Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

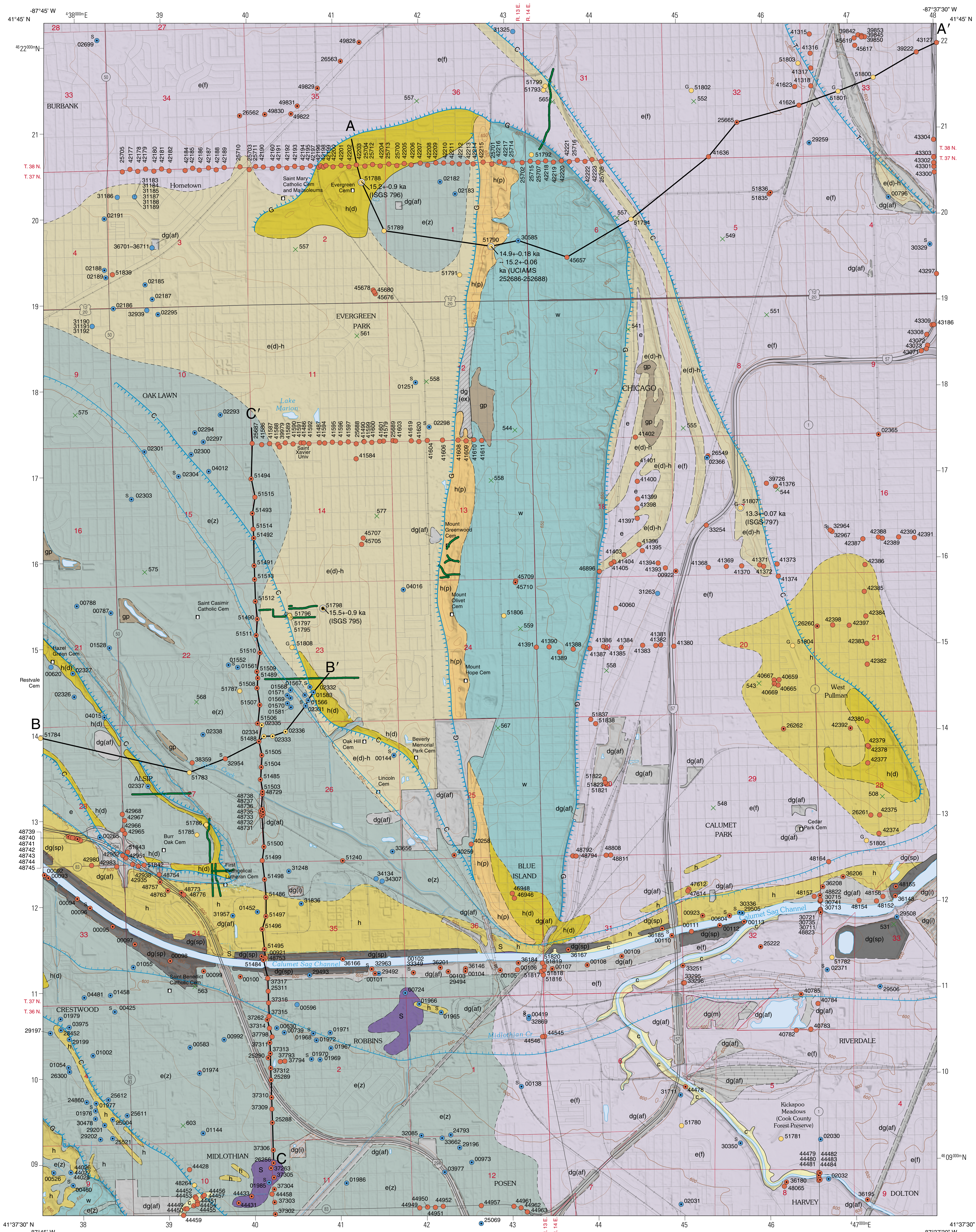
SURFICIAL GEOLOGY OF BLUE ISLAND QUADRANGLE

