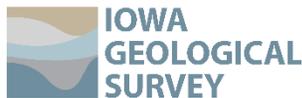


**SUMMARY REPORT OF THE
SURFICIAL GEOLOGIC MAP OF
THE LOWELL 7.5' QUADRANGLE, DES MOINES,
HENRY, AND LEE COUNTIES, IOWA**

**Iowa Geological Survey
Open File Map OFM-17-6
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INTRODUCTION

The ‘Surficial Geologic Map of the Lowell 7.5’ Quadrangle, Des Moines, Henry, and Lee Counties, Iowa’ represents the first phase of surficial mapping in southeast Iowa. A bedrock geologic map was also produced in conjunction with the surficial geologic map (Clark et al., 2017). The Lowell Quadrangle covers an area from 40° 45’ to 40° 52’ 30” N latitude and 91° 30’ to 91° 22’ 30” W longitude. The Lowell Quadrangle is located on the Southern Iowa Drift Plain landform region (Prior and Kohrt, 2006). The map area is dominated by loess mantled till plains in the uplands, and glacial outwash and finer-grained alluvial deposits within the Skunk River valley and its tributaries. Stratigraphically, this area contains Illinoian age glacial deposits, which are only present in a small area of southeastern Iowa. The terminal moraine runs roughly north to south through the Lowell Quadrangle, with Pre-Illinoian deposits to the west and Illinoian deposits to the east. The thickness of Quaternary materials varies widely across the quadrangle generally ranging from 0 to 18 m (0-60 ft), and reaching a maximum thickness of 64 m (210 ft) in the northern part of the mapping area. Bedrock outcrops are located primarily in the eastern half of the quadrangle, along the Skunk River and its tributary creeks including Mud Creek, Cedar Creek, Sutton Creek and Hell Hollow.

Mapping the Lowell and Danville quadrangles provides the first study of the regional Quaternary stratigraphy of southeast Iowa in almost 40 years since Hallberg (1980a,b) established the stratigraphy for the Illinoian and Pre-Illinoian glacial advances in eastern and southeastern Iowa. The majority of the drill cores and outcrops for those studies were north and east of the Lowell Quadrangle. Additional data available since that time (LIDAR, DEMs, and digital soil surveys), have allowed for the refinement of the Illinoian boundary and greater detail in mapping the valleys. The only other surficial map of the area consists of the Des Moines 4° x 6° Quadrangle at a scale of 1:1,000,000 (Hallberg et al., 1991). Several Iowa Geological Survey (IGS) field trip guidebooks outline the Pleistocene, Devonian, and Mississippian stratigraphy (Witzke et al., 2002; Witzke and Tassier-Surine, 2001), but their focus was on the area near Burlington (to the east).

PURPOSE

Detailed geologic mapping in southeast Iowa was completed as part of the IGS’s ongoing participation in the United States Geological Survey (USGS) STATEMAP Program. Mapping was completed as part of the IGS Developing Areas and Impaired Watershed mapping initiatives and provides comprehensive surficial and bedrock geologic information. These maps are the basis for further development of derivative datasets and map products for use by local, county and state decision-makers. An increased demand for groundwater resources in the region, new research into the Lower Skunk River watershed, development of additional aggregate resources, and expanding urban areas led to the selection of southeast Iowa as the next target for geologic mapping by the Iowa State Mapping Advisory Committee (SMAC). Key societal concerns that can be aided by this mapping project include watershed management, groundwater quantity and quality assessment, flood mitigation, aggregate resource protection, and land use planning and development.

Bedrock mapping efforts were successful in subdividing the Mississippian Augusta Group mapping unit used by Witzke and others (2010) into formations and in better identifying Pennsylvanian outliers. From a Quaternary perspective, characterizing and identifying the extent of the Illinoian glacial advance, and establishing the loess thickness were primary objectives of the surficial map. The map area also

includes the Skunk River, which carried outwash from the Wisconsin age Des Moines Lobe glacial advance. Mapping has also helped to further delineate alluvial terraces, as well as identify and characterize sand and gravel resources associated with glacial outwash. Combining the bedrock and surficial map information is allowing stakeholders to address key questions related to shallow rock areas, groundwater protection, water supply concerns, and aggregate resource potential and protection.

