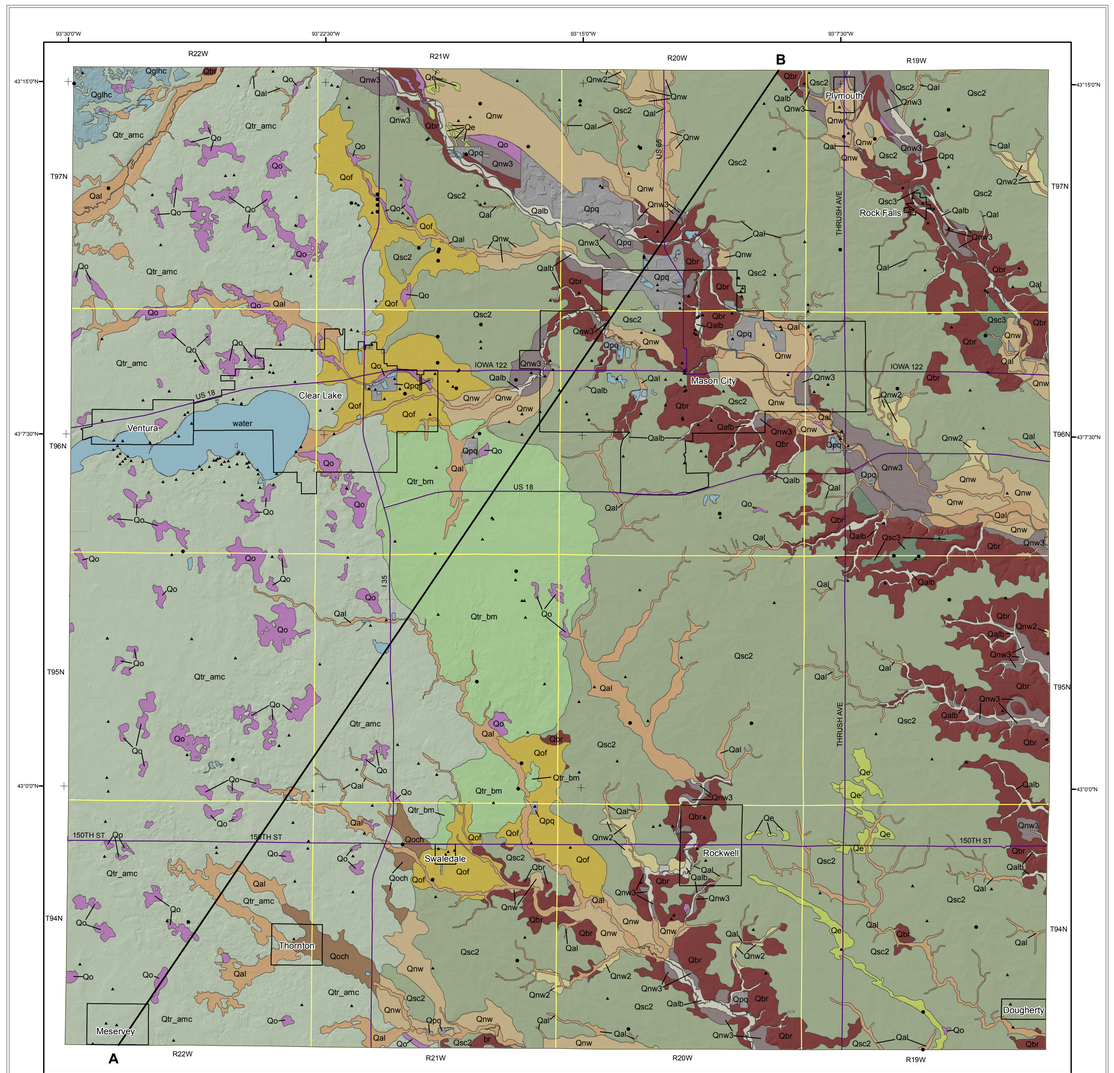
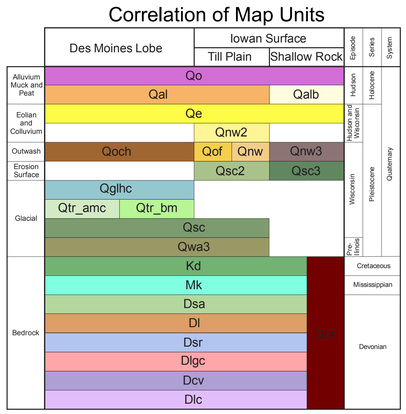
Surficial Geology of Cerro Gordo County, Iowa