COOK COUNTY, ILLINOIS

STATEMAP Blue Island-SG

Andrew C. Phillips, B. Brandon Curry, and Alexandra Sanchez

2021



QUATERNARY DEPOSITS

Description	Unit	Interpretation
HUDSON EPISODE (~14,700 years before present (B.P.) to today)[1]		
Diamicton, silt, sand, and gravel	Disturbed ground (spoil) dg(sp)	**Dredge spoil** from construction of Cal-Sag canal and post-construction maintenance
Removed earth	Disturbed ground (excavated) dg(ex)	**Bretz (1939) identified excavated area,** likely exploiting sand of the Henry Formation, Parkland facies
Diamicton, sand, and gravel; up to 35 feet thick	Disturbed ground (fill) dg(af)	**Made land** infilling clay excavations (Alsip), sand excavations, and elevating roadways. Much of map area is covered with <5 feet of fill and so not mapped; many small areas with >5 feet of fill not mapped
Diamicton, sand, gravel, slag, chemical wastes, construction debris; up to 25 ft thick	Disturbed ground (industrial) dg(i)	**Areas used for steel manufacture and other industry**
Glass, plastic, metal, sand, gravel, and organic matter; up to 15 feet thick	Disturbed ground (municipal) dg(m)	**Municipal waste deposits** including automobile recyling and earth materials mounds
Peat, muck, organic silt and clay; up to 5 feet thick	Grayslake Peat gp	**Organic matter** accumulated in depressions
Sand, silt, clay; massive to bedded; up to 10 feet thick in Little Calumet River, up to 5 feet thick in Cal-Sag Canal	Cahokia Formation c	**Alluvium** in the beds of Little Calumet River and the Cal-Sag Canal; undifferentiated along Stony Creek
Late WISCONSIN EPISODE and HUDSON EPISODES (~17,600 years B.P. to today)[1] [also shown as 16,700]		
Sand, silty fine to medium, to sandy loam, with basal cobble gravel beds; stratified; up to 30 feet thick	Henry Formation h	**Glacifluvial deposits and lake bottom sand sheets,** locally intercalated with lake sediment and grading into post-glacial alluvium; southern margin excavated during Cal-Sag Channel construction
Sand, fine grained and well sorted; stratified; up to 10 feet thick	Henry Formation (Parkland facies) h(p)	**Sand dunes** formed on west flank of the Blue Island; dated to Glenwood Phase of Lake Chicago; large areas have been excavated
Sand, well sorted, with local gravel; stratified; typically less than 10 feet thick	Henry Formation (Dolton facies) h(d)	**Littoral sand** deposited in Pleistocene Lake Chicago; associated with any of the three shorelines: the Glenwood, Calumet, and Toleston beach ridges (Bretz, 1939)
Clay and silt; laminated to weakly bedded; up to 25 feet thick	Equality Formation (fine facies) e(f)	**Lake sediment deposited in Pleistocene Lake Chicago.** Unit e(f) is a fine-grained facies, deposited under quiet, typically off-shore conditions; unit e(z) is a coarser, lithologically heterogeneous facies with laminated zones and common clasts from ice rafting; unit e(d) is a diamicton facies including ice-rafted debris and debris flow; it is pervasive as uppermost facies north of the Cal-Sag Canal; relatively high strength possibly caused by dewatering under iceberg loading
Silt and clay, silty diamicton; laminated to bedded; typically 10–20 but up to 30 feet thick	Equality Formation (silty facies) e(z)	
Silty diamicton; bedded; 2–20 feet thick	Equality Formation (diamicton facies, cross sections only) e(d)	
Silt, clay, fine to medium sand, and silty diamicton, with local gravel; intercalated up to 15 feet thick	Equality Formation and Henry Formation Complex e(d)-h	**Littoral and nearshore facies of Lake Chicago;** Elongate ridges on the east side of the Blue Island are littoral features but largely erosional into lake clays; sand is intercalated or occurs as onlapping sheets
WISCONSIN EPISODE: Michigan Subepisode (~29,000–14,700 years B.P.)[1] [also shown as 29,000–17,600]		
Clay loam diamicton; very stiff; typically less than 20 feet thick but possibly up to 90 feet thick under the Blue Island	Wadsworth Formation w	**Till,** very similar in texture to the diamicton facies of the Equality Formation and may include rafts of Equality Formation
Ppebbly loam to silt loam diamicton with little clay; massive to bedded; sand, gravel, and silt interbeds; very hard; typically 15–30 ft thick	Haeger Member, Lemont Formation (Cross sections only) l-h	**Till and ice-marginal sediment**
Sand, medium to coarse, and gravel; stratified; up to 25 ft thick	Beverly Tongue, Henry Formation (Cross sections only) h-b	**Glacifluvial deposits**

PRE-QUATERNARY DEPOSITS

Description	Unit	Interpretation
SILURIAN SYSTEM (440-410 million years B.P.)		
Dolomite with local shale	Silurian S	**Dolomitized carbonate bank deposits** with layers of glacially injected diamicton along bedding planes near bedrock surface (described in boring records as "broken"); Knobs extend to within 5 feet of the surface; Cal-Sag Canal design was excavated to bedrock

[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. 2015).

Data Type

- Stratigraphic boring
- Engineering boring
- Water-well boring
- Boring with age data
- Passive seismic sounding

SG 31681 — Labels indicate samples (S) or geophysical log (G). Boring labels indicate the county number. Dot indicates boring or outcrop is to bedrock.

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.

- Contact
- Contact approximate
- Contact inferred
- A—A′ Line of cross section
- Ground penetrating radar profile line
- Paleoshorelines of glacial Lake Chicago; triangles point offshore. Labels indicate age: (C) Calumet, (G) Glenwood, and (T) Toleston.
- Terrace scarp, Calumet

Base map compiled by Illinois State Geological Survey from digital data (2018 US Topo) provided by the United States Geological Survey. Shaded relief derived from LiDAR elevation data provided by Cook County (2018).

North American Datum of 1983 (NAD 83)
Projection: Transverse Mercator
1,000-meter ticks: Universal Transverse Mercator grid system, zone 16

SCALE 1:24,000

1 MILE / 7000 FEET / 1 KILOMETER

BASE MAP CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1988

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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.

