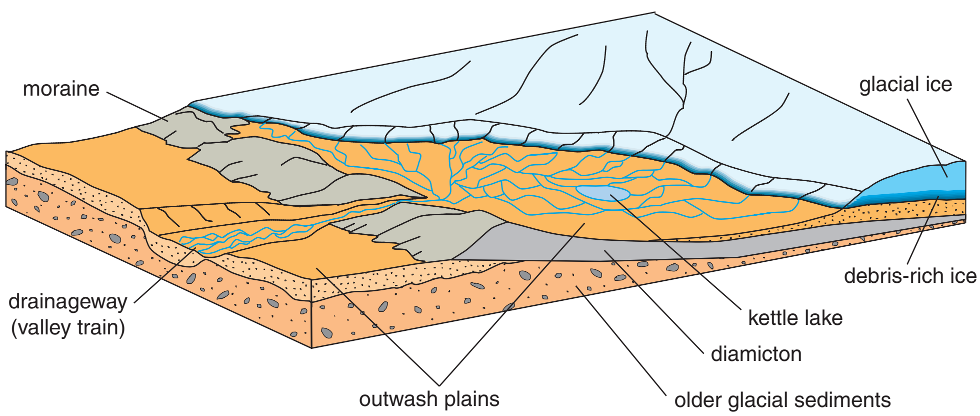


Figure 2 Conceptual model of landform-sediment assemblages associated with the margins of continental glaciers (from Curry et al. 1997).

Terraces

Relatively thin sediment composed of fossiliferous, laminated silt and smectite-rich clay forms subtle terraces at levels lower than the ice-walled lake plains. The clay mineralogy is significant because it indicates the material forming the terraces is loess. Fossil ostracodes indicate the sediment was deposited in a lacustrine environment; geomorphic relationships indicate the lakes were formed by local damming of stream channels.

Deglacial Topographic Inversion

The surface topography became inverted during the final stages of deglaciation between the time when the ice-walled lakes and the time slackwater lakes existed. At first, the surface of the glacier was like Swiss cheese with the ice-walled lake occupying the holes. After the glacier melted during the 15,125 to 13,900 yr B.P. time frame, the sediment that had accumulated in the ice-walled lakes occupied intermediate topographic positions on the landscape between moraine crests and drainage lows, including kettles.

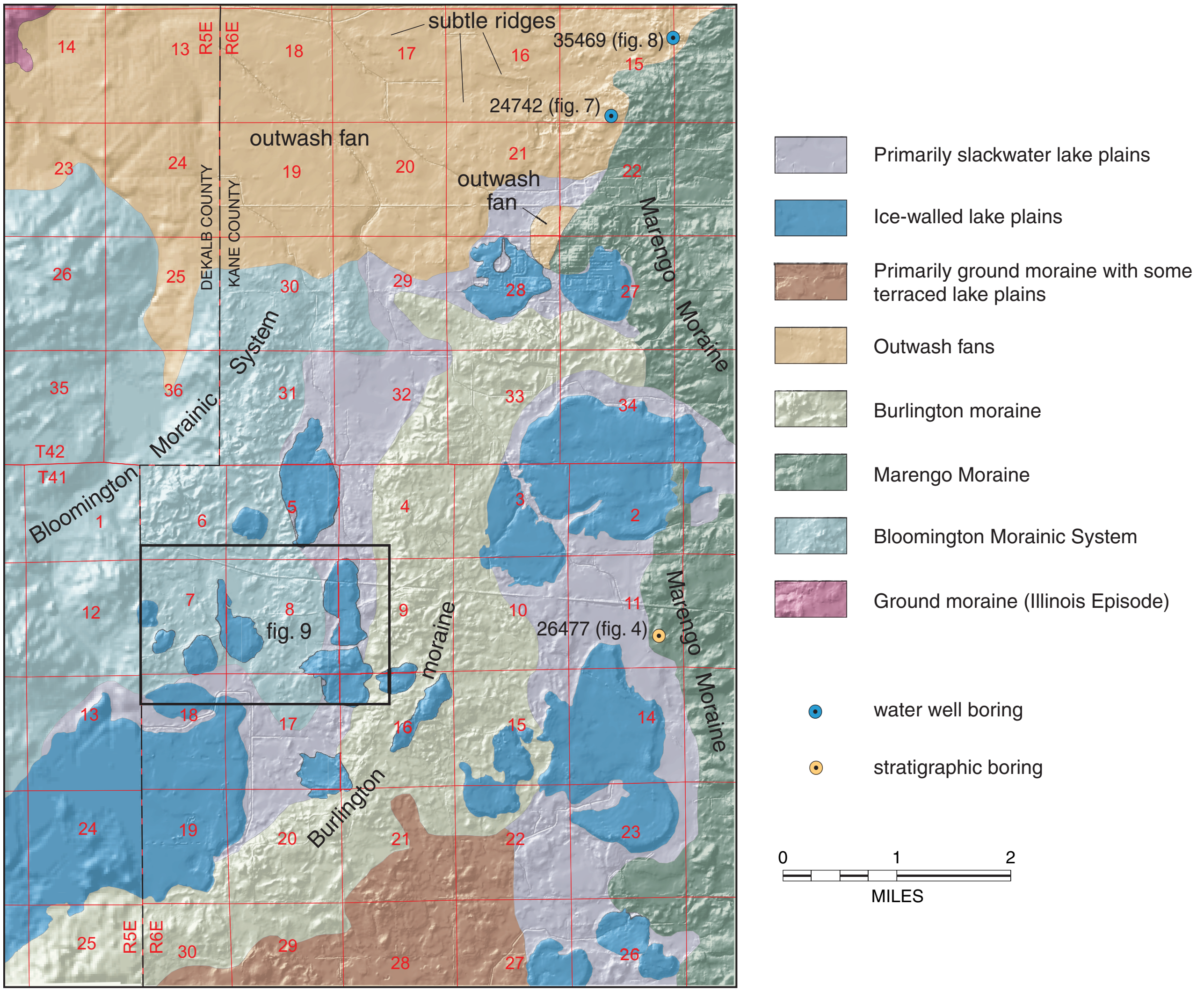


Figure 3 Shaded relief map of the Hampshire Quadrangle, from a 10-foot resolution DEM (derived from 2-foot contours) of Kane County and a 30-meter DEM of DeKalb County. Formal names include the Marengo Moraine and Bloomington Morainic System. The Burlington moraine is informal. The locations of borings shown in figures 4, 7, and 8 are shown. The box shows the location of figure 9.

Data Sources and Methods

The sources of data used to prepare the map of surficial geology and cross sections are shown on the data point location map (Curry 2007). Of the 378 records, the most important information includes (1) the stratigraphic boring F-4 (26477; fig. 4; Kempton et al. 1987), (2) eight natural gamma-ray logs of stratigraphic borings and private water wells, (3) 27 shallow cores sampled by the Illinois State Geological Survey (ISGS) ranging in depth from 13 feet to about 55 feet, (4) 12 geologic sample sets containing representative cuttings from the drilling of municipal water wells completed for Hampshire and Burlington, and (5) 58 shallow (<15 feet) structural boring logs from property assessment reports.

