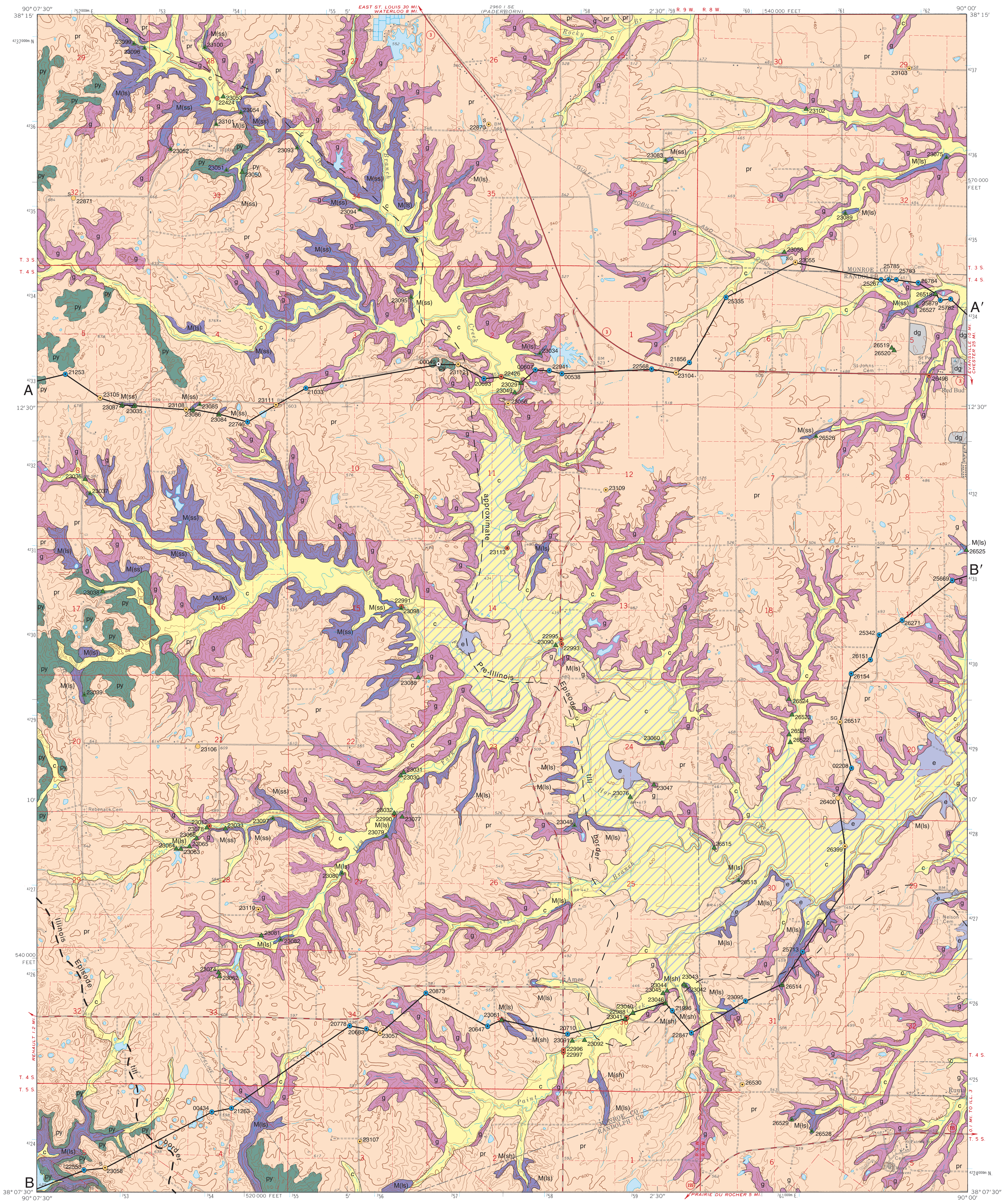
Institute of Natural Resource Sustainability
William W. Shilts, Executive Director
ILLINOIS STATE GEOLOGICAL SURVEY
E. Donald McKay III, Interim Director