Correlation of Map Units

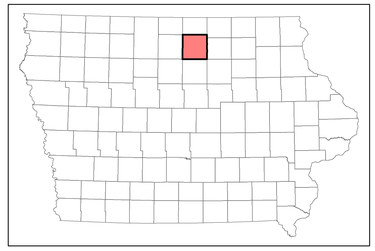


1:100,000

0 1 2 4 6 8 Miles

0 1 2 4 6 8 Kilometers

Location Map



MN

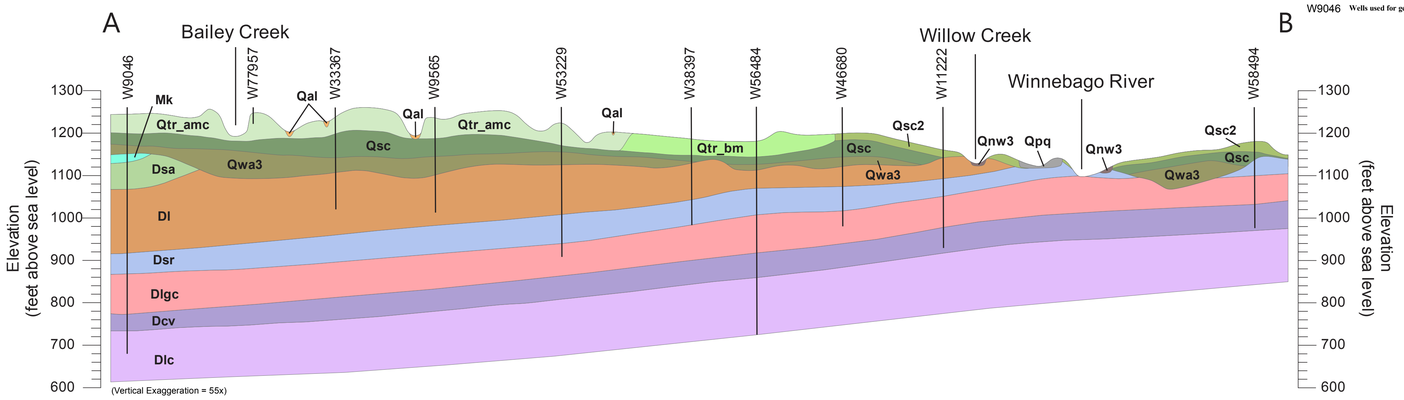
GN

0°11´ 3 MILS

0°0´ 0 MILS

UTM GRID AND 2015 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

GEOLOGIC CROSS-SECTION A-B



LEGEND

CENOZOIC

QUATERNARY SYSTEM

HUDSON EPISODE

Qo – Depressions (DeForest Formation- Woden Member) - Generally 2.5 to 6 m (8-20 ft) of black to very dark gray, calcareous, muck, peat and silty clay loam colluvium and organic sediments in drained and undrained closed and semi-closed depressions. Overlies gray, calcareous, loam diamicton (Dows, Sheldon Creek, Wolf Creek, or Alburnett formations) or Noah Creek Formation sand and gravel. Associated with low relief features that occupy depressions and low sags on the landscape. Supports wetland vegetation and can be permanently covered by water. High water table. *This unit is too thin to be shown on the cross-section.*

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, massive to stratified silty clay loam, clay loam, loam to sandy loam alluvium and colluvium in stream valleys, on hillslopes and in closed depressions. May overlie the Noah Creek, Dows, Sheldon Creek, Wolf Creek, or Alburnett formations or fractured Devonian carbonate bedrock. 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.

