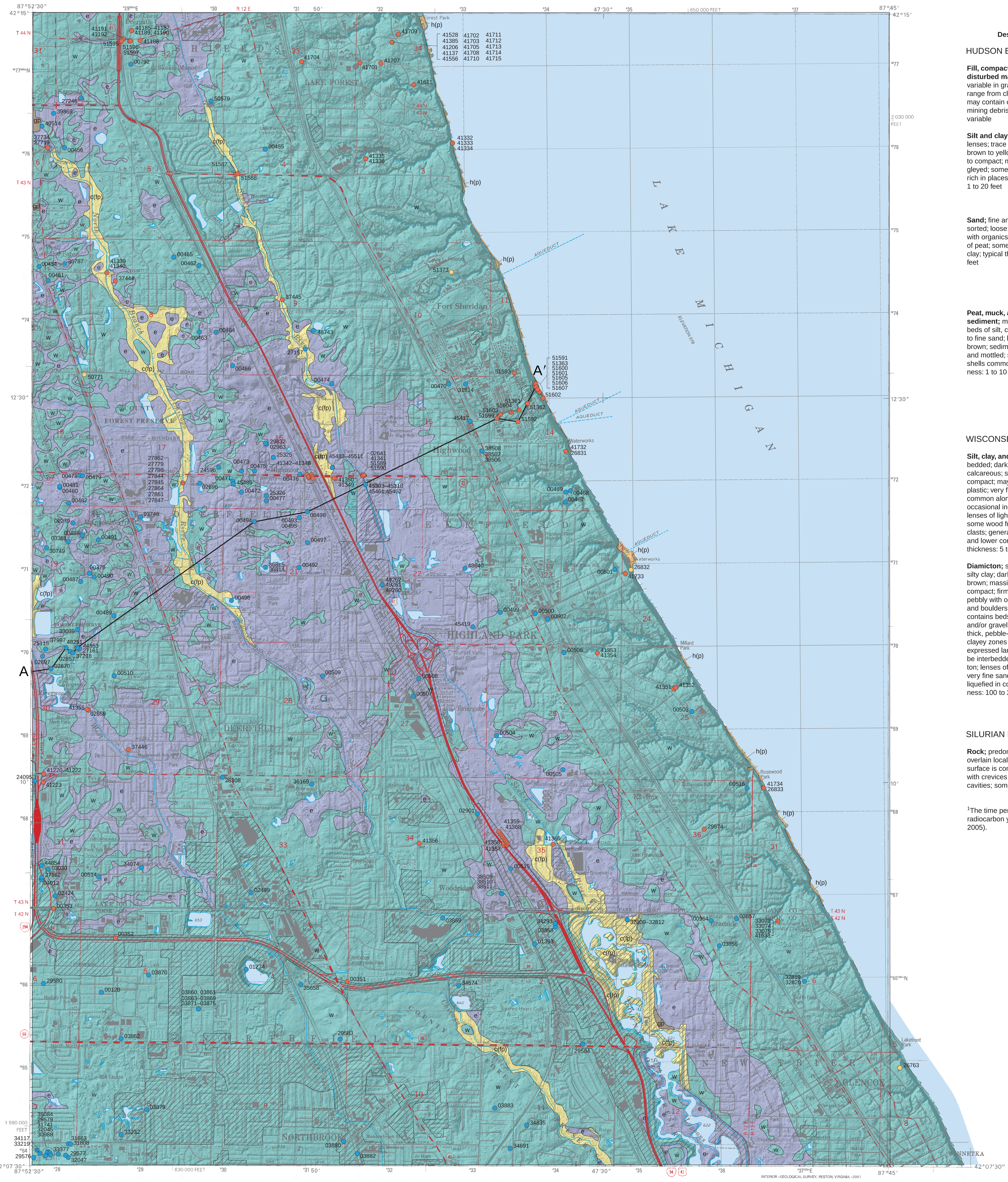
Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