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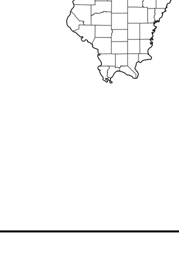


1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Berwyn
2 Englewood
3 Jackson Park
4 Palos Park
5 Lake Calumet
6 Tinley Park
7 Harvey
8 Calumet City

APPROXIMATE MEAN DECLINATION, 2021

ROAD CLASSIFICATION

Interstate Route — State Route
U.S. Route — Local road

Introduction

The surficial geologic map of the Blue Island 7.5' quadrangle is part of a long-term geological mapping project in northeastern Illinois (see, for example, Curry et al. 2020, Caron and Curry 2019, Caron and Curry 2018, and Caron and Phillips 2015). This map continues ISGS efforts in northeastern Illinois to map deposits at the land surface and in the subsurface down to bedrock to gain a better understanding of the complex geology resulting from at least two glaciations and their associated meltwater flooding events. Bretz (1939) following Alden (1902) constructed the prevailing geologic framework. Much of their "areal" maps comprise geomorphic features in addition to geologic features; our map units are more strictly lithologic units. The Blue Island Quadrangle includes the prominent Blue Island ridge itself, once an island protruding from glacial Lake Chicago, the Lake Chicago plain, and the upper Chicago Outlet. Today, the Blue Island lies about 8 miles from the southern shore of Lake Michigan. The Quaternary geology depicted here represents preliminary interpretations from this mapping effort. The map builds upon the existing geologic framework and supports studies of water and aggregate resources, infrastructure, glacial processes, and geologic history.

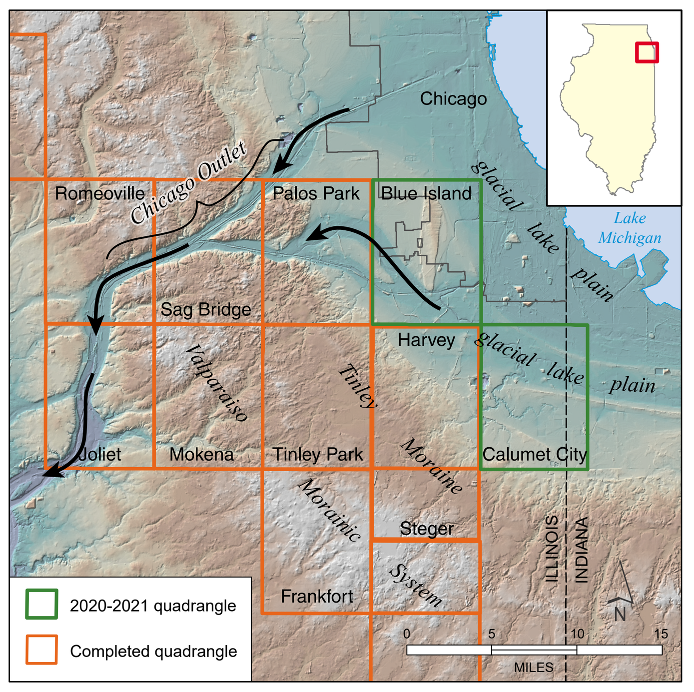


Figure 1 Location and landform map of the southern Chicago mapping region. Blue Island and Calumet City quadrangles are a focus of STATEMAP mapping in FY2020.

Methods

The surficial geology was analyzed from compilations of boring records archived at the Illinois State Geological Survey (ISGS), aerial imagery (various), prior mapping (Alden 1902, Bretz 1939, Kay et al. 1996, observations in archived ISGS field notes), and soil surveys (Soil Survey Staff 2019). Locations of the water well (n = 149) and geotechnical borings (n = 446) shown on the surficial map were confirmed with the best available data, including engineering drawings, historic plat maps, tax records, and aerial photographs. Most of the water well locations shown are likely within 10 to 330 ft of their true locations, though some may be yet further afield because of generalized plat map information. Geotechnical boring locations are within 1–50 ft of their true locations. New data were generated by sample set studies in the ISGS Samples Library, core sampling by push probe, ground penetrating radar profiling, and interpretation of recent high-resolution elevation data (Cook County, Illinois 2017). Coring with hydraulic push methods to depths of 14 to 39 feet at 25 sites (totaling 569 feet of core) targeted key landforms and geologic units. In addition, 7 cone penetrometer soundings with hydraulic property profiles were collected to depths of 21–47 feet. Physical and chemical data collected on core samples included particle size analyses by laser diffraction (n = 25), elemental characterization by Energy Dispersive X-Ray Fluorescence (n=17), water content (n = 92), and strength by pocket penetrometer (summary results in Table 1). Plant remains in four core samples were dated with radiocarbon methods although one sample returned a modern age. Three additional core samples were dated by optically stimulated luminescence (Table 2). The horizontal to vertical spectral ratio passive seismic technique (HVSR) was used to sound bedrock depth at 33 locations with excellent results. A total of 3.5 miles of GPR profiles were collected, although most individual transects were short.

