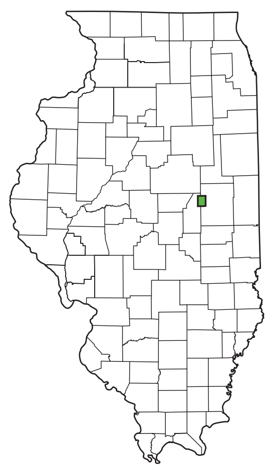
STATEMAP
Mahomet-SG

Surficial Geology of Mahomet Quadrangle

Champaign and Piatt Counties, Illinois

David A. Grimley, Jia J. Wang, and Rachel P. Oien

2016



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 61820-6918
(217) 244-2414
http://www.isgs.illinois.edu

Introduction

The Mahomet 7.5-minute quadrangle is located in the Upper Sangamon River Basin in western Champaign and eastern Piatt Counties, east-central Illinois (Figs. M1, M2 [map sheet 2]). Surficial geology maps provide an important framework for land and groundwater use, resource evaluation, engineering and environmental hazards assessment, and geological or archeological studies. This study is part of a broader geologic mapping and research program undertaken by the Illinois State Geological Survey (ISGS) in east-central Illinois (Stumpf and Dey, 2012; Stumpf, 2010, 2014). These prior mapping projects were mainly focused on the early and middle Quaternary deposits in the Mahomet Bedrock Valley for use in groundwater models. This mapping project was more focused on the near-surface geological sediments of the last glaciation (Wisconsin Episode), the penultimate glaciation (Illinois Episode), and post-glacial times.

The Mahomet Quadrangle is located within an area glaciated multiple times during the pre-Illinois, Illinois, and Wisconsin episodes (Fig. M1; Hansel and McKay 2010; Curry et al. 2011; Stumpf and Dey, 2012; Grimley et al., 2016). The mapped area is centered over the ~15-mi-wide (~25-km-wide) buried Mahomet Bedrock Valley (Fig. 1), a segment of the Teays-Mahomet Bedrock Valley System that stretches from West Virginia to central Illinois (Horberg 1950; Kempton et al. 1991). The bedrock valley is preglacial, likely forming during the Pliocene and Early Pleistocene (Horberg 1950; Willman and Frye 1970; Kempton et al. 1991). During pre-Illinois Episode glaciations, ice likely advanced from the Lake Michigan basin and eastern Great Lakes region (Willman and Frye 1970; Johnson, 1986; Hansel and McKay, 2010), with glacial and glaciofluvial deposition partially filling the broad valley system. After the Yarmouth interglacial episode, glacial ice once again advanced across the region during the Illinois Episode, originating from the Lake Michigan basin and reaching as far south as Carbondale, Illinois and as far southwest as St. Louis, Missouri (Hansel and McKay 2010). During multiple glacial advances or ice margin fluctuations of the Illinois Episode, the Mahomet Valley became completed infilled with mainly till and outwash. The last glaciation, during the Wisconsin Episode, is responsible for most of the constructional landforms the are visible today, including the Cerro Gordo and Champaign Moraines (Fig. M2). During various deglacial times of the Illinois and Wisconsin Episodes, valley incision followed by glacial meltwater events resulted in outwash sedimentation in the Sangamon Valley and its tributaries, including a possible proto-Sangamon Valley (Illinois Episode). Outwash is today found in terraces, lowlands, and fans of the present-day landscape and is extensively mined in some areas. Loess deposits (windblown silt) drape uplands throughout the quadrangle and contain the modern soil profile (Mount, 1982; Martin, 1991). The Sangamon River valley served as a last glacial meltwater valley conduit, but for a relatively short time frame from ~23,000 to 22,000 years B.P. (Grimley et al., 2016); thus, it did not serve as a major Wisconsin Episode loess source. Postglacial (including postsettlement) alluvial sedimentation has occurred in the Sangamon River and Madden Creek valleys and their tributaries.

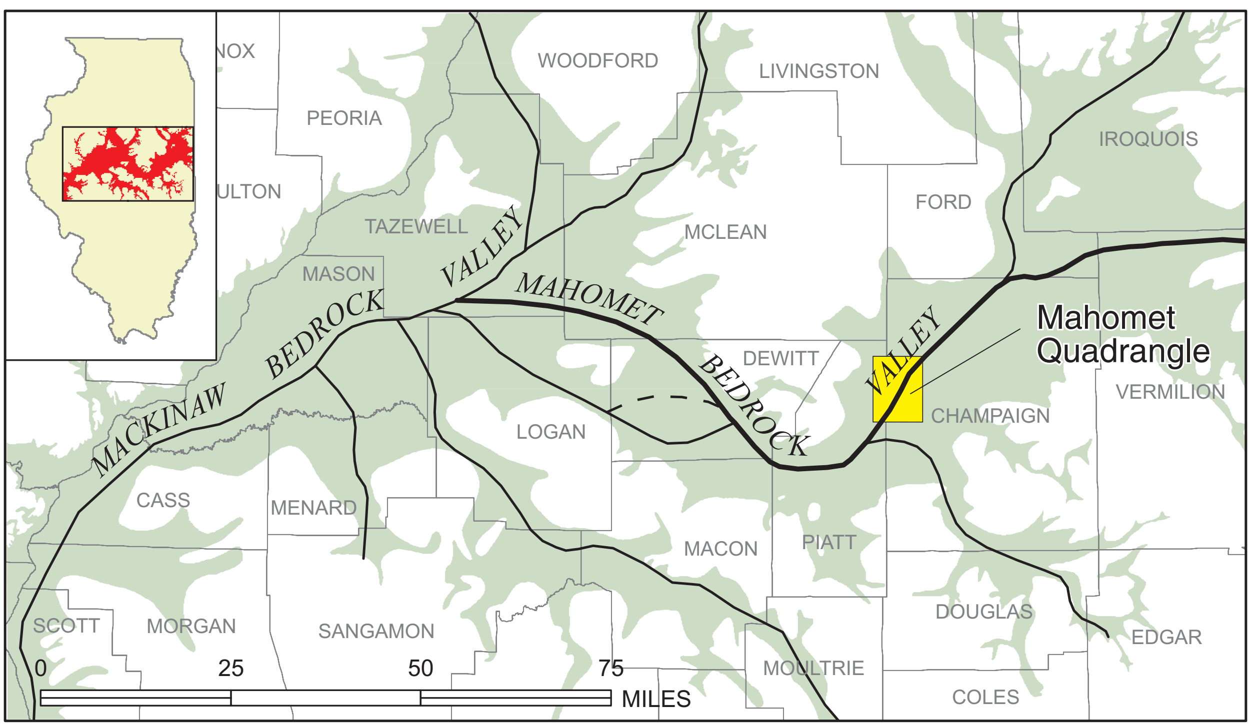


Figure 1 The Mahomet Quadrangle (in yellow) is shown in relation to the Mahomet Bedrock Valley (low ares on the bedrock surface are highlighted in green). The axis of the Mahomet Bedrock Valley extends through the quadrangle.

