SUMMARY REPORT OF THE SURFICIAL GEOLOGIC MAP OF THE SPERRY 7.5' QUADRANGLE, DES MOINES COUNTY, IOWA

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INTRODUCTION

The 'Surficial Geologic Map of the Sperry 7.5' Quadrangle, Des Moines County, Iowa' is the second phase of surficial geologic mapping in southeast Iowa. A bedrock geologic map was also produced in conjunction with the surficial geologic map (Clark et al., 2018). The Sperry Quadrangle covers an area from 40° 52' 30" to 41° 00' N latitude and 91° 15' to 91° 07' 30" W longitude. The Sperry 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 fine to coarse grained alluvial deposits within Flint Creek 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 for the Illinoian glacial advance is six to eight miles west of the mapping area. The thickness of Quaternary materials varies widely across the quadrangle, generally ranging from 5 to 20 m (15-66 ft) and reaching a maximum thickness of 110 m (360 ft) in the southeastern part. Bedrock outcrops are limited in the map area, occurring along Big Hollow Creek, Yellow Spring Creek, and tributaries to Flint Creek.

Mapping the Lowell and Danville quadrangles (Tassier-Surine et al., 2017a,b) provided the first study of the regional Quaternary stratigraphy of southeast Iowa in almost 40 years when Hallberg (1980a,b) established the stratigraphy for the Illinoian and Pre-Illinoian glacial advances in eastern and southeastern Iowa. Three of the drill cores and outcrops for those studies were located in the northern portion of the Sperry Quadrangle and provided a framework for data analysis. 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.

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 identification and protection, and land use planning and development.

From a Quaternary perspective, characterizing the Illinoian glacial till deposits and establishing the loess thickness were primary objectives of the surficial map. The map area also includes Flint Creek, which drains into the Mississippi River and has very limited geologic information. Mapping helped to further delineate alluvial terraces, as well as characterize the Post-Illinoian materials associated with this creek. Bedrock mapping efforts were successful in subdividing the Mississippian Augusta Group mapping unit used by Witzke and others (2010). No Pennsylvanian outliers were identified on the Sperry Quadrangle.

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, between 190,000-130,000 years ago (Curry et al., 2011). The Sperry 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 Illinos Episode till present in Iowa is the Glasford Formation Kellerville 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. Illinoian till is 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 terraces in Flint Creek. 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 four meters (12 ft).

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 Flint Creek. Both an intermediate and high Holocene terrace may be present, and occur several meters above the modern floodplain. Due to the difficulty of differentiating these terraces, they were combined into one mapping unit. Coarse sand and gravel deposits, ranging in thickness from two to five meters (6-16 ft) are found below the Holocene alluvial units in Flint Creek. The age of these deposits is unknown, but they are younger than the Illinoian deposits and are always overlain by Holocene alluvium.

METHODS

Numerous existing sources of geologic information were utilized in the production of the surficial and bedrock geologic maps of the Sperry 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 reposited at the IGS and stored in the IGS online GeoSam database. Over 110 public and private wells in GeoSam, including strip logs, were reviewed for lithology, stratigraphy and locational accuracy, and updated where needed. NRCS digitized soils data (Brown, 1983) 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 survey to help delineate areas of shallow rock outcrop prior to field reconnaissance. New geologic information was obtained from field investigations of eight outcrops and logging of well cutting samples for 17 unstudied wells totaling 3,636 feet. Quaternary geologists utilized the IGS Giddings truck mounted probe to drill a mix of solid stem and continuous core holes. Nine new drill holes totaling 286 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 July, 2018. Project geologists combined information from the sources listed above to delineate surficial geologic mapping units at 1:24,000 scale for the Sperry Quadrangle. IGS mappers used ArcGIS and on-screen digitizing techniques developed during previous STATEMAP projects. The final map entitled 'Surficial Geologic Map of the Sperry 7.5' Quadrangle, Des Moines County, 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 six formations (youngest to oldest): Hudson DeForest; Wisconsin Peoria and Pisgah; 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. Loess deposits include both Peoria and Pisgah formation silt that are present mantling the upland till units and 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 mapping. Illinoian glacial sediments are found throughout the mapping area and consist of uniform dense till. Pre-Illinoian glacial deposits are not exposed at the surface, but are present at depth 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.

Two bedrock mapping units, the Mississippian Keokuk and Burlington formations, are exposed at the surface in the Sperry Quadrangle. Four additional units are mapped on the bedrock surface in the quadrangle (Mississippian Kinderhookian formations and the Devonian English River, Saverton Shale, and Grassy Creek formations). 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. See Clark and others (2018) for a detailed bedrock geologic map of the Sperry Quadrangle.

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. Eight 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 Formation glacial till, Peoria Formation loess or eolian sand, or post-Illinoian sand and gravel. Associated with low-relief modern floodplains, 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 Flint Creek. Overlies post-Illinoian 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-Roberts Creek and Gunder members) 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 post-Illinoian sand and gravel along Flint Creek. Occupies terrace and valley margin positions 1 to 2 m (3-7 ft) above the modern floodplain. Seasonal high water table and low to moderate flooding potential.

WISCONSIN EPISODE

Qptlp - Late Phase High Terrace (LPHT) (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. Grades downward to poorly to moderately well sorted, moderately to well stratified, coarse to fine feldspathic quartz sand, loam, or silt loam alluvium.

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. Drainage is variable from well drained to poorly drained.

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 thick) 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 moderately well drained to poorly drained.

PRE-ILLINOIS EPISODE

Qwa3 - Till (Wolf Creek or Alburnett formations) Generally 5 to 20 m (16-66 ft) of very dense, massive, fractured, loamy glacial till of the Wolf Creek or Alburnett formations. The Yarmouth Paleosol is formed in this unit, and it is overlain by Illinoian deposits. Drainage is variable from moderately well drained to poorly drained. This unit is shown only on the cross-section.

Qbr - Loamy Sediments Shallow to Dolomite, Limestone, Shale and Sandstone (DeForest, Peoria, and Glasford 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 Mississippian and Devonian 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 Sperry Quadrangle.

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