SURFICIAL GEOLOGY OF AMES QUADRANGLE
MONROE AND RANDOLPH COUNTIES, ILLINOIS

David A. Grimley and Greg A. Shofner
2008

Illinois Geologic Quadrangle Map
IGQ Ames-SG



QUATERNARY DEPOSITS

Description	Unit	Interpretation
HUDSON EPISODE (~12,000 years before present (B.P.) to today)		
Fill or removed earth; sediment of various types; up to 15 feet thick	Disturbed ground dg	**Man-made fill or excavations;** includes small areas of disturbed sediment in the northeast quarter of the map near the town of Red Bud
Silt loam to loam to sandy loam to gravelly sand; sand and gravel beds are more common in lower portions of unit or as a basal lag (<2 feet thick); dark brown to dark yellowish brown to brownish gray; massive to well-stratified; medium to stiff consistency; noncalcareous; up to 20 feet thick	Cahokia Formation c	**Alluvium (river deposits);** in stream valley floodplains; derived from fluvial reworking and sorting of loess, diamicton, sand, and bedrock exposed in uplands and slopes; coarser alluvium is more common in higher-gradient western watersheds such as Dry Fork and South Fork
Silt loam to pebbly silt loam to pebbly silty clay loam diamicton; brown to yellow brown; massive to crudely stratified; pebbles and cobbles are generally angular and typical of local sedimentary bedrock; noncalcareous; up to 10 feet thick	Peyton Formation py	**Colluvium (deposited by gravity along slopes);** derived from creep, slumping, or landslides of local materials (loess, diamicton, sand, and/or bedrock) exposed in sloping areas; also common in areas with sinkholes (karst)
WISCONSIN EPISODE (~55,000–12,000 years B.P.)		
Silty clay loam to silty clay; brown to grayish brown to dark gray; massive to faintly laminated; soft to medium consistency; leached to calcareous; up to 15 feet thick	Equality Formation e; Areas where buried	**Lake deposits;** likely deposited as slackwater sediment in Horse Creek during peak glacial aggradation of the Mississippi River; terraces occur up to about 420 feet above sea level; includes up to a 4-foot cover of loess; also occurs below Cahokia Formation alluvium
Silt loam to silty clay loam; brown to yellowish brown to grayish brown (upper part) to slightly pinkish brown (lower part); massive to blocky structure; friable; medium to stiff consistency; mainly leached of carbonates; more clayey and more soil structure in upper few feet (modern soil); up to 15 feet thick	Peoria and Roxana Silts (>5 feet thick) pr	**Loess (windblown silt);** includes areas of redeposited loess along sloping areas and in sinkholes; mapped where >5 feet thick; approximately upper two-thirds of unit is Peoria Silt (where uneroded) and lower one-third is Roxana Silt (slightly pinkish brown); generally thickest in uneroded areas to the southwest
ILLINOIS EPISODE (~200,000–130,000 years B.P.)		
Pebbly silty clay loam, silty clay, or clay loam diamicton (within 5 feet of surface); contains few sand and gravel bodies; yellowish brown to light olive-brown to dark gray (at depth); diamicton is generally massive; stiff to very stiff; commonly fractured or jointed; leached (upper portion) to calcareous (lower portion); contains sandstone, shale, carbonate, and coal pebbles (typically <2 inches); few igneous/metamorphic erratics; upper few feet may be weathered to reddish brown or mottled with blocky structure; up to 60 feet thick	Glasford Formation g	**Till and ice-marginal sediment;** upper few feet of diamicton may contain Sangamon Geosol alteration; although mainly till, this unit includes minor occurrences (generally <10 feet thick) of proglacial outwash, supraglacial deposits, and lake deposits; crops out along steep slopes in much of the quadrangle; locally covered by <5 feet of loess
PRE-ILLINOIS EPISODE (~700,000–400,000 years B.P.)		
Pebbly clay to clay loam diamicton; includes some sand and gravel bodies; yellowish brown to grayish brown; massive to weakly laminated; stiff to very stiff; noncalcareous to calcareous (at depth); up to 15 feet thick	Banner Formation undifferentiated (cross sections only) b	**Till and ice-marginal sediment;** upper 10 feet or so may contain weathering or oxidation attributed to the Yarmouth Geosol; this alteration zone may be partially eroded or truncated by younger units; distribution in subsurface is patchy and may include zones of proglacial outwash or residuum; overlain by Glasford Formation

MISSISSIPPIAN BEDROCK

Description	Unit	Interpretation
Limestone bedrock (outcrops or within 5 feet of surface); yellowish brown to brownish gray; stratified; hard; commonly contains marine fossils such as crinoids, bryozoans, brachiopods, blastoids, and gastropods; calcareous; includes areas or interbeds of sandstone, chert, and/or shale	Mississippian limestone M(ls)	**Shallow marine environment;** includes St. Louis and St. Genevieve Limestones in western areas (with karst), Renault Limestone in central and southern areas, and undifferentiated Chesterian limestones in northeastern areas
Sandstone bedrock (outcrops or within 5 feet of surface); orange-brown to pale olive to light gray; generally fine grained; laminated to bedded to cross-bedded; hard where unweathered (otherwise somewhat friable); may contain herringbone structure; mainly noncalcareous with zones having calcite cement; includes few areas of limestone and/or shale	Mississippian sandstone M(ss)	**Deltaic or fluvial environment**; includes some tidal sequences; predominantly Aux Vases Sandstone in western areas with minor areas of Cypress Sandstone in eastern areas
Shale bedrock (outcrops or within 5 feet of surface); reddish brown to gray; laminated to bedded; very stiff to hard; may be fractured; mainly noncalcareous with some calcareous zones; includes areas or interbeds of limestone, chert, and/or sandstone	Mississippian shale M(sh)	**Marine or deltaic environment;** includes areas of Paint Creek Formation and Yankeetown Formation; outcrops mainly in south-central areas

Data Type

- Outcrop
- Stratigraphic boring
- Water well boring
- Engineering boring
- Other boring, including oil and gas

SG 26211 — Labels indicate samples (S) or geophysical log (G). Boring and outcrop labels indicate the county number. Dot indicates boring is to bedrock.

Unit Contact Type

- Horizontal accuracy generally within 200 feet
- Horizontal accuracy may exceed 200 feet
- Approximate border of Illinois Episode till. Glasford Formation till has not been found south or west of this line.
- Approximate border of pre-Illinois Episode till. Banner Formation till has not been found south or west of this line. This line is based on limited data, and the Banner till is patchy in distribution northeast of this line.

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 the Illinois State Geological Survey from digital data (Raster Feature Separates) provided by the United States Geological Survey. Topography compiled from imagery dated 1968. Field checked 1970.

North American Datum of 1927 (NAD 27)
Projection: Transverse Mercator
10,000-foot ticks: Illinois State Plane Coordinate system, west zone (Transverse Mercator)
1,000-meter ticks: Universal Transverse Mercator grid system, zone 15

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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 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology based on field work and data compilation by David A. Grimley 2006–2007 and Greg A. Shofner, 2002–2004.