Methods

Surficial Map

This surficial geology map is based in part on soil parent material data (Mount, 1982; Martin, 1991), supplemented by data from outcrop studies and stratigraphic test holes obtained for this STATEMAP project, engineering borings (Illinois Department of Transportation, Champaign and Piatt County highway departments), water-well records, and oil and gas-type borings. Electrical resistivity transects were also utilized to help with mapping of surficial sandy deposits, both from prior ISGS studies and new transects obtained for this mapping project. Map contacts were also adjusted according to the surface topography, geomorphology, and observed landform–sediment associations. Analytical data (grain size, engineering properties, mineralogy, geochemistry, geochronology) was useful for distinguishing units in the subsurface, for characterizing units, and for regional correlations.

Localities of important data used for the surficial geology map, cross sections, or landform–sediment associations are shown on the map. All outcrops and stratigraphic test holes are shown on the surficial map, as are key engineering, petroleum type and water-well borings that were utilized for mapping or for developing the geologic framework. Many water-well borings had sample sets, many of which were examined and described as part of this project. Some of the stratigraphic, water well, and gas storage borings had geophysical logs that were useful in confirming the unit contacts or bedrock surface elevation where geologic samples were lacking. The locations of many water well borings were verified by tax parcel locations, plat books, permit maps, field confirmations (for water wells only), or a combination of methods. Many data in this quadrangle, particularly oil-and-gas-type borings and water wells, are not shown because of poor descriptions of surficial materials or unconfirmed locations. Further information on all data shown, as well as other data, is available from the ISGS Geological Records Unit or from the ILWATER Internet map service (http://www.isgs.illinois.edu/ilwater). Data can be identified based on their location and the labeled county number (5-digit portion of the 12-digit API number).

Cross Sections

The cross sections portray unconsolidated deposits as would be seen in a vertical slice through the earth down to bedrock, and are vertically exaggerated 20 times. The lines of cross section are indicated on the surficial map and inset figures (Fig. 2). Data used for subsurface unit contacts (in approximate order of quality for the purpose of this map) are from studied outcrops, stratigraphic test holes, engineering boring records, water-well records, and oil/gas-well records. Units less than 5 feet in maximum thickness are not shown on the cross sections. Dashed contacts are used to indicate where data are less reliable or are not present. The full extent of wells that penetrate into bedrock is not shown.

Bedrock Topography Map

The bedrock topography map (Fig. 2; from Stumpf, in prep.) is based on data from which a reliable bedrock elevation could be determined. Data within about a mile of the map were also utilized (not shown). A total of ~ 25 data locations were used in the map area, including, 3 stratigraphic tests, 6 water-well borings, 1 monitoring well, 8 oil- and gas-type borings (some with geophysical logs), and several seismic profile estimations. The bedrock surface was hand-contoured from data points; the contoured map was later converted to a digital grid. The bedrock surface elevation in the Mahomet Quadrangle ranges from about 360 to 520 feet above sea level (160-foot relief). The drift thickness (unconsolidated Quaternary sediments overlying Paleozoic bedrock) ranges from about 200 to 440 feet thick.

Quaternary Deposits

Near-surface deposits are divided into three landform–sediment associations: (1) glacial (Wisconsin Episode) successions in upland till plains and moraines, (2) proglacial (Wisconsin Episode) sediments in terraces, fans and lowlands, and (3) postglacial alluvial sediments in modern floodplains. With the exception of the postglacial Holocene floodplains, all areas are draped by ~ 3 to 6 feet of loess deposits (windblown silt) that contain modern soil profiles (Mollisols and Alfisols), extensively utilized for agriculture purposes. Older concealed Quaternary sediments include (4) Illinois Episode glacial sequences and older (5) Illinois and pre-Illinois Episode glaciofluvial and alluvial sediments that infill buried Mahomet Bedrock Valley. Areas of anthropogenically disturbed ground (~ 2 % of map area) consist mainly of spoil pile s at sand and gravel pits and areas of fill below roadways and interstate interchange cloverleaves. Mining for sand and gravel has been ongoing in the Mahomet area since the early 20th century (Krumbein, 1930; Eckblaw, 1945; Anderson, 1960).

(1) Upland Till Plains and Moraines (last glacial sequence)

The upland landscape of the present-day Mahomet Quadrangle is mainly a reflection of last glacial (Wisconsin Episode) processes and sedimentation. Upland areas (~ 70 % of map area) are underlain by loess covered till units, either the Batestown Member or Tiskilwa Formation, both direct deposits from glaciers during the last glaciation. Below the Tiskilwa Formation, silty loessal sediment and interstadial peat are sometimes found, which essentially mark the base of the last glacial sequence, at ~ 20 to 110 feet depth, above older Pleistocene sediments. Surficially, the uplands are covered by 3 to 5 feet of loess (windblown silt) that was deposited during late glacial times, probably ~ 22 to 16 ka (Nash, 2016). The loess deposits, stratigraphically classified as the Peoria Silt (Hansel and Johnson, 1996), are relatively thin, in comparison to the till deposits, and thus are not shown as