Qalb - Alluvium Shallow to Bedrock (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 hillslopes and in closed depressions. May overlie the Noah Creek Formation or Devonian carbonate bedrock. Bedrock surface is within 5 m (16 ft) of the land surface. 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. *This unit is too thin to be shown on the cross-section.*

HUDSON and WISCONSIN EPISODES

Qe - Sand Dunes and Sand Sheets (Peoria Formation- sand facies) - Generally less than 3 m (10 ft) of yellowish brown, massive, calcareous loamy sand to fine sand. It may overlie yellowish-brown coarse-grained sand and gravel (Noah Creek Formation), or it may overlie yellowish to grayish brown, usually calcareous, stratified loam to silt loam to sandy loam diamicton (Sheldon Creek, Wolf Creek, or Alburnett formations). Usually restricted to a narrow belt along major river valley bottoms, adjacent uplands, or may occur as sand stringers or dunes overlying unnamed erosion surface loamy sediments.

Qnw2 - Sand and Gravel (Noah Creek Formation) - 2 to 12 m (7-40 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. Along many valleys a thin mantle of loess, reworked loess, or fine-grained alluvium (Qal) may be present. This unit includes silty colluvial deposits derived from the adjacent map units. In places this unit is mantled with 1 to 3 m (3-10 ft) of well sorted fine to medium sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in low-relief stream valleys during the Wisconsin and Hudson episodes. Seasonal high water table and some potential for flooding.

WISCONSIN EPISODE

Qglhc - Collapsed Lake Sediments-hummocky isolated ice-walled lake plains (flat-topped hummocks) (Dows Formation- Lake Mills or Morgan members) - Generally less than 3 m (10 ft) of dark grayish brown, massive, calcareous silty clay loam to silt loam; often overlying a thin basal increment of sand and gravel (<1 m). It overlies yellowish to grayish brown, usually calcareous, stratified loam to silt loam to sandy loam diamicton; textures can be quite variable (Dows Formation- Morgan Member). Isolated ice-walled lake plains comprise a portion of the Des Moines Lobe. Other hummocks consist of less than 15 m (49 ft) of yellowish to grayish brown usually calcareous, stratified loam to silt loam to sandy loam diamicton (Dows Formation- Morgan Member). Overlies gray, calcareous, massive, dense loam diamicton (Dows Formation- Alden Member). Moderate to high relief hummocky landform area with 3 to 10 m (10-33 ft) of local relief.

Qnw - Sand and Gravel (Noah Creek Formation) - Generally less than 10 m (33 ft), but there may be significantly thinner coarse-grained deposits in smaller stream valleys. Yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. In the map area the unit usually overlies the middle Wisconsin-age Sheldon Creek Formation, but may overlie Pre-Illinoian Episode diamicton of the Wolf Creek or Alburnett formations in isolated areas. This unit encompasses outwash deposits that accumulated in valley trains during the Wisconsin Episode.

Qnw3 - Sand and Gravel Shallow to Bedrock (Noah Creek Formation) - 1 to 3 m (3-10 ft) of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. May be overlain by up to 2 m (7 ft) of silty alluvial material. In places mantled with fine to medium well-sorted feldspathic quartz sand derived from wind reworking of the alluvium. Fractured carbonate bedrock is less than 5 m (16 ft) below the land surface. The unit encompasses deposits that accumulated in river and stream valleys during the late Wisconsin as well as exhumed Pre-Illinoian Episode deposits of the Wolf Creek and Alburnett formations.

Qoch - Valley Train Outwash (Noah Creek Formation) - Generally 3 to 8 m (10-26 ft) of dark gray, dark grayish brown, dark brown to dark yellowish brown, medium to coarse sand, gravelly sand to pebbly gravel. Overlies gray, calcareous, massive, dense loam diamicton (Dows Formation- Alden Member). In valley positions, it is at the land surface of older terraces. On the modern floodplain it is buried by DeForest Formation alluvium. Low-relief landforms expressed as broad terraces; long, narrow longitudinal terraces; or cuspate-shaped point terraces. Terraces associated with the major valleys are benched on a gray, calcareous, massive, dense loam diamicton (Dows Formation- Alden Member).

Qof - Outwash Fan (Noah Creek Formation) - Thickness can be quite variable from 3 to 12 m (10-39 ft) of yellowish-brown coarse-grained sand and gravel. May overlie gray, calcareous, massive, dense loam diamicton (Sheldon Creek Formation). Broad low-relief apron that gently slopes away from the moraine front. Seasonal high water table.