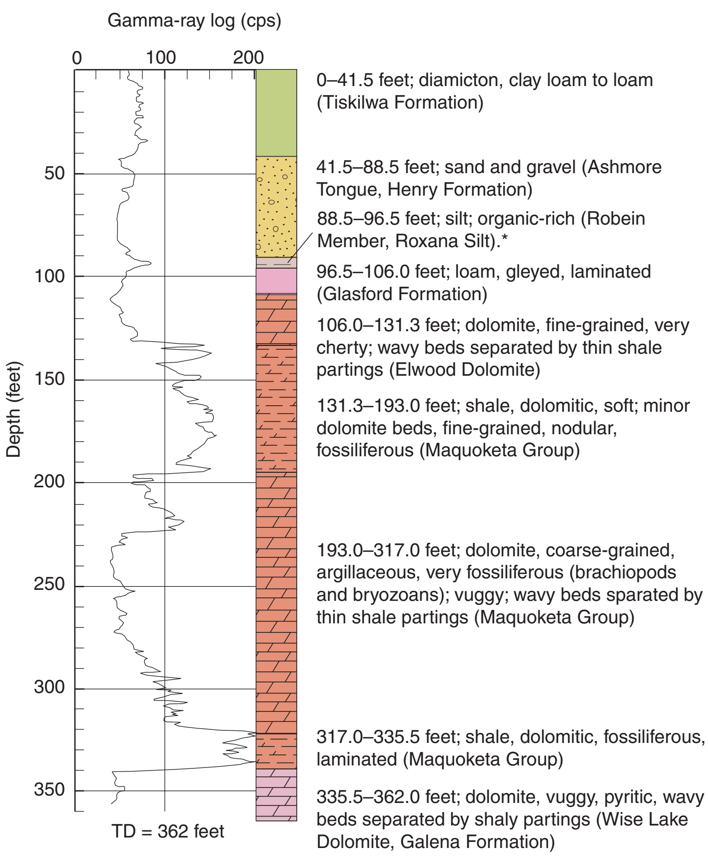
These data required different levels of interpretation based on their assumed quality. The highest-quality data (the key stratigraphic boring, sample sets, and borings with gamma-ray logs) were used to prepare preliminary cross sections. Supplemental data from engineering boring logs and meaningful water-well logs were added, where available, along the lines of section. The preliminary cross sections were prepared by downloading interpretive log data from the database of Dey et al. (2007) into a software package (RockWorks 2002) that promoted rapid iterations of preliminary cross sections.

On the map, boundaries between surficial geology map units were drawn based in part on previous investigations (Wickham et al. 1988), interpretations of county soil survey maps (Deniger 2004a, b), and on new interpretation of sediment and landforms associated with the ice-walled lakes. The lithology of several cores verified the new interpretations.

Natural gamma-ray logs were used as an integral part of interpreting the glacial succession, particularly in cross section. The logs provide a continuous record of the natural radiation emitted from the drift and bedrock adjacent to the boring. In this region, clay-rich sediment and shale emit more gamma-ray radiation than do sand, gravel, and dolomite bedrock (fig. 4). The logs give quality assurance for descriptive logs. In some cases, it was possible to confidently interpret the succession of drift and bedrock from water wells with no supporting data such as descriptive logs.

Shaded Relief Maps

Within Kane County, mapping the surficial geology was facilitated by interpretion of a digital elevation model (DEM) created from 2-foot contour elevation data (Curry 2006). The DEM was converted to a shaded relief map using ArcGIS. From the map, three terraces and subtle linear ridges of sand and gravel can be identified on the upper middle portion of the outwash fan west of the Marengo Moraine in the northern part of the quadrangle (fig. 3). The higher-quality DEM data are not available for DeKalb County, which occurs in the western third of the mapping area.



*Ages of 27,150 ± 340 ^{14}C yr B.P. (ISGS-1294) and 38,600 ± 3200 ^{14}C yr B.P. (ISGS-1295) were determined on samples from 90.0–90.2 feet and 95.0–96.5 feet, respectively (Curry 1989).

Figure 4 Lithologic and gamma-ray log of boring F-4 (26477; SE SE Sec. 11, T41N, R6E) located about 3 miles south and 1 mile east of Hampshire. This boring is used in cross section C–C′. Modified from Kempton et al. (1987). cps, counts per second.

Bedrock Topography

Several steps were taken to complete the map of bedrock surface topography (fig. 5). First, the appropriate data were selected from the electronic database of Dey et al. (2007). For some water well-records, the top of bedrock was inferred because of the common practice among water-well drillers in this region to have the screen and lower casing of the water well rest on the top of bedrock. The first step was to create a digital surface from these data using an inverse distance weighted algorithm in ArcGIS. Point values of the bedrock surface were then sampled along a grid with 600-foot node spacings. Using the same algorithm, the gridded data and original data set were recontoured. The final contours were adjusted by hand to honor most data and to form valleys and ridges typical of an assumed dendritic drainage pattern. The difference in resistance to weathering between shale and dolomite would likely produce slopes with ledges and overhangs. Some, if not all, of these irregularities were likely modified by glacial erosion. Due to lack of detailed data, these phenomena are not indicated on the cross sections or on the bedrock topography map.

Classification and Terminology for Materials (Lithostratigraphic Units)

Geologic materials may be classified by physical properties such as color, bedding structure, and grain-size distribution, and by their specific level in the succession of sediment layers (see map legend on map sheet 1). Mappable bodies of material with unique properties are known as lithostratigraphic units (Hansel and Johnson 1996). For deposits of the last glaciation (Wisconsin Episode), a special distinction is made based on grain size and sorting. Deposits of similar grain size (i.e., well-sorted sediment or poorly graded sediment) are classified with the Mason Group, whereas deposits composed of a poorly sorted mixture of grain sizes (i.e., diamicton) are classified with the Wedron Group (Hansel and Johnson 1996). Regionally important layers of sand and gravel or fine-grained sediment that occur between named lithostratigraphic units of the Wedron Group are classified as stratigraphic tongues, such as the Ashmore Tongue of the Henry Formation (see map legend on map sheet 1).

“Diamicton” describes a deposit with a wide range of grain sizes ranging from clay to boulders. Most diamicton of glacial origin in Illinois is matrix-supported, meaning that the larger particles (gravel to boulders) are encased in a mixture of finer particles (clay, silt, and sand). Commonly in northeastern Illinois, moraines are formed of diamicton with unique lithologies; the moraines on the Hampshire Quadrangle are unusual because they are all formed of diamicton of the Tiskilwa Formation.

