

Surficial Geology of the Manly (Iowa)

7.5' Quadrangle

SURFICIAL GEOLOGY OF THE MANLY 7.5' QUADRANGLE, WORTH AND CERRO GORDO COUNTIES, IOWA

Iowa Geological and Water Survey
Open File Map OFM-10-4
September 2010

prepared by

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Supported in part by the U.S. Geological Survey
Cooperative Agreement Number G04C00100
National Cooperative Geologic Mapping Program (STATEMAP)

ACKNOWLEDGMENTS

Recognized for contributions to map's production: Andrew Asell, Chris Kahle, Brian Witke, Ray Anderson, Bill Banker, Mary Pat Heitman, and Lois Bair. New subsurface geologic data was generated by the University of Iowa student Kyle Bracken who produced descriptive logs of water well drill samples. Jason Vogelgesang provided samples for stratigraphic logging. Drilling was provided under contract with Aquadrell of Swisher, Iowa and Cahoy Well and Pump Service of Frederickburg, Iowa. Special thanks to drillers Dennis Add and Mark Claassen. Assistance with field work during drilling was provided by Bob Rowden and Jason Vogelgesang. Special thanks to all landowners who graciously allowed access to their land for drilling: Leon Benjergens, Van Butler, Palmer Dahl, James Dohel, Don and Karen Gordon, Tim and Melinda Holden, and Gary Marken. Robin Wisner, Kathy Woods, LeAnn Camp, Neil Suss, and Elizabeth Swaberg assisted with field work and describing cores as part of the mapping update for the Iowa Cooperative Soil Survey Update for Worth County. Dean Mueller of the Worth County Conservation Board assisted with finding drilling locations on public lands. Shane Banzow, Worth County Sanitarian, assisted with acquiring well drillers records.

INTRODUCTION

The Manly Quadrangle is located in Worth County and Cerro Gordo County in north-central Iowa. The mapping area lies within the Wisconsin-age Iowan Erosion Surface (IES) Landform Region which lies near the eastern border with the Late Wisconsin-age Des Moines Lobe Landform, the most recently glaciated region of the state (Prior and Kohrt, 2006). Generally speaking, the map area consists of unglaciated loess materials (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. Significant areas of bedrock outcrop or areas with less than 15 feet of loamy material over rock are present, especially along the Shell Rock River valley and Beaver Creek in the southeastern portion of the county.

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 thickness of the "drift" along the 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 Witke, 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 1:100,000 (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-Illinoian Episode glacial deposits and associated buried dunes are overlain by much younger Wisconsin-age glacial deposits. During earlier and mid Wisconsin-age, ice advanced south 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" (Rube, 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, siltification, strong winds and a host of other periglacial processes (Walters, 1996). The result was that surface soils were removed from the IES and the Pre-Illinoian till surface was significantly eroded, resulting in the development of a region-wide colluvial lag deposit referred to as a "stone line". Other common features of this region are isolated and unidirectional topographic highs of less mantled Pre-Illinoian till. These elongated or elliptical shaped ridges have a directional orientation from northwest to southeast and exist as erosional outliers of the once higher and older landscape. Thick packages of stratified loamy and sandy sediments located low in the map area and adjacent to streams are remnants of siltification lobes dating to this period. Associated with the formation of the IES, thick wedges of sand were transported downslope. Along the course of the Shell Rock River, bedrock exposures are common along the valley and alluvial deposits are relatively thin. On slopes near this area, the colluvial cone is the only protection for local groundwater resources. The modern landscape is best characterized as one of subdued relief and uncharacteristic long, gentle slopes. The majority of the map area is covered by Quaternary age glacial, erosional sediments and alluvial deposits.

Surficial deposits of the map area are composed of six formations: DeForest, Noah Creek, Peoria, Sheldon Creek, Wolf Creek, and Alburtett 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 Noah Creek, Roberts Creek, Gunder, Cornington, Black, and Wadon members. The Noah Creek Formation includes coarse sand and gravel associated with outwash from the Des Moines Lobe. The Noah Creek Formation 2 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 west of the Shell Rock river valley as well as stringers on the IES surface. Eolian materials may also be intermittedly present mantling much 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 Alburtett Formation. The Wolf Creek is divided into the Winthrop, Aurora and Hickory Hills members (oldest to youngest). The Alburtett Formation consists of several "undifferentiated" members.