SURFICIAL GEOLOGY OF HIGHLAND PARK QUADRANGLE

LAKE AND COOK COUNTIES, ILLINOIS

STATEMAP Highland Park-SG

Michael L. Barnhardt
2011



QUATERNARY DEPOSITS

Description	Unit	Interpretation
HUDSON EPISODE (~14,600 years before present [B.P.] to today)[1]		
Fill, compacted land, or other disturbed material; highly variable in grain size (may range from clay to gravel), and may contain construction and mining debris; typical thickness: variable	Disturbed ground (dg)	**Human-disturbed deposits** modified during construction of buildings, roads, and landfills; includes excavations in gravel pits and quarries; urbanized areas and industrial and commercial build-up
Silt and clay; occasional sand lenses; trace gravel; stratified; brown to yellowish brown; loose to compact; may be mottled and gleyed; some bedding; organic-rich in places; typical thickness: 1 to 20 feet	Cahokia Formation (floodplain deposits) c(fp)	**Postglacial (modern) stream sediments** deposited on active floodplains; derived mainly from eroded loess and diamicton; may overlie or interfinger with lacustrine silt and clay; includes silty slopewash deposits along footslope and minor drainage-ways on moraines
Sand; fine and medium; well sorted; loose; may be mixed with organics, including layers of peat; some thin lenses of clay; typical thickness: 1 to 10 feet	Henry Formation (Parkland facies) h(p)	**Windblown sand in dunes** and sheet-like deposits between active shoreline of Lake Michigan and wave-eroded bluff; local relief generally less than 12 feet; interdune swales often contain peat, muck, and organic-rich sand; eolian facies of Henry Formation; includes beach sand
Peat, muck, and organic-rich sediment; may contain interbeds of silt, clay, and very fine to fine sand; black to dark brown; sediment may be gleyed and mottled; soft to firm; snail shells common; typical thickness: 1 to 10 feet	Grayslake Peat (gp)	**Organic-rich sediments** accumulated in low-lying depressions, drainageways, and on floodplains; may include small areas of open water; locally intertongued with modern alluvium, or lake sediment; commonly found around lakes and marshes and channels connecting bodies of water; may be intermixed with sand dunes (h(p))along Lake Michigan
WISCONSIN EPISODE (~29,900 years–14,600 B.P.)[1]		
Silt, clay, and sand; massive to bedded; dark gray to light gray; calcareous; soft to hard; compact; may be sticky and plastic; very fine and fine sand common along bedding planes; occasional inclusions and lenses of light gray to white silt; some wood fragments; very few clasts; generally abrupt upper and lower contacts; typical thickness: 5 to 25 feet	Equality Formation (e)	**Postglacial and glacial proglacial lake deposits** that infill low-lying areas, or depressions in drainage channels and where water was impounded behind moraines, such as the Blodgett Moraine; at the surface, these sediments may interfinger with or be overlain by alluvium and organic-rich deposits
Diamicton; silty clay loam to silty clay; dark gray to yellowish brown; massive; calcareous; compact; firm to very hard; pebbly with occasional cobbles and boulders; commonly contains beds of silt, clay, sand, and/or gravel; may contain thick, pebble-free, silty and clayey zones with strongly expressed laminations that may be interbedded with the diamicton; lenses of saturated silt and very fine sand are loose and liquefied in core; typical thickness: 100 to 200 feet	Wadsworth Formation (w)	**Subglacial and ice-marginal sediments (till)** deposited from Wadsworth glacial ice; includes sediment that melted out on top of the glacier or along the ice margin and reworked by slope processes and water; bedded sequences may be more than 40 feet thick, but their areal extent is irregular and difficult to delineate; extensive areas and thicknesses of bedded sand, silt, and clay may be intermixed with diamictons of mudflow and meltout origin along the ice margin

PRE-QUATERNARY DEPOSITS

Description	Unit	Interpretation
SILURIAN PERIOD (~443 to 416 million years B.P.)		
Rock; predominantly dolomite overlain locally by shale; upper surface is commonly fractured with crevices and solution cavities; some oil staining	Bedrock (cross section only)	**Bedrock** buried by ~150 to 250 feet of Quaternary sediments

[1]The time periods for the Wisconsin Episode and the Hudson Episode are reported as calibrated radiocarbon years and can be directly compared to calendar years before 1950 (Stuiver et al. 2005).

Data Type

- Engineering boring
- Stratigraphic boring
- Water well boring
- 26211 — Boring label indicates the county number. Dot indicates boring is to bedrock.
- Contact
- A—A′ Line of cross section

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

Base map compiled by Illinois State Geological Survey from digital data (Raster Feature Separates) provided by the United States Geological Survey. Planimetry derived from imagery taken 1988. Photoinspected using imagery taken 2000. PLSS and survey control current as of 1976. Shaded relief from LiDAR provided by Lake and Cook counties.

