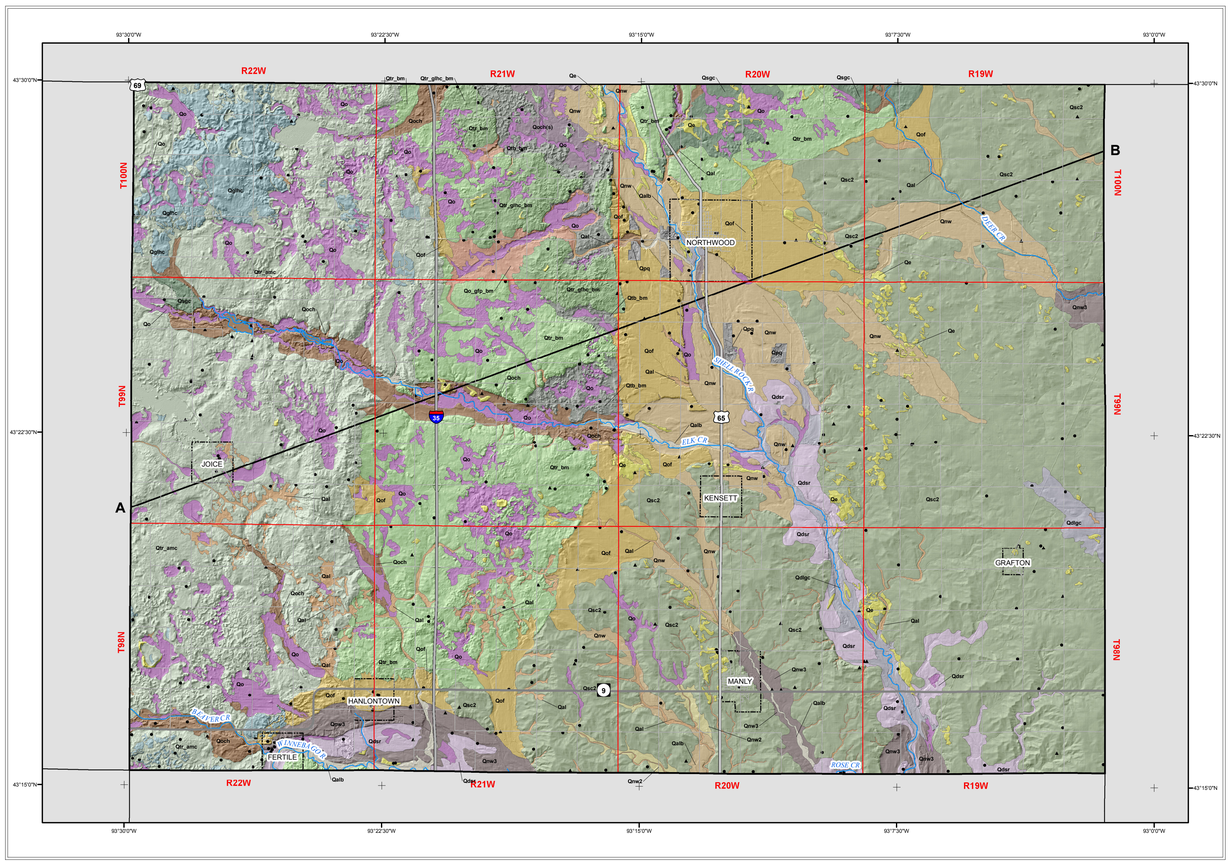
Surficial Geology of Worth County, Iowa



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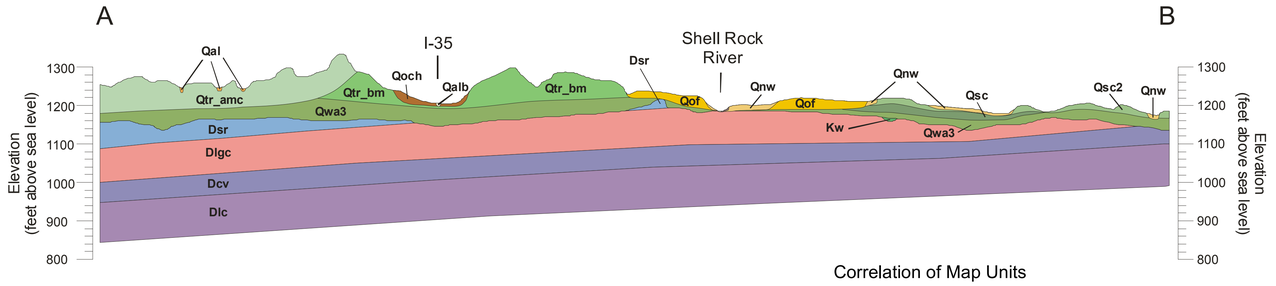
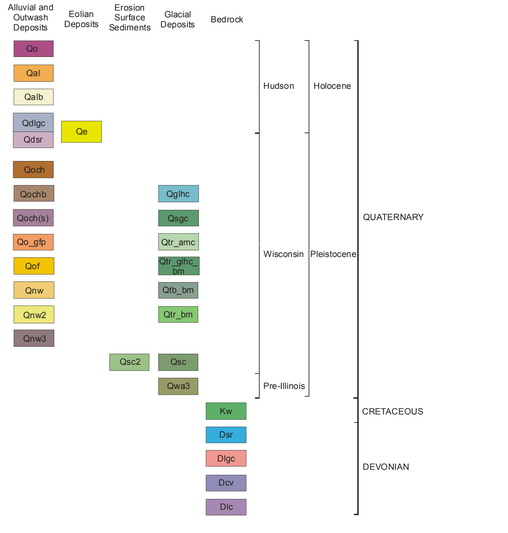
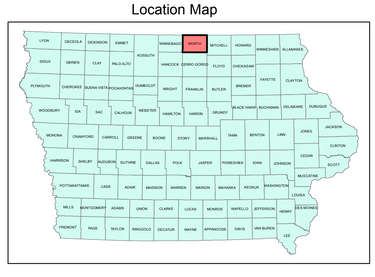
GEOLOGIC CROSS-SECTION A-B



Correlation of Map Units



Location Map



LEGEND

CENOZOIC

QUATERNARY SYSTEM

HUDSON EPISODE

Qo - Depressions (DeForest Formation-Woden Mbr.). Generally 2.5 to 6 m (8-20 ft) of black to very dark gray, calcareous, muck, peat, silty clay loam colluviums, and organic sediments in drained and undrained closed and semi-closed depressions. Overlies gray, calcareous, loam diamicton (Dows Fm.-Morgan Alden Mbr.) or Noah Creek Fm. sand and gravel or Sheldon Creek Fm. loam diamicton. 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.

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 Noah Creek Formation, Wolf Creek or Albumett 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 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.

HUDSON and WISCONSIN EPISODE

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 Fm.) or it may overlie yellowish to grayish brown, usually calcareous, stratified loam to silt loam to sandy loam diamicton (Dows Fm-Morgan Mbr.). Usually restricted to a narrow belt along major river valley bottoms or adjacent uplands on the Des Moines Lobe. Of the Des Moines Lobe this unit is not restricted to dunes along valley areas and may occur as sand stringers overlying unmapped erosion surface loamy sediments.

Qdsr - Loamy Sediments Shallow to Limestone, Dolomite, and Shale (DeForest-Noah Creek-Shell Rock Formation). 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 sediment that overlies the Upper Devonian bedrock surface. This formation is the major top bedrock unit in the quad, the maximum thickness of this map unit is up to 3.3 m (10.8 ft), consisting of dolomitic and dolomitic limestone, partially characterized by interbeds of unfossiliferous to sparsely fossiliferous laminated lithographic and sublithographic limestone and dolomitic limestone, in part argillaceous or with slight shale. "Birdseye" carbonate fabric is common in some layers.