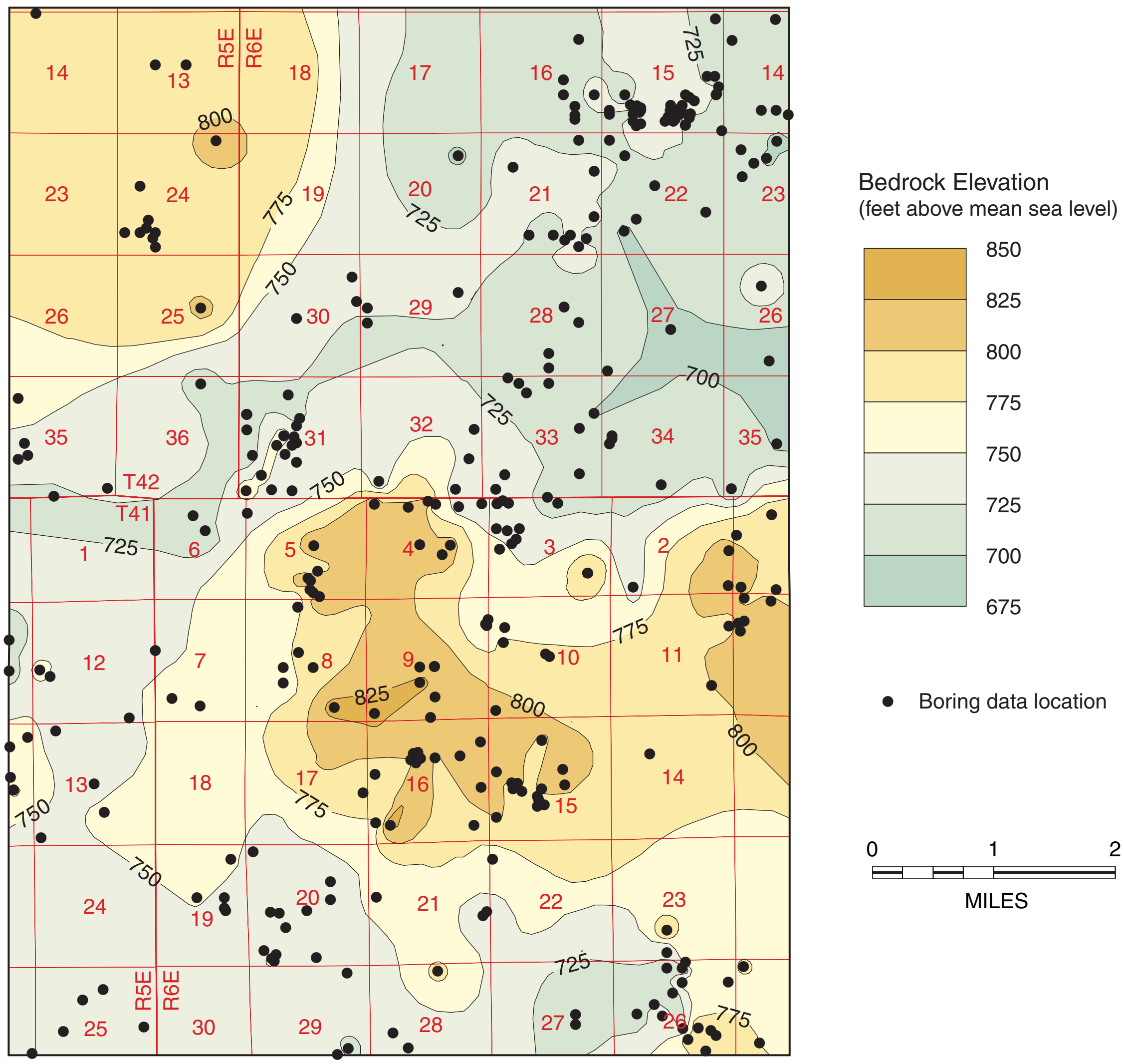


Figure 5 Bedrock topography of the Hampshire Quadrangle.

Landform-Sediment Assemblages

On the Hampshire Quadrangle, the successions of sediments associated with particular landforms (also known as landform-sediment assemblages) include moraines, terraces of ice-walled lakes and slackwater lakes, and outwash fans. Their spatial relationships are readily apparent on a map that drapes the surficial geology on the shaded relief map (fig. 6). Several cores and gamma-ray logs were used to infer the composition of these landforms and the environments of deposition that formed them.

Moraines

The three moraines on the Hampshire Quadrangle are formed by a series of sediment layers representative of a glaciogenic succession, including from base to top

Unit 1. sand and and gravel with lenses of lake silt and diamicton (Ashmore Tongue, Henry Formation),

Unit 2. diamicton with lenses of sand and gravel (Tiskilwa Formation), and

Unit 3. patchy layers of sand and gravel (Henry Formation) and silt (Equality Formation).

The succession represents sediments that were deposited by meltwater or by the glacier, including outwash (alluvium) deposited by the approaching glacier (Unit 1), till deposited at the base of the glacier (Unit 2), and outwash, lake sediment, and some debris flows deposited on or against the ice as it melted (Unit 3). Boring F-4 (26477; fig. 4) exemplifies this succession.

Diamicton of the Tiskilwa Formation has remarkably consistent texture and clay mineralogy (table 1). The diamicton classifies as clay loam to loam in the U.S. Department of Agriculture textural triangle (Buol et al.1980) and as CL in engineering classification (Holtz and Kovacs 1981). The natural gamma-ray signature of Tiskilwa diamicton is relatively invariant with values that fall within a range of about 75 counts per second (fig. 4). Layers of sand and gravel have gamma-ray values less than that of the diamicton; in contrast, layers of silt and clay typically have greater values. These characteristics are used to identify lithologies in borings with zones of core loss (figs. 4, 7, and 8).

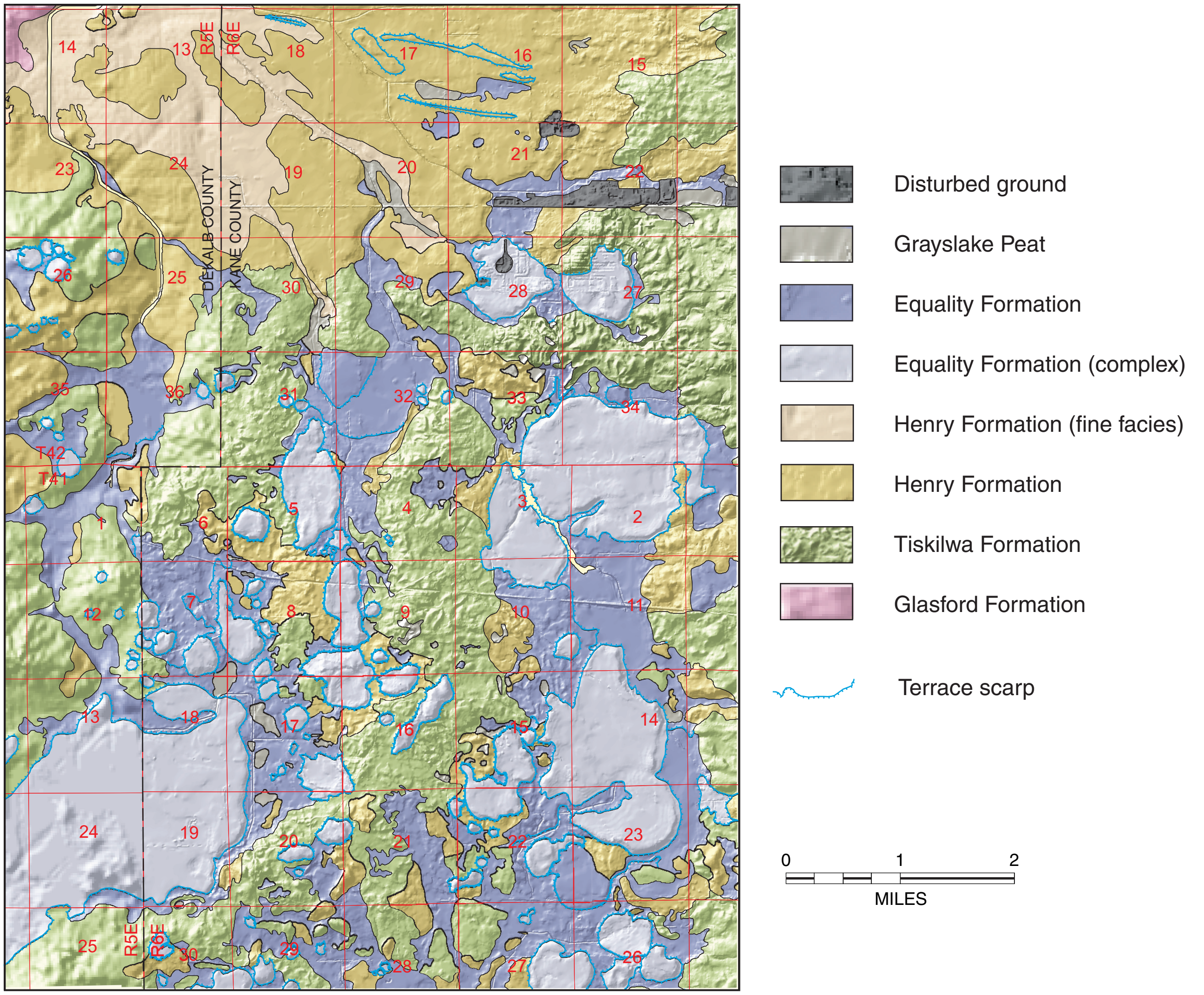


Figure 6 The surficial geology draped over the shaded relief map of the 10-foot DEM of Kane County and 30-meter DEM of DeKalb County. The high terraces (light purple), formed of laminated lake sediment sandwiched by thin layers of sand and gravel, stand out against the lower terraces (dark purple), formed of fine-grained lake sediment. The high terraces were formed in ice-walled lakes and the low terraces in slackwater lakes.