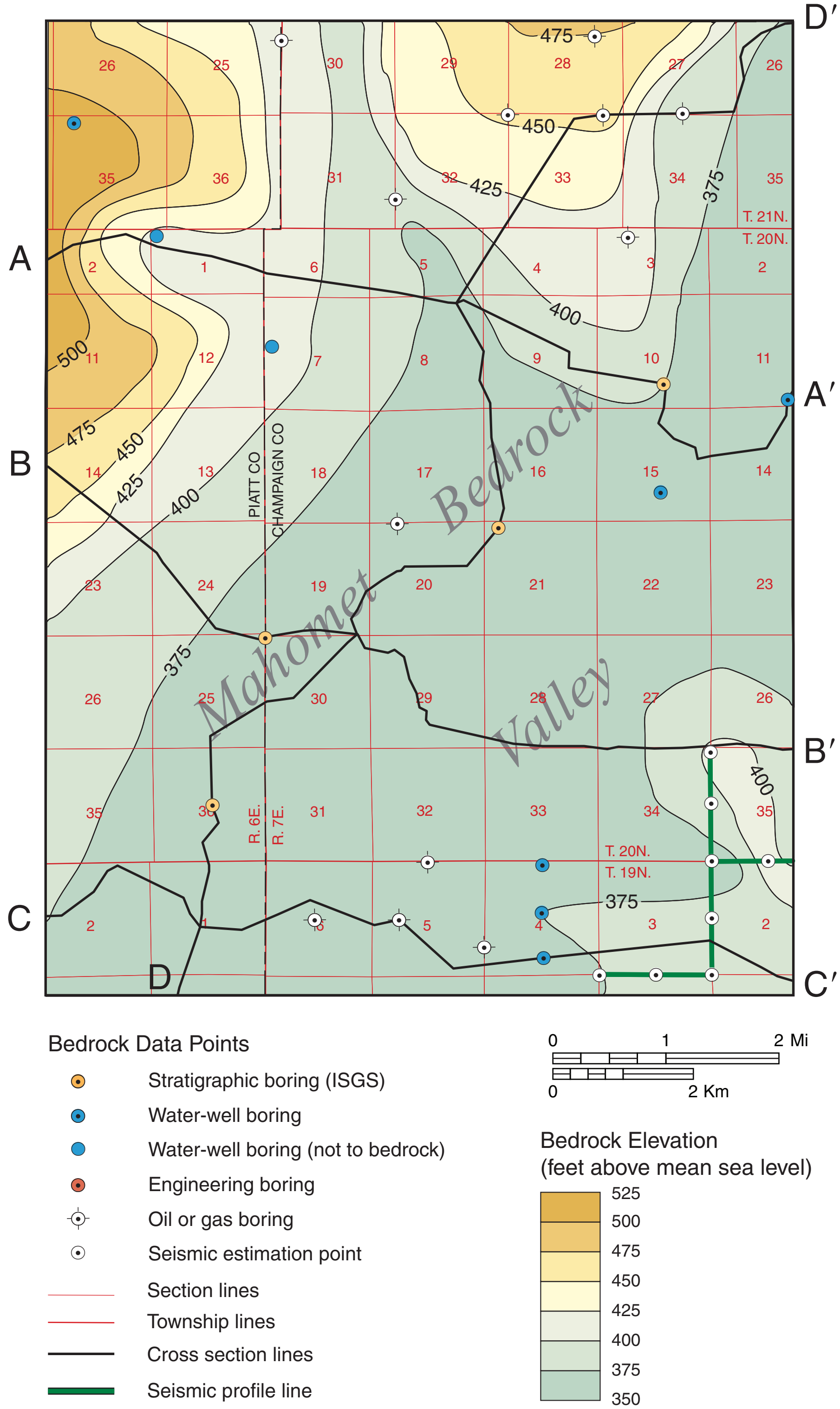


Figure 2 Bedrock topography of the Mahomet Quadrangle. Localities of all data that reliably indicate the bedrock surface are shown (some data not shown on the surficial map). Map scale is 1:100,000.

a thin uppermost draping in the cross sections (map sheet 2). Loess deposits also serve as the parent material for modern soil profiles on uplands, which range from Mollisols to Alfisols (Mount, 1982; Martin, 1991) across areas that were prairies or woodlands during pre-settlement times.

Direct glacial deposits, of the last glaciation, are here divided into the Batestown Member, Lemont Formation and the slightly older Tiskilwa Formation (Hansel and Johnson, 1996). In the Mahomet Quadrangle, the Batestown Member occurs in the Champaign Moraine (Fig. M2) and northwards. The Batestown till is finer-grained and also significantly softer than the Tiskilwa Formation (Table 1). The Batestown till typically has ~ 45 to 60 % silt (2 to 63 um), compared with 30 to 40 % silt for the Tiskilwa till (Table 1). The Batestown till is mainly gray to grayish brown and calcareous, but oxidizes to a light olive brown (2.5Y 5/4) above the water table, generally the upper 3 to 15 feet. In outcrop, the Batestown till contains various sedimentary rock fragments (dolostone, shale, sandstone, chert, etc.) with some igneous rocks, such as granite cobbles. Pebbles are typically < 9 inches in maximum length, vary mainly from subangular to subrounded, and many are faceted. The till is typically fractured in upper portions but less so with depth, below the permanent water table. Basal portions of the Batestown till may be slightly denser and sandier, based on a deep stratagraphic testhole into the crest of the Champaign Moraine (API: 27717). In its area of occurrence, the Batestown till generally directly overlies the Tiskilwa Formation, but in places a gravelly sand unit (h-u; unnamed tongue of the Henry Formation) is found between the two units and is as much as 20 feet thick (cross section A-A'). This sand and gravel unit was observed in outcrop along banks of the Sangamon River near Mahomet at sections MHT-11f and MHT-12f (Secs. 10 and 15, T20N, R7E). The sand here has significant accumulations of manganese oxides and secondary carbonate cement.

The Tiskilwa Formation is found surficially on uplands in the southern half of the quadrangle, separated by areas of the Sangamon River valley and other lowlands areas. The Tiskilwa Formation has some complexities within its depositional sequence, but is overall more sandy and dense (Table 1) than the Batestown till unit. It is nearly entirely calcareous and is mostly pebbly loam diamicton with 3 to 7 % pebbles. The uppermost zone of the Tiskilwa Formation, up to 10 feet thick, is typically light olive brown and may contain sandy lenses and thin debris flows that may be related to supraglacial or periglacial-cryogenic processes (French and Shur, 2010). Periglacial processes and patterned ground is well documented in this part of central Illinois and is clearly visible on some aerial photographs (Johnson, 1990). Below the supraglacial-cryogenic zone is typically a grey, sandy facies that was formerly delineated as the Piatt Till Member (Wickham, 1979) or Piatt Member of the Tiskilwa Formation (Hansel and Johnson, 1996). The thickness of this grey facies was not found to exceed about 10 feet in stratigraphic test hole and its textural, geochemical and mineralogical composition was not found to differ significantly from the main body of the Tiskilwa below (which has a slight pinkish hue). The change in color, probably representing some change in the source material from up-glacier (Hansel and Johnson, 1996), is sometimes gradational and a contact can be difficult to delineate. Thus, on this map it was decided to not differentiate the Piatt Member and to map only the undifferentiated Tiskilwa Formation. The Tiskilwa till below the gray facies, is slightly pinkish brown to grayish brown (generally 7.5 YR 4/2 to 10YR 4/2), with pinkish hues becoming more noticeable in outcrops that have more oxidized sediment. This middle-lower or main portion of the Tiskilwa is quite dense and very stiff. The lowest portion of the Tiskilwa Formation, but not always present, is the informally classified Oakland facies (Hansel and Johnson, 1996). This facies is essentially a basal facies that consists of incorporated fine-grained substrates (loess, lacustrine, peat and interglacial paleosol material) into the base of the glacier, perhaps a deforming bed (Johnson and Hansel, 1999). The texture of the Oakland facies becomes progressively siltier and softer with depth, in comparison to the main Tiskilwa above and its geochemical and mineralogical properties begin to resemble a mixture of the underlying material and till above. Organic wisps (from the Robein Member below) and inclusions are sometimes found.