WISCONSIN EPISODE

Qglhc- Collapsed lake sediments-hummocky isolated ice-walled lake plains (flat-topped hummocks) (Dows Formation-Lake Mills Mbr./ Morgan Mbr.) Generally less than 3 m (10 ft) of dark gray-ish 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 Fm.–Morgan Mbr.). Isolated ice-walled lake plains comprise a portion of this landform area. Other hummocks consist of less than 1.5 m of yellowish to grayish brown usually calcareous, stratified loam to silt loam to sandy loam diamicton (Dows Fm.–Morgan Mbr.). Overlies gray, calcareous, massive, dense loam diamicton (Dows Fm.– Alden Mbr.). Moderate to high relief hummocky landform area with 3 to 10 m (10 to 32 ft) of local relief.

Qnw - Sand and Gravel (Noah Creek Formation) Generally less than 8 m (26 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 overlies middle Wisconsin-age Sheldon Creek Fm. This unit encompasses outwash deposits that accumulated in valley trains during the Wisconsin Episode.

Qnw2 - Sand and Gravel (Noah Creek Formation) 2 to 12 m (7 to 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 uplands. In places this unit is mantled with 1 to 3 m (3-10 ft) of fine to medium, well-sorted medium to fine sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in low-relief stream valleys during the Wisconsin Episode and Holocene Episode. Seasonal high water table and some potential for flooding.

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-Illinois Episode deposits of the Wolf Creek and Albumett formations.

Qo_gfp_bm - Complex glaciofluvial plain (Noah Creek Formation). Greater than 3m but less than 15 m (10 ft but less than 48 ft) of grayish brown, often calcareous, stratified sand and gravel. Overlies gray, calcareous, massive, dense loam diamicton (Dows Fm.-Alden Mbr. or Sheldon Creek Fm) or in several locations Paleozoic limestone bedrock. It may have sand and gravel at the land surface. Indepressions and sags it may be buried by several meters of Deforest Fm-Woden Mbr. This area is associated with lows and sags on the Bemis Moraine.

Qoch - Valley train outwash (Noah Creek Formation). Generally 3 m (10 ft) to less than 8 m (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 Fm-Alden Mbr.). In valley positions, it is at the land surface of older terraces. On the modern floodplain it is buried by DeForest Fm alluvium. Low-relief landforms expressed as broad terraces, long, narrow longitudinal terraces or cuspate-shaped point terraces. Terrace associated with the major valleys are benched on a gray, calcareous, massive, dense loam diamicton (Dows Fm.-Alden Mbr.).

Qochb - Valley train outwash shallow to bedrock (Noah Creek Formation). Generally 1 to 5 meters (3 to 16 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 Fm-Alden Mbr.). It is at the land surface of older terraces. On the modern floodplain it is buried by DeForest Fm. alluvium. Low-relief landforms expressed as broad terraces; long, narrow longitudinal terraces or cuspate-shaped point terraces. Unit is benched on Upper Devonian age Shell Rock Formation limestone, dolomites or shale.

Qoch(s) - Shallow later deposits overlying valley train outwash (Noah Creek Formation-silt facies). Generally less than 3 meters (10 ft) of dark grayish brown to yellowish brown, massive to laminated, calcareous silt loam. Unit overlies < 5 meters of dark gray, dark grayish brown, dark brown to dark yellowish brown medium to coarse sand, gravelly sand to pebbly gravel. Low-relief landforms expressed as broad terraces, long, narrow longitudinal terraces or cuspate-shaped point terraces. Unit is benched on a gray, calcareous, massive, dense loam diamicton (Dows Fm-Alden Mbr.). No flooding potential.

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 (Dows Fm.-Alden Mbr. or Sheldon Creek Fm.). Broad low-relief apron that gently slopes away from the moraine front. Seasonal high water table.

Qsgc - Supraglacial complex (Dows Formation-Pilot Knob Mbr./ Morgan Mbr.) Greater than 3 m (10 ft) but less than 15 m (49 ft) of yellowish brown, often calcareous and fractured, stratified sand and gravel with interbedded stratified loam diamicton. Collapse features are usually evident. In depressions and sags on upland surfaces, fine sand and gravel may be buried by DeForest Fm.-Woden Mbr. Overlies gray, calcareous, massive, dense loam diamicton (Dows fm. – Alden Mbr.). Moderate to high relief 3 to 8 m (10 to 26 ft) hummocks, beaded ridges, kames and associated linked drainages on upland surfaces.