Ice-walled Lake Plains

Mapped as a complex of the Equality Formation (e(x) on map sheet 1), ice-walled lake plains are circular to semicircular flat-topped features, ranging in diameter from about 30,000 feet to less than 100 feet across, that form high terraces that collectively range in elevation from about 930 to 880 feet. In some areas, adjoining landforms merge with or step down to mound surfaces. In other areas, the mounds rise more than 20 feet above adjacent terraces formed of slackwater lake sediment. Although readily identified on aerial photography and high-resolution shaded relief maps (fig. 9), the low relief and large size render the mounds as subtle features in the field. The light-toned rims and dark interiors observed on aerial photography connote the often-used term "glacial doughnuts" (Gravenor and Kupsch 1959, Clayton 1967, Bleuer 1974). Earlier investigations, primarily those of Flemal et al. (1973) who named these features DeKalb mounds, noted that the rims are breached by one or two channels. Other features include superposed doughnuts and narrow moats. Flemal et al. (1973) noted that the mounds are composed of loess-capped, laminated lake sediment with unidentifiable organic matter.

This study has determined that the "unidentifiable organic matter" described by Flemal et al. (1973) includes tiny plant macrofossils suitable for radiocarbon dating. The lake sediment also contains microfossils (ostracodes and the head capsules of chironomids) that provide clues about the lake environment. Of the 95 mounds mapped on the Hampshire Quadrangle, five have been cored for study. An analysis of the shaded relief map of Kane County (McGarry 2000) and aerial photography indicates that ice-walled lake plains are present elsewhere, especially on the adjoining Maple Park (Grimley 2004) and Pingree Grove Quadrangles (Grimley 2005) where they were mapped as lake sediment associated with patches of sand and gravel. Since their discovery in Kane County, fossil-bearing ice-walled lake plain sediments have been cored and described elsewhere in the state, notably

Table 1 Particle-size distribution, moisture content, and semi-quantitative clay mineral data (mean ± standard deviation) of unweathered samples of key stratigraphic units.

	Tiskilwa Fm diamicton		Equality Fm complex		Peoria Silt
	Regional[1]	Local	Silt loam facies	Oxidized subfacies	
Particle size distribution, %[2]					
Gravel	7.3 ± 5.1	8.6 ± 5.8	0.2 ± 1.2	---	0.0 ± 0.0
Sand (2,000–64 µm)	34.6 ± 9.6	41.3 ± 7.5	35.4 ± 29.3	---	14.6 ± 12.2
Silt (64–4 µm)	39.2 ± 5.2	33.6 ± 4.8	46.3 ± 21.1	---	56.7 ± 9.3
Clay (<4 µm)	26.2 ± 6.1	25.1 ± 3.6	18.4 ± 9.3	---	28.7 ± 7.7
Moisture content, %	11	10.0 ± 0.6	21 ± 3	---	28 ± 5
Samples, no.	851	25	22	---	9
Clay mineral data (%)[3]					
Expandable clay minerals	11 ± 2.8	13.6 ± 1.7	12.9 ± 1.9	24.4	72.9
Illite	66 ± 3.0	64.6 ± 4.0	61.3 ± 1.8	60.4	16.8
Kaolinite plus chlorite	23 ± 2.6	21.8 ± 2.8	25.8 ± 1.2	15.2	10.3
Calcite, cps	38 ± 12.3	39.1 ± 6.1	32.7 ± 4.2	38.3	0
Dolomite, cps	59 ± 20.8	54.2 ± 7.5	56.7 ± 8.0	68.5	0
Samples, no.	918	10	30	10	3

[1]Data from Wickham et al. (1988) and Graese et al. (1988).

[2]Gravel percentage is with respect to the whole sample; sand, silt, and clay percentages are with respect to the <2,000-µm fraction.

[3]Expandable clay mineral (%) + illite (%) + (kaolinite + chlorite (%)) = 100%. cps, counts per second.

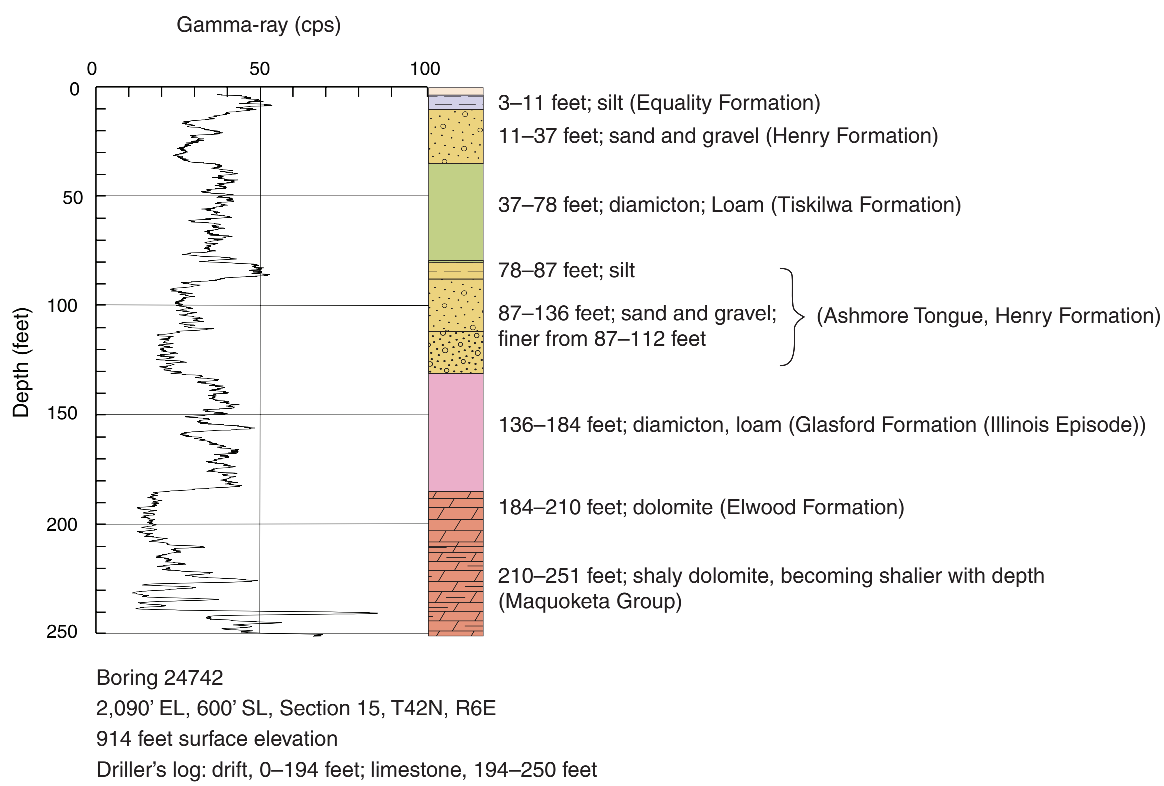


Figure 7 Lithologic and gamma-ray log of boring 24742 (SE SE Sec. 15, T42N, R6E) located north of Hampshire. This boring is used in cross section A–A′ on map sheet 2. cps, counts per second.