Below the Tiskilwa Formationare thin loessal deposits in the Morton Tongue and peaty deposits in the Robein Member, Roxana Silt. These units are differentiable in core and outcrop; however, they are combined for the purposes of the cross sections because their combined thickness is typically < 10 feet, making their separation cartographically difficult. The Morton Tongue is a gray to grayish brown silt that is mainly moderately to weakly calcareous. It may consist of loess or, more typically in this area, resedimented loess in lowlands. At some exposures, thin fine to medium sand beds are found within the unit. Sand channels, a few feet wide and one-foot-thick at the top of the Morton Tongue and below the Tiskilwa Fm., were observed at outcrop MHT-6f (API # 1201927616 in Sec. 15, T20N, R7E) on a south bank of the Sangamon River. Multiple fossil conifer logs were found in the sand channel (Fig. 3). A conventional radiocarbon age of 20,220 +/- 140 ^{14}C years (ISGS-7106) was determined on *Picea* wood from this stratigraphic position at the site from sampling in 2015. A similar age of 20,180 ^{14}C years (ISGS-7071) was determined on wood sampled from the same river bank and at the same stratigraphic position in 2014, laterally approximately within 100m of the first age. Three other ages on the Morton Silt from core MHT-5 of this mapping project ranged between 22.2 ^{14}C ka, on wood fragments near the base of the unit above the Robein, and 20.6 ^{14}C ka from fragments in the silt immediately below the Tiskilwa till [#22716, Sec. 17-T20N-R7E] and MHT-6 [#21690, Sec. 24-T20N-R6E]. Lastly, a radiocarbon age from outcrop # 27614 [west bank of Sangamon R., Sec. 20, T20N, R7E] was previously found to be 21.7 ^{14}C ka, in what may have been organic-rich Morton Tongue (Hansel and Johnson, 1996, p.81). Based on the 20.6 ^{14}C ka age and the 20.2 ^{14}C ka ages, all from conifer wood immediately below the Tiskilwa Fm., it is inferred that this was time that Wisconsin Episode glacial ice first crossed the Mahomet area. Radiocarbon ages below glacial till near the last glacial margin are ~ 20.0 ^{14}C ka at Charleston, Illinois (Hansel et al., 1999) and Shelbyville, Illinois (Johnson, 1971). This implies that ice advanced rather rapidly from the Mahomet area to the last glacial maximum margin, advancing ~ 70 km over perhaps ~ 500 years; average rates of ~140 m/year). A likely explanation for the fast rates is that glaciers surged over soft,

Table 1 Values shown in table indicate typical ranges of the various physical and chemical properties within typical materials for each geological unit in the Mahomet Quadrangle, Illinois.

Unit	Geotechnical properties[1]			Particle size and compositional data[2]					
	w (%)	Q_u (tons/ft²)	N	Sand (%)	Silt (%)	Clay (%)	MgO mass % (< 250 um fraction)	Carbonate content (< 74 um fraction)	MS
Cahokia Formation (alluvium)	ND3	ND	ND	14-28	43-55	27-32	ND	mainly noncalcareous	15-35
Equality-Henry Fm. (lacustrine-outwash)	ND	ND	ND	silty clay loam to sandy loam to gravelly sand			ND	leached to calcareous	ND
Peoria Silt (loess)	20-35	1.0-2.5	ND	3-9	60-75	22-36	ND	noncalcareous	10-45
Henry Formation (mostly outwash)	ND	<0.5	ND	loamy sand to gravelly sand			ND	leached to calcareous	11-50
Batestown Member, Lemont Fm. (till)	11-14	1.5 – 4.0	10-22	23-40	44-59	16-29	3.6 – 4.0	24 – 32 %	21-29
Tiskilwa Fm. (till)	9-13	2.0 – 7.0	20-50	31-58	28-49	11-29	3.3 – 3.9	25 – 33 %	10-35
Morton silt tongue (loess-lacustrine)	~19	1.5-4.0	ND	2-4	85-88	10-11	~ 1.0	weakly calcareous (< 10 %)	18-70
Robein Member (wetland)	18 - 100	0.5-3.0	ND	18	75	8	~ 0.8	mainly noncalcareous	5-8
Berry Clay Member, Glasford Fm. (depressional)	11-20	1.0 – 4.5	5-20	24-45	26-40	22-36	0.9 – 1.3	noncalcareous	5-17
Pearl Fm (outwash)	ND	<0.5	ND	loamy sand to gravelly sand			ND	leached to calcareous	20-55
tongue of Pearl Fm. (outwash)	ND	ND	30-40	52-97	3-40	0-9	ND	calcareous	ND
upper Glasford Formation (till)	7-12	4.0 to 12.0	30-100	23-59	23-52	13-24	3.2 – 3.5 (Radnor) 3.8 - 4.2 (upper Vand.)	24- 30 % (Radnor) 35–40 % (upper Vandalia)	8-33
lower Vandalia Member (till)	8-11	3.0->4.5	ND	36-43	39-41	17-24	3.9 – 4.2	33 – 39 %	17-40
Grigg tongue, Pearl Fm. (outwash)	20-25	0.25-1.25	ND	80-82	13-14	4-7	~ 1.5 – 2.0	~ 40 %	25-75
Mahomet Sand M., Banner Formation (outwash)	ND	ND	ND	sand to gravelly sand			ND	calcareous	20-55

[1]Geotechnical properties are based on tens of measurements (total for all units) from ~30 engineering (bridge) borings and 7 stratigraphic test borings in the quadrangle. w, moisture content = mass of water/mass of solids (dry); Qu, unconfined compressive strength; N, blows per foot (standard penetration test). Number in parentheses after geotechnical properties indicates number of cores/borings used for data; each core may have one or more depths with data.

[2]Particle size and geochemical data are based on a tens of samples from 5 stratigraphic borings. Sand = % >63 µm; silt = % 2–63 µm; clay = % < 2 µm (proportions in the <2–mm fraction from hydrometer analyses). Mg0 mass% based on x-ray fluorescence. Carbonate content based on dissolution and capture of CO_2 gas. MS, magnetic susceptibility (x10–8 m³/kg) of < 2 mm fraction from 5 stratigraphic borings, 5 engineering borings and 2 water well sample sets using a Bartington MS2 meter and MS2B attachment (boring # 120192771700 had downhole MS logging).

[3]ND = no data available.

Figure 3 Fossil *Picea* wood found in a sand channel below the Tiskilwa Formation and above the Morton Tongue at site #27620 (Sec. 15-T20N-R7E) on a south bank of the Sangamon River.

saturated, and fine-grained unconsolidated substrates such as loess (Morton Tongue), lake deposits, interstadial and interglacial paleosols. A fast rate of advance is also consistent with a recent time-distance diagram of Caron and Curry (2016).