The bedrock topography map (Fig. 2) was constructed by machine contouring of point (boring, HVSR) observations and contour interpretations with the Topo to Raster tool of ArcGIS. In addition to the 236 data points shown, another 203 points span a mile-wide buffer around the map area. Contours from early iterations were modified to improve geologic reasonableness in some areas because data are sparse, especially in the northern and eastern sectors, and to remove small features. These contours were then fed back into subsequent iterations. The bedrock topography map was constructed from these data as a 50 m raster grid. The unconsolidated sediment thickness map (Fig. 3) was constructed by differencing the bedrock topographic surface with the surface digital elevation map which had been downsampled to a 50 m grid. The computer-generated surface was noisy and so resulting contours generalized and smoothed by hand.

Geologic Setting

Major surficial landscape elements on the Blue Island Quadrangle were formed during the latter phases of the last glaciation (Wisconsin Episode) and early to middle parts of the current interglaciation (Hudson Episode) between about 18,500 and 6,000 cal yr BP (Curry et al. 2018; Hansel and Mickelson 1988). The prominent Blue Island ridge, located centrally in the quadrangle, has been interpreted as both end moraine (Alden 1902, Bretz 1939) and as a crevasse fill feature. A broad, Y-shaped depression described as "glacial river bottom" by Bretz (1939) is relict from outwash flows during the late Wisconsin Episode (Hansel and Michelson 1988; Curry et al. 2018). Between the arms of the Y is a high terrace of relict lacustrine sediment and associated shoreline features, possibly undergirded by bedrock. The lower arm of the Y has been excavated into the Calumet-Saganashkee Channel (known as the "Cal-Sag"). It is joined on the east end by the Little Calumet River, which originally drained east from there, prior to being reversed by Cal-Sag construction. Much of the rest of the quadrangle comprises a flat plain of thick lake deposits ("glacial lake bottom" to Bretz 1939), which drape across the Y-valley (cross section B–B'). Long, linear, onlapping ridges are relict of ancient Lake Michigan shorelines during recession of Lake Chicago in the latest Wisconsin Episode (Glenwood and Calumet shorelines or beach ridges) and into the Hudson Episode (Toleston shoreline or beach ridge) (Hansel and Michelson 1988; Curry et al. 2018). Except for cemeteries, most of the land surface is occupied by residences, commercial entities, or industry, which are built in a veneer of fill across the landscape. Original landscape features have been mined for clay to make brick or borrowed for other uses, and depressions have been filled for occupation. The very low relief overall fine textured surficial sediments make much of the area conducive to flooding, especially south of the Cal-Sag Channel (McGuire et al. 2021)

Important Findings

Bedrock surface The bedrock is mostly Silurian dolostone with minor shale. Overall bedrock surface relief is low. A southwest-northeast trending high deepens from near-surface in the southeast to depths of 75–100 feet in the north and east. Several knobs in the southeast quadrant were mapped as "near surface" and bedrock is exposed at the bottom of the Cal-Sag Channel where original design criteria included bedrock excavation. Two bedrock valleys tributary to the broad Worth valley north and west of the quadrangle were delineated, as were valleys trending eastward towards Lake Michigan. Quaternary sediment thickness is greatest, up to 100 feet thick, under the Blue Island itself and also thickens into these broader valleys.

Chronology A handful of new dates constrain the landform history (Table 2). Three radiocarbon dates on needles tightly cluster around 15,000 ± 90 cal yr B.P. to confirm the deposition of eolian dunes (Henry Formation, Parkland facies) on the west flank of the Blue Island during the high Glenwood Phase of Lake Chicago. The OSL date 15,000 ± 900 cal yr B.P. (ISGS795) also confirms the spit at the northern tip of the Blue Island as Glenwood in age. Likewise, an OSL date of 15,200 ± 900 cal yr B.P ago (ISGS-796) suggests that the broad lake plain sheltered between the Blue Island and the spit is largely a terraced remnant of a Glenwood Phase feature. The third OSL date of 13,300 ± 800 cal yr B.P. (ISGS-797), determined on beach ridge sediment, confirms the swarm of ridges on the east side of the Blue Island as Calumet Phase deposits.

Geologic Units This map is notably different than that of Bretz (1939), who largely followed Alden (1902). Bretz's map units were geomorphic assemblages whereas the geologic units shown here were lithostratigraphically differentiated. In particular, dominant features on Bretz (1939) were "Glacial river bottom" and "Glacial lake bottom", which were described as largely erosional features. By contrast, this map shows facies of Equality Formation covering most of the Lake Chicago plain, with geomorphic features shown by shorelines and terrace scarp symbols. At higher mapping resolutions, more facies within Equality Formation may be differentiable (McGuire et al. 2021).