Two bedrock mapping units (Devonian Shell Rock and Lithograph City formations) are exposed as outcrop in the map area. Bedrock outcrops occur along the Shell Rock River, with some exposures along Beaver Creek in the southeast part of the quadrangle. Middle and lower Upper Devonian carbonate rocks of shallow-marine origin comprise the bedrock strata in the mapping area. The strata form the upper part of a thick Devonian carbonate succession within the northern portion of the Iowa Basin. The bedrock strata in the map area are carbonates of Cedar Valley Group; they vary between limestone and dolomite with minor shale. Bedrock is subdivided into the Shell Rock and Lithograph City formations, and is dominated by the Shell Rock Formation. The Shell Rock Formation is characterized by fossiliferous and stromatoporoid-rich carbonates. The underlying Lithograph City Formation, typically composed of laminated lithographic and sublithographic limestone and dolomite, occurs along the Shell Rock River and in a subsurface valley in the western part of the quad. In areas covered by thicker deposits of glacial sediments the bedrock formation distribution is known solely from water well cutting samples.

References

Bettis, E.A., III, 1989, Late Quaternary history of the Iowa River Valley in the Coralville Lake area in Plocher, O.W., Geologic Reconnaissance of the Coralville Lake area. Geological Society of Iowa Guidebook 51, p. 93-100.
Bettis, E.A., III, 1997, Late-Middle and Early-Late Wisconsin Glaciation in North Central Iowa. Geological Society of America North-Central Section Meeting Abstracts with Programs 29 (4):5.
Bettis, E.A., III, Quade, D.J., and Kemmis, T.J., 1996, In Hops, Bogs, and Logs: Quaternary Deposits and Environmental Geology of the Des Moines Lobe. Edited by E.A. Bettis, III, D.J. Quade, and T.J. Kemmis. Iowa Department of Natural Resources-Geological Survey Bureau, Guidebook Series No. 18, 170 p.
Calvin, S., et al., 1981 Preliminary outline map of the drift sheets of Iowa. Iowa: Boellstorff, J., 1978a, North American Pleistocene Stages reconsidered in light of probable Pliocene-Pleistocene continental glaciation. Science, v. 202 p.305-307.
Boellstorff, J., 1978b, Chronology of some late Cenozoic deposits from the central United States and the ice ages. Transactions of the Nebraska Academy of Science, v. 6, p. 35-49.
Hallberg, G.R., 1980, Pleistocene stratigraphy in east-central Iowa. Iowa Geological Survey Technical Information Series 10, 168p.
Hallberg, G.R., 1986, Pre-Wisconsin glacial stratigraphy of the central plains region in Iowa, Nebraska, Kansas, and Missouri. In Richmond, G.M. and Fullerton, D.S., eds., Quaternary Glaciations in the United States of America. Report of the International Correlation Programme-Project 24. In Sibrava, V., Bowen, D.Q., and Richmond, G.M., eds., Quaternary Science Reviews, Quaternary Glaciations in the Northern Hemisphere, v. 5, p. 11-15.
Hallberg, G.R., Lindbeck, J.A., Mickelson, D.M., Knox, J.C., Goshel, J.E., Hobbs, H.C., Whitfield, J.W., Ward, R.A., Boellstorff, J.D., and Swinchart, J.B., 1991, Quaternary geologic map of the Des Moines 4' x 6' quadrangle, United States. U.S. Geological Survey, Miscellaneous Investigations Series, Map I-1420, 1:100,000 scale map sheet.
Hershey, E.H., 1969, Late-Middle and Early-Late Wisconsin Glaciation in Iowa. Geological Survey, scale 1:500,000 (out of print).
Prior, J.C., 1976, Landforms of Iowa. Iowa City, University of Iowa Press, 154p.
Prior, J.C. and Kohrt, C.J., 2006, The Landform Regions of Iowa, Iowa Geological Survey, digital map, available on IDNR GIS Library: <http://www.iglw.iowa.edu/iglw/>
Rube, R.V., 1950, Reclassification and correlation of the glacial drifts of northwestern Iowa and adjacent areas: University of Iowa Department of Geology, Iowa City, unpublished Ph.D. thesis, 124 p.
Walters, J.C., 1996, General and Environmental Geology of the Cedar Falls/Waterloo Area, The Iowan Surface, in General and Environmental Geology of Cedar Falls/Waterloo and Surrounding Area, Northeast Iowa, Iowa Geological Survey Guidebook Series No. 22, p.7-9.
Williams, I.A., 1899, Geology of Worth County. Iowa Geological Survey, Annual Report, v. 10, p. 315-378.
Witke, B.J., Anderson, R.B. and Pope, J.P., 2010, Bedrock Geologic Map of Iowa, scale: 1:500,000, Iowa Geological and Water Survey, Open File Digital Map OFM-10-1.