QUATERNARY HISTORY AND REGIONAL SETTING

The glacial history of Iowa began more than two million years ago, as at least seven episodes of Pre-Illinoian glaciation occurred between approximately 2.6 and 0.5 million years ago (Boellstorff, 1978a,b; Hallberg, 1980a). Early researchers believed there were only two episodes of Pre-Illinoian glaciation in Iowa. Later regional studies determined that at least seven episodes of Pre-Illinoian glaciation had occurred and led to the abandonment of the classic glacial and interglacial terminology: Kansan, Aftonian and Nebraskan (Boellstorff, 1978a,b; Hallberg, 1980a, 1986). Hallberg (1980a,b, 1986) undertook a regional scale project in east-central Iowa that involved detailed outcrop and subsurface investigations, including extensive laboratory work and synthesis of previous studies. Hallberg's study marked a shift from the use of time-stratigraphic terms and resulted in the development of a lithostratigraphic framework for Pre-Illinoian till. In east-central Iowa, Hallberg formally classified the units into two formations on the basis of differences in clay mineralogy: the Alburnett Formation (several undifferentiated members) and the younger Wolf Creek Formation (including the Winthrop, Aurora and Hickory Hills members). Both formations are composed predominantly of till deposits, but other materials are present. Paleosols are formed in the upper part of these till units.

A limited area of southeastern Iowa was glaciated during the Illinois Episode, around 300,000-130,000 years ago (Hallberg, 1980b). The eastern half of the Lowell Quadrangle was glaciated during this time. The Illinoian till was deposited by the advancing Lake Michigan Lobe which moved across western Illinois into Iowa from the northeast (Leverett, 1899; Wickham, 1980). The Lake Michigan Lobe incorporated Paleozoic bedrock materials from the Lake Michigan Basin which are distinguished by both the clay mineralogy of the matrix as well as the pebbles and clasts (Lineback, 1980; Wickham, 1980). Coal fragments were commonly identified in core; this is unique to Illinoian age glacial till in Iowa. Hallberg (1980b) defined the formal stratigraphic nomenclature in Iowa. The only Illinoian Episode till present in Iowa is the Glasford Formation Kellerville Till Member (Willman and Frye, 1970). Following the Illinoian glaciation, this area underwent landscape development and erosion until the Wisconsin Episode loess began to be deposited. The Illinoian and Pre-Illinoian till are only exposed in drainages and relatively steep sideslopes.

In eastern Iowa, the highly eroded and dissected Illinoian and Pre-Illinoian upland and older terraces are mantled by two Wisconsin loesses. The older Pisgah Formation is thin and includes loess and related slope sediments that have been altered by colluvial hillslope processes. The unit is characterized by the presence of a weakly developed soil recognized as the Farmdale Geosol. It is not uncommon to see the Farmdale developed throughout the Pisgah Formation and into the underlying older Sangamon Paleosol. The Pisgah loess was most likely deposited on the eastern Iowa landscape from 30,000 to 24,000 years ago (Bettis, 1989) and is typically buried by Peoria Formation loess. The Peoria Formation loess accumulated on stable landsurfaces in eastern Iowa from 25,000 to 21,000 years ago. Peoria Formation eolian materials mantle the upland till units and are present on the Wisconsin outwash terraces. On the uplands, the Peoria Formation is a uniform silt loam; in the valleys the silt commonly grades downward

to fine sand. The loess deposits in the mapping area are relatively thin, generally less than 4 meters (12 ft).

The Skunk River deposited coarse sand and gravel associated with glacial outwash (Noah Creek Formation) of the Des Moines Lobe during the Wisconsin Episode. The sand and gravel is much thinner (typically less than 6 m) than in many other rivers in Iowa that carried Wisconsin outwash. Based on the alluvial framework established by Esling (1984), three terrace assemblages can be identified, the Early and Late Phase high terraces, and Low Terrace deposits. The high terraces are characterized by the presence of Peoria and Pisgah formation sediments overlying alluvium, with or without the intervening Sangamon Paleosol. Low Terrace deposits are younger and not overlain by the Peoria loess. These terraces may be found along the Skunk River and Big Creek. Also of significance is the presence of a relatively thick (greater than 20 ft) sequence of slackwater sediments below the highest elevation loess-mantled terrace. These materials are related to the Equality Formation (Willman and Frye, 1970) defined in Illinois and were deposited during a time of high flow in the Mississippi River that caused the Skunk River to back up (Curry and Grimley, 2006).

