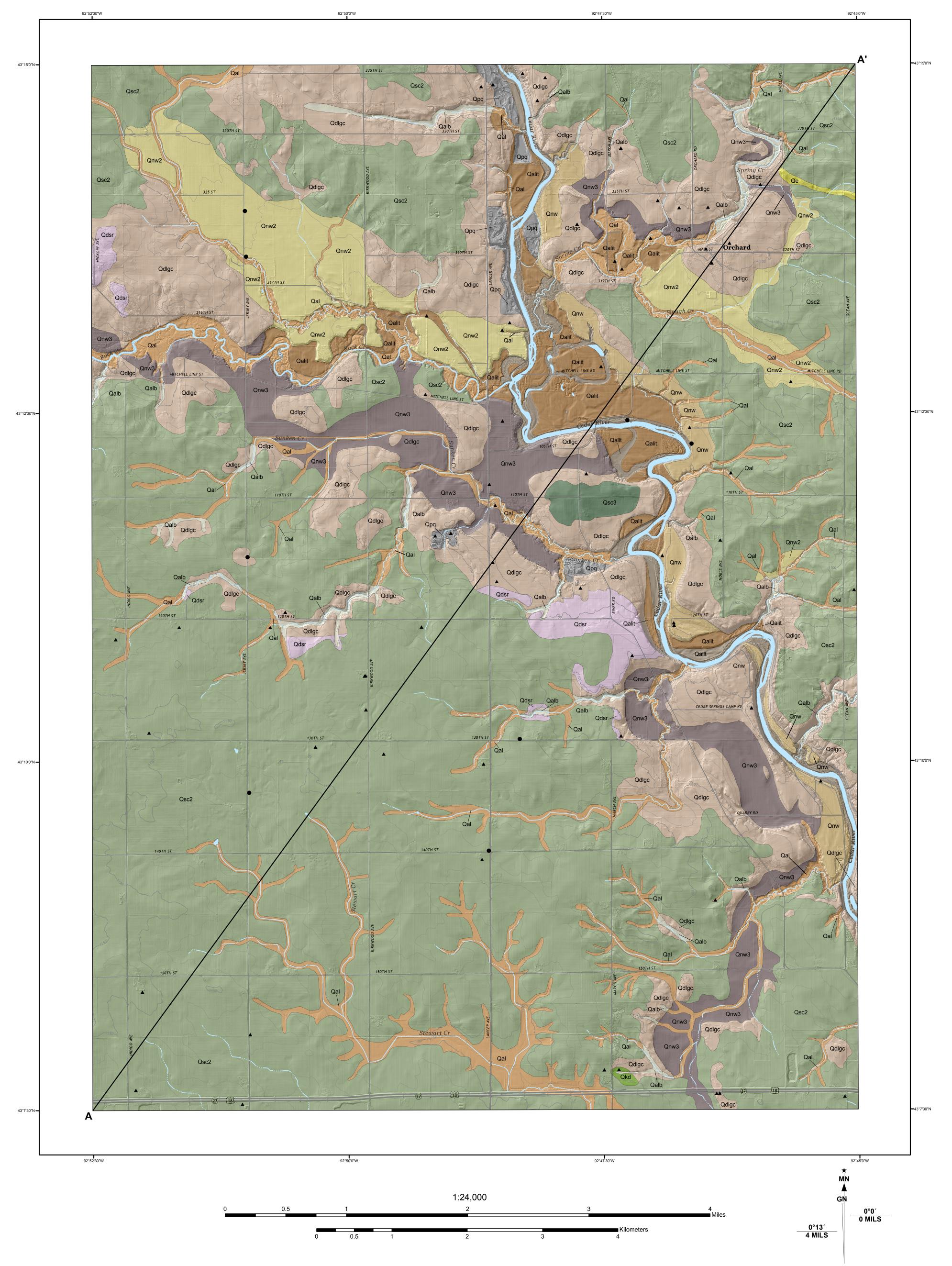
Surficial Geologic Map of the Orchard (Iowa) 7.5' Quadrangle