North American Datum of 1927 (NAD 27)
Projection: Transverse Mercator
10,000-foot ticks: Illinois State Plane Coordinate system, east 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 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology based on field work by Michael L. Barnhardt, 2008–2010.

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

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This map has not undergone the formal Illinois Geologic Quadrangle map review process. Whether or when this map will be formally reviewed and published depends on the resources and priorities of the ISGS.

ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Prairie Research Institute
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 244-2414
http://www.isgs.illinois.edu

1	2	3
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ADJOINING QUADRANGLES
1 Libertyville
2 Waukegan
3
4 Wheeling
5
6 Arlington Heights
7 Park Ridge
8 Evanston

APPROXIMATE MEAN DECLINATION, 2011

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

Most of the counties in northeastern Illinois are among the most rapidly growing areas of population in the state and some communities are among the most rapidly growing in the country. Although some communities of this region (including those within the Highland Park Quadrangle) draw the majority of their drinking water from Lake Michigan, a significant portion, including most within the rapidly-growing areas, rely upon groundwater from Quaternary sand and gravel deposits or from shallow bedrock.

The Illinois State Geological Survey (ISGS) has implemented a mapping program to develop three-dimensional maps of the glacial geology from land surface to the top of bedrock. Funding for mapping the surficial geology of the Highland Park Quadrangle was provided in part by a grant from the United States Geological Survey (USGS) National Cooperative Geologic Mapping Program, STATEMAP subprogram. These funds were used to develop the detailed map of the surficial geology, the cross section, and the extensive database that is required to accomplish the planned three-dimensional mapping. The 3-D mapping is funded by a separate cooperative agreement with the USGS Great Lakes Geologic Mapping Coalition (GLGMC) and additional funding from the General Revenue Fund of the State of Illinois. Map and digital products that will be developed include three-dimensional models of the material (sediment) and aquifer units, and maps of the surficial geology, bedrock topography, data point distribution, drift thickness, hydraulic conductivity, aquifer sensitivity, recharge, aquifer geometry, and susceptibility to contamination. These maps and products can be used by county and municipal agencies and the public to better understand issues related to groundwater withdrawal, land use, and transportation network planning, and open space and environmental protection.

Regional and Local Setting

The surficial geology of the Highland Park Quadrangle is primarily the result of continental glaciers and their meltwater during the last glaciation (Wisconsin Episode). While the thickness of glacial sediments in Lake County ranges from about 120 to 350 feet, in the Highland Park Quadrangle they are generally less than 230 feet and typically between 150 and 200 feet with the thinner accumulations being in the southwest portion of the map. These sediments were deposited throughout Lake County during at least three major glacial advances that occurred between about 29,900 and 14,600 years ago (Wisconsin Episode) and a fourth (and possibly more) that occurred between about 200,000 and 130,000 years ago (Illinois Episode). In the Highland Park Quadrangle area, however, the majority of the sediments were most likely deposited during the last 19,000 years the oldest of which directly overlie bedrock and comprise the bulk of the sediments found in the Lake Border Morainic System (see cross section; fig. 1). The five moraines comprising the Lake Border Morainic System are, from oldest to youngest (west to east), the Park Ridge, Deerfield, Blodgett, Highland Park, and Zion City, respectively. The four oldest occur on the Highland Park map (see cross section; figs. 1 and 2).