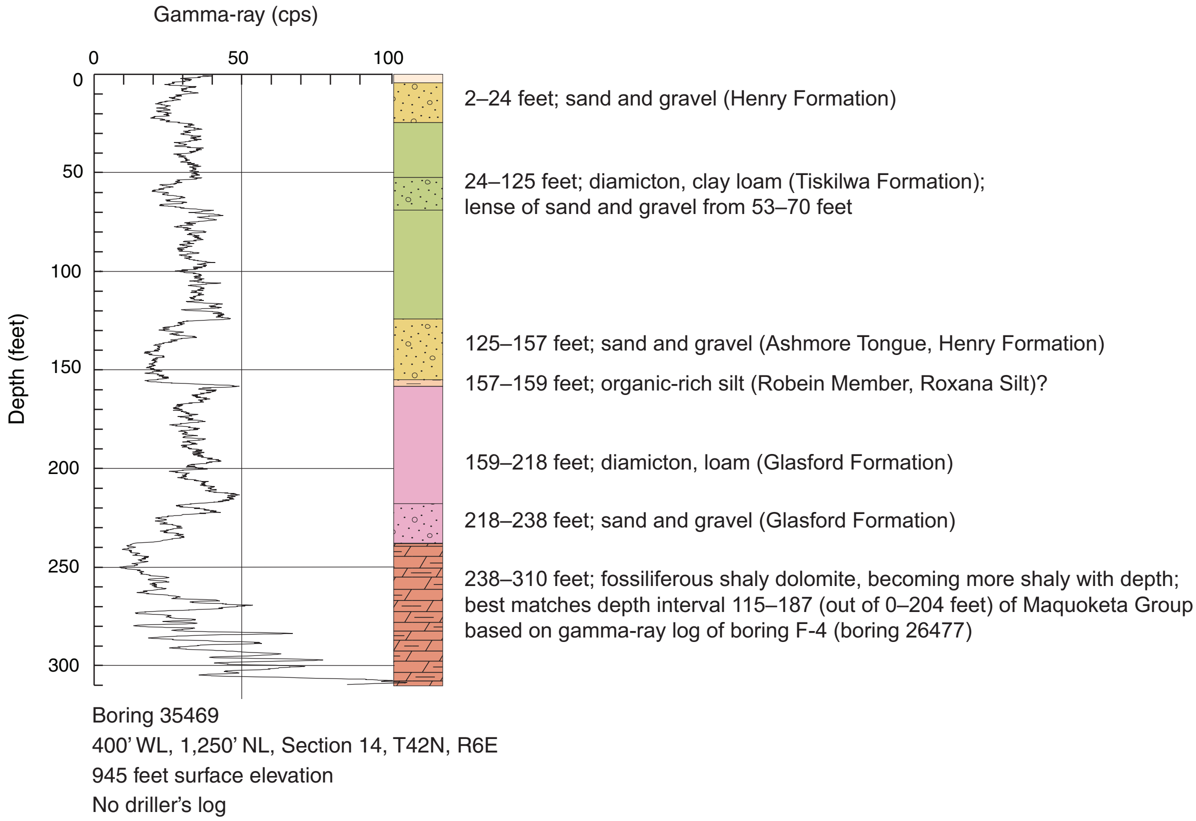


Figure 8 Lithologic and gamma-ray log of boring 35469 (NW Sec. 14, T42N, R6E) located 1.5 miles north and 1 mile east of Hampshire. This boring is used in cross section A–A′ on map sheet 2. cps, counts per second.

on the Tinley Moraine about 7 miles west of Lake Michigan in Lake County to as far south as the Gilman Moraine in Livingston County (Curry 2006).

Fossils and geomorphic relationships indicate that the laminated Unit 2 was deposited in ice-walled lakes (Curry and Yansa 2004, Konen et al. 2005). Originally thought to be the scars of melted pingos (complex extrusive features associated with continuous permafrost), analysis of core samples reveals fossil ostracodes that collectively live today in Lake Michigan at depths greater than 50 feet (Buckley 1975, Curry and Yansa 2004). The fossiliferous lacustrine sediment forms the highest terrace surfaces on the Hampshire Quadrangle; the terraces are bounded by 1- to 22-foot-high scarps that were formed by contact with ice (fig. 10; see also cross section B–B′ on map sheet 2). *Salix herbacea* (snowbed willow) leaves (fig. 11a), washed from cores of Unit 2, sampled at four sites, yielded ages between about 17,250 and 15,125 ^{14}C yr B.P. (table 2). The youngest leaf-bearing sediment is overlain by about 3 feet of weathered laminated sediment that is barren of fossils, indicating that the ice-walled lakes in this area persisted beyond 15,125 ^{14}C yr B.P. The plants were likely growing on the thin soils on the glacier surface; the leaves either washed in or were reworked from a slump of icy debris along the lake margin. The range of ages may correspond to a period of relative regional warming. For example, the ages correspond to a period when several thin organic horizons attributed to the Jules Geosol formed in the thick loess successions along the reaches of the middle and lower Illinois River valley (Grimley et al. 1998, Wang et al. 2000).

Slackwater Lakes

Younger, thinner lake deposits are present adjacent to ditched drainageways leading from the moraines. The lake sediment forms wide benches (terraces) ranging from 915 to 860 feet in elevation. The low-lying landscape position of the terraces indicates formation under slackwater conditions caused by temporary damming of low-gradient streams. Fossil limnic ostracodes indicate that some, if not all, of the sediment was deposited in long-lived lakes and not by seasonal floods. The sediment dams were probably formed of rapidly deposited alluvium. The slackwater successions are covered by thin, patchy deposits of Holocene alluvium (Cahokia Formation). Several twigs in the lake sediment sampled from a temporary backhoe ditch in Sec. 31, T42N, R5E (API 28514) yielded a radiocarbon age of 13,870 ± 40 ^{14}C yr B.P. (CAMS-18871). Like the overlying deposit of loess, the slackwater lake sediment is enriched in expandable clay minerals. In contrast, the clay mineralogy of ice-walled lake sediment is identical to the underlying diamicton of the Tiskilwa Formation. There are as many as three levels of terraces formed of loess-mantled slackwater lake sediment. Visible on the shaded relief map (fig. 6), the scarps are generally less