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

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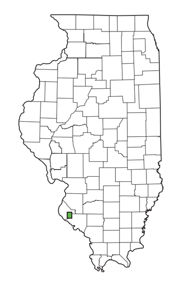
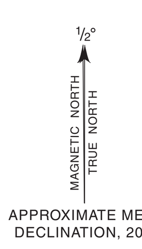
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

For more information contact:
Institute of Natural Resource Sustainability
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 244-2414
http://www.isgs.illinois.edu



1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Waterloo
2 Paderborn
3 New Athens West
4 Renault
5 Red Bud
6 Bloomsdale
7 Prairie du Rocher
8 Evansville



APPROXIMATE MEAN DECLINATION, 2008

ROAD CLASSIFICATION
- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Unimproved road
- State Route

Introduction

The surficial geology map of the Ames 7.5-minute Quadrangle, located in Illinois about 30 miles southeast of St. Louis, Missouri (fig. 1), provides a framework for land and groundwater use, engineering assessments, environmental hazard assessments, and related geological studies. This investigation is part of a broader geologic mapping program undertaken by the Illinois State Geological Survey (ISGS) in developing areas of the St. Louis Metro East region (Phillips 2004, Grimley 2008, Grimley and Phillips 2006), which includes Madison, St. Clair, and Monroe Counties in Illinois.

The Ames Quadrangle, located in eastern Monroe County and western Randolph County, includes the maximum extents of glacial ice during the Illinois and pre-Illinois Episodes (fig. 1) (Grimley et al. 2001). During the Illinois Episode, all but the extreme southwestern portion of this map was covered by glacial ice at its maximum extent. The limit of ice during a pre-Illinois Episode glaciation is more speculative, but appears to extend approximately to Horse Creek Valley (fig. 1). Glacial ice in southwestern Illinois generally advanced from the northeast, originating from the Lake Michigan basin during the Illinois Episode and from the Lake Michigan basin and/or the more eastern Great Lakes region during pre-Illinois Episode glaciation (Willman and Frye 1970). Deposits of both glacial episodes have also been reported within about 15 miles of this area (McKay 1979, Grimley 2008). Glacial ice did not reach the study area during the Wisconsin Episode; however, glacial meltwater associated with glaciers in the upper Mississippi River drainage basin deposited outwash throughout the middle Mississippi Valley. This outwash was the source for loess deposits (windblown silt) that blanket uplands in southwestern Illinois. Concurrently, slackwater lakes were formed in impounded tributary valleys to the Mississippi River as a result of high levels of aggradation. The bedrock topography (and to some extent the surface topography) relates to preglacial bedrock cuestas (trending north-northwest to south-southeast) that resulted from differential erosion of Paleozoic bedrock lithologies that dip regionally to the northeast (fig. 2). Depth to bedrock in the quadrangle ranges from 0 to 100 feet but is less than 50 feet in most areas (fig. 3).

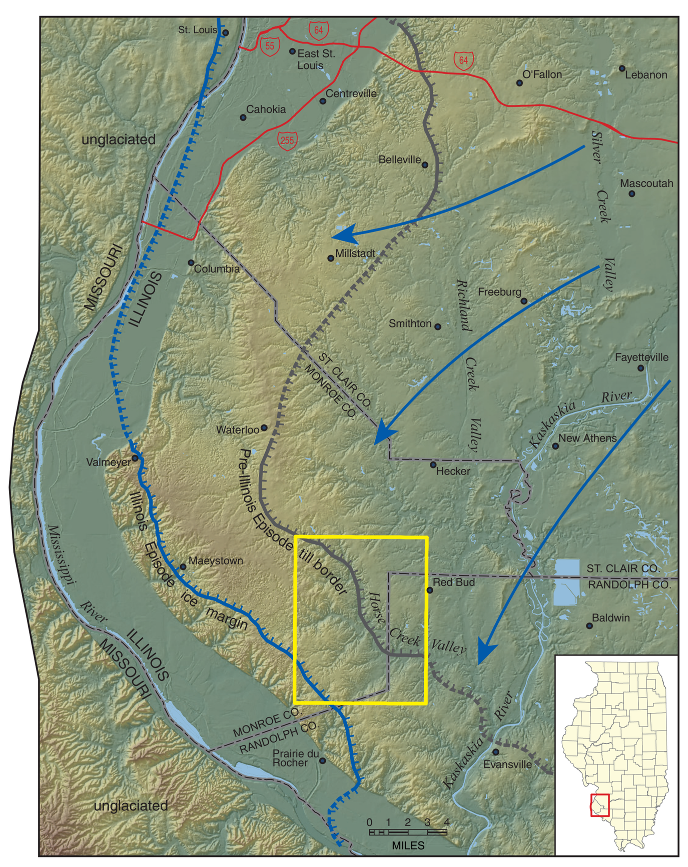


Figure 1 Shaded relief map of the southern portion of the St. Louis Metro East region. The Ames Quadrangle is outlined in yellow. The approximate Illinois Episode ice margin and flow direction are shown in blue. The approximate pre-Illinois Episode till border is shown in gray.

Methods

Surficial Map

The surficial geology map is based in part upon soil parent material data (Higgins 1984, Leeper 1999) and is supplemented by data from many outcrops, stratigraphic test holes from this project and Shofner (2006), engineering boring records from the Illinois Department of Transportation (IDOT) and Monroe County Highway Department, and ISGS water-well records and oil-well records. Locations of data that are important to understanding the surficial geology or used in cross sections are shown on the map. To the extent possible, data point locations have been verified from plat maps, water-well permits, or original documentation on file at the Illinois State Geological Survey. Map contacts were also adjusted according to the surface topography, geomorphology, and observed landform-sediment associations.