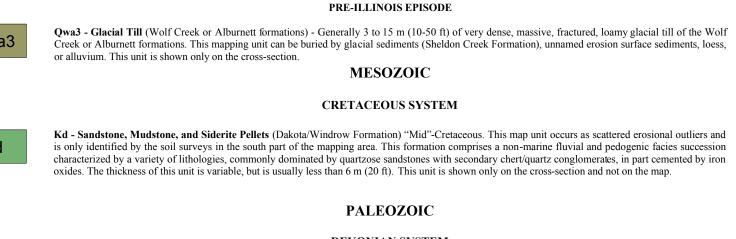


LEGEND				
	SURFICIAL GEOLOGIC MAP OF			
CENOZOIC	THE ORCHARD 7.5' QUADRANGLE,			
QUATERNARY SYSTEM	-			
HUDSON EPISODE	FLOYD AND MITCHELL COUNTIES, IOWA			
Illuvium (DeForest Formation- Undifferentiated) - Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous to us, massive to stratified silty clay loam, clay loam, loam to sandy loam alluvium and colluvium in stream valleys, on hillslopes and in closed ons. May overlie Noah Creek, Sheldon Creek, Wolf Creek or Alburnett formations or fractured Devonian carbonate bedrock. Associated with low-odern floodplain, closed depressions, modern drainageways or toeslope positions on the landscape. Seasonal high water table and potential for frequent .				
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.	Phil Kerr, Stephanie Tassier-Surine, Matthew Streeter, Huaibao Liu, and Ryan Clark Iowa Geological Survey, IIHR-Hydroscience & Engineering, University of Iowa, Iowa City, Iowa			
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 Cedar River. Overlies the Noah Creek Formation. Occupies the lowest position on the floodplain, i.e. modern channel belts in the Cedar River Valley. Seasonal high water table and frequent flooding potential.	IOWA GEOLOGICAL SURVEY			
Qalit - Intermediate Terrace (DeForest Formation- Camp Creek, Roberts Creek, and Gunder members) - Variable thickness of less than 1 m to 5 m (3-16 ft) of very dark gray to brown, noncalcareous, stratified silty clay loam to loam that overlies the Noah Creek Formation. Occupies the low terrace position in the Cedar River Valley. Seasonal high water table and frequent flooding potential.	Iowa Geological Survey, Robert D. Libra, State Geologist			
HUDSON and WISCONSIN EPISODE	Supported in part by the U.S. Geological Survey			
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 occurs as sand stringers or dunes overlying unnamed erosion surface loamy sediments.	Cooperative Agreement Number G15AC00242 National Cooperative Geologic Mapping Program (STATEMAP) Completed under contract with the Iowa Department of Natural Resources			
Qkd - Loamy Sediments Shallow to Sandstone and Mudstone (DeForest, Noah Creek, or Dakota/Windrow formations) - 0 to 2 m (0-7 ft) of yellowish brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandy and silty alluvial sediment that overlies the "Mid"-Cretaceous bedrock surface. Bedrock outcrop may be present in isolated areas. A detailed description of the Dakota/Windrow Formation is provided below.	THE UNIVERSITY HYDROSCIENCE & Engineering			
Qdsr - Loamy Sediments Shallow to Limestone, Dolomite, and Shale (DeForest, Noah Creek, or Shell Rock formations) - 0 to 2 m (0-7 ft) of yellowish brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandyand silty alluvial sediment that overlies the Upper Devonian bedrock surface. Bedrock outcrop may be present in isolated areas. A detailed description of the Shell Rock Formation is provided below.	ACKNOWLEDGMENTS			