The Robein Member is a peaty or peaty silt, typically black to dark brown, that was deposited in wetlands or depressions, prior to being overridden (and preserved) by glaciers that deposited the Tiskilwa Formation in this area. It is generally noncalcareous, organic rich and has many fragments of conifer wood. Thus, the Robein can have a very high water content, (Table 1). In the late 19th century, Leverett (1899) described a peat below till exposed along the Sangamon River (SW, Sec. 16-T20N-R7E) that he classified as Sangamon (interglacial) peat. This site has been noted since by several others, such as Savage (1931); fossil beetles within the peat were described by Wickham (1917). The peat was assumed to have been interglacial because of its stratigraphic position between Wisconsin and Illinois Episode glacial sediments. However, AMS radiocarbon dating of the Robein peat in many locations in central and northern Illinois since the mid-20th century have demonstrated its age to range between ~ 40 and 20 ^{14}C ka or ~ 45 to 24 cal ka (Willman and Frye, 1970; Hansel and Johnson, 1996; Curry et al., 2011). Thus, it is now considered an interstadial wetland deposit, in places having characteristics of an organic-wetland type paleosol. Several radiocarbon ages on the Robein Member from this mapping project were determined from cores MHT-5 [#22716, Sec. 17-T20N-R7E] and MHT-6 [#21690, Sec. 24-T20N-R6E]. Radiocarbon ages typically ranged between 26.0 and 24.7 ^{14}C ka (ISGS#s A3829-A3831, A3833-A3835). Although the Morton Tongue and Robein Member are exposed at several locations along the Sangamon River, their areal exposure is not great enough to accurately show as a polygon on the surficial map.

The base of the Wisconsin Episode sequence is by definition denoted by the Sangamon Geosol (Willman and Frye, 1970; Hansel and McKay, 2010), which is formed in Illinois Episode deposits. However, since the paleosol is in some places eroded, the Robein peat, immediately above, is sometimes used to approximate the contact between deposits of the last two glaciations, within a few feet, from water-wells logs and other boring records that were not described by geologists.

(2) Lowlands, Terraces, and Alluvial Fans (late glacial sediments)

Last glacial (Wisconsin Episode) waterlain sediments occur surficially in terraces, ice-proximal alluvial fans, and lowlands, comprising about 20 % of the mapped area of the Mahomet Quadrangle. The glaciofluvial and lacustrine sediments in these landforms are mantled by about 3 to 6 feet of loess deposits (Peoria Silt). A similar thickness of loess on these surfaces, in comparison with upland till units (Batestown and Tiskilwa units) suggests that the proglacial waterlain sediment packages were laid down fairly quickly as the last glacial ice margin receded northeastward from central Illinois. Stratigraphic units that were deposited in proglacial or ice-contact environments include three facies of the Henry Formation (Mackinaw, Batavia, and Wasco facies) and an undifferentiated Equality-Henry Formation complex. The Henry Formation facies were originally defined as members (Willman and Frye, 1970) and later modified to informal sedimentary facies (Hansel and Johnson, 1996).

Sand and gravel outwash in last glacial terraces along the Sangamon River valley, and small areas on its tributaries and Madden Creek valley, are mapped as the Mackinaw facies, Henry Formation. This unit typically represents valley-train deposition in braided glacial meltwater streams (Willman and Frye, 1970) and its mapped distribution in the Mahomet Quadrangle suggests some relation to both the Cerro Gordo and the Champaign Moraines. The outwash ranges from stratified fine-medium sand to gravelly coarse sand. The deposit is calcareous and yellowish brown to light yellowish brown, where oxidized. In exposure at the gravel pits (NW, Sec. 29, T20N, R7E), cross bedding is evident and alternating 2 to 3 foot thick sedimentary packages of the finer sand and gravelly sand are found; likely representing shifting braided stream systems. Bedding tends to dip towards the WSW or SW, approximately parallel to the down-valley direction of the Sangamon Valley. The Mackinaw facies is 10 to 30 feet thick in many areas, but can be up to 60 feet thick in isolated areas, where it is actively being mined or has already mined away. In some boring descriptions and notes, the total thickness of sand and gravel in the area of mining is reported to be up to 90 or 100 feet thick. However, from examinations of samples provided by MidAmerica Sand and Gravel company and from correlations, we suspect that the basal portion of the sand and gravel is the Illinois Episode Pearl Formation. Yet without an intervening paleosol, a deep channel (tunnel channel ?) that was infilled with last glacial Henry outwash cannot be ruled out. Early reports on the sand and gravel resources were provided by Anderson (1960) and Krumbein (1930). Today, exposures of the Mackinaw facies can be found at several locations along the banks of the Sangamon River south of the Champaign Moraine crest (south of Interstate-74 crossing), such as at outcrop 27615 (Sec.22-T20N-R7E) and in active and inactive sand and gravel pits. Optically stimulated dating of the Mackinaw facies at fresh exposures in an active pit (#27618) provide age estimates of ~ 22 to 23 ka (using a minimal age model with quartz grains) from fine sand units 13 to 20 feet below original ground surface (Grimley et al., 2016). This age likely represents the age for deposition of the Batestown Member in the Champaign Moraine during the Putnam Phase, consistent with recent last glacial chronology for the Lake Michigan Lobe (Caron and Curry, 2016).

Sandy and gravelly deposits, interpreted to have been deposited in proglacial fans, were mapped as the Batavia facies of the Henry Formation (Willman and Frye, 1970). The Batavia facies here is a loamy sand to gravelly sand and its distribution is limited to frontal areas of the Cerro Gordo Moraine and Champaign Moraine, where fans once formed from small, temporary meltwater streams at the ice front. The boundary of the fan deposits was difficult to trace based on soil parent material maps (Mount, 1982; Martin, 1991) and so a few hand augers and high resolution elevation data (from LiDAR) were used to help guide the mapped boundaries. The boundaries of the Batavia facies unit are generally dashed because of lower confidence in their distribution.

Loamy sand to gravelly sand is also found in ice-contact hills in a few areas of the Cerro Gordo Moraine. These ice contact deposits are mapped as the Wasco facies, Henry Formation (Willman and Frye, 1970). These deposits are only noted in a water well boring and in descriptions of a road cut into a small kame from Anderson (1960) and a borehole of Wickham (1979). Other small areas of the Wasco facies may occur in isolated hills amongst the Cerro Gordo Moraine. This unit is leached to calcareous.

In lowlands and small basins, interbedded or spatially variable deposits of silty clay loam, loam, loamy sand, and gravelly sand are found; they are here mapped as an Equality-Henry Formation complex ("eh" symbol). This unit is mapped based on hand augers and shallow test borings, including a one or two boring logs reported by Wickham (1979). The waterlain unit, consisting of outwash and lacustrine sediment, is 5 to 10 feet thick; a cover of 4 to 6 feet of loess and resedimented loess makes this unit difficult to map reliably based on the soil parent material maps. County soil maps (Mount, 1982; Martin, 1991) indicate many areas of Drummer silty clay loam, along with others with fine sandy parent material, in areas mapped the Equality-Henry Formation complex.