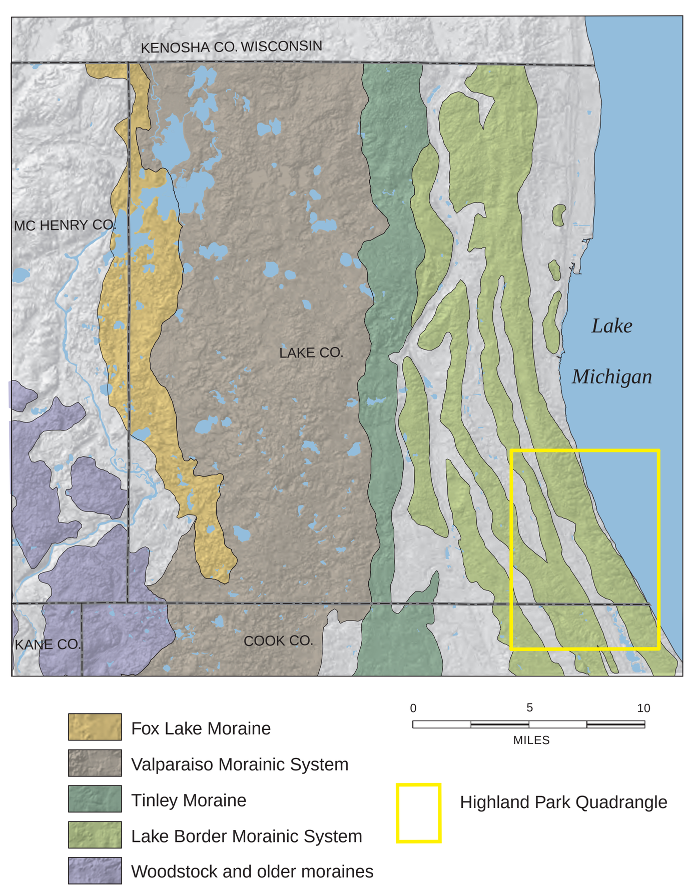

Figure 1 Surface topography and moraines of northeastern Illinois. After Willman and Frye 1970; Willman and Lineback 1970.

The earlier ice advances that originated in the Lake Michigan basin appear to have scoured to bedrock and removed all or most of the previously deposited sediments in the study area. There is little evidence in the sediment records from boreholes drilled in the study area that suggests the presence of significant amounts of sediment much older than 19,000 years. As each glacier moved westward out of the Lake Michigan basin across Lake County, large amounts of sediment were deposited during both the advance and retreat stages resulting in a complex stratigraphy with a considerable range in age that increases with distance from modern Lake Michigan. In addition, the glacier margin was most likely irregular due to localized minor pulses and surges of ice and variable rates of calving and downwasting. Meltwater that was impounded by ice and sediment drained as outlets opened and closed. These and other factors combined to create significant spatial and vertical differences in sediment thickness, texture, and sequence across the county (Barnhardt 2005, 2008, 2009, 2010; Barnhardt et al. 2001; Hansel 2005; Stumpf and Barnhardt 2005; Thomason and Barnhardt 2007, 2008; Stumpf 2004, 2006).

Landscapes and Geomorphology

The geomorphology of the Highland Park Quadrangle is quite young. Radiocarbon ages on organic and fossil-rich sediments from the base of ice-walled lakes formed on the Tinley and Deerfield Moraines are 17,290 to 16,580 and 16,250 cal yr BP, respectively (Curry 2008). These dates confirm that the Tinley Moraine was deposited by the Joliet sublobe during the Crown Point Phase [>17,300 and <16,700 cal yr BP] and the Lake Border moraines were formed during the Glenwood Phase of Glacial Lake Chicago [<16,700 and >14,670 cal yr BP] (Curry 2008, Curry et al. 2010). Glacial Lake Chicago formed between the ice margin of the Lake Michigan Lobe and the mainland as the ice margin retreated. The impounded meltwater deepened and, then, stabilized at an elevation of about 640 feet at the Chicago Outlet (Curry 2008). Subsequent fluctuations and advances of the ice margin out of the Lake Michigan basin resulted in the ice advancing into Glacial Lake Chicago and displacing the water or depositing and mixing new sediments in the lake.