Qdlgc - Loamy Sediments Shallow to Limestone, Dolomite, and Shale (DeForest, Noah Creek, or Lithograph City formations) - 0 to 2 m (0-7 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 bedrock surface. Bedrock outcrop may be present in isolated areas. A detailed description of the Lithograph City Formation is provided below.	Special thanks to Lindsey Falk of Falk Construction, Inc., Art Weisen, Dan Swann, and Ulland Brothers for allowing us access to their properties. Special thanks to the landowners who allowed access to their properties: Brad Balsley, Todd Bates, Boyd Campbell, Gary Dieterich, Nancy Folkerts, Charles Sounder, Ray Stonecipher and the Floyd County Conservation Board. Zachary Demanett of the Iowa Geological Survey (IGS) and Austin Pothoff of the University of Iowa (UI) prepared well cutting samples for stratigraphic logging. Zachary Demanett also assisted with field work during drilling. New subsurface geologic data was generated by Tanner			
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. Thickness in the bedrock valley in the center of the mapping area may exceed 30 m (98 ft). 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. This unit encompasses deposits that accumulated in low-relief stream valleys during the Wisconsin and Hudson episodes.	Hartsock, a UI student, by producing descriptive logs of water well drilling samples. Thanks also to Rick Langel (IGS) for managing the Iowa geologic sampling database (GEOSAM). Also, special thanks to Kathy Woida, Natural Resources Conservation Service, Deborah Quade, Iowa Department of Natural Resources, and Art Bettis, University of Iowa Department of Earth and Environmental Sciences, for assistance with core description and for numerous valuable discussions regarding the geology of north-central Iowa. Casey Kohrt and Chris Kahle of the Iowa Department of Natural Resources provided GIS technical help. Administrative support was provided by Megan Delaney, Teresa Gaffey, and Sara Conrad.			
WISCONSIN EPISODE				
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 this unit usually overlies the middle Wisconsin-age Sheldon Creek Formation, but may overlie Pre-Illinois Espisode 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.	Introduction to the Surficial Geologic Map of the Orchard 7.5' Quadrangle Floyd and Mitchell Counties, Iowa			
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 sediments. 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 and the deposits that fill the paleo channel in the center of the mapping area during the late Wisconsin as well as exhumed middle Wisconsin and Pre-Illinois Episode deposits of the Wolf Creek and Alburnett formations.	The Orchard 7.5' Quadrangle is located in north-central Iowa on the Wisconsin-age Iowan Surf (IS) landform region (Prior and Kohrt, 2006). It lies within Floyd and Mitchell counties. The map are dominated by unnamed loamy sediments (IS materials) of variable thickness overlying Wisconsin- Sheldon Creek Formation glacial sediments and shallow Devonian carbonate bedrock. Significant ar			
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.	of bedrock outcrop or areas with less than 5 m (16 ft) of loamy material over rock are present, especi along the Cedar River and its tributaries. The thickness of Quaternary deposits in the Orchard Quadrar is generally thin as they are typically less than 15 m (50 ft) in the quadrangle, though deposits reac			
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	maximum thickness of 31 m (117 ft) in a bedrock valley found on the western edge of the mapping at			