Nearly all the map units that we tested, whether glacial diamicton, laminated lake sediment, bedded lake diamicton, or littoral and associated deposits, share a matrix texture of silt loam (Table 1). However, our studies of core samples revealed a wider range of matrix textures. Geologic units were differentiated based on proportions of clay at expense of sand, >2 mm clast proportions, strength, water content, and contacts. Three facies of Equality Formation were differentiated, laminated deposits with slightly more clay, laminated deposits with slightly more silt and 1–3% clasts interpreted as ice-rafted debris, and bedded to laminated diamicton which was interpreted as an proglacial or even subglacial ice-contact deposit. The diamicton is very similar in texture to diamicton of the Wadsworth Formation, which is interpreted as glacial till or debris flow. However, Equality Formation diamicton is slightly softer and has slightly higher water contents (~16–29%, 20% mean, interpreted from geotechnical borings, Table 3) than Wadsworth Formation diamicton (~11–44%, 18 % mean). Nonetheless, Equality diamicton is stiffer and has lower water content than typical for Equality Formation. We speculate this was caused by consolidation under the weight of icebergs or glacial ice.

Gray, dolomitic, very hard, dry (<15% moisture), pebbly silty diamicton is interpreted here as Haeger Member (Lemont Formation) (Table 1, Table 3). Although those properties are typical of the Haeger Member, it is puzzling that this unit thickens to the north at the expense of Wadsworth Formation, which is typically softer, less pebbly, and more clay-rich. Possibly the unit is a basal till facies of the Wadsworth Formation. This situation is evident by comparing Cross Sections A–A' and C–C'. In A–A', Haeger Member is depicted as an even bed at the base of the Quaternary sequence, with Wadsworth Formation thickening in the Blue Island but then thinning westward to where it disappears in the northern portion of C–C' despite clearly forming a portion of the Tinley Moraine further to the west (Caron and Curry 2019). Alternatively, the Blue Island ridge may have first been formed by Lemont ice ("w or l-h" polygon in A–A') and subsequently buried during the Wadsworth advance.

We attempted to delineate and characterize disturbed ground following Kay et al. (1996). Their analysis was based mainly upon study of historic records and interpretation of aerial photography. We differentiated 5 categories of disturbed ground: Excavations, spoil, fill, municipal fill, and industrial fill. Excavations were identified from previous maps by Bretz (1939), Kay (1996), comparison of aerial photography of different dates, soil maps (Soil Survey Staff 2019), and lidar interpretations. Spoil was mostly associated with Cal-Sag Channel. Fill was differentiated only where is was greater than 5 feet thick; most geotechnical borings log some thickness of fill at the top. Areas of thicker fill are mainly in elevated roadways and bridge cones. Small patches also occur near excavations, in previous excavations (abandoned Illinois Brick Company pit along cross section B–B'), and isolated areas associated with industry. Municipal waste includes piles of recycling debris, sanitary landfills. Industrial areas were taken from Kay et al. (1996) and manly include solid and chemical wastes from steel processing.

Geochemical characterization and GPR profile data were still being processed at the time of map delivery, but are expected to help correlate diamicton units within the map area and to differentiate Equality Formation and Henry Formation strata that occur along Glenwood, Calumet, and Toleston shorelines.

Acknowledgements

We thank the many landowners and land managers for access to field sites, especially The Chicago Park District, Cook County Forest Preserves, and the villages of Alsip and Evergreen Park. The ISGS drill team cheerfully managed a challenging schedule. ISGS staff Erin Huggett supported coring and Nicholas Karahalios collected HVSR data. Jennifer Carrell completed the cartography. This map was made possible by the USGS National Cooperative Geologic Mapping Program under STATEMAP award number G20AC00371.

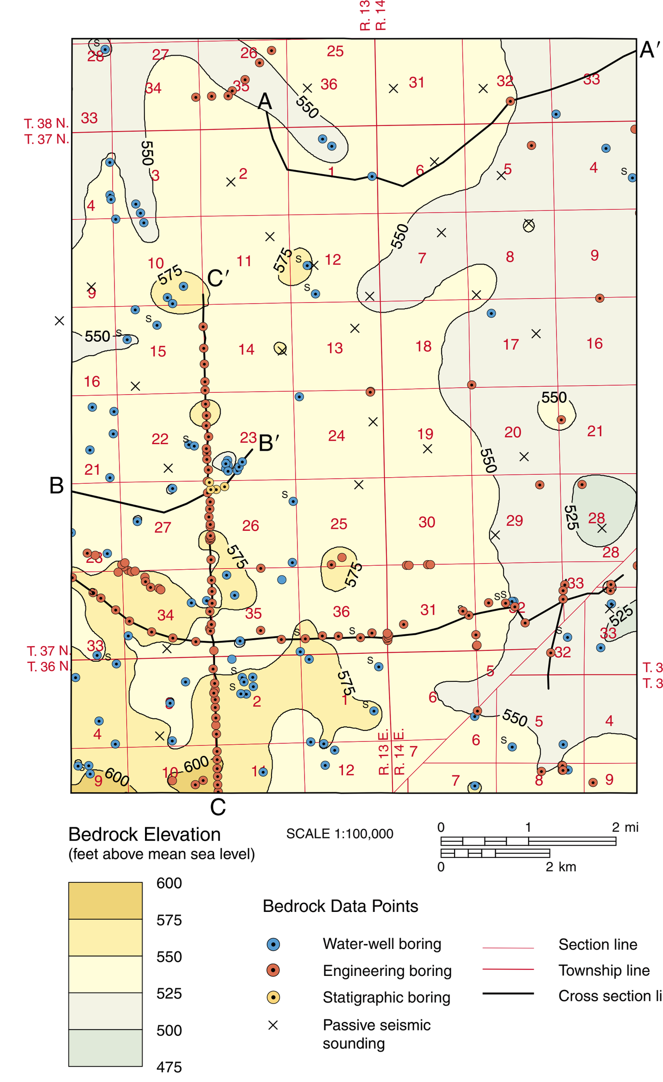


Figure 2 Bedrock topography of the Blue Island quadrangle.