(3) Postglacial sediments in floodplains

Postglacial (Holocene or Hudson Episode) stream deposits are found in the Sangamon River valley and its tributaries as well as in Madden Creek. These areas constitute ~ 8% of the mapped area in the Mahomet Quadrangle. These stream deposits, mapped as Cahokia Formation, consist mainly of fine-grained (silt loam to silty clay loam) material that is weakly stratified. Loamy zones or beds of fine sand may be found in point bar channel deposits and in basal portions of the unit. The Cahokia Formation is typically up to 15 feet thick in the alluvium of the main Sangamon and is generally < 10 feet thick in the smaller tributary valleys. The Cahokia alluvium mainly consists of reworked loess, till, and outwash that was eroded along ravines, slopes, and river banks and redeposited. Because of periodic flooding during postglacial times, areas mapped as the Cahokia Formation (undivided) have relatively youthful, modern soil profiles that generally lack B horizons compared with profiles for upland soil (Mount, 1982). Based on recent studies using the first occurrence of magnetic fly ash (from coal combustion), the thickness of post-settlement alluvium (post-~1850) in the mapped area is typically ~ 2-feet-thick in the main Sangamon Valley and ~ 1-foot-thick in its tributary valleys (Grimley et al., 2016; Grimley et al., in review). Because of enhanced topsoil erosion and proportionally less bank erosion, post-settlement alluvium is typically slightly darker and siltier than the pre-settlement alluvium, which can be slightly sandier. Overall, sedimentation rates are estimated to have been about an order of magnitude higher during the post-settlement period in comparison to pre-settlement rates.

Radiocarbon ages from aquatic gastropods (*Pleurocera acuta*) in the basal 2 feet of the Cahokia Formation from borings 27572, 27573 and 26354 in the modern Sangamon Valley at River Bend County Forest Preserve (Sec. 16-T20N-R7E) range between ~4500 and 6000 ^{14}C years before present (Grimley et al., 2016). The ages constrain the base of the Cahokia Formation at this particular location, possibly representing when a pre-existing channel widened or else when an incisional event occurred in the Upper Sangamon River Basin. Prior radiocarbon ages for Cahokia alluvium in the Mahomet Quadrangle (H. Johnson, Sangamon Sewer Site; 40° 12' 58" N, 88°22' 42" W) include an age of 11,550 +/- 130 (ISGS-1074) on wood from a sandy silt alluvium ~ 3.6 m below ground surface and 0.5 m above a basal erosion surface cut into Henry Formation outwash (Liy et al., 1986). Also at this same general location, also in the Sangamon Valley, a radiocarbon age of 5080 +/- 70 (ISGS-1077) was determined on wood at the base of an overbank sequence that marks the beginning of overbank sedimentation in an abandoned channel cut into older alluvium. This 5 ka age is similar to those dated at the River Bend Park, ~ 3 miles down valley, and so this period may represent a time of renewed alluviation following an incisional period sometime during the early Holocene (~ 11,000 to 6,000 ^{14}C yrs B.P.)

(4) Concealed sediments (Illinois Episode)

Concealed sediments on this map can be divided into the Illinois Episode glacial sequences (mainly till and outwash), described in this section, and older glaciofluvial and alluvial sand and gravel likely deposited during both the Illinois and pre-Illinois episodes (next section). The Illinois Episode glacial sequence consists of up to possibly three glacial advance sequences, but which have here been divided into only two mappable units: the lower Vandalia Member of the Glasford Formation (g-v1) and the upper Glasford Formation (locally divisible into the upper Vandalia till and the Radnor Member till). Glaciofluvial deposits of the Pearl Formation (sand and gravel outwash) may occur above the Glasford Formation, intercalated with the Glasford till units as tongues or lenses, or below the entire sequence of Glasford till (see Grigg tongue discussion in section 5). The Glasford and Pearl Formations are bounded at the top by the Berry Clay Member of the Glasford Formation in some areas. Sangamon Geosol (interglacial) soil development within the Berry Clay Member, or formed directly into uppermost till of the Glasford Formation, serves to separate the entire Illinois Episode sediment package from that of the last glaciation (Wisconsin Episode). However, the Sangamon paleosol may be eroded or considerably truncated in many areas and is not reliably recorded in water well records; thus the peaty Robein Member is typically used to delineate the last two glaciations. There are descriptions of greenish clay in some water wells and engineering borings, sometimes below the peat (Robein), and such greenish layers are interpreted as the Berry Clay Member with a poorly drained Sangamon paleosol if the elevations reasonably fit with other data.

The Berry Clay Member is an upper member of the Glasford Formation, overlying till deposits generally, but also is locally a member of the Pearl Formation. The Berry Clay Member, typically a noncalcareous, dark greenish gray to very dark gray silty clay loam to clay loam, contains interglacial soil alteration features (Sangamon Geosol) and is overlain by the organic-rich Robein Member, Roxana Silt. Although originally classified as an upper member of the Glasford Formation (Willman and Frye, 1970), the Berry Clay has more recently been also classified as a member of the Pearl Formation (Grimley, 2010; Grimley and Webb 2010) where it overlies this unit. Deposition and alteration of the Berry Clay likely occurred during the Sangamon Episode (interglacial) and accumulation continued into the early Wisconsin Episode until it was finally covered by the Robein Member, Roxana Silt. Deposits of loessal facies of the Roxana Silt were too thin in the Mahomet area (likely ~1-foot-thick), such that the loess was either incorporated into an upwardly growing cumulic profile of the Sangamon Geosol or else was resedimented into lowlands and depressions. The Berry Clay may be several feet thick; upper portions of the Berry Clay can be viewed at a few outcrops on the Sangamon River at low water levels (below the Robein). Otherwise, Illinois and pre-Illinois Episode deposits are not exposed in the quadrangle.

The Pearl Formation is a gravelly sand to fine sand glaciofluvial unit that occurs above Glasford Formation till units and also intertongues with them. The uppermost Pearl Formation outwash in the Mahomet Quadrangle was likely deposited in association with glacial meltwaters emanating from the ice margin, perhaps into a proto-Sangamon Valley, when it was receding northeastward towards Lake Michigan. Some of this outwash may be the basal portions of the sand and gravel that is being mined today in Sections 20 and 29, T20N, R7E (cross section D-D'). Deeper in the subsurface, tongues and lenses of the Pearl Formation are found in many areas. Some of these tongues are relatively thin, but can be traceable over a few miles (such as the one occurring between 610 and 630 feet asl in cross section B-B'). Other tongues are thicker, such as the one in northern part of cross section D-D' that is up to 60 feet thick. The three dimensional connectivity of the sand and gravel lenses and tongues is unclear without additional drilling, location verification (of some water wells), and geophysical studies. Some of these lenses and tongues served as household water supply for wells that encounter these units before reaching the deeper Mahomet aquifer. This upper aquifer has sometimes been termed the "Glasford aquifer", but the sand bodies could be stratigraphically assigned to either the Glasford or Pearl Formation. In this study, we choose to restrict sand and gravel bodies within the Glasford Formation to only those that are thin and interpreted as relatively discontinuous.