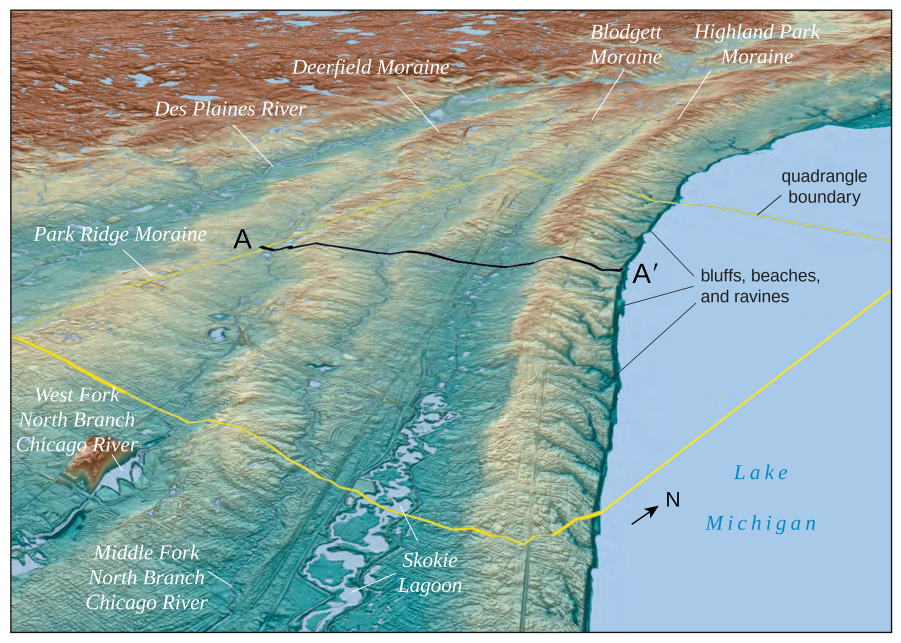

Figure 2 Oblique view of Highland Park Quadrangle surface topography of with cross section A–A′. Digital elevation model was generated from LiDAR data provided by Lake and Cook counties. The scene has been vertically exaggerated 20×.

At many locations across Lake County, borehole evidence reveals thick, massive diamictons (till) frequently intertongued with thin to thick beds and mixtures of fine sand, silt, and clay suggesting that lacustrine environments abutted the ice mass. The widespread occurrence of mudflows, deltas, beach deposits, and other subaqueous features attest to the presence of standing water across Lake County for much of the last 30,000 years as ice lobes moved westward out of the Lake Michigan basin.

Landscapes and subsurface sediment sequences within the Highland Park Quadrangle exhibit the deposition related to at least four ice advances, extensive sedimentation in proglacial lakes, and dynamic shoreline changes (cross section and surficial geology map). The Park Ridge Moraine is not traversed by the cross section but it is prominent in the southwestern part of the map and is revealed in greater detail in adjacent maps of the Wheeling and Libertyville Quadrangles (Barnhardt 2005, 2008; fig. 1). The Deerfield Moraine runs roughly parallel to and just east of the Park Ridge Moraine (fig. 1). It is a large, broad moraine that appears to merge with the Blodgett Moraine in the south-central part of the map. Although there is sparse high-quality borehole information for the middle of the map, the Blodgett Moraine, in this area, appears to be composed mostly of reworked sandy-silt lacustrine sediments, while in the Deerfield Moraine, a larger proportion of the moraine is diamicton and associated sand and gravel lenses (see cross section). This is not necessarily unusual for the Lake Border moraines but it underscores the importance, and prevalence, and persistence of lacustrine environments in the development of the glacial landscape of northeast Illinois. The Highland Park Moraine is very prominent and due to its curvature and the modern configuration of the Lake Michigan shoreline, it now comprises the bulk of the lakeshore from Waukegan to south of Winnetka where it is exposed along its longitudinal axis in many eroded bluffs.

Berg and Collinson (1976) examined and measured bluff erosion at about two dozen locations from the Great Lakes Naval Training Center to south of Winnetka. Many exposures reveal extensive thicknesses of lacustrine sand, silt, and clay in bedded and laminated sequences overlying and interfingering with massive glacial diamictons. Several of these exposures just north of Fort Sheridan were revisited during this study to better understand how these types of sediment sequences could be interpreted from driller's records. The Highland Park Moraine is also dissected by about a dozen deep ravines originating at the shoreline that were initiated during the Chippewa phase, an exceptionally low stand of the ancestral Lake Michigan that lasted from about 11,500 to 6,300 cal yr BP. This means the Highland Park Moraine was in place by about 15,000 cal yr BP. The beach deposits that occur in selected locations were emplaced during the Algoma and Modern phases of Lake Michigan [about 4,200 cal yr BP to present] (about 3,800 ^{14}C years BP) and are ephemeral and transitory in their southward migration (Chrzastowski and Frankie 2000). Most of the beaches on the Highland Park map are reinforced by jetties, groins, and breakwaters and may receive periodic sand replenishment. At locations where the beach is broader (e.g., Fort Sheridan Forest Preserve), small wave-cut terraces are capped with beach sand and some sand dunes have formed.

Unit Characterization and Stratigraphy

Several lithologically distinct diamictons, silt and clay beds, and sand and gravel units were deposited by the Lake Michigan lobe as it repeatedly advanced and retreated across northeast Illinois from about 29,900 to 14,600 years ago (fig. 1). The Quaternary deposits in the mapping area overlie directly dolomitic bedrock of Silurian age. The uppermost part of this bedrock may be shaly, highly fractured, vuggy, and, locally, oil-stained. The regional slope dips into the Lake Michigan basin but over small areas may be rather flat.