Hudson age deposits are associated with fine-grained alluvial, organic, and colluvial sediments and include the DeForest Formation which is subdivided into the Camp Creek, Roberts Creek, and Gunder members. These deposits are present in valleys and upland drainages throughout the map area. The Holocene low terrace deposits occupy the active channel belt of the Skunk River and portions of Big Creek. Both an intermediate and high Holocene terrace are present along the Skunk River and may be several meters above the modern floodplain. Due to the difficulty of differentiating these terraces where only one was present, they were combined into one mapping unit.

METHODS

Numerous existing sources of geologic information were utilized in the production of the surficial and bedrock geologic maps of the Lowell Quadrangle including subsurface information, USDA NRCS soil survey data, aerial photography, DEM's, satellite imagery, landform characteristics, and LiDAR. Where available, engineering borings from public utilities, the Iowa Department of Transportation, and monitoring well records of the USGS were used. Subsurface lithologic and stratigraphic information was mostly derived from analysis of water well cutting samples repositied at the IGS and stored in the IGS online GeoSam database. Over 900 public and private wells in GeoSam, including 322 strip logs, were reviewed for lithology, stratigraphy and locational accuracy, and updated where needed. NRCS digitized soils data (Brown, 1983; Seaholm, 1985; and Lockridge, 1979) provided information regarding shallow rock areas, helped to guide valley mapping units, and defined slope areas where glacial till is exposed. Bedrock mappers also used the digital soil surveys to help delineate areas of shallow rock outcrop prior to field reconnaissance. New geologic information was obtained from field investigations of more than 100 outcrops (including quarry exposures) and logging of well cutting samples for 115 unstudied wells totaling 24,318 feet. Quaternary geologists worked with a contract driller and utilized the IGS Giddings probe to drill a mix of solid stem and continuous core holes. Twelve new drill holes totaling 1,398 feet were completed in the quadrangle to characterize the Quaternary sediments and establish unit thickness. Samples have been submitted to the Quaternary Materials Lab at the University of Iowa's Earth and Environmental Sciences Department for grain-size analysis. All results are expected by August, 2017. Two samples associated with the Wisconsin slack water deposits were submitted to the Illinois Geological Survey Radiocarbon Dating Laboratory for age analysis.

Project geologists combined information from the sources listed above to delineate surficial geologic mapping units at 1:24,000 scale for the Lowell Quadrangle. IGS mappers used ArcGIS and on-screen digitizing techniques developed during previous STATEMAP projects. The final map entitled ‘Surficial Geologic Map of the Lowell 7.5’ Quadrangle, Des Moines, Henry, and Lee Counties, Iowa’ will be available as a shapefile in the Iowa Department of Natural Resources NRGIS library, as a pdf file on the IGS Publications website, and will be submitted to the USGS National Geologic Map Database. This Summary Report is also available as a PDF file on the IGS Publications website.

STRATIGRAPHIC FRAMEWORK FOR SOUTHEAST IOWA

The stratigraphic framework for southeast Iowa was established by Hallberg (1980a,b) nearly 40 years ago. Surficial deposits in the map area are composed of seven formations (youngest to oldest): Hudson DeForest; Wisconsin Peoria, Pisgah, and Noah Creek; Illinoian Glasford; and Pre-Illinoian Wolf Creek and Alburnett. Hudson age deposits associated with fine-grained alluvial, organic, and colluvial sediments include the DeForest Formation which is subdivided into the Camp Creek, Roberts Creek, Gunder, and Corrington members. The Noah Creek Formation includes coarse sand and gravel associated with outwash from the Des Moines Lobe. Loess deposits include both Peoria and Pisgah formation silt that are present mantling the upland till units and high terraces. On the high terraces, the Peoria Formation grades downward to eolian sand. Eolian deposits are found intermittently on Holocene terraces. The only Illinoian till unit present in Iowa is the Glasford Formation Kellerville Member. The primary work on these deposits was completed to the north of the current mapping area. Although numerous drill holes in the previous study suggested a supraglacial facies may be present, limited evidence was found in the current study. Illinoian till is found on the east side of the moraine and consists of uniform dense till. Pre-Illinoian glacial deposits are found throughout the mapping area and consist of two formations: the younger Wolf Creek Formation and the Alburnett Formation. The Wolf Creek Formation is divided into the Winthrop, Aurora, and Hickory Hills members (oldest to youngest). The Alburnett Formation consists of several “undifferentiated” members. Pre-Illinoian tills are the uppermost till unit in the western portion of the Lowell Quadrangle.