Till units that were deposited by glaciers during the Illinois Episode are classified as the Glasford Formation (Willman and Frye, 1970). In this study, up to 3 packages of Illinois Episode till were observed in deep stratigraphic test cores (e.g., 27717 [Sec 8-T20N-R7E], 21539 [Sec 36-T20N-R6E]). In water wells, a lower hardpan till ("clay"), dense till, or uniform till was commonly noted and the upper portion of the Glasford Formation was interstratified with sand lenses or sand tongues in many places. Divisions of till units within the upper Glasford were attempted but could not be objectively correlated with much degree of confidence. Therefore, from a mapping standpoint, until more analytical data can be acquired from more sites, it was decided to subdivide the Glasford Formation into a lower Vandalia Member till unit (g-vl, which corresponds with unit g-v1 of Stumpf and Dey, 2012; Stumpf and Atkinson, 2015) and into an undivided upper Glasford Formation unit. The lower Vandalia Member is conceptually a very stiff subglacial till unit with very few sand lenses and is fairly uniform in both texture and composition. The lower part of the lower Vandalia, above the Grigg tongue, is sometimes noted as slightly softer in a few water well logs. The upper Glasford Formation has portions which are siltier till and very hard sandy till, but overall has more inherent variability in its texture and has more interbeds and tongues of sand and gravel (Pearl Formation), as is evident on the cross sections (map sheet 2). Overall, the Illinois Episode Glasford tills are generally harder, somewhat sandier, and have higher carbonate content (esp. dolomite) and lower water content compared with Wisconsin Episode tills in the Mahomet Quadrangle (Table 1).

Boring 27717 (at intersection of cross sections A-A' and D-D') provides an example of the Glasford till unit sequences and changes in physical and chemical properties. In this boring, the lower Vandalia till is composed of 33 to 38 % carbonate (< 74 um fraction), has 39 to 41 % silt (< 2 mm fraction), and has ~ 8 to 11 % water content. The lower part of the upper Glasford, a pebbly and sandy version of the upper Vandalia has 35 to 39 % carbonate, 36 to 42 % silt, 7 to 10 % water content and has a few interbeds of sand. The upper Glasford contains and upper zone that is siltier (45 to 47 %), has lower carbonate (25 to 30 %), has 10 to 12 % water content and overlies an outwash tongue of the Pearl Formation that is several feet thick. Based on these data and the stratigraphic position, this upper Glasford till is possibly correlative with the Radnor till, a silty upper Glasford diamicton unit (Willman and Frye, 1970; Follmer et al., 1979). A siltier and lower carbonate till was also found in boring 21539 in cross section D-D' which could be the same Radnor unit. However, extrapolation of the Radnor till (if present) from these borings using mainly water well logs would be speculative. If the Radnor till does become tracable in the future, then some of the unnamed tongues of the Pearl Formation below this unit could be classified as the Toulon Member (Willman and Frye, 1970) or Toulon tongue of the Pearl Formation (to be consistent with Hansel and Johnson (1996) framework). The Vandalia till is mapped extensively in central and southern Illinois as the surficial till beyond the last glacial boundary (Follmer et al., 1979; Curry et al., 1994; Curry et al., 2011). Thus, it is reasonable to assume that the lower Vandalia till may represent the glacial advance to the southernmost margin south of Carbondale, Illinois and to St. Louis, Missouri. Till and ice marginal deposits of the upper Glasford Formation, as well as intercalated Pearl Formation outwash, likely record ice margin fluctuations during the waning phase of the Illinois Episode ice sheet as the margin receded northwards.

(5) Concealed sediments (pre-Illinois Episode) filling the Mahomet Bedrock Valley

An extensive buried bedrock valley, known as the Mahomet Bedrock Valley, underlies most of the Mahomet Quadrangle with exceptions being in minor areas in the northwestern part of the quadrangle (Fig. 1). In this northwest area, higher bedrock surface elevations occur (> 450 feet asl) and a bedrock tributary valley isfound; these areas still have sand and gravelly sand sediment above bedrock, and could be considered marginal areas of the valley with more variable thicknesses of glaciofluvial deposits and aquifer materials. The Mahomet Valley likely experienced multiple periods of glacial meltwater, alluvial, and direct glacial coverage during the Illinois and pre-Illinois episodes, and is an area of particularly thick glacial drift, generally ~ 300 to 440 feet thick in the main part of the buried valley. Mapped glaciofluvial and alluvial units that infilled the Mahomet Bedrock Valley include the Grigg tongue (conceptually Illinois Episode), the Mahomet Sand Member, Banner Formation (conceptually pre-Illinois Episode) and the Dewitt facies, Canteen Member, Banner Formation (conceptually preglacial, pre-Illinois Episode).

Very fine, fine and medium sand in the Grigg tongue of the Pearl Formation is found underneath the Glasford Formation in nearly the entire quadrangle (see cross section). This deposit is likely of glaciofluvial origin (outwash) from the first advance of the Illinois Episode ice front. The Grigg tongue is up to 40 feet thick and consists of relatively fine-grained sand that is calcareous, moderately dense, and can be weakly cemented in many areas, according to water well drilling logs and described samples. The considerable thickness of the Grigg tongue is likely a result of rivers systems in the Mahomet Valley draining away from the advancing ice sheet and thus capturing significant distal outwash over perhaps decades to centuries. Deposits mapped as the Grigg tongues are interpreted as Illinois Episode in age; however, there is little age control other than the fact that the unit is found conformably below what is correlated to the lower Vandalia till unit. The lack of oxidation, leaching or alteration at the upper contact of the Grigg tongue implies that there was little time for weathering before this unit was buried by the first glacial advance of the Illinois Episode.