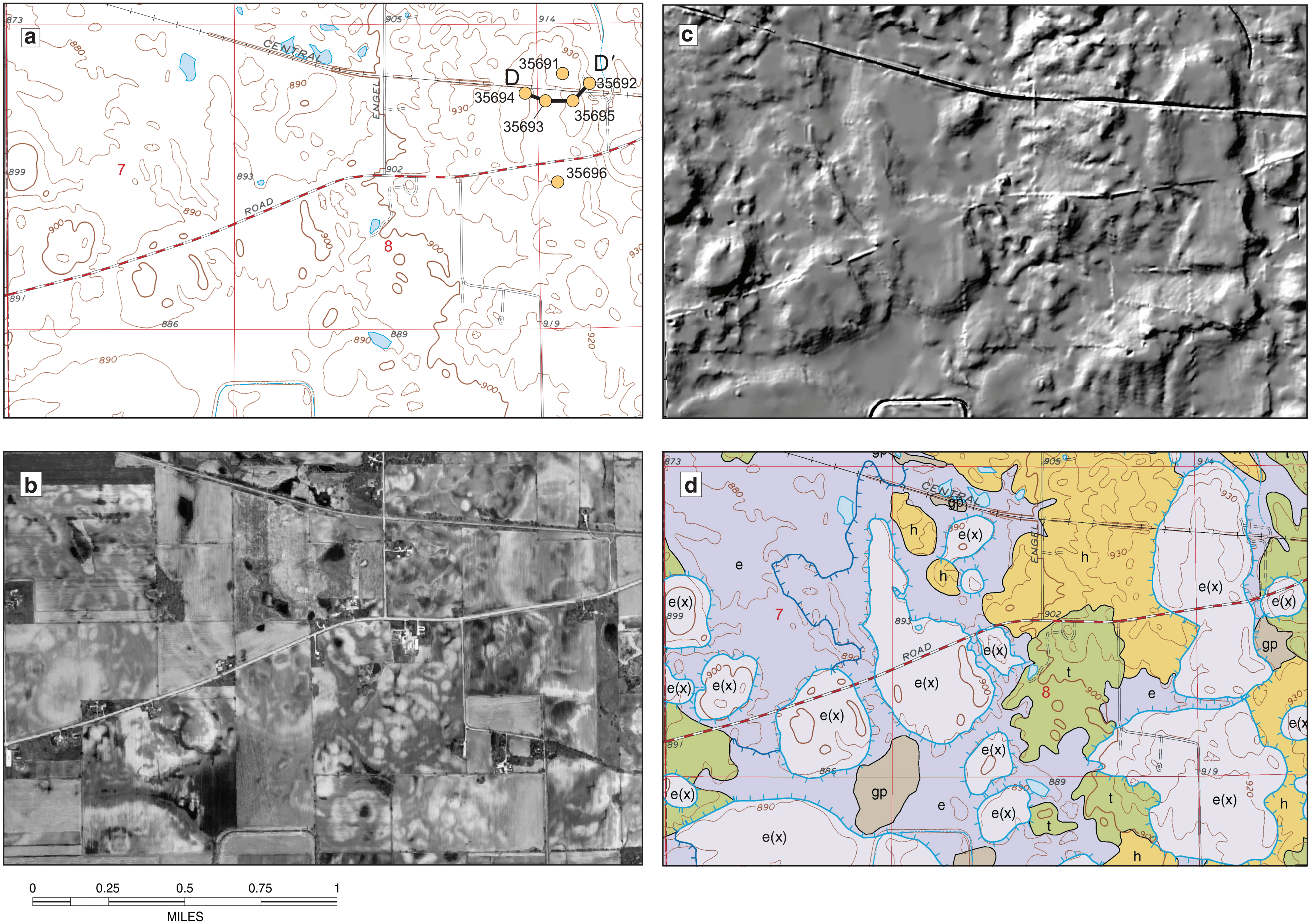


Figure 9 Four maps of the same area along Plank Road, immediately west of Burlington, showing several DeKalb mounds (see figure 3 for location of the area). The maps show (a) topography with boring locations and line of section for figure 10, (b) U.S. Geological Survey digital orthophoto quadrangle (DOQ) imagery, (c) shaded relief made from a DEM of 2-foot contours, and (d) the surficial geology map. gp, Grayslake Peat; e, Equality Formation; e(x), Equality Formation complex; h, Henry Formation; t, Tiskilwa Formation.

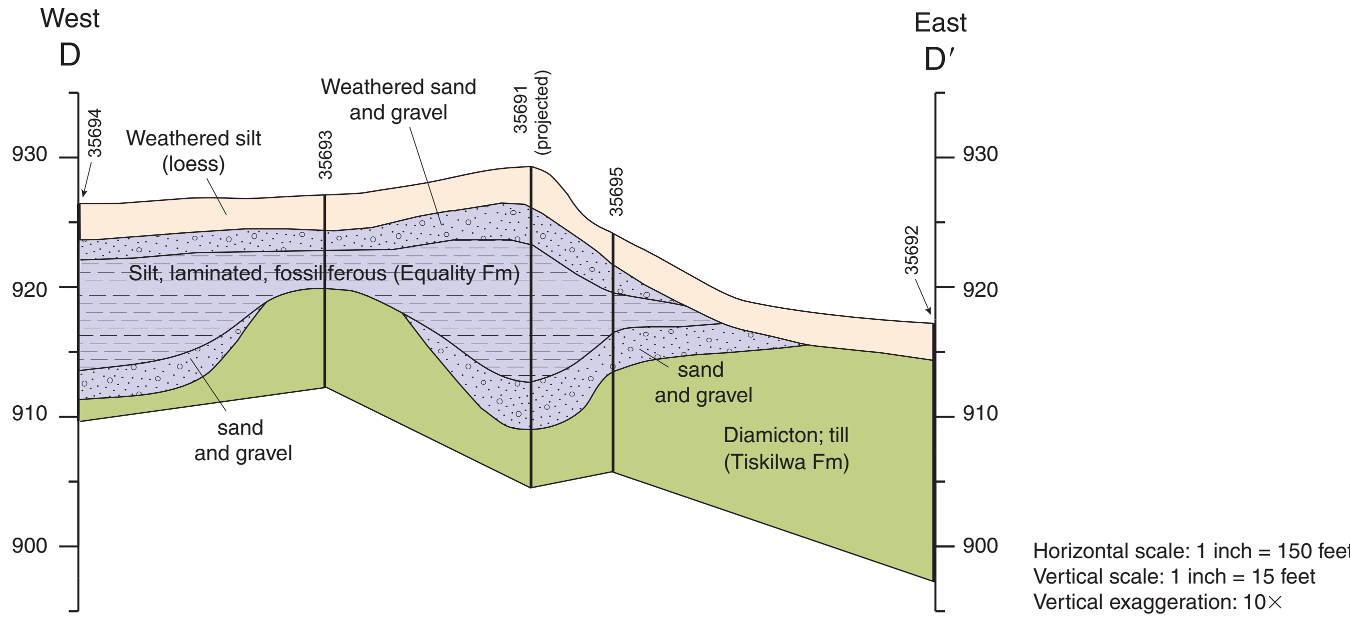


Figure 10 Cross section across part of an ice-walled lake deposit 1 mile west of Burlington. The line of section is shown on figure 9a.

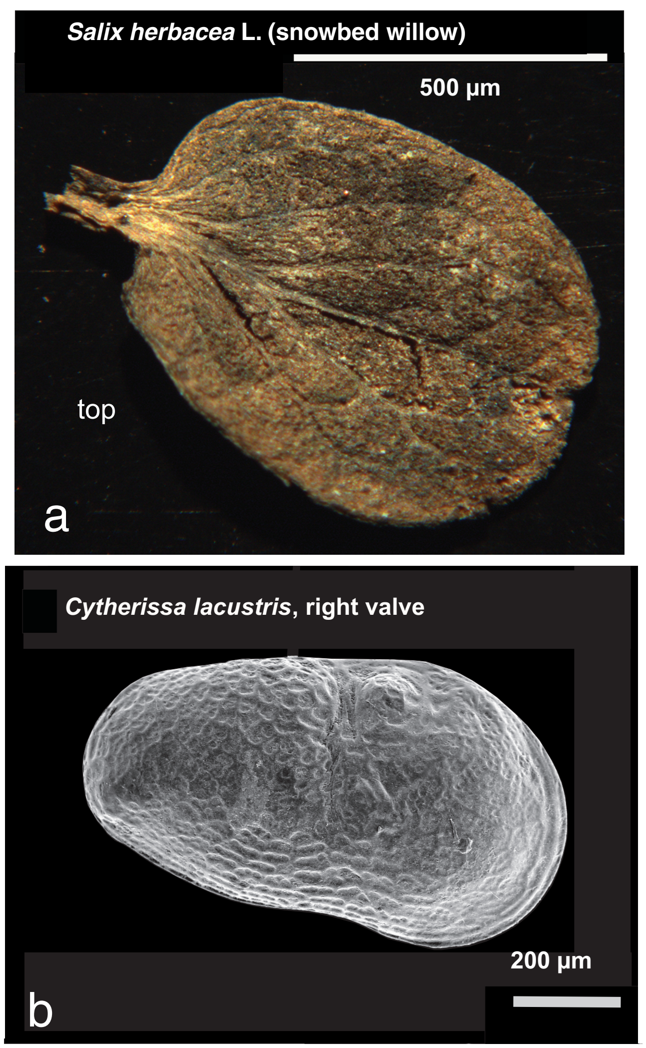


Figure 11 Examples of fossils recovered from boring 35696 (Sec. 9, T41 N, R6E) (a) leaf of *Salix herbacea* (snowbed willow) and (b) *Cytherissa lacustris*, an ostracode.

than 3 feet high and are not readily observed in the field. The scarps were formed by backwasting of gentle slopes by stream migration initiated by a lowering base level. The agents involved in this process may vary from man-made modifications (primarily through ditching and tiling) to natural means such as damming by beavers.