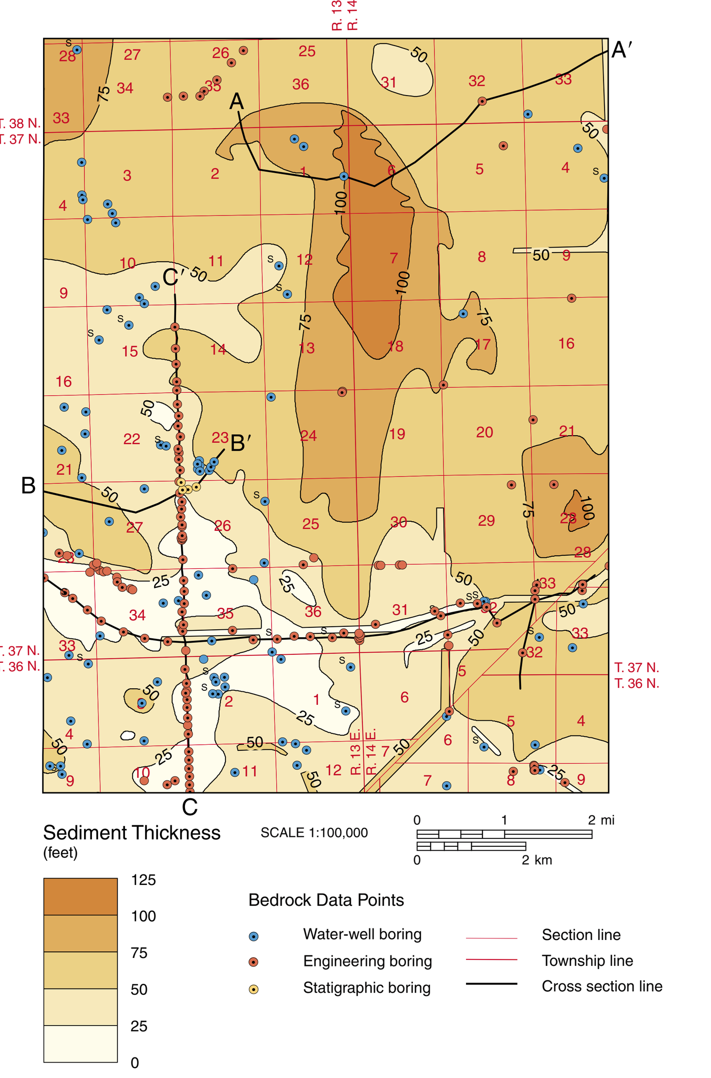


Figure 3 Quaternary sediment thickness of the Blue Island quadrangle.

Table 1 Mean and standard deviation of unit properties, including depth (feet), SPT (Standard Penetration Test), % refusal (SPT > 100/ft), moisture content, unconfined compressive strength (Qu, t/ft²), and particle size distribution data (determined with Mastersizer at PRI).

Unit	Statistic	Qp[1] (t/ft²)	Moisture content (%)	gravel % Total	less than 2 mm fraction: sand %	silt %	clay %<4 μm	n	USDA Texture Class[2]
d(af)	Mean	2.1	28						
	St dev	0.82	14.9						
	n	3	8						
h	Mean	4	16						
	St dev	0.62	6						
	n	3	8.0						
h(p)	Mean	2.3	17						
	St dev	0	3.0	0–1	13–70	26–69	4–16	2	SL–ZL
	n	1	2						
e(f)	Mean	3.4	18						
	St dev	1.35	4.0	0–7	4–25	59–85	10–26	8	ZL
	n	12	13						
e(z)	Mean	3.4	15						
	St dev	1.34	3.4	0–0	6–9	67–86	8–24	3	Z–ZL
	n	8	9						
e(d)	Mean	3.2	16						
	St dev	1.10	3.1	0–25	6–35	52–75	8–19	15	ZL
	n	22	32						
w	Mean	3.5	16						
	St dev	1.15	2.4	1–5	10–16	65–70	14–21	6	ZL
	n	13	14						
l–h	Mean	4.5	10						
	St dev	0	1.5	14–20	9–13	57–66	10–11	2	ZL
	n	3	4						

[1]Pocket Penetrometer; [2]SL = sandy loam; Z = silt; ZL = silt loam

Table 2 Ages from core samples dated by optically stimulated luminescence

Method	Laboratory ID	Sample ID	Depth (ft)	Organics	Radiocarbon Years B.P.	±	Calibrated Years B.P.*	±
Radiocarbon*	252686	BLI-P11	4.2	needles	12535	30	14,900	180
	252687	BLI-P11	9.8	needles	12560	35	15,000	90
	252688	BLI-P11	10.1	wood fragments	12705	30	15,150	65