Cross Sections

The cross sections portray unconsolidated deposits as would be seen in a vertical slice through the earth down to bedrock (vertically exaggerated 20 times). The lines of cross section are indicated on the surficial map and in figures 2 and 3. Data used for subsurface unit contacts (in approximate order of quality for this purpose) are from studied outcrops, stratigraphic test holes, engineering boring records, water-well records, and oil-well records. Units less than 5 feet in maximum thickness are not shown on the cross sections. Dashed contacts are used to indicate where data are less reliable or not present. The full lengths of borings that penetrated deeply into bedrock are not shown.

Bedrock Topography and Drift Thickness

Figure 2 (bedrock topography) and figure 3 (drift thickness) are based on data from which a reliable bedrock elevation could be determined (shown in fig. 3). Points within about a mile of the map were also utilized (not shown in fig. 3). A total of 461 data locations were used, including 42 outcrops, 17 stratigraphic tests, 24 engineering borings, 370 water-well borings, and 8 oil test borings. The bedrock surface was modeled utilizing a "Topo to Raster" program in ArcMap 9.0 (ESRI). This program incorporated a combination of three information types: (1) 461 data points coded with bedrock top elevations, (2) digitized contour lines coded with bedrock top elevations (from outcrops and soil survey observations), and (3) digitized "streams" (ArcMap term) that forced the bedrock surface model to conform to a typical stream drainage network, guided by geological insights. Subsequently, a drift thickness map was created by subtracting the bedrock topography digital elevation model (DEM) from a surface DEM, both with a 30-meter cell size. Areas shown to have a drift thickness less than zero were reevaluated and modified through use of additional synthetic points, contour lines, "streams," or reinterpretations of original data. Multiple iterations of this process were repeated until reasonable bedrock surface and drift thickness maps were obtained. For the final bedrock topography map, bedrock elevations higher than the surface DEM were replaced with the value of the surface DEM, so that the final calculated drift thickness map would not have values less than zero.

Surficial Deposits

The surficial deposits are divided into two geomorphic terrains: (1) uplands and eroded slopes, containing predominantly glacial, colluvial, and windblown sediments at or near the surface, and (2) valleys, containing predominantly postglacial waterlain sediments at or near the surface. There are also older (pre-Illinois Episode) concealed deposits whose occurrence and thickness are more related to the bedrock surface topography than to the surface geomorphology (fig. 2). Areas of anthropogenically disturbed ground are mapped in a few areas in the northeastern portion of the map on the western edge of the town of Red Bud.

Uplands and Eroded Slopes

Uplands and eroded slopes constitute about 87% of the quadrangle's area. Uneroded uplands (~70% of map area) are blanketed by about 7 to 25 feet of windblown silt (loess), underlain mainly by glacial till or bedrock. The loess deposits (Peoria and Roxana Silts) are mapped where greater than 5 feet thick, but also thinly cover (<5 feet) many mapped areas of till and bedrock. The thickest loess occurs on uneroded uplands in southwestern areas of the map, closest to its Mississippi Valley source of deflation. The loess was deposited during the last glaciation (Wisconsin Episode) when silt-size particles, derived from Mississippi Valley glacial meltwater deposits, were periodically windswept and carried in dust clouds eastward to vegetated upland areas, where they settled across the landscape. Where relatively unweathered, the loess deposits are typically a silt loam to heavy silt loam. In the modern soil solum (generally the upper 3 to 5 feet), the loess is altered to a heavy silt loam or silty clay loam (Higgins 1984, Leeper 1999). The Peoria Silt is generally yellow-brown to grayish brown and is the upper and younger loess unit. The Roxana Silt, having a slight pinkish hue, is the lower loess unit (Hansel and Johnson 1996). The Peoria Silt, when uneroded, typically constitutes about two-thirds of the total loess thickness. Because both loess units here are similar in physical properties (slightly to moderately weathered, oxidized, leached of carbonates), they were not mapped separately or distinguished in the cross sections.