The Yarmouth Geosol is the primary basis to distinguish Banner Formation sediments (till, outwash, etc.) from Illinois Episode deposits in the Pearl (Grigg tongue) or Glasford Formations (Willman and Frye, 1970). However, interglacial soil development (Yarmouth Geosol), was not noted in any core or sample set in this quadrangle. Here it is inferred to have existed (and then eroded) based on correlations to outside the Mahomet Quadrangle. The Mahomet Sand Member of the Banner Formation, up to 125 feet thick in the Mahomet Quadrangle (see cross sections), was originally named by Horberg (1953) for thick deposits of sand and gravel encountered in numerous public water-supply wells near the town of Mahomet. Thus, mapping of the Mahomet Sand Member is based on correlations to 3 water well sample sets that were noted by Horberg (1953) and Willman and Frye (1970) to be essentially the type samples. It is unfortunate that none of these 3 sample sets contain the Yarmouth Geosol or an overlying Banner Formation till unit that would stratigraphically constrain the Mahomet Sand Member, which is defined as underlying Banner till units. Sample sets and water well logs in the Mahomet Quadrangle indicate a coarser gravelly sand (Mahomet Sand Member) below the Grigg tongue, Pearl Formation that is texturally distinguishable from the finer-grained Illinois Episode deposits. The Mahomet Sand also sometimes contains very coarse sand grains of white chert or orange-colored mineral grains (perhaps stained quartz) in sample sets that are not visible in the finer Grigg tongue. The elevation of top of the Mahomet Sand M. (~ 470 to 490 feet asl) is consistent with that mapped by Stumpf and Atkinson (2015) and this mapping follows that model for consistency. The upper part of the Mahomet Sand, and any overlying Banner Formation till is interpreted to have been removed by stream incision and erosion during the Yarmouth Episode (interglacial) or by meltwater streams associated with the Illinois Episode glacial advance. The age of the Mahomet Sand is relatively unknown, but is likely between ~ 400 ka and 1000 ka (Hansel and McKay, 2010). Due to the absence of the Yarmouth Geosol between the Grigg tongue and the Mahomet Sand M., and the lack of reliable chronological means to date the sand, it is possible that some of the upper Mahomet Sand could be Illinois Episode in age.

Preglacial sand and gravel alluvium in basal areas of the Mahomet Valley, immediately above the bedrock unconformity, consists of weathered local Paleozoic bedrock. This gravelly sand unit, below the Mahomet Sand Member and up to 15 feet thick, is classified informally as the Dewitt facies of the Canteen member, Banner Formation (Stumpf and Dey, 2012; Stumpf and Atkinson 2015). The Canteen member is a fine-grained preglacial alluvium mapped in the subsurface in southwestern Illinois (Phillips 2004; Grimley and Phillips 2011) and the Dewitt facies is a coarse-grained facies that may be stratigraphically correlative. In places in east-central Illinois, the Dewitt facies is fossiliferous, with freshwater mussels and gastropods that today live in the Ohio River Basin and have measured amino acid ratios are consistent with an early Pleistocene age (Miller et al. 1992; Stumpf and Dey 2012).

Economic Resources

Sand and Gravel

Economically minable deposits in the quadrangle potentially include sand and gravelly sand in the Henry and Pearl Formations, particularly in the Mackinaw facies of the Henry Formation. The Mackinaw facies [h(m)] varies from fine sand to coarse and very coarse sand with 30% gravel. However, thick deposits (> 25 feet thick) with significant gravelly zones are spatially restricted. The Mackinaw facies has been mined extensively in several sand and gravel pit southwest of Mahomet in the past several decades. The Mackinaw facies may overlie deposits of the Pearl Formation in areas of the thickest sand and gravel (50 to 90 feet thick) in a NE-SW trending line of active and former sand and gravel operations. The confinement of glacial meltwater streams in subglacial or ice-walled glacial meltwater streams is possible; however, it is also possible that the glaciofluvial material is entirely outwash.

The Wasco facies of the Henry Formation is not a recommended source in this area for construction aggregate because of its variability, limited thickness, and lack of widespread coarse sand and gravel. Sand lenses and tongues in the upper Pearl Formation unit are generally too unpredictable, too deep or too limited in extent. The Grigg tongue of the Pearl Formation and the Mahomet Sand Member are buried much too deeply, > 200 feet below surface. Additional boreholes or geophysical tests would be necessary for site-specific projects to determine the economic viability of occurrences of the Mackinaw facies or upper Pearl Formation resources.

Groundwater

With the lack of significant surface water resources, groundwater is extensively used for household, public, and industrial water supplies in east-central Illinois. The groundwater used in the Mahomet Quadrangle for household, municipal, and irrigation use is obtained solely from aquifers within the glacial sediment; primarily the Mahomet Aquifer, a vital regional glacial aquifer (Kempton and Visocky 1992; Herzog et al. 1995; Kempton and Herzog 1996; Stumpf 2010). Nearly 1 million people (90% of the population) in east-central Illinois rely on groundwater in the Mahomet aquifer. Because of its importance, the aquifer was designated a Sole Source Aquifer by the U.S. Environmental Protection Agency in 2015. The Mahomet Aquifer includes groundwater within the Grigg tongue, Mahomet Sand Member, and Dewitt facies because these coarse-grained units are in contact without and intervening fine-grained till or glacial lake sediment. Saturated sand and gravel in the Pearl Formation (including unnamed tongues and the Grigg tongue) or, to a greater extent, the Mahomet Sand Member of the Banner Formation, constitute the predominant glacial aquifer materials in the Mahomet Quadrangle. Known sand and gravel units, tongues, and lenses are stippled in the cross sections. Most water wells are screened in the Mahomet Sand Member or in both the Grigg tongue and the Mahomet Sand Member. Fine-textured diamictons and other deposits (lower Vandalia till, Glasford Fm., etc.) covers the Grigg tongue and Mahomet Sand Member, and generally protects it from downward migration of potential contaminants on short time scales (Berg 2001). A hydrofacies model of unconsolidated sediments in the central Illinois region was described by Atkinson et al., (2014). Any bedrock aquifers are more than 400 feet depth and are not used in the area because of the extensive glacial aquifers.

Environmental Hazards

Groundwater Contamination

Surface contaminants pose a potential threat to groundwater supplies in near-surface aquifers that are not overlain by a protective confining (clay-rich and unfractured) deposit, such as till or lake sediment (Berg 2001). Groundwater in near-surface sand and gravel units (e.g., Henry Formation; unnamed tongues of the Pearl Formation) are most vulnerable to agricultural, surface mining, or industrial contaminants. The potential for groundwater contamination depends on the thickness and character of fine-grained alluvium, loess, or till deposits that overlie an aquifer, in addition to land use. Because of lateral and three-dimensional groundwater flow, the position of a site in the overall groundwater flow system also needs to be considered. Deeply buried glacial aquifers, such as the Mahomet Aquifer (consisting mainly of saturated sediment in the Grigg tongue, Pearl Formation and the Mahomet Sand Member) generally have a lower contamination potential than shallow aquifers if the groundwater is protected by a considerable thickness of unfractured, clay-rich till or clayey lake sediments. The lower Vandalia till provides a continuous cover above the Mahomet Aquifer with dense, uniform, subglacial till; fractures in this till unit are likely minimal. Overlying till units in the upper Glasford Formation, Tiskilwa Fm. also serve to protect the aquifer, but may be more fractured than the lower Vandalia (g-v1), have more sand lenses and tongues, and have been eroded in some areas, especially in the Sangamon River valley. Some local areas in the Sangamon River valley have considerably thinner covers of confining till material, but do not appear to have any direct connection to near-surface aquifers in the Mahomet Quadrangle. The Batestown Member till provides another fine-grained till cap in areas of the Champaign Moraine and northward, providing further protection from surface contaminants. More information on the Mahomet Aquifer is provided by Roadcap et al. (2011).

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