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 (eolian sand or silt). Overlies fractured Devonian carbonate rocks. Seasonal high water table may occur in this map unit.

Osc - Glacial Till (Sheldon Creek Formation- Undifferentiated) - Generally 3 to 15 m (10-50 ft) of a 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 to 7 m (10-20 ft) may be periglacially altered. is unit overlies Pre-Illinois diamicton or Devonian carbonate bedrock. This unit is only shown on the cross-section.

Calvin (1902) described and mapped the Quaternary and Paleozoic bedrock geology of Mitchell County. He noted the extreme variability of the till units and the presence of significant sand and gravel bodies. Statewide bedrock geologic maps by Hershey (1969), and most recently by Witzke and others (2010), illustrate the improved understanding of the complex distribution of geologic units at the bedrock surface across north-central Iowa, including Mitchell County. Previous surficial geologic mapping completed as part of the STATEMAP program in Mitchell County includes Surficial Geology of the Osage



DEVONIAN SYSTEM

Dsr - Limestone, Dolomite, and Shale (Shell Rock Formation) Upper Devonian. This map unit forms the bedrock surface mainly in the southwest part of the mapping area. Due to erosion, this unit usually has a thickness of 0-14 m (0-45 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. Fossiliferous layers, especially containing abundant bryozoans, commonly occur in the lower part of the unit. Stromatoporoids, brachiopods, corals, and crinoids are abundant in some intervals of this formation. This unit is shown only on the cross-section and not on the map.

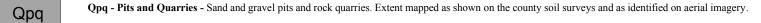
Dlgc - Dolomite, Limestone, and Shale (Lithograph City Formation) Middle to Upper Devonian. This map unit dominates the bedrock surface except the southwest part and the deep valley in the northeast part of the quadrangle. The thickness of this unit is usually around 21-27 m (70-90 ft), with a maximum thickness up to 35 m (115 ft) in the mapping area. It consists of limestone, dolomitic limestone, and dolomite. This unit is usually characterized by interbeds of laminated lithographic and sub-lithographic limestone and dolomitic limestone, in part argillaceous or with some green to gray shale. "Birdseye" structures, vugs and calcite vug-fills are common. Some intervals are fossiliferous and stromatoporoid-rich. This unit is shown only on the cross-section and not on the

Dcv - Limestone and Dolomite (Coralville Formation) Middle Devonian. This map unit occurs on the bedrock surface along the Cedar River and in a large Dcv bedrock valley in the northern part of the quadrangle. The thickness of this map unit varies between 12 and 21 m (40-70 ft) in the mapping area. It is dominated by limestone, dolomitic limestone, and dolomite, in part laminated, argillaceous, or shaly. Brachiopods, echinoderm debris and corals usually occur in the limestone facies. This unit is shown only on the cross-section and not on the map.

Dlc - Dolomite, Limestone and Shale (Little Cedar Formation) Middle Devonian. This map unit only occurs on the bedrock surface within the bedrock valley Dlc in the northeast part of the quadrangle. The thickness of this formation ranges from 27 to 40 m (90-130 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. A shaly layer with a thickness around 3 to 6 m (10-20 ft) commonly occurs in the upper part of the formation. This unit is commonly fossiliferous, and brachiopods are especially abundant in the lower portion. This unit is shown only on the cross-section and not on the map.

Dpr - Dolomite and Dolomitic Limestone (Pinicon Ridge Formation) Middle Devonian. This formation consists of dolomite and dolomitic limestone with varying textures (shaly, laminated, brecciated, sandy, and/or cherty). The thickness of this unit usually ranges from 6 to 14 m (20-45 ft). Compared to other Devonian strata in the mapping area, this formation is usually unfossiliferous. This unit is shown only on the cross-section and not on the map.

Dsp - Dolomite (Spillville Formation) Middle Devonian. This unit is dominated by medium to thick bedded dolomite with scattered to abundant fossil molds, with a maximum thickness of approximately 21 m (70 ft) in the mapping area. Its basal part, where present, is variably sandy, shaly, and/or conglomeratic with reworked Ordovician chert clasts. This unit is shown only on the cross-section and not on the map.