On the many side slopes and ravines, where loess has been eroded to less than 5 feet thick, the underlying diamicton (a massive, poorly sorted mixture of clay, silt, sand, and gravel)), weathered diamicton, and/or associated sorted sediment are mapped as the surficial unit (Glasford Formation). The diamicton is mainly interpreted as glacial till (deposited directly by glacial ice) but locally includes unsorted debris flow materials. Near-surface Glasford Formation is common in slopes of nearly all tributary valleys to Horse Creek and along other small creek valleys in the quadrangle where postglacial loess erosion has been significant. In its uppermost portion, the Glasford Formation contains a buried interglacial soil known as the Sangamon Geosol. Alteration features are prevalent in the upper 5 to 10 feet of this soil, including root traces, fractures, carbonate leaching, oxidation or color mottling, strong soil structure, clay accumulation, and/or clay skins that help to delineate the contact below loess deposits. Oxidation (to light olive-brown) and fracturing may extend 15 to 25 feet into the Glasford diamicton before completely unaltered gray till is encountered (Shofner 2006). The upper few feet of Glasford Formation can sometimes include a few feet of weathered loess or redeposited loess that contains the Sangamon Geosol. The main body of the Glasford Formation is predominantly a pebbly silty clay loam diamicton, interpreted as till and up to 60 feet thick, that was deposited during the Illinois Episode. The diamicton can be interspersed with, overlain by, or underlain by waterlaid sand and gravel or silt lenses that are included within the Glasford Formation. Sand and gravel or silt beds are usually less than 10 feet thick and not very extensive or predictable in distribution; thus they were mapped as part of the Glasford Formation. Shofner (2006) referred to some of these zones as Glasford outwash or the Glasford silt and sand lithofacies. Lacustrine silts underlying Glasford Formation, mapped as Petersburg Silt in other areas (Phillips 2004, Grimley and Phillips 2006), were observed at some outcrops but are here included within Glasford Formation because of limited thickness (generally <5 feet) and occurrence. Glasford till in the Ames Quadrangle is typically not as stiff or dense as it is to the northeast (Phillips 2004, Grimley 2008), probably due to a more clayey texture (silty clay loam) and a higher moisture content, typically 16 to 27% (table 1), compared to 11 to 20% for Glasford till 15 to 20 miles to the northeast (Grimley 2008). Relatively soft tills with high moisture contents in the Ames area may, in part, be the result of thin glacial ice near the margin of Illinois Episode glaciation, which would have limited compaction and densification of the underlying sediment. Another important factor is the more clayey nature of the Glasford Formation here than in eastern St. Clair and Madison Counties, likely as a result of local incorporation of clay-rich bedrock residuum, shale, and pre-Illinois Episode sediments (loess, till, and lake sediments) into the basal glacial ice. With thin ice conditions and compressive flow up the regional bedrock slope, locally incorporated material would have composed a high proportion of the glacial sediment. Incorporation of bedrock was apparent in many till exposures; for instance, at sites 23043 and 23045 (Sec. 36, T4S, R9W), local red shale fragments incorporated into the till have resulted in a pale pink hue in the Glasford till matrix.

Near-surface Mississippian bedrock (fig. 4) is present along steep ravines in much of the quadrangle. Areas with thinner drift and commonly occurring near-surface bedrock include the high-relief northwest quarter of the quadrangle, the unglaciated southwest corner, and a northwest-southeast band (following bedrock strike) in the northeastern portion of the map (see map and fig. 3). Regionally, the bedrock bedding has a shallow dip to the east-northeast toward the center of the Illinois Basin. Near-surface bedrock generally consists of horizontally bedded fossiliferous limestone, red or gray shale, or fine-grained sandstone. Interbeds or lateral variations with other bedrock lithologies, including zones of chert, can occur within these map units. Additionally, the mapped bedrock units may be overlain by thin (typically <5 feet) alluvium, loess, lake sediment, till, ice marginal sediment, or bedrock residuum. The geologic formations primarily included within these bedrock map units are the St. Louis, St. Genevieve, and Renault formations (limestone), Paint Creek or Yankeetown formations (shale), and Aux Vases Sandstone or Cypress Sandstone, based on prior bedrock mapping (Devera 2002). Karstic landscapes occur locally in areas of near-surface limestone (within about 25 feet of land surface). Areas with abundant sinkholes are especially prevalent in places underlain by the St. Louis or St. Genevieve Limestones (extreme southwest, south-central, and northwest), and are also common west of this quadrangle (Panno et al. 2008).


Figure 4 Outcrop of bedded sandstone (Aux Vases Formation) on the south bank of a tributary to Dry Fork in Sec. 28, T4S, R9W (site 23097).

Colluvial deposits (sediment moved downslope by gravity) are relatively common on the steeper slopes, including in sinkholes, particularly in western portions of the quadrangle. Deposits in these areas, consisting of silt, pebbly silt, and/or pebbly silty clay loam, are classified as Peyton Formation (Hansel and Johnson 1996). In areas with shallow bedrock, pebbles and cobbles can be slabby and angular. The Peyton Formation was derived from downslope movement of loess, till, residuum, and/or bedrock as a result of creep or slumping. Deposition of this unit was mainly postglacial (continuing to the present), but some deposition was concurrent with Wisconsin Episode loess or even older units. Many other areas with thin colluvial deposits occur on sloping areas but are not mapped as such due to limited thickness and/or extent.

Valleys

Valleys, constituting about 13% of the quadrangle's area, are mainly filled with silty to sandy, weakly to well-stratified, postglacial stream deposits (Cahokia Formation). In general, due to relatively thin glacial drift cover, the larger modern creek valleys are superimposed on preglacial bedrock valleys (fig. 2). Cahokia Formation deposits, up to 20 feet thick in the Horse Creek Valley, range from silty loam and loam to gravelly sand. This map unit commonly includes 1- to 2-foot-thick beds of stratified sand, particularly in basal portions, as a lag on glacial till, but also includes channel sand deposits in modern streams. The Cahokia Formation comprises resedimented loess, till, and bedrock that are exposed along eroding ravines and slopes in the watershed. Steeper sloping tributaries with higher gradients and abundant till and bedrock exposures tend to have coarser alluvium (e.g., Dry Fork and South Fork) than do lower gradient floodplains (e.g., lower Horse Creek). Due to periodic flooding during post-glacial times, areas mapped as the Cahokia Formation have relatively youthful modern soil profiles that generally lack B horizons and have thinner profiles than upland soils (Higgins 1984, Leeper 1999).