Outwash Fans

Outwash fans extend west of the Marengo Moraine and north of the Burlington moraine and Bloomington Morainic System (fig. 3). The outwash is primarily fine- to coarse-grained sand with occasional gravel and cobbles. The fan is subdivided here into the proximal and medial fan. The proximal fan is distinguished by having discontinuous areas with a pitted surface. The pits are readily discerned on aerial photography and appear as circular to semicircular areas with dark tones about 200 to 400 feet across. From floor to lip, the pits have about 3 to 7 feet of relief and occur in a one-mile-wide area parallel to the Marengo Moraine. The pits likely formed as ice blocks, embedded in the outwash, melted (cf. Benn and Evans 1998). Such features are known as kettles.

The proximal and medial tracts of the outwash fan are covered by about 5 feet of silty sand and gravel classified as the fine facies of the Henry Formation (h(f) on map sheet 1). Soils with this parent material are particularly poorly drained. The origin of the fine sediment is attributed to waning stream power during the latter stages of glaciation.

Downslope of the pitted outwash surface, two pairs of unusually straight, parallel, and narrow ridges occur on the medial fan. Formed of sand and gravel, these subtle features extend to the north and west into a similar-sized area on the Marengo South Quadrangle (fig. 3). Trending from N60°W to N70°W, the ridges may have formed against channel walls of ice and are thus levees. Because the ridges are beyond

Table 2 Radiocarbon ages (mean ± standard deviation) of plant macrofossils (leaves and stems).

Boring API number	Depth interval (feet)		Mean depth (feet)	^{14}C age (years B.P.)	Laboratory number
	Top	Bottom			
28514	7.0	7.2	7.1	13,870 ± 40	CAMS-18871
23513	13.8	14.4	14.1	15,150 ± 45	UCIAMS-23773
35696	13.5	13.8	13.6	15,740 ± 150	UCIAMS-23772
35155	16.1	16.6	16.3	17,290 ± 140	UCIAMS-23765
35696	8.7	8.9	8.8	15,125 ± 45	UCIAMS-23768
35696	10.9	11.0	11.0	17,090 ± 190	UCIAMS-23770
35696	19.8	19.9	19.9	17,250 ± 60	UCIAMS-23769
35527	19.7	20.3	20.0	16,700 ± 90	OxA-W917-11
35527	24.3	25.6	24.9	17,610 ± 270	OxA-W917-9
23512	16.2	16.6	16.4	24,950 ± 150	UCIAMS-23774
26477	90.0	90.2	90.1	27,150 ± 340	ISGS-1294
26477	95.0	96.5	95.3	38,600 ± 3200	ISGS-1295

the glacial limit, the ice was likely formed of “aufeis” or “icings.” Today, aufeis commonly forms terraces in subalpine and arctic regions; the source of water comes from either groundwater (often infused with dissolved carbonate rock; Clark and Lauriol 1997) or meltwater that upwells adjacent to mountainsides and moraines (Menzies and Shilts 1996). The outwash that presently forms the ridges was deposited in steep-walled channels about 10 feet high that formed in the aufeis. The straight and parallel nature of the four ridges is attributed to stress release.

Discussion and Summary

The Hampshire Quadrangle is located in an area that is critical to understanding the timing of regional glacial advances during the Wisconsin Episode (last glaciation) in northeastern Illinois. Ice first reached the area during the last glaciation at about 24,000 ^{14}C yr B.P. when the Marengo Moraine and possibly the Burlington moraine were formed. Ice-flow direction shifted during the interaction of the Lake Michigan Lobe with the Huron-Erie Lobe from about 22,000 to 17,500 ^{14}C yr B.P., and in the area of the Hampshire Quadrangle, ice stagnated (Wickham et al. 1988, Curry and Yansa 2004). Ice-walled lakes formed on the glacier surface from about 17,250 to 15,150 ^{14}C yr BP. After the ice melted, wind-blown silt accumulated on uplands and in slackwater lakes from about 13,900 to 12,500 ^{14}C yr B.P. (Curry et al., unpublished).

The presence of ice-walled lake plains is a new discovery made while mapping the Hampshire Quadrangle. Ice-walled lake plain deposits are from about 20 to 45 feet thick and characteristically contain the following sediment succession: basal sand and gravel (0 to10 feet); laminated, fossiliferous silt, clay, and very fine sand (5 to 35 feet); weathered to fresh sand and gravel and sandy diamicton (3 to 15 feet); and weathered silt and clay loess (3 feet). The lake sediment contains fossil leaves and stems of *Vaccinium uliginosum* ssp. *alpinum* (Bigelow.) Hulten (arctic bilberry), *Dryas integrifolia* Vahl. (Arctic dryad), and *Salix herbacea* (snowbed willow), in addition to the ostracodes *Cytherissa lacustris*, *Limnocythere friabilis,* and *Heterocypris* spp. (fig. 11; Curry and Yansa 2004). The tundra plants were growing on a thin soil atop the glacier, and their leaves and stems were redeposited in the ice-walled lakes. Later, topographic inversion occurred when the ice melted and slackwater lakes formed in poorly drained areas between deposits of the ice-walled lakes.

Many households and farms obtain their water from a sand and gravel aquifer buried by diamicton of the Tiskilwa Formation. Mapped as the Hampshire aquifer by Dey et al. (2007), the aquifer is more than 100 feet thick and includes deposits mapped here as the Ashmore Tongue of the Henry Formation and contiguous sand and gravel deposits of the Glasford Formation. Detailed mapping along the western flank of the Marengo Moraine indicates that the thickness of the aquifer changes laterally because of its undulating upper surface. Natural gamma-ray logs indicate that the upper part of the aquifer contains some beds of fine-grained sediment that are not conducive to water flow. Because the material was deposited on an alluvial fan, these fine-grained deposits are not likely continuous in the mapping area.

Further Research

Several puzzling questions remain unanswered regarding the glacial deposits on the Hampshire Quadrangle. One issue is the unknown age of the Burlington moraine. On the shaded relief map of Kane County, its northeastern terminus appears to be truncated by the Marengo Moraine (McGarry 2000). This relationship suggests that the Burlington moraine is older than 24,000 ^{14}C yr B.P., the age of the Marengo Moraine (Curry et al. 1999, Curry and Yansa 2004). This supposition should be tested by age-dating of in situ organics or other sediment associated with the Robein Member buried by sediment forming the Burlington moraine and Bloomington Morainic System in this area.

Regarding the ice-walled lake plains, little is known about their genesis. What initiated the formation of these features? The latent heat of freezing is often invoked to explain rapid formation of ice-walled lakes in other areas, but the ice-walled lakes mapped on the Hampshire Quadrangle persisted for more than 2,100 years. The fine laminae in the lacustrine sediment requires sedimentation from fallout in a water column; perhaps the sediment was delivered through seasonal discharge of turbid water from subterranean springs.