Method	Laboratory ID	Sample ID	Depth (ft)	Equivalent Dose (Gy)	Dose rate (Gy/ka)	Age (ka)	n (accepted/ total)
Optically Stimulated Luminescence***	795	BLI-P19b	6	27.8 ± 1.3	1.80 ± 0.07	15.5 ± 0.9	31/34
	796	BLI-P9	10	28.9 ± 1.4	1.91 ± 0.07	15.2 ± 0.9	33/34
	797	BLI-P29	6	28.2 ± 1.4	2.12 ± 0.07	13.3 ± 0.8	30/33

*Ages determined at the Keck Carbon Cycle AMS Facility, University of California at Irvine

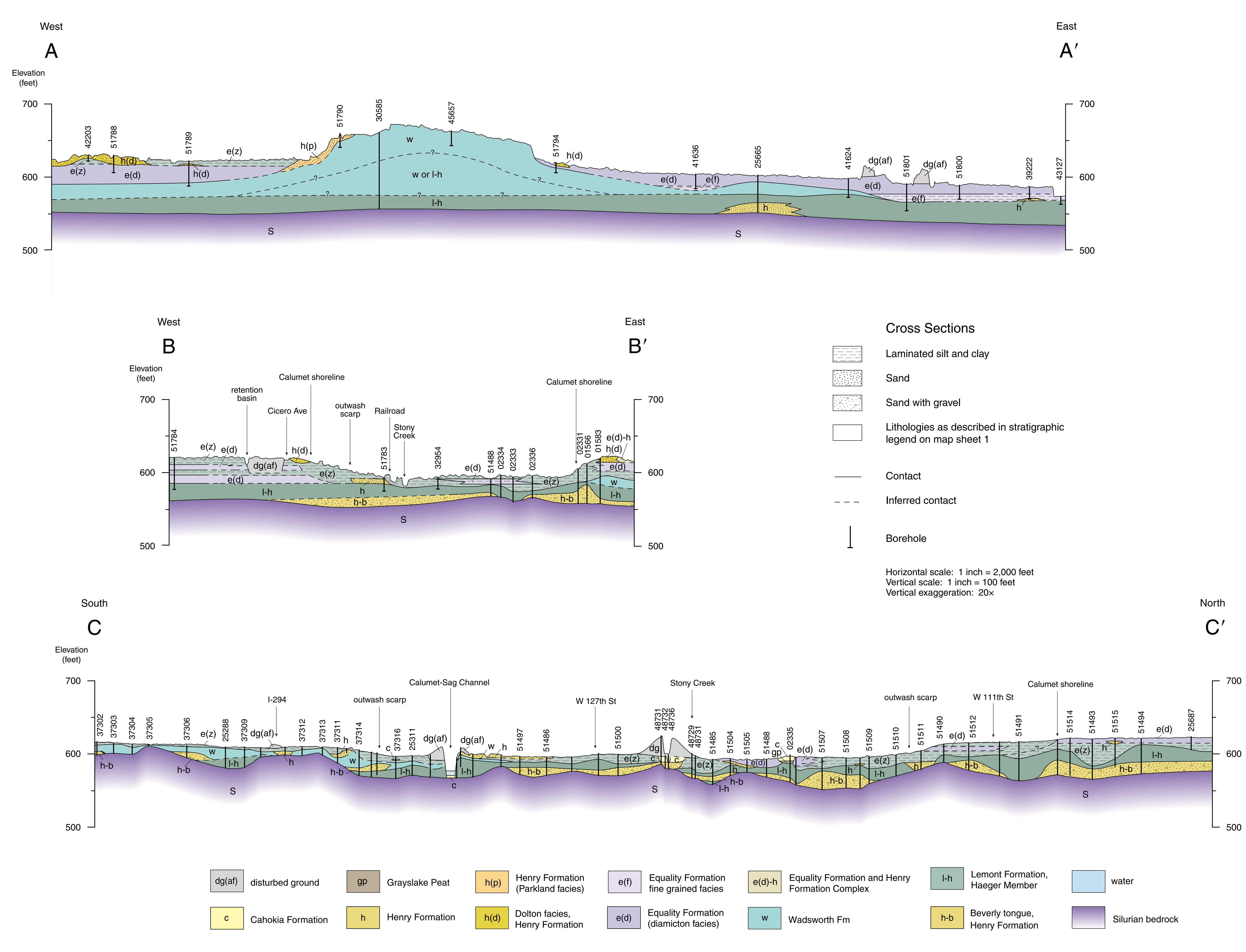
**Radiocarbon ages calibrated to calendar years before 1950 (Intcal20.14c; Reimer et al., 2020) using CALIB 8.2 (Stuiver and Reimer 2020)

***Ages determined at the Illinois State Geological Survey Optically Stimulated Luminescence Dating Laboratory

Table 3 Classification of geotechnical data from engineering borings[1]