Qtr_glhc_bm - Collapsed lake sediments - hummocky isolated ice-walled lake plains to flat-topped hummocks-- (Dows Formation-Lake Mills Mbr./ Morgan Mbr.). Generally less than 3 m (10 ft) of dark grayish brown, massive, calcareous silty clay loam, to silt loam overlying a thin basal increment of sand and gravel (<1 m or 3 ft). It overlies yellowish to grayish brown usually calcareous, stratified loam to silt loam to sandy loam diamicton; textures can be quite variable (Dows Fm-Morgan Mbr) and Alden Mbr from 9 to 4.0 m thick (27 to 128 ft). Isolated ice-walled lake plains comprise a portion of this landform area. Other hummocks consist of less than 4 m of yellowish to grayish brown usually calcareous, stratified loam to silt loam to sandy loam diamicton (Dows Fm-Morgan Mbr.). Overlies a gray, calcareous, massive, dense loam diamicton (Dows Fm.– Alden Mbr.). Moderate to high relief hummocky landform area with 3 to 10 m (10 to 32 ft) of local relief. These features are usually associated with the Altamont Moraine Complex but in the map area are present on the Bemis Moraine. Seasonal high water table.

Qtr_amc - Till ridge (Dows Formation-Morgan Mbr. or Pilot Knob Mbr or Lake Mills Mbr.). Generally 9 to 15 meters (27 to 49 ft) of yellowish to grayish brown, usually calcareous and fractured, stratified loam to silt loam; stratified sands and gravels to sandy loam diamicton; texture can be quite variable. Overlies gray, calcareous, massive, dense loam diamicton (Dows fm.-Alden Mbr.). The Alden Mbr. 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 to 32 ft) of local relief. This landform 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.

Qtb_bm - Till bench (Dows Formation-Morgan Mbr. or Pilot Knob Mbr or Lake Mills Mbr.). Generally 9 to 20 meters (27 to 64 ft) of yellowish to grayish brown, usually calcareous and fractured, stratified loam to silt loam; stratified sands and gravels to sandy loam diamicton; texture can be quite variable. Overlies gray, calcareous, massive, dense loam diamicton (Dows Fm.- Alden Mbr.). The Alden Mbr. in this mapping unit can extend to depths in excess of 25 meters (64 ft). This sediment package overlies the Sheldon Creek Formation diamicton. The bench cut into the Bemis Moraine surface at an elevation of approximately 1250 feet. Appears to be related to a meltwater release associated with the younger Altamont Moraine Complex. Moderate relief hummocky landform features exceed 3 to 6 m (10 to 20 ft) of local relief. This landform is characterized by moderate to high relief hummocks and ice-walled lakes; and is associated with the Altamont Moraine Complex. The surface pattern is primarily rounded circular to rounded irregularly shaped patterns. Seasonal high water table.

Qtr_bm - Till ridge (Dows formation-Morgan Mbr.). Generally 3 to 15 m (10 to 49 ft) of yellowish to grayish brown, usually calcareous and fractured, stratified loam to silt loam; stratified sands and gravels to sandy loam diamicton; texture can be quite variable. Overlies gray, calcareous, massive, dense loam diamicton (Dows Fm.-Alden Mbr.). The Alden Mbr. 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 to 16 ft) of local relief. This landform is associated with the Bemis Moraine. The surface pattern is irregularly shaped patterns. Seasonal high water table.

Qsc2 - Loamy Sediments Shallow to Glacial Till (Unnamed erosion surface sediment.) 1 to 3 m (3 to 10 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.

Qsc - Glacial Till (Sheldon Cr eek formation-undiff.). Generally 3 to 15 m (10 to 49 ft.) of a yellowish brown to gray, calcareous fractured to massive clay loam; at depth this unit can be variably textured and contains gnificant sand and gravel bodies. The upper 3 to 7 m (10 to 20 ft) may be periglacially altered. It is not uncommon to see few Pierre Shale clasts in core samples. The presence of unaltered Sheldon Creek till in the eastern portion of the county is questionable. This unit overlies Pre-Illinois diamicton and is only shown on the cross-section.