A few terraces of the last glacial age (Wisconsin Episode) are found in the broader portions of the Horse Creek Valley and contain lake sediments (Equality Formation) related to slackwater conditions in the Kaskaskia River valley. The terraces formed during the peak of the Wisconsin Episode when Mississippi River sediment aggradation caused slackwater conditions far up the low-gradient Kaskaskia River valley and, at times, its tributaries such as the Horse Creek Valley (fig. 1). The maximum elevation of the slackwater lake and related Equality Formation deposits in the Kaskaskia Valley region is typically 425 feet above sea level, based on terrace elevations (Grimley 2008). Terraces mapped in the Ames Quadrangle, typically covered by a few feet of Peoria Silt, were likely incised prior to late glacial times (prior to 15,000 radiocarbon years before present). Deposits in the terrace (Equality Formation) typically consist of weakly stratified silt loam to silty clay with minor beds of fine sand, likely derived from eroded and redeposited loess and till deposits in the drainage area of Horse Creek. The Equality Formation also underlies the Cahokia Formation in lower Horse Creek Valley, where it can be as much as 20 feet thick (site 26399; cross section B–B′)

Concealed Deposits

In a few areas of the map, pre-Illinois Episode glacial deposits (classified as the Banner Formation) are preserved below the Glasford Formation and above bedrock (see cross sections). The Banner Formation here is not known to outcrop or occur near land surface, having been eroded from bedrock topographic highs during interglacial periods or by glacial ice during the Illinois Episode. Deposits in the Banner Formation are generally fine-grained and consist mainly of clay-rich till (fig. 5), but also can include paleosols, lake sediment, loess, and bedrock residuum. A few areas may include sand and gravel lenses or beds. The Banner Formation has been definitively identified here only in two stratigraphic test cores (e.g., sites 26399 and 26517 on cross section B–B′), where it is separated from the Glasford Formation based on the presence of a partially truncated Yarmouth Geosol (interglacial paleosol) developed in its upper portion. The Yarmouth Geosol is more strongly developed than the Sangamon Geosol and may consist of a stronger reddish brown color (5 YR colors on Munsell chart), stronger blocky structure, and more abundant clay skins. The Banner Formation (including the Yarmouth soil in upper parts) is mainly preserved where it has been protected from later erosion in the ancestral Horse Creek Valley (fig. 2 and cross sections), a preglacial valley that loosely follows the present-day Horse Creek Valley. The predominant bedrock lithologies below the Banner Formation or other Quaternary deposits are sandstone, shale, and limestone, with scattered chert beds and areas of bedrock residuum. The bedrock lithologies are not shown on cross sections due to fairly inconsistent descriptive logs from water-well drillers. Some areas of buried karst are speculated to occur in the subsurface, such as in Sec. 28, T3S, R9W (see map and fig. 2), where deep engineering borings encounter what is thought to be a large sinkhole or karst window infilled with till, lake sediment, and alluvium. This area is nearly completely surrounded by bedrock uplands. Many areas with a high variability of bedrock surface elevations were noted in the western part of the quadrangle.

Figure 5 Core sample of Banner till (site 26517; cross section B–B′) in Sec. 19, T4S, R8W, Randolph County, Illinois. Local yellow-brown sandstone, red shale, and carbonate pebbles are visible within the clay-rich diamicton at about a depth of 30 feet.

Economic Resources

Sand and Gravel

Economically minable sand and gravel deposits are not mapped in the Ames Quadrangle. Sand and gravel deposits do occur within some units but are generally less than 10 feet thick and are not very extensive laterally (see cross sections). Thin sand deposits are present within basal portions of the Cahokia Formation in the Horse Creek Valley and occasionally occur within the Glasford and Banner Formations. Overall, the unconsolidated surficial materials are dominantly fine grained.

Groundwater

Groundwater is extensively used for household, public, and industrial water supplies in southwestern Illinois. In the Ames Quadrangle, the vast majority of water wells utilize groundwater from bedrock aquifers at depths typically ranging from 50 to 500 feet. Bedrock aquifers consist of Mississippian sandstone and/or fractured or karstic limestone and are commonly used for household water supplies due to their relatively shallow depth (fig. 3) and the limited occurrence of aquifer materials in overlying Quaternary deposits.

A few large-diameter wells in the Ames Quadrangle utilize groundwater in shallow, minor sand and gravel lenses in the Cahokia, Glasford, or Banner Formations for low-yield, household water supply. Areas of sand and gravel greater than 5 feet thick have primarily been identified in valleys and are stippled in the cross sections. However, other minor sand and gravel lenses are undoubtedly present; thin, discontinuous layers have been observed within till (or diamicton) units. Due to their relatively limited thickness and extent, Quaternary aquifers in the map area are typically only suitable for low-yield water wells. More significant surface water and groundwater resources from glacial aquifers are present several miles east of this quadrangle in the Kaskaskia River valley. For example, the water supply for the town of Red Bud (eastern edge of this map) currently comes from wells in thick sand and gravel deposits (probably Illinois Episode outwash) underlying the Kaskaskia River valley. Prior to the 1980s, the municipal water supply for Red Bud was from the Mississippian Aux Vases Sandstone, but maximum withdrawals were limited due to the aquifer transmissivity and the limited recharge under drought conditions (Poole and Heigold 1981).

Environmental Hazards

Groundwater Contamination

Surface contaminants pose a potential threat to groundwater supplies in near-surface aquifers that are not overlain by a confining (clay-rich and unfractured) deposit. Unprotected near-surface aquifers, such as shallow bedrock aquifers or sand lenses in the Cahokia or Glasford Formations, can be vulnerable to agricultural or industrial contaminants. Shallow bedrock aquifers can be particularly vulnerable to contaminants in areas of sinkholes and karstic limestone (Panno et al. 2008) or in areas of extensive bedrock outcroppings. Overlying materials, such as shale, clayey till, or lake sediment, can help protect buried aquifers from near-surface sources of contamination (Berg 2001). The potential for groundwater contamination depends on the thickness and character of shale, fine-grained alluvium, loess, or till deposits that overlie the aquifer. Fracturing or jointing in the Glasford till can increase hydraulic conductivity substantially (Herzog and Morse, 1990) and, in this area, can extend to depths of 50 or 60 feet below ground surface (Shofner 2006).