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 and silty clay loam colluvium and organic sediments in drained and undrained closed and semi-closed depressions. Overlies Noah Creek Fm. sand and gravel, Sheldon Creek Fm. loam diamicton or Devonian carbonate bedrock. 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, 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. Underlies modern drainage ways or toe slope 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 drainage ways or toe slope 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. May overlie yellowish-brown coarse-grained sand and gravel (Noah Creek Fm.), or yellowish to grayish brown, usually calcareous, stratified loam to silt loam to sandy loam diamicton (Sheldon Creek Fm.). Usually restricted to a narrow belt along major river valley bottoms or adjacent uplands on the Des Moines Lobe. Off the Des Moines Lobe this unit is not restricted to dunes along valley areas and may occur as sand stringers overlying unnamed 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, usually with a thickness of 12 to 18 m (40-60 ft). It is characterized by fossiliferous carbonates with some shale. Layers with abundant subpherical and tabular stromatoporoids, which may be replaced by calcite crystal masses, commonly occur in the lower part of the formation. Around southwest part of the quad, this formation is dominated by argillaceous dolomite and dolomitic limestone, and the thickness can be up to 30 m (100 ft).
- Qdlgc** - **Loamy Sediments Shallow to Dolomite, Limestone, and Shale** (DeForest-Noah Creek-Lithograph City 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 Middle to Upper Devonian bedrock surface. Maximum thickness of this map unit is up to 30 m (100 ft), consisting of dolomite 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

- Qnw** - **Sand and Gravel** (Noah Creek Formation) - 3 m (10 ft) to more than 23 m (75 ft) of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. In places mantled with 1 to 3 m (3-10 ft) of fine to medium, well sorted sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in stream valleys during the Wisconsin Episode.
- Qnw-T3** - **Sand and Gravel, Terrace 3** (Noah Creek Formation) - 3 m (10 ft) to more than 23 m (75 ft) of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. In places mantled with 1 to 3 m (3-10 ft) of fine to medium, well sorted sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in stream valleys during the Wisconsin Episode. Terrace 3 occupies the lowest terrace position and is located adjacent to Elk Creek and the Shell Rock River.
- Qnw-T2** - **Sand and Gravel, Terrace 2** (Noah Creek Formation) - 3 m (10 ft) to more than 23 m (75 ft) of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. In places mantled with 1 to 3 m (3-10 ft) of fine to medium, well sorted sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in stream valleys during the Wisconsin Episode. Terrace 2 is at an elevation approximately 3 m (10 ft) above Terrace 3. This terrace has limited eolian deposits.
- Qnw-T1** - **Sand and Gravel, Terrace 1** (Noah Creek Formation) - 3 m (10 ft) to more than 23 m (75 ft) of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. In places mantled with 1 to 3 m (3-10 ft) of fine to medium, well sorted sand derived from wind reworking of the alluvium. This unit encompasses deposits that accumulated in stream valleys during the Wisconsin Episode. Terrace 1 represents the oldest and highest elevation of the Noah Creek Formation terraces. Terrace 1 is commonly mantled by Peoria Formation eolian deposits.
- Qnw2** - **Sand and Gravel** (Noah Creek Formation) - 12 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 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 Hudson 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. This 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 Alburtett formations.
- Qof** - **Outwash fan** (Noah Creek Formation) - Thickness can be quite variable from 1 to 12 m (3-39 ft) of yellowish-brown coarse-grained sand and gravel. May overlie yellowish to grayish brown usually calcareous, stratified loam to silt loam to sandy loam diamicton or gray, calcareous, massive, dense loam diamicton (Sheldon Creek Fm.), textures can be quite variable. Narrow low-relief aprons that gently slope away from the moraine front. Seasonal high water table.
- Qsc2** - **Loamy Sediments Shallow to Glacial Till** (Unnamed erosion surface sediment) - 1 to 3 m (3-10 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 of the Sheldon Creek Formation.
- Qsc** - **Glacial Till** (Sheldon Creek Formation-sand/ilt) - 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 structured and contain significant sand and gravel bodies. Pure shale clasts may be present in core samples. This unit may not be present on relatively steep hillslopes near valleys. This unit overlies Pre-Illinoian diamicton and is only shown on the cross-section.

PRE-ILLINOIS EPISODE

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

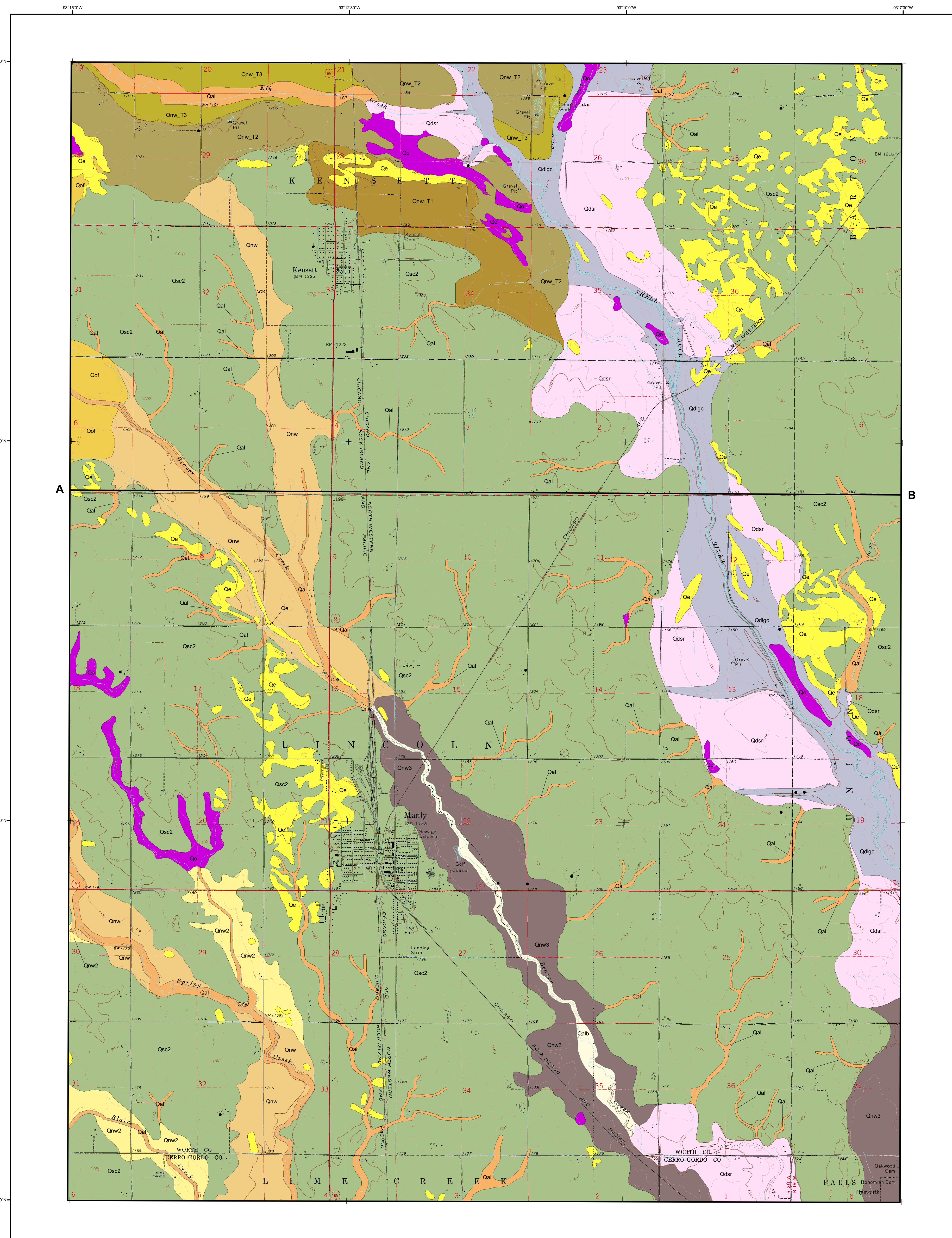
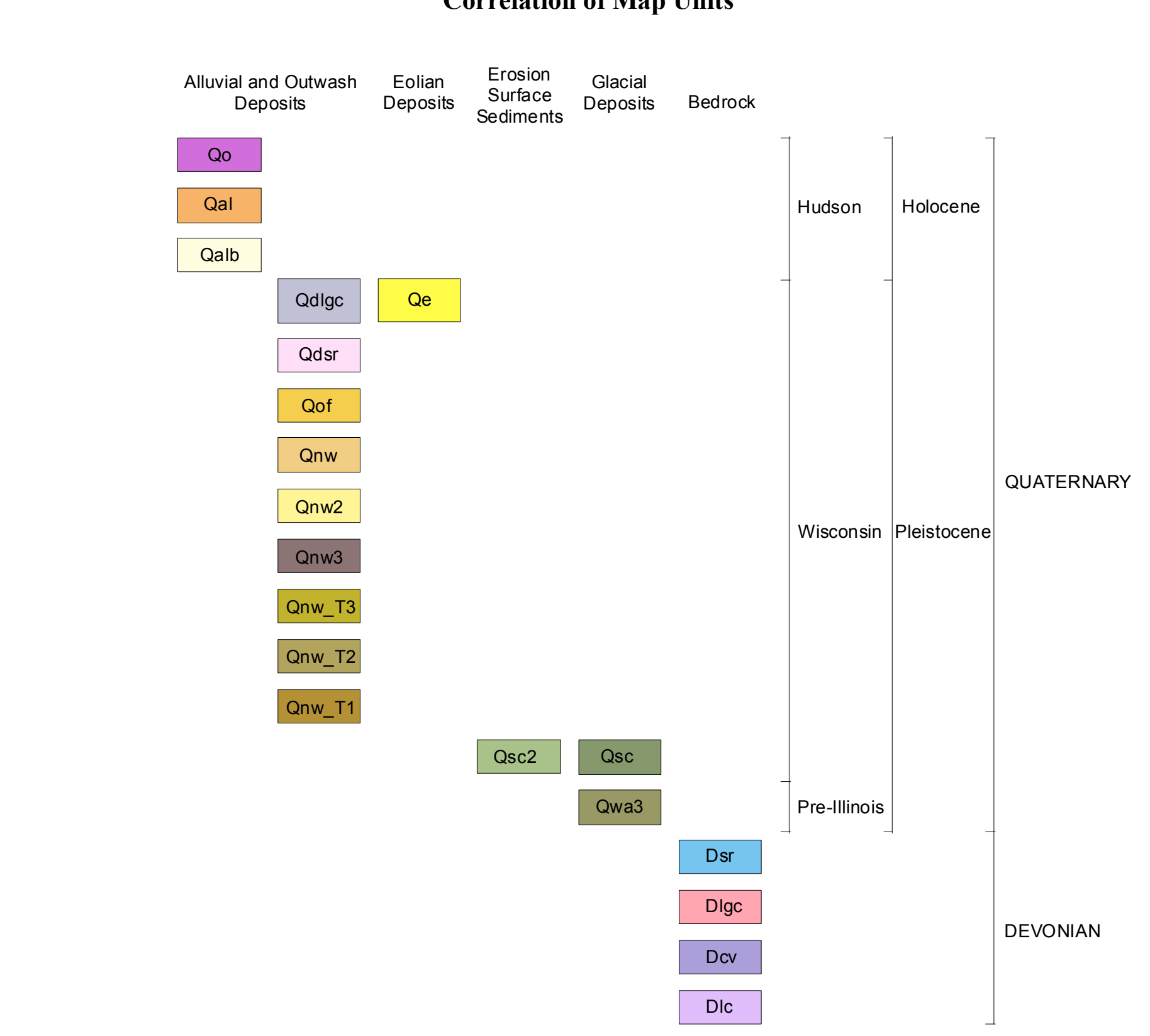
PALEOZOIC

DEVONIAN SYSTEM