Map Unit	n[2]	STP[3] (blows)	Qu[4] (t/ft²)	Qp[5] (t/ft²)	Moisture Content (%)
dg(af)	193	9 ± 7.1	2.92 ± 1.694	1.88 ± 1.118	18 ± 5.7
gp	1	5 ± 0			
c	7	6 ± 4			
h	31	37 ± 34.2	3.53 ± 0.252	3.40 ± 1.556	13 ± 4.7
h(b)	83	70 ± 31.3	5.04 ± 3.070	4.50 ± 0	11 ± 4.6
e	64	9 ± 5.5	2.75 ± 1.025	1.56 ± 1.39	38 ± 48.4
e(z)	120	18 ± 13.8	5.10 ± 3.358	2.09 ± 1.278	22 ± 24.4
w	74	33 ± 21.2	3.43 ± 1.882	3.26 ± 1.686	18 ± 4.3
w or l-h	3		4.94 ± 0.730		14 ± 6.4
h(b) or l-h	13	53 ± 11.3		4.50 ± 0	13 ± 3.7
l-h	151	59 ± 28.2	7.26 ± 2.567	7.69 ± 2.751	12 ± 3.2
S	4	78 ± 15.6			

[1]Total of 749 observations from 79 borings; [2]total classified observations; [3]Standard Penetration Test; [4]Undrained Shear Strength (lab test); [5]Pocket Penetrometer



References

Alden, W.C., 1902, Chicago folio, Riverside, Chicago, Desplaines, and Calumet quadrangles, Illinois-Indiana: Geologic atlas of the United States no. 81, The Survey, Washington, D.C. 1:62,500, report and 12 plates.

Bretz, J.H., 1939, Map 15 Surficial geology of the Blue Island Quadrangle: from Geology of the Chicago Region, Part II, the Pleistocene, 1:24,000.

Caron, O.J., and B.B. Curry, 2018, Surficial Geology of Tinley Park Quadrangle, Will and Cook Counties, Illinois. Illinois State Geological Survey, contract report. Two sheets. 1:24,000.

Caron, O.J, and A.C. Phillips, 2015, Surficial Geology of Frankfort Quadrangle, Will and Cook Counties, Illinois, Illinois State Geological Survey, contract report. Two sheets. 1:24,000.

Caron, O., and B.B. Curry, 2019, Surficial Geology of the Palos Park Quadrangle, Cook County, Illinois: Illinois State Geological Survey, USGS-STATEMAP contract report, 2 sheets, 1:24,000.

Curry, B.B., A.R. Bruegger, and J.L. Conroy, 2018, Highstands and overflow history of glacial Lake Chicago and downstream impacts on Gulf of Mexico δ18O values, Geology 46: 667-670, doi.org/10.1130/G40170.1

Cook County, Illinois, 2017, Digital Elevation Model (DEM) derived from LiDAR data: Illinois Height Modernization Program, Illinois State Geological Survey, US Geological Survey and Dewberry, 2002–2021 Illinois Height Modernization Program (ILHMP): LiDAR data: Illinois State Geological Survey, https://clearinghouse.isgs.illinois.edu/data/elevation/illinois-height-modernization-ilhmp (accessed November 19, 2021).

Hansel, A.K., and Mickelson, D.M., 1988, A reevaluation of the timing and causes of high lake phases in the Lake Michigan basin: Quaternary Research, v. 29, p. 113–128, https://doi.org/10.1016/0033-5894(88)90055-5.

McGuire, M.P., D.A. Grimley, A.C. Phillips, A.S. Stillwell, R. William, J. Shen, and M. Schneeman, 2021, Retrofitting urban land through integrative, subsoils-based planning of green stormwater infrastructure: a research framework: Environmental Research: Infrastructure and Sustainability 1, 035003 https://doi.org/10.1088/2634-4505/ac27bd

Reimer, P., W.E.N Austin, E. Bard, A. Bayliss, P.G. Blackwell, R.C. Bronk, C. Ramsey, M. Butzin H. Cheng, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, I. Hajdas, T.J. Heaton, A.G. Hogg, K.A. Hughen, B. Kromer, S.W. Manning, R. Muscheler, J.G. Palmer, C. Pearson, J. van der Plicht, R.W. Reimer, D.A. Richards, E.M. Scott, J.R. Southon, C.S.M. Turney, L. Wacker, F. Adolphi, U. Büntgen, M. Capano, S. Fahrni, A. Fogtmann-Schulz, R. Friedrich, P. Köhler, S. Kudsk, F. Miyake, J. Olsen, F. Reinig, M. Sakamoto, A. Sookdeo, and S. Talamo, 2020, The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP): Radiocarbon 62. doi:10.1017/RDC.2020.41.

Stuiver, M. and P.J. Reimer, 2020, CALIB Radiocarbon Calibration Program: v. 8.1.0, downloaded from http://calib.org/calib/download/ on 11/17/2020.

Soil Survey Staff, 2019, Soil Survey Geographic (SSURGO) database for Cook County, Illinois: U.S. Department of Agriculture, Natural Resources Conservation Service Fort Worth, Texas, Online resource: https://websoilsurvey.sc.egov.usda.gov/ accessed 1/21/2021.