Recent drilling, core analysis, mapping, and 3-D interpretation of thousands of descriptions from water-well, engineering, and stratigraphic boreholes suggests that a large percentage, if not a majority, of the sediment comprising a moraine (e.g, the Blodgett Moraine) may be of lacustrine origin rather than diamicton of subglacial origin (till). (see cross section; surface geology map, fig. 2). This seems to apply also to moraines developed during earlier glacial advances across Lake County. In western Lake County where glaciers did not erode and/or redeposit as much of the previously deposited sediments like they did in the Lake Border moraines, multiple diamictons (tills) are found in some of the moraines; however, they are also intermingled with lacustrine sediments. Lakes of various sizes, depths, and longevity seem to have occupied large portions of Lake County during the last 29,900 years and were interacting with the glaciers as they moved through the region.

The Wadsworth diamicton ("w" on cross section) is the only till exposed at land surface or in cross section on the Highland Park Quadrangle. It is predominantly a dark grayish brown, silty clay to silty clay loam diamicton (a massive to poorly sorted mixture of clay, silt, sand, and gravel), but it also contains lenses and thick beds of sorted sediment, especially silty clay, silt, and fine sand (symbolized on cross section with various stippled patterns). Near a moraine front, the Wadsworth diamicton may exhibit a coarser texture and an increase in the number and thickness of lenses and beds of sand and/or gravel. The diamicton is composed of beds of till (that were deposited subglacially) and more variable (bedded and coarser) diamicton that may represent material that melted out near the ice margin, on top of the glacier or was deposited as debris flows in a body of water. No extensive surface deposits of outwash sand and gravel of the Henry Formation were identified on this quadrangle although some are present in the Waukegan and Zion Quadrangles, which also border Lake Michigan. Deposits of the Equality Formation (e) are generaly located between the Deerfield, Blodgett, and Highland Park Moraines. These sediments were deposited in water impounded between the moraines and the ice front. These deposits are generally thin and may include some sediment deposited during the Glenwood phase high lake stand. Geomorphically, they are low areas and are presently occupied by streams which may be depositing modern silt-dominated alluvium mapped as the Cahokia Formation, floodplain deposits (c(fp)). These sediments are usually found along larger active floodplains but can be found on upland positions along smaller channels and drainageways. Often, they are not of sufficient extent or thickness to map but can be identified on the LiDAR-generated digital elevation model (DEM) which underlies the surface geology map.

Uplands may also contain small isolated depressions in which peat has accumulated. Grayslake Peat (gp) and sand of the Henry Formation, Parkland facies, h(p), may also occur and be intermixed along beaches where peat, muck, and organic-rich sand occur within and between the arcuate ridges of sand dunes. While these units are more abundant in the beach-ridge plain to the north and where beaches are broad, they are similar in that the sediments are very young (<5,500 ^{14}C years BP) [<6,300 cal yrs BP] and represent the most dynamic landscape on the map (Chrzastowski and Frankie 2000).

Mapping Techniques

The map of surficial geology is based largely on digitized soils maps (scale 1:15,840) from the Soil Survey of Lake County, Illinois (Paschke and Alexander 1970, U.S. Department of Agriculture 2004). Initially, individual soil series were grouped by their parent material following (1) the classification key in Soils of Illinois (Fehrenbacher et al. 1984, USDA 2005), (2) profile descriptions in the survey report, (3) NRCS field notes, (4) discussions with NRCS soil mappers, and (5) updated individual Soil Series Description sheets acquired either directly from the USDA-NRCS or downloaded from their web site. These parent material classes then were grouped into more general geologic material classes comprising the mapping units used for this map, following Hansel and Johnson (1996) and Willman and Frye (1970).

The parent material (geologic material) classes were generalized for the surficial geology map because the soil-based data layer created a very complex map with polygons that were too small for incorporation into cross sections. It is assumed the thickness of each soil unit is at least 6 to 10 feet or more based upon the depth to which the soil scientists sample during their mapping. The thickness of specific units was adjusted where our drilling, field observations, or records suggested otherwise. Selected soil series, or in some cases individual polygons in various soil series, were regrouped into different geologic material classes following extensive fieldwork and data analysis for this and other quadrangles in Lake County (Barnhardt 2005, 2008, 2009, 2010; Barnhardt et al. 2001; Stumpf 2004, 2006; Stumpf and Barnhardt 2005; Hansel 2005; Thomason and Barnhardt 2007, 2008).

The sediment at land surface (parent material for the soils) was examined and correlated with its geomorphic (landscape) position to develop a sediment-landscape model. This was accomplished within ArcGIS by draping the sediment (parent material/surficial geology) layer over a digital elevation model (DEM) with a 2-foot resolution (surface geology map and fig. 2). In addition, the original, high-complexity soil series layer was added to increase the degree of detail available for analysis. Variations of this model were combined with records of water-well and stratigraphic and engineering borings and analyzed in ArcScene to better understand the subtle sediment-landscape relationships and the changes in subsurface stratigraphy as depicted in the cross section. This model was used to interpret the sediment description for every water-well, stratigraphic, or engineering boring used in the mapping.

The ISGS has drilled fourteen boreholes to bedrock within the area delineated as the Lake Border Morainic System (see fig. 1). Each was drilled and continuously sampled using either a CME-75 or Mobile B-57 drill rig, which are equipped with a wireline sampler. Downhole natural gamma-ray logs were also collected for each and observation wells were installed where appropriate to monitor long term water levels in sand and gravel units. Subsamples were taken for particle-size analysis. Each of the high-quality sediment cores from these boreholes was described in great detail and analyzed in conjunction with their gamma logs and, then, reviewed and discussed by ISGS geologists to better understand and interpret the depositional environment in which this sediment was deposited. This information was used to develop a framework of depositional environments within which considerably less detailed descriptive records from adjacent water wells could be examined. Geologic information for subsurface units depicted on the cross section was obtained from core descriptions for the ISGS boreholes and other sample sets and drilling logs obtained from water wells and engineering boreholes, which are available in databases at the ISGS. A total of 653 location-verified water well and engineering boreholes are located on the Highland Park Quadrangle most of which are verified to tax parcel size and repositioned as needed (fig. 3). The quality of the geologic information for each borehole was evaluated as they were selected for developing and validating the surficial geology map and cross section. The legend of map units provides additional discussion on the variability of sediments and their occurrence on the landscape.

The ages reported herein are calibrated calendar years before 1950 as calculated following Reimer et al. (2004). The equivalent ^{14}C age is presented parenthetically for information cited from Chrzastowski and Frankie (2000) because the calibrated years given in this report are those of this author and not theirs, which were reported as uncalibrated ^{14}C years in their report.

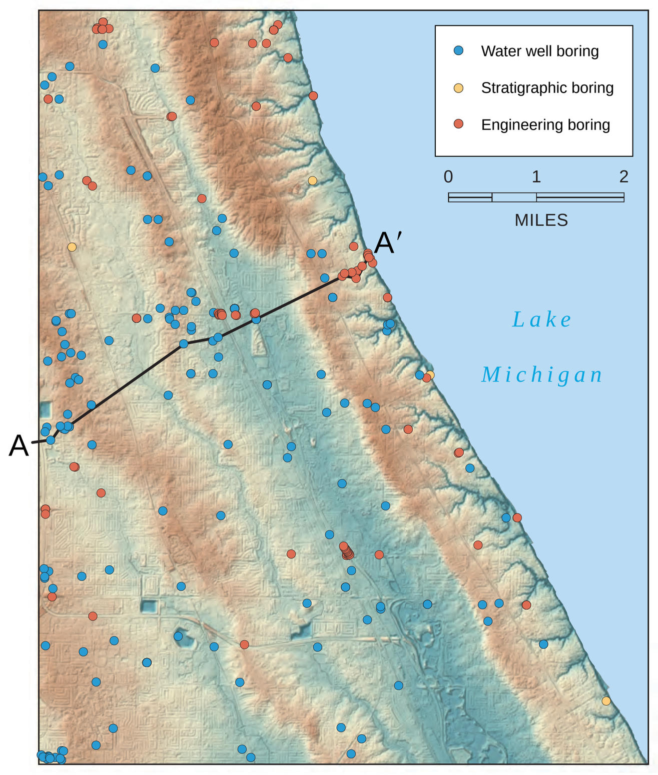

Figure 3 Locations of boreholes and cross section.

Acknowledgments

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