Four bedrock mapping units (Pennsylvanian lower Cherokee Group; and the Mississippian Pella and “St. Louis”, Warsaw, and Keokuk formations) are exposed at the bedrock surface in the Lowell Quadrangle. The Mississippian Pella and “St Louis” formations and the Pennsylvanian lower Cherokee Group comprise the bedrock in most of the map area, especially in the upland areas. The other Mississippian units occur within the bedrock valleys and tributaries. Seventeen rock outcrops and three quarries are located in the map area and were investigated in the field. Bedrock exposures or rock present within one to two meters (7 ft) of the land surface are designated as ‘Qbr’ on the map. Specific bedrock units are shown on the cross-section and defined in the legend. For detailed bedrock information see The Bedrock Geologic Map of the Lowell 7.5’ Quadrangle (Clark et al., 2017).

Recent studies and mapping indicate that the map area encompasses a complex suite of depositional landforms and sediment sequences related to glaciations, alluviation, subaerial erosion, and wind-blown transport. To map diverse landscapes at 1:100,000 scale, we have selected the most comprehensive mapping strategy- a landform sediment assemblage (LSA) approach. Various landforms are the result of specific processes at work in the geologic system. Landforms typically have similar relief, stratigraphic and sedimentologic characteristics. Recognition of the genetic relationship among landforms and their underlying sediment sequences allows one to generalize and map complex glacial terrains over areas of large extent (Sugden and John, 1976; Eyles and Menzies, 1983). Bettis and others (1999) found that LSA

mapping concepts were extremely useful in overcoming the difficulties of mapping in large valleys and noted that LSA's provided a unique opportunity to associate landforms with their underlying sediment packages. Eleven landform sediment assemblage units were identified in the map area utilizing aerial imagery, topographic expression, digitized soils, LiDAR and existing and new subsurface geologic boring information. The following is a description of each landform sediment assemblage listed in order of episode:

HUDSON EPISODE

Qal - Alluvium (DeForest Formation-Undifferentiated) Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous to calcareous, stratified silty clay loam, clay loam, loam to sandy loam alluvium and colluvium in stream valleys, on hill slopes and in closed depressions. May overlie Glasford or Pre-Illinoian formation glacial till, Peoria Formation loess or eolian sand, or Noah Creek Formation sand and gravel. Associated with low-relief modern floodplain, closed depressions, modern drainageways or toeslope positions on the landscape. Seasonal high water table and potential for frequent flooding.

Qallt - Low Terrace (DeForest Formation-Camp Creek and Roberts Creek members) Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous, stratified silty clay loam, loam, or clay loam, associated with the modern channel belt of the Skunk River and Big Creek. Overlies Noah Creek Formation sand and gravel. Occupies the lowest position on the floodplain ie. modern channel belts. Seasonal high water table and frequent flooding potential.

Qali-ht - Intermediate-High Terrace (DeForest Formation-Gunder Member) Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous, silty clay loam to loam alluvium or colluvium. Overlies Noah Creek Formation sand and gravel along the Skunk River and Big Creek. Occupies terrace and valley margin positions 1 to 2 m (3-7 ft) above the modern floodplain. Two terrace levels are present in some areas. Seasonal high water table and low to moderate flooding potential.

WISCONSIN EPISODE

Qnw - Sand and Gravel (Noah Creek Formation) Generally 3 to 9 m (10-30 ft), but may be up to 15 m (50 ft), of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel with few intervening layers of silty clay. This unit is buried by younger Hudson-age alluvial deposits associated with the Skunk River valley and encompasses deposits that accumulated in river valleys during the Wisconsin Episode. This unit is shown only on the cross-section.