Mass Wasting (Slope Stability)

Erosion, undercutting, and slumping of loess and till deposits along steep slopes are potential hazards to property and stream environments (Killey et al. 1985). Slumps, which are rotational failures in sediment along a curved slip surface, are common in areas where groundwater saturates loess overlying the more clayey and less permeable Sangamon Geosol developed in the Glasford Formation or where it saturates loess and till overlying shallow bedrock (Killey et al. 1985). Such areas of shallow bedrock, particularly shales, or areas with clayey paleosols provide a slippage surface for the overlying unconsolidated sediments. Slumps within the loess and Glasford Formation till have been noted along many large creek cutbanks in the Ames Quadrangle, for example, at sites 23030 (Sec. 22, T4S, R9W), 23049 (Sec. 2, T4S, R9W), and 23060 (Sec. 24, T4S, R9W). The more clayey texture (silty clay loam diamicton), higher moisture contents, and softer character of the Glasford till in the area, compared to counties north and east, likely contribute to the abundance of slumps observed. The shallow depth to bedrock, which may immediately underlie Glasford till at many of these exposures, is also likely a major factor.

Soil Erosion

Steep slopes and ravines are subject to severe soil erosion due to the friable nature of loessal soils. In particular, the Peoria and Roxana Silts are soft and weakly cohesive, have low shear resistance, and are easily eroded by running water. Runoff during rain storms can thus quickly enlarge rills and gullies (fig. 6), thereby accelerating erosion, as water is channeled into the growing drainage system. Mass wasting processes (slumping) and some agricultural and construction practices can also contribute greatly to the amount of sediment in creek valleys.


Figure 6 Erosion and redeposition of loess deposits related to land use in Sec. 19, T4S, R8W.

Karst (Sinkhole and Cavern Development)

Karst topography is evident at the surface in many areas of the quadrangle where limestone bedrock is within about 25 feet of land surface (mainly southwest, northwest, and south-central areas). In such areas, where thin loess, thin till, and/or residuum overlie relatively pure limestone (here the St. Louis, St. Genevieve, or Renault Formations), sinkhole and underground cavern development become prevalent (Panno et al. 1997). Underground drainage in karstic areas can be rapid, and flow is commonly controlled by joint sets. Aquifers developed in karstified limestone are highly susceptible to contamination because groundwater flows quickly into the cavernous bedrock and is not well filtered through soil, clay, or slowly permeable bedrock (Panno et al. 1997, Panno and Weibel 1998). Karstic regions also pose a hazard to building structures because of the danger of sinkhole collapse and subsequent widening.

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

	Engineering properties[1]			Particle size and composition[2]					Geophysical data[3]	
	w (%)	Q_u (tons/ft^2)	N	Sand (%)	Silt (%)	Clay (%)	Clay mineralogy	Carbonate content (%)	Natural gamma	MS
Cahokia Formation	17–32	0.1–1.3	1–10	variable texture (silty and sandy)			high expandables	typically 0	variable	ND
Equality Formation	23–30	0.3–1.0	3–7	1–18	50–63	27–45	high expandables	ND[4]	high	5–25
Peoria and Roxana Silts	23–27	1.0–2.0	5–10	2–10	60–80	17–30	20–35% illite (high expandables)	typically 0	mod.	8–80
Glasford Formation (till)[5]	16–27	1.2–4.5	8–25	10–25	40–55	28–41	35–55% illite	5–13	high	8–30
Banner Formation (till)[5]	22–25	2.5 –4.0	ND	10–15	30–36	49–54	30–37% illite	4–7	high	10–20
Limestone and sandstone bedrock	ND	>4.5	>50	ND	ND	ND	ND	highly variable	low	2–12
Shale bedrock	12–23	>3.5	>45	ND	ND	ND	ND	ND	very high	5–20

[1]Engineering properties are based on hundreds of measurements (total for all units) from about 20 engineering (bridge) borings and 5 stratigraphic test borings in the quadrangle. w, moisture content = mass of water/mass of dry solids; Q_u, unconfined compressive strength; N, blows per foot (standard penetration test).

[2]Particle size and composition data are based on a more limited dataset (~50 samples) from 5 stratigraphic borings and 13 outcrops. Sand = % >63 µm; silt = % 4 to 63 µm; clay = % <4 µm (proportions in the < 2-mm fraction). Clay mineralogy = proportions of expandables, illite, and kaolinite/chlorite (in <4-µm clay mineral fraction); these calculations using Scintag diffractometer traces have about one-fourth more illite than previous data using the General Electric X-ray diffractometer.

[3]Geophysical data: natural gamma, relative intensity of natural gamma radiation (data from two stratigraphic borings). MS, magnetic susceptibility ($\times 10^{-5}$ SI units) (detailed data from 5 stratigraphic borings).

[4]ND, no data available.

[5]Properties for the Glasford and Banner Formations are mainly for calcareous till (excludes sand and gravel lenses and strongly weathered zones); weathered upper portions can be less stiff and more clayey, have higher water contents, and be leached of carbonates.