- Water features Rivers, lakes and small ponds. Extent mapped as shown in the county soil survey and as identified on aerial imagery.
- New drill holes for this map project
- IGS GEOSAM data points records available at www.iowageologicalsurvey.com
- W29402 Wells used for geologic cross-section

Qal

Qalb

Qdsr

Qnw2

Qnw

Dsi

Dlgc

Dpr

Dsp

CORRELATION OF MAP UNITS

	Iowan Surface			Episode	Series	System	
	Till Plain		S,	Shallow Rock		Sei	Sys
Alluvium	Qal	Qallt	Qalb	Hudson	Holocene		
	Qai	Qalit					
Eolian	C	le			Hudson and	т	
Colluvium	Qnw2			Qnw3	Wisconsin		Quaternary
Outwash	Qnw					ne	Quate
Erosion Surface	Qsc2			Qsc3	Wisconsin	Pleistocene	
Glacial	Qsc*					Ple	
	Qw	a3*			Pre-Illinois		
			Qkd		Creta	20018	
					Ciela	Leous	

Quadrangle (Tassier-Surine et al., 2014) and Surficial Geology of the New Haven Quadrangle (Kerr et al., 2015)

Iowa has a rich and complex Quaternary geologic history punctuated by at least seven periods of glaciation between 2.6 million to 500,000 years ago (Boellstorff, 1978a,b; Hallberg, 1980, 1986). In the map area, Pre-Illinois Episode glacial deposits and associated buried soils are overlain by much younger Wisconsin-age materials, dating from approximately 40,000 to 26,000 years before present. In Iowa, these glacial deposits are formally recognized as the Sheldon Creek Formation (Bettis et al., 1996; Bettis, 1997) and in earlier literature are referred to as the "Tazewell till" (Ruhe, 1950). The most recent glacial advance of the Des Moines Lobe did not extend into Mitchell and Floyd counties, but its influence is evident in the development of river valleys and periglacial alteration of the landforms.

Results from this mapping project and others in Worth, Cerro Gordo, and Mitchell counties indicate that the Sheldon Creek glacial materials extend much farther east than were previously mapped. The Sheldon Creek formation is found predominatly across the entire mapping area, except in isolated areas. The southeastern margin of the advance extends beyond the Orchard Quadrangle.

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). As a result, surface soils were removed from the IS and the Sheldon Creek 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 Rock, Slough, Spring, and Sunken creeks.

Surficial deposits in the map area are composed of four formations: DeForest, Noah Creek, Peoria, and Sheldon Creek, as well as unnamed erosion surface sediments. These are in places underlain by the Wolf Creek and Alburnett formations. 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 Noah Creek Formation includes coarse sand and gravel associated with outwash from the Des Moines Lobe, 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 present northwest of Orchard and intermittently mantle the unnamed erosion surface mapping unit. 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, but generally coincides with the position of the Little Cedar River in Mitchell County and along a drainage divide in the Charles City quadrangle based on the work of Tassier-Surine and others (2016) and Streeter and others (2016). 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.

Five bedrock mapping units (Cretaceous Dakota/Windrow Formation; Devonian Shell Rock, Lithograph City, Coralville, and Little Cedar formations) comprise the bedrock surface in the Orchard Quadrangle, with the Shell Rock and Lithograph City formations representing most of the bedrock outcrops in the map area. Bedrock is exposed along the Cedar River and most creeks in the mapping area. Fifty-five rock outcrops including quarries are located in the map area and were investigated in the field. The Devonian rocks are dominated by carbonates and accompanied by minor shale. The Cretaceous Dakota/Windrow Formation is characterized as a reddish, shaly sandstone with siderite pellets.

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UTM GRID AND 2016 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



Location Map

*units only shown on the cross-section

Adjacent 7.5' Quadrangles

OSAGE SW OSAGE NEW HAVEN

RUDD ORCHARD FLOYD

ROCKFORD ROSEVILLE CHARLES

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> Base map from USGS Orchard 7.5' Digital Raster Graphic (IGS GIS file IA_Orchard_USGS_topo.tif) which was scanned from the Orchard 7.5' Topographic Quadrangle map, published by US Geological Survey in 2015 Land elevation contours (10' interval).

lowa Geological Survey digital cartographic file Orchard SurficialGeology.mxd, version 6/30/16 (ArcGIS 10.3) 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.

> Research supported by the U. S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G15AC00242. 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.

GEOLOGIC CROSS-SECTION A - A'