Qpt - Loess Mantled Terrace (Peoria Formation-silt and/or sand facies) 2 to 7 m (7-23 ft) of yellowish brown to gray, massive, jointed, calcareous or noncalcareous, silt loam and intercalated fine to medium, well sorted, sand. May grade downward to poorly to moderately well sorted, moderately to well stratified, coarse to fine feldspathic quartz sand, loam, or silt loam alluvium (Late Phase High Terrace) or may overlie a Farmdale Geosol developed in Pisgah Silt which in turn overlies a well-expressed Sangamon Geosol developed in poorly to moderately well sorted, moderately to well stratified, coarse to fine sand, loam, or silt loam alluvium (Early Phase High Terrace).

Qpt-eq - Loess Mantled Terrace Over Slackwater Deposits (Peoria Formation-silt and/or sand facies) 3 to 10 m (10-30 ft) of yellowish brown to gray, massive, jointed, calcareous or noncalcareous, silt loam and intercalated fine to medium, well sorted, sand. Grades downward to poorly to moderately well sorted, moderately to well stratified, coarse to fine feldspathic quartz sand, loam, or silt loam alluvium (Noah

Creek Formation). Overlies uniform to laminated, gray, non-calcareous, silt, silty-clay or very fine sand with occasional organic debris. This silty unit represents slackwater deposits associated with a time of high flow in the Mississippi River during the Wisconsin Episode and is equivalent to the Equality Formation recognized in Illinois.

Qps - Loess (Peoria Formation-silt facies) Generally 2 to 5 m (7-15 ft) of yellowish to grayish brown, massive, jointed calcareous or noncalcareous silt loam to silty clay loam. May overlie a grayish brown to olive gray silty clay loam to silty clay (Pisgah Formation- eroded Farmdale Geosol) which is less than 1.5 m (5 ft) thick. The Pisgah Formation is in the same stratigraphic position as the Roxanna Silt which is mapped in Illinois. The Farmdale Geosol may be welded to an older Sangamon Geosol developed in loamy glacial till of the Wolf Creek or Alburnett formations. This mapping unit encompasses upland divides, ridgetops and convex sideslopes. Well to somewhat poorly drained landscape.

Qps-gla - Loess (Peoria Formation-silt facies) Generally 2 to 5 m (7-15 ft) of yellowish to grayish brown, massive, jointed, calcareous or noncalcareous silt loam to silty clay loam. May overlie a grayish brown to olive gray silty clay loam to silty clay (Pisgah Formation- eroded Farmdale Geosol) which is less than 1.5 m (5 ft) thick. The Pisgah Formation is in the same stratigraphic position as the Roxanna Silt which is mapped in Illinois. The Farmdale Geosol may be welded to an older Sangamon Geosol developed in loamy glacial till of the Glasford Formation. This mapping unit encompasses upland divides, ridgetops and convex sideslopes. Well to somewhat poorly drained landscape.

ILLINOIS EPISODE

Qgla - Till (Glasford Formation) Generally 3 to 10 m (10-33 ft) of very dense, massive, fractured, loamy glacial till of the Illinoian Glasford Formation with or without a thin loess mantle (Peoria Formation- less than 2 m) and intervening clayey Farmdale/Sangamon Geosol. Overlies the Yarmouth Paleosol formed in Pre-Illinoian till. This mapping unit encompasses narrowly dissected interfluves and side slopes, and side valley slopes. Drainage is variable from well drained to poorly drained.

PRE-ILLINOIS EPISODE

Qwa3 - Till (Wolf Creek or Alburnett formations) Generally 10 to 35 m (33-115 ft) of very dense, massive, fractured, loamy glacial till of the Wolf Creek or Alburnett formations with or without a thin loess mantle (Peoria Formation- less than 2 m) and intervening clayey Farmdale/Sangamon Geosol. This mapping unit encompasses narrowly dissected interfluves and side slopes, and side valley slopes. Drainage is variable from well drained to poorly drained.

OTHER MAPPING UNITS

Qbr - Loamy Sediments Shallow to Dolomite, Limestone, Shale and Sandstone (DeForest, Noah Creek, Peoria, Glasford, Wolf Creek, and Alburnett formations) - 1 to 2 m (3-7 ft) of yellowish brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandy and silty sediments that overlie the Pennsylvanian or Mississippian bedrock surface. All areas of bedrock outcrop or shallow to bedrock soils are shown in red on the map, regardless of the bedrock mapping unit. Bedrock units are shown on the cross-section and may be identified on the bedrock map of the Lowell Quadrangle.

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