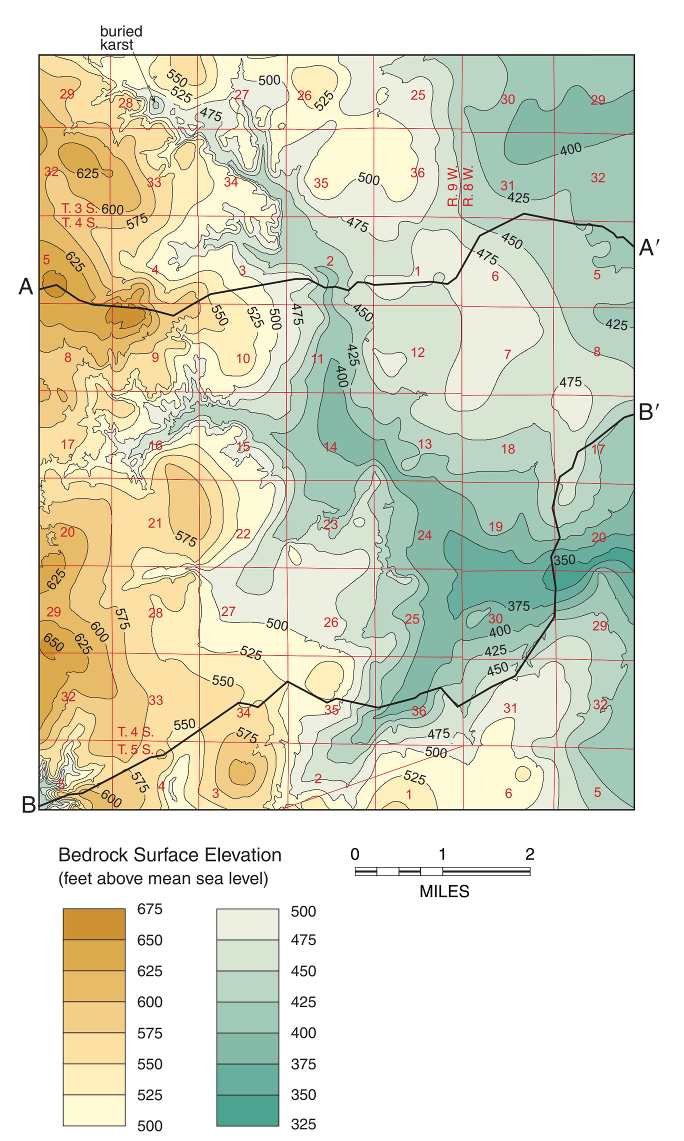

Figure 2 Bedrock topography of the Ames Quadrangle. Section boundaries are shown in red and cross section lines in black. Locations of all data that were used are shown in figure 3. Map scale is 1:100,000.

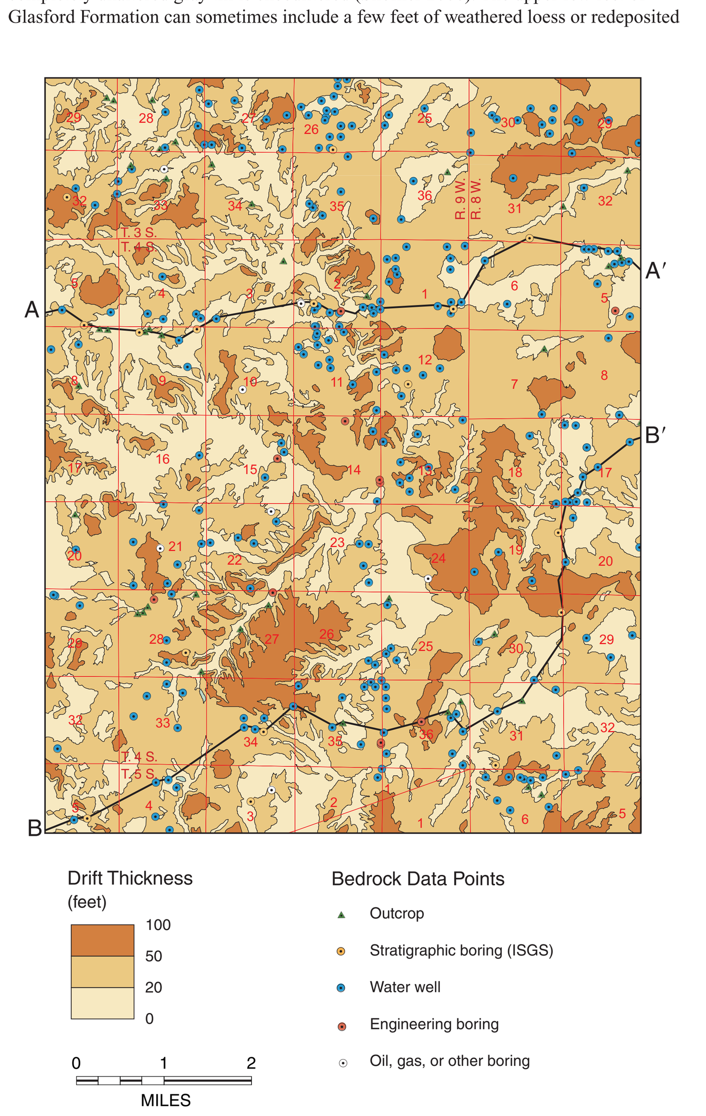

Figure 3 Drift thickness of the Ames Quadrangle. Drift includes all unconsolidated sediments above bedrock (loess, till, alluvium, lake sediment, etc.). Section boundaries are shown in red and cross section lines in black. Map scale is 1:100,000.