PRE-ILLINOIS EPISODE

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

MESOZOIC

CRETACEOUS SYSTEM

Kw – Sandstone, Mudstone, and Siderite Pellets (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 shly sandstone and mudstone or siderite pellets. Its thickness is variable, but usually less than 6 m (20 ft). This unit is shown only on the cross-section, not on the map.

PALEOZOIC

DEVONIAN SYSTEM

Dsr - Limestone, Dolomite, and Shale (Shell Rock Formation) Upper Devonian. This map unit usually has a thickness of 12 to 18 m (40-60 ft), and occurs in the southern part of the quad. The unit is characterized by fossiliferous carbonates, with some grey to light green shale. 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. This unit is shown only on the cross-section, not on the map.

Dlgc - Dolomite, Limestone, and Shale (Lithographic City Formation) Middle to Upper Devonian. This map unit forms the major uppermost bedrock in the quad, with a maximum thickness of up to 33 m (110 ft). This unit consists of dolomite and dolomitic limestone, partially characterized by interbeds of laminated lithographic and sublithographic limestone and dolomitic limestone, in part argillaceous or with slight shale. "Birdseye" structures are common. Some intervals are fossiliferous and stromatoporoid rich. This unit is shown only on the cross-section, not on the map.

Dcv - Limestone and Dolomite (Coralville Formation) Middle Devonian. The thickness of this map unit varies between 10 and 18 m (35-60 ft), and it is dominated by limestone, dolomitic limestone, and dolomite, in part laminated and argillaceous. Brachiopods and corals usually occur in the limestone facies This unit is shown only on the cross-section, not on the map.

Dlc - Dolomite and Limestone (Little Cedar Formation) Middle Devonian. The thickness of this map unit ranges from 27 to 35 m (90 ft 115 ft) in the county. The unit is dominated by slightly argillaceous to argillaceous dolomite and dolomitic limestone, usually vuggy and partially laminated and/or chetty. This unit is commonly fossiliferous, and brachiopods are especially abundant in the lower portion. This unit is shown only on the cross-section, not on the map.

Qpq - Pits and Quarries

▲ **Drill Holes**

● **Water Well Logs**

Base map from iowa DOT Road Map Layers 2009. Shaded relief from Iowa Lidar Project 2007-2011.

Iowa Geological and Water Survey digital cartographic file Worth_Co_SurficialGeology2012.mxd, version 9/28/12 (ArcGIS 10.0)
Map projection and coordinate system based on Universal Transverse Mercator (UTM) Zone 15, 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.

SURFICIAL GEOLOGY OF WORTH COUNTY, IOWA

Iowa Geological and Water Survey
Open File Map OFM-12-02
September 2012

prepared by

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Introduction to the Surficial Geology of Worth County, Iowa

Worth County lies in north-central Iowa and straddles the eastern margin of the Late Wisconsin-age Des Moines Lobe Landform (DML), the most recently glaciated region of the state and the Wisconsin-age Iowan Erosion Surface (IES) Landform Region (Prior and Kohrt, 2006). Generally speaking, in the western portion of the map area, the DML consists of a complex suite of depositional landforms and sediment sequences related to supraglacial, subglacial, and proglacial sedimentation. Quaternary deposits in this region can reach a maximum thickness of 59 m (195 ft). 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 noteable features of the DML are the Bemis Moraine, the terminal moraine of the DML which is dated at approximately 14,500 to 14,000 RCYBP (radiocarbon years before present), and the slightly younger Altamont Moraine Complex which is dated at approximately 13,500 RCYBP. 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 margins and in the Shell Rock River, Elk Creek and Winnebago River valleys. The eastern portion of the map area is dominated by unmanned loamy sediments (IES materials) of variable thickness overlying Wisconsin-age Sheldon Creek Fm glacial sediments, Pre-Illinoian glacial sediments or shallow rock. These deposits are regionally extensive and in this county, are on average less than 15 m (50 ft) in thickness. Significant areas of bedrock outcrop or areas with less than 5 m (15 ft) of loamy material over rock are present, especially along the Shell Rock River and Winnebago River valleys. Bisecting the eastern portion of the map area is the Shell Rock River valley. The valley is younger than the Bemis Moraine and was cut approximately 12,500 RCYBP during the catastrophic drainage of the younger Algona Moraine. The valley is dominated by a variable thickness of coarse-grained outwash associated with the "last-gasp" drainage of the DML.