Qtr_amc - Till Ridge (Dows Formation- Morgan, Pilot Knob, or Lake Mills member) Generally 9 to 15 m (27-49 ft) of yellowish to grayish brown, usually calcareous and fractured, stratified loam to silt loam, stratified sands and gravels to sandy loam diamicton; textures can be quite variable. Overlies gray, calcareous, massive, dense loam diamicton (Dows Formation- Alden Member). The Alden Member in this mapping unit can extend to depths in excess of 25 meters (85 ft). This sediment package overlies the Sheldon Creek Formation diamicton. Moderate to high relief hummocky landform features exceed 3 to 10 meters (10-33 ft) of local relief. This mapping unit is characterized by moderate to high relief hummocks, esker and kame features and ice-walled lakes and is associated with the Altamont Moraine Complex. Seasonal high water table.

Qtr_bm - Till Ridge (Dows Formation- Morgan Member) - Generally 3 to 15 m (10-49 ft) of yellowish to grayish brown, usually calcareous and fractured, stratified loam to silt loam, stratified sands and gravels to sandy loam diamicton; textures can be quite variable. Overlies gray, calcareous, massive, dense loam diamicton (Dows Formation- Alden Member). The Alden Member in this mapping unit rarely extends to depths greater than 15 meters (49 ft) and overlies the Sheldon Creek Formation diamicton. At the DML margin, this landform may be mantled with a thin layer of Peoria Formation silt. Low to moderate relief hummocky landform features exceed 3 to 5 m (10-16 ft) of local relief. This mapping unit is associated with the Bemis Moraine. The surface topography is characterized by irregularly shaped patterns. Seasonal high water table.

Qsc2 - Loamy Sediments Shallow to Glacial Till (Unnamed erosion surface sediment) - 1 to 6 m (3-20 ft) of yellowish brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandy and silty erosion surface sediment. Map unit includes some areas mantled with less than 1 m (3 ft) of Peoria Formation (silt or sand facies). Overlies massive, fractured, slightly firm glacial till of the Sheldon Creek Formation. In general, the Sheldon Creek Formation is significantly thinner, and in some isolated areas may be absent, in the southeastern portion of the county.

Qsc - Glacial Till (Sheldon Creek Formation- Undifferentiated) - Generally 3 to 15 m (10-50 ft) of yellowish brown to gray, calcareous, fractured to massive clay loam; at depth this unit can be variably textured and contain significant sand and gravel bodies. The upper 3 m (10-20 ft) may be periglacially altered. This unit overlies Pre-Illinois diamicton or Devonian carbonate bedrock and is only shown on the cross-section. In general, the Sheldon Creek Formation is significantly thinner, and in some isolated areas may be absent, in the southeastern portion of the county.

Qsc3 - Loamy and Sandy Sediment Shallow to Rock (Unnamed erosion surface sediment) - Generally 1 to 6 m (3-20 ft) of yellowish brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandy and silty erosion surface sediment. Map unit includes some areas mantled with less than 3 m (10 ft) of Peoria Formation sand facies (eolian sand). Overlies fractured Devonian carbonate bedrock.

PRE-ILLINOIS EPISODE

Qwa3 - Till (Wolf Creek or Alburnett formations) - Generally 3 to 23 m (10-75 ft) of very dense, massive, fractured, loamy glacial till of the Wolf Creek or Alburnett formations. This mapping unit can be buried by glacial sediments (Sheldon Creek Formation), unnamed erosion surface sediments, loess or alluvium and is shown only on the cross-section.

OTHER MAPPING UNITS

Qbr – Loamy Sediments Shallow to Dolomite, Limestone, and Shale (DeForest, Noah Creek, and Sheldon Creek 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 alluvial sediments that overlie the Middle to Upper Devonian or "Mid" Cretaceous bedrock surface. All areas of bedrock outcrop or shallow to bedrock soils are shown in red on the map, without labels, regardless of the bedrock mapping unit. Bedrock units are shown only on the cross-section and may be identified on the bedrock map of Cerro Gordo County with the following descriptions:

MESOZOIC

CRETACEOUS SYSTEM

Kd – Sandstone, Mudstone, and Siderite Pellets (Dakota/Windrow Formation) "Mid"-Cretaceous. This map unit occurs as erosional outliers and is only found occasionally in well cuttings in the mapping area. The formation is characterized by reddish shaly sandstone with siderite pellets. The thickness of this unit is variable, but usually less than 6 m (20 ft).

PALEOZOIC

MISSISSIPPIAN SYSTEM

Mk – Limestone and Dolomite (Kinderhookian Stage) Lower Mississippian. This map unit includes Chapin and Maynes Creek formations occurring in the southwest corner of this map. Total thickness of this unit is about 9 m (30 ft) in the mapping area, characterized by limestone and dolomite with oolitic structure and abundant crinoid fossils. Cherty carbonate often occurs in the upper part of this unit.

DEVONIAN SYSTEM

Dsa – Shale, siltstone, Limestone, and Dolomite (Sheffield and Aplington formations) Upper Devonian. This map unit forms the bedrock surface in the southwest part of the map. Thickness of this unit varies between 9 m and 18 m (30-60 ft) in the mapping area. The Sheffield Formation consists of gray shale with minor amounts of dolomite, some layers contain geodes. The Aplington Formation is characterized by argillaceous dolomite with discontinuous beds of chert.

Dl – Shale, Limestone, and Dolomite (Lime Creek Formation) Upper Devonian. This map unit occupies most of the bedrock surface in the mapping area. Thickness of this unit usually varies between 0 and 22 m (0-73 ft), but can be up to 49 m (160 ft) in the southern part of the county. This unit can be subdivided into a lower part of calcareous shales and an upper part of limestone, dolomitic limestone, and dolomite. Thick yellowish siltstone is also reported in the southern part of the county.

Dsr - Limestone, Dolomite, and Shale (Shell Rock Formation) Upper Devonian. This map unit forms the bedrock surface in the northern part of the mapping area, usually with a thickness between 12 and 23 m (40-75 ft) in the mapping area. The unit is characterized by fossiliferous limestone, dolomitic limestone and dolomite, with some gray to light green shale and/or argillaceous carbonates. Layers containing abundant subspherical and tabular stromatoporoids commonly occur in the lower part of the unit. Brachiopods, bryozoans, corals, and crinoids are abundant in some intervals, especially in the upper part of the unit.

Dlgc - Dolomite, Limestone, and Shale (Lithograph City Formation) Middle to Upper Devonian. This map unit occurs as the bedrock surface along the Winnebago River and Shell Rock River and in a bedrock valley in the north-central part of the map. The maximum thickness of this unit is about 34 m (110 ft) in the mapping area. It consists of dolomite and dolomitic limestone, usually characterized by interbeds of laminated lithographic and sublithographic limestone and dolomitic limestone, in part argillaceous or with minor shale. "Birdseye," vugs and calcite vug-fills are common. Some intervals are fossiliferous and stromatoporoid-rich.

Dcv - Limestone and Dolomite (Coralville Formation) Middle Devonian. The thickness of this map unit varies between 11 and 18 m (35-60 ft). It is dominated by limestone, dolomitic limestone, and dolomite, in part, laminated and argillaceous. Brachiopods, echinoderm debris and corals usually occur in the limestone facies.

Dlc - Dolomite and Limestone (Little Cedar Formation) Middle Devonian. The thickness of this formation ranges from 27 to 46 m (90-150 ft) in the mapping area. This unit is dominated by slightly argillaceous to argillaceous dolomite and dolomitic limestone, usually vuggy and partially laminated and/or cherty. This unit is commonly fossiliferous, especially in the lower portion.

OTHER FEATURES

Qpq - Pits and Quarries - Sand and gravel pits and rock quarries. Extent mapped as shown in the county soil survey and as identified on aerial imagery.

Water Features - Rivers, lakes, and small ponds. Extent mapped as shown in the county soil survey and as identified on aerial imagery.

Roads

Cities

New Drill Holes for this map project

IGS GEOSAM Data Points- records available at www.iowageologicalsurvey.com

W9046 **Wells used for geologic cross-section**

Base map from Iowa DOT Road Map Layers 2006. Shaded relief from Iowa Lidar Project 2007-2011.

Iowa Geological Survey digital cartographic file CerroGordo_Co_SurficialGeology.mxd, version 6/30/15 (ArcGIS 10.3)
Map projection and coordinate system based on Universal Transverse Mercator (UTM) Zone 15 N, datum NAD83.

The map and cross section are based on interpretations of the best available information at the time of mapping. Map interpretations are not a substitute for detailed site specific studies.

Research supported by the U. S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G14AC00229. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.

SURFICIAL GEOLOGY OF CERRO GORDO COUNTY, IOWA

Iowa Geological Survey
Open File Map OFM-15-2
June 2015

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Iowa Geological Survey, IIHR-Hydroscience & Engineering, University of Iowa, Iowa City, Iowa

IOWA GEOLOGICAL SURVEY

Iowa Geological Survey, Robert D. Libra, State Geologist

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National Cooperative Geologic Mapping Program (STATEMAP)
Completed under contract with the Iowa Department of Natural Resources

The University of Iowa | IIHR Hydroscience & Engineering | DNR

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Introduction to the Surficial Geology of Cerro Gordo County, Iowa

Cerro Gordo County is located in north-central Iowa, straddling the eastern margin of the Late Wisconsin-age Des Moines Lobe (DML) landform region, the most recently glaciated region of the state, and the Wisconsin-age Iowan Surface (IS) landform region (Prior and Kohrt, 2006). The western part of the map area consists of a complex suite of depositional landforms and sediment sequences related to supraglacial, subglacial, and proglacial sediments associated with the advance of the DML. Within Cerro Gordo County, Quaternary deposits are typically less than 15 m (50 ft) on the IS, and reach a maximum thickness of 53 m (175 ft) on the DML. The Des Moines Lobe is characterized by hummocky terrain that forms arcuate belts of moraine complexes and undulating plains with thick increments of supraglacial sediment (>3 m). In the map area, the most notable features of the DML are the Bemis Moraine, the terminal moraine of the DML which is dated at approximately 14,500 to 14,000 years before present, and the slightly younger Altamont Moraine Complex which is dated at approximately 13,500 years before present. Supraglacial and proglacial sediments (coarse-grained glaciofluvial, ice-contact sediments associated with hummocky terrain, outwash fans, and channel deposits) encompass a large area of the eastern flank of the DML and are extensively mapped at the former ice margin and in the Winnebago and Shell Rock rivers, as well as in the Calmus, Willow, Beaverdam and Bailey creek valleys. The eastern portion of the map area is dominated by unnamed loamy sediments (IS materials) of variable thickness overlying Wisconsin-age Sheldon Creek Formation glacial sediments, Pre-Illinoian glacial sediments or shallow rock. Significant areas of bedrock outcrop or areas with less than 5 m (16 ft) of loamy material over rock are present, especially along the Winnebago, Shell Rock, and West Fork Cedar rivers, as well as Little Beaver, Rock, Beaver, Rapid, Beaverdam, East and West Branch Beaverdam, and Lillibridge creeks. The Winnebago River valley, which crosses the northeastern portion of the map area, was cut approximately 12,500 years before present during the catastrophic drainage of the younger Algona Moraine. The valley is dominated by a variable thickness 1 to 10 m (3 to 32 ft) of coarse grained outwash associated with the "last-gasp" drainage of the DML. The outwash thickness in the rest of the county is highly variable, ranging from 3 to 12 m (10 to 40 ft).

Calvin (1896) described and mapped the Quaternary and Paleozoic bedrock geology of Cerro Gordo County. He noted the extreme variability of the till units and also the presence of significant sand and gravel bodies. Statewide bedrock geologic maps by Hershey (1969), and most recently by Witzke et al. (2010), depict the increased understanding of the complex distribution of geologic units at the bedrock surface across north-central Iowa, including Cerro Gordo County. Kemmis (1991) undertook a systematic study of glacial landforms, sedimentology, and depositional environments of the northern Des Moines Lobe, and his study has served as the foundation for the development of a lithostratigraphic framework for DML deposits in Iowa. Previous surficial geologic mapping completed as part of the STATEMAP program in Cerro Gordo County includes Surficial Geology of the Clear Lake East Quadrangle (Quade et al., 2013), Surficial Geology of the Mason City Quadrangle (Tassier-Surine et al., 2014a), and Surficial Geology of the Nora Springs Quadrangle (Tassier-Surine et al., 2014b). Mapping adjacent to the project area includes Surficial Geology of Worth County, Iowa (Quade et al., 2012).

The map area has a rich and complex Quaternary geologic history punctuated by at least seven periods of glaciation between 2.6 million and 500,000 years ago (Boellstorff, 1978a,b; Hallberg, 1980, 1986). In this area, Pre-Illinoian Episode glacial deposits and associated buried soils are overlain by much younger Wisconsin-age glacial deposits, dating from approximately 40,000 to 26,000 years before present. In Iowa, this glacial deposit is formally recognized as the Sheldon Creek Formation (Bettis et al., 1996; Bettis, 1997) and in earlier literature is referred to as the "Tazewell till" (Ruhe, 1950). Results from this mapping program and others in Worth, Cerro Gordo, and Mitchell counties indicate that the Sheldon Creek glacial materials extend much farther east than was previously thought.

A period of intense cold occurred during the Wisconsin full glacial episode from 21,000 to 16,500 years ago (Bettis, 1989). This cold episode and ensuing upland erosion led to the development of the distinctive landform recognized as the IS (Prior, 1976). A periglacial environment prevailed during this period with intensive freeze-thaw action, solifluction, strong winds, and a host of other periglacial processes (Walters, 1996) resulting in surface soils being removed from the IS, as the Sheldon Creek and Pre-Illinoian till surface was significantly eroded. Thick packages of stratified loamy and sandy sediments located low in the upland landscape and adjacent to streams are remnants of solifluction lobes associated with the formation of the IS. These materials can be found along tributaries of the Winnebago and Shell Rock rivers, and Beaverdam Creek.

Shortly following the IS formation, the southern edge of the Laurentide Ice Sheet split into several lobes that each flowed down regional topographic lows. The DML extended from central Canada through the Dakotas and Minnesota into Iowa and was active in Iowa between about 15,000 and 12,000 radiocarbon years before present terminating at what is now the City of Des Moines. The DML advance occurred well into a period of regional warming (Kemmis et al., 1994), and ice thickness reconstructions indicate that the DML was probably thin and gently sloping (Mathews, 1974; Clark, 1992; Brevik, 2000; Hoover and Iverson, 2002). This ice advance was rapid and episodic, and was most likely fueled by basal lubrication; in other words, a warm-based, non-deforming bed glacier. These assumptions are backed up by evidence of numerous plants (Baker et al., 1986) and trees (Bettis et al., 1996) found near the base of the DML package. Furthermore, the complex landform sediment assemblages found on the DML in Iowa seem more indicative and explained by regional stagnation caused by a surging-type glacier, not rapid recession.

Surficial deposits in the map area are composed of seven formations: DeForest, Dows, Noah Creek, Peoria, Sheldon Creek, Wolf Creek, and Alburnett formations, as well as unnamed erosion surface sediments. The Hudson age DeForest Formation is composed of fine-grained alluvial, organic, and colluvial sediments, and is subdivided into the Camp Creek, Roberts Creek, Gunder, Corrington, Flack, and Woden members. The Dows Formation consists of upland glacial deposits and is subdivided into the Alden, Lake Mills, Morgan and Pilot Knob members. The Noah Creek Formation includes coarse sand and gravel associated with outwash from the DML, as well as coarse to finer grained fluvial deposits associated with local stream and river valleys. Unnamed erosion surface sediments consist of reworked till and slopewash deposits associated with periglacial activity during the Wisconsin ice advance. Areas of Peoria Formation eolian materials are intermittently present mantling most other mapping units, and are more abundant near stream valleys. Sheldon Creek Formation glacial deposits are undifferentiated and occur in northwest and north-central Iowa. The maximum extent of these deposits is still not fully understood. Pre-Illinoian glacial deposits in Iowa 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.

Bedrock outcrops occur along most rivers and creeks on the Iowan Surface. More than 150 rock outcrops including quarries are located in the map area and were investigated in the field. Four bedrock mapping units (Devonian Sheffield/Aplington, Lime Creek, Shell Rock, and Lithograph City formations) are exposed at the surface in Cerro Gordo County, with the Lime Creek and Shell Rock formations comprising most of the outcrop in the map area. These Devonian rocks are dominated by carbonates, varying between limestone and dolomite, and shale.

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