Acknowledgements

The author would like to thank Michael Konen (Northern Illinois University) and Catherine Yansa (Michigan State University) for their help with investigations of the geomorphology and fossil plants associated with the ice-walled lake plains. This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program, award number 98HQAG2050. 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.

References

Benn, D.I., and D.J.A. Evans, 1998, Glaciers and glaciation: New York, Arnold Publishers, 734 p.

Bleuer, N.K., 1974, Distribution and significance of some ice-disintegration features in west-central Indiana: Bloomington, Indiana, Department of Natural Resources Geological Survey, Occasional Paper 8, 11 p.

Buckley, S.B., 1975, Study of post-Pleistocene ostracode distribution in the soft sediments of southern Lake Michigan:University of Illinois at Urbana-Champaign, Ph.D. dissertation, 179 p.

Buol, S.W., F.D. Hole, and R.J. McCracken, 1980, Soil genesis and classification, 2nd ed: Ames, Iowa, The Iowa State University Press, 404 p.

Clark, I.D., and B. Lauriol, 1997, Aufeis of the Firth River Basin, northern Yukon, Canada; Insights into permafrost hydrogeology and karst: Arctic and Alpine Research, v. 29, p. 240–252.

Clayton, L., 1967, Stagnant-glacial features of the Missouri Coteau in North Dakota, *in* L. Clayton and T. F. Freers, eds., Glacial geology of the Missouri Coteau and adjacent areas: Grand Forks, North Dakota, North Dakota Geological Survey, Miscellaneous Series 30, p. 25–46.

Curry, B.B., 1989, Absence of Altonian glaciation in Illinois: Quaternary Research, v. 31, p. 1–13.

Curry, B.B., 2006, Subtle ice-walled lake terraces identified and mapped with shaded relief maps of 2-foot DEMs from aerial photography or LIDAR: Geological Society of America, Abstracts with Programs, v. 38, no.7, p. 164.

Curry, B.B., 2007, Data point locations of Hampshire Quadrangle, Kane and DeKalb Counties, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map, IGQ Hampshire-DP, 1:24,000.

Curry, B.B., R.C. Berg, and R.C. Vaiden, 1997, Geologic mapping for environmental planning, McHenry County, Illinois: Illinois State Geological Survey, Circular 559, 79 p.

Curry, B.B., D.A. Grimley, and J.A. Stravers, 1999, Quaternary geology, geomorphology, and climatic history of Kane County, Illinois: Illinois State Geological Survey, Guidebook 28, 40 p.

Curry, B.B., E.C. Grimm, J.E. Slate, B.C. Hansen, and M.E. Konen, 2008, The late glacial and early Holocene geology and paleoecology of the Brewster Creek site, a proposed restored wetland, Pratt's Wayne Woods Forest Preserve and James "Pate" Philips State Park, Bartlett, Illinois: Illinois State Geological Survey, Circular 571, 52 p.

Curry, B.B. and P.R. Seaber, 1990, Hydrogeology of the shallow groundwater resources, Kane County, Illinois: Illinois State Geological Survey, Contract/Grant Report 1989–3, 34 p.

Curry, B.B., and C.H. Yansa, 2004, Evidence for stagnation of the Harvard sublobe (Lake Michigan lobe) in northeastern Illinois, U.S.A., from 24,000 to 17,600 BP and subsequent tundra-like ice-marginal paleoenvironments from 17,600 to 15,700 BP: Géographie physique et Quaternaire, v. 58, p. 305–321.

Deniger, J.A., 2004a, Soil survey of De Kalb County, Illinois: U.S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Illinois Agricultural Experiment Station, 254 p.

Deniger, J.A., 2004b, Soil survey of Kane County, Illinois: U.S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Illinois Agricultural Experiment Station, 437 p.

Dey, W.S, A.M. Davis, B.B. Curry, D.A. Keefer and C.C. Abert, 2007, Kane County water resources investigations: Final report on geologic investigations: Illinois State Geological Survey, Contract Report, 114 p.

Flemal, R.C., K.C. Hinkley, and J.L. Hesler, 1973, DeKalb mounds: A possible Pleistocene (Woodfordian) pingo field in north-central Illinois, *in* R.F. Black, R.P. Goldthwait, and H.B. Willman, eds., The Wisconsinan

Stage: Boulder, Colorado, Geological Society of America, Memoir 136, p. 229–250.

Graese, A.M., R.A. Bauer, B.B. Curry, R.C. Vaiden, W.G. Dixon Jr., and J.P. Kempton, 1988, Geological-geotechnical studies for siting the SSC in Illinois—Regional summary: Illinois State Geological Survey, Environmental Geology Notes 123, 100 p.

Gravenor, C.P., and W.O. Kupsch, 1959, Ice-disintegration features in western Canada: Journal of Geology, v. 67, p. 48–64.

Grimley, D.A., 2004, Surficial geology of Maple Park Quadrangle, Kane and DeKalb Counties, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Maple Park-SG, 1:24,000.

Grimley, D.A., 2005, Surficial geology of Pingree Grove Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Pingree Grove-SG, 1:24,000.

Grimley, D.A., L.R. Follmer, and E.D. McKay, 1998, Magnetic susceptibility and mineral zonations controlled by provenance in loess along the Illinois and central Mississippi River valleys: Quaternary Research, v. 49, p. 24–36.

Hansel, A.K., and W.H. Johnson, 1992, Fluctuations of the Lake Michigan Lobe during the late Wisconsin subepisode: Sveriges Geologiska Undersökning, Series Ca 81, p. 122–144.

Hansel, A.K., and W.H. Johnson, 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.

Holtz, R.D., and W.D. Kovacs, 1981, An introduction to geotechnical engineering: Englewood Cliffs, New Jersey, Prentice-Hall, 733 p.

Illinois Census 2000, http://illinoisgis.ito.state.il.us/census2000/. Accessed June 25, 2007.

Kane County Regional Planning Commission, 2004, Kane County, Illinois 2030 land resource management plan: Geneva, Illinois, 184 p.

Kempton, J.P., R.A. Bauer, B.B. Curry, W.G. Dixon, Jr., A.M. Graese, D.R. Kolata, P.C. Reed, M.L. Sargent, and R.C. Vaiden, 1987, Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois: Part I: 1984 fall drilling program: Illinois State Geological Survey, Environmental Geology Notes 117, 102 p.

Konen, M.E., E.T. Stromberg, and B.B. Curry, 2005, The DeKalb mounds revisited: Geological Society of America Abstracts with Programs, v. 37, p. 22.

McGarry, C.S., 2000, Shaded relief map of Kane County, Illinois, OFS2000-6: Illinois State Geological Survey, 1:62,500.

Menzies, J., and W.W. Shilts, 1996, Subglacial environments, *in* J. Menzies, ed., Past glacial environments: Sediments, forms, and techniques, glacial environments, volume 2: Oxford, UK, Butterworth-Heinemann, p. 15–136.

Northern Illinois Planning Commission, 2007, http://www.chicagoareaplanning.org/data/forecast/2030_revised/ENDORSED_2030_forecasts_9-27-06.xls.

RockWorks, 2002, Version 2.3.5: Golden, Colorado, Rock Ware.

Vaiden, R.C., E.C. Smith, and T.H. Larson, 2004, Groundwater geology of DeKalb County, Illinois, with emphasis on the Troy Bedrock Valley: Illinois State Geological Survey, Circular 563, 39 p.

Wang, H., L.R. Follmer, and C.L.J. Liu, 2000, Isotope evidence of paleo-ENSO cycles in the loess-paleosol record in the Central USA: Geology, v. 28, p. 771–774.

Wickham, S.S., W.H. Johnson, and H.D. Glass, 1988, Regional geology of the Tiskilwa Till Member, Wedron Formation, Northeastern Illinois: Illinois State Geological Survey, Circular 543, 35 p.

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