Williams (1899) described and mapped the Quaternary and Paleozoic bedrock geology of the county and discussed the stratigraphy of Devonian strata that were exposed at the land surface. He also noted the extreme thinness of the "drift" along the Winnebago River and nearby Shell Rock River and the remarkable difference in surface features between the eastern and western portions of Worth County. Statewide bedrock geologic maps by Hershey (1969) and most recently by Witzke, Anderson, and Pope (2010), depict the increased understanding of the complex distribution of geologic units at the bedrock surface across this region, including Worth County. The only regional 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).

The map area has a rich and complex geologic history punctuated by at least seven periods of glaciation between 2.2 million to 500,000 years ago (Boellstorff, 1978a, b; Hallberg, 1980, 1986). In this area, Pre-Illinois Episode glacial deposits and associated buried soils are overlain by much younger Wisconsin-age glacial deposits. During earlier and mid Wisconsin-age, ice advances dating from approximately 40,000 to 26,000 years before present were deposited throughout the map area. 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). 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 IES (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). The result was that surface soils were removed from the IES, and the Sheldon Creek and Pre-Illinois till surface was significantly eroded, resulting in the development of a region-wide colluvial lag deposit referred to as a "stone line." Following the IES formation, the southern edge of the Laurentide Ice Sheet split into several lobes that each flowed down regional topographic lows. The Des Moines Lobe extended from central Canada through the Dakotas and Minnesota into Iowa, terminating at what is now the City of Des Moines. The Des Moines Lobe was active in Iowa between about 15,000 and 12,000 RCYBP, about 5,000 to 8,000 years later than glacial lobes to the east made their southermost maximum advance (Johnson, 1986; Fullerton, 1986). The Lobe advance occurred well into a period of regional warming and was thus climatically out of equilibrium (Kemmis et al., 1994). Ice thickness reconstructions indicate that the lobe was probably thin and gently sloping (Mathews, 1974; Clark, 1992; Brevik, 2000; Hooyer and Iverson, 2002). Clark (1992) reconstructed the Lobe's thickness near Ames, Iowa, at ~80 m (262 ft). More recently, ice reconstructions by Hooyer and Iverson (2000) were based on a model assuming the Bemis Moraine was ice-cored, which yielded ice thickness estimates of ~250 m (820 ft). Despite these variations, all agree that the Des Moines Lobe ice sheet was extremely thin and gently sloping. 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 of the map area are composed of seven formations: DeForest, Dows, Noah Creek, Peoria, Sheldon Creek, Wolf Creek, and Albumett formations, as well as unnamed erosion surface sediments. 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, 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 Des Moines Lobe. The Noah Creek Formation includes 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 present along the the Shell Rock River valley as well as stringers on the IES surface. Eolian materials may also be 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 full 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 Albumett Formation. The Wolf Creek is divided into the Winthrop, Aurora, and Hickory Hills members (oldest to youngest). The Albumett Formation consists of several "undifferentiated" members.

Two bedrock mapping units (Devonian Shell Rock and Lithograph City) are exposed as outcrop in the map area. Bedrock outcrops occur primarily along the Shell Rock River and to some extent along Elk Creek and the Winnebago River. The Devonian rocks are dominated by carbonates varying between limestone and dolomite, accompanied with minor shale. Based on lithologic features and fossils, uppermost bedrock of Devonian in the mapping area can be subdivided into, in descending order, the Shell Rock, Lithograph City, and Coralville formations (Witzke et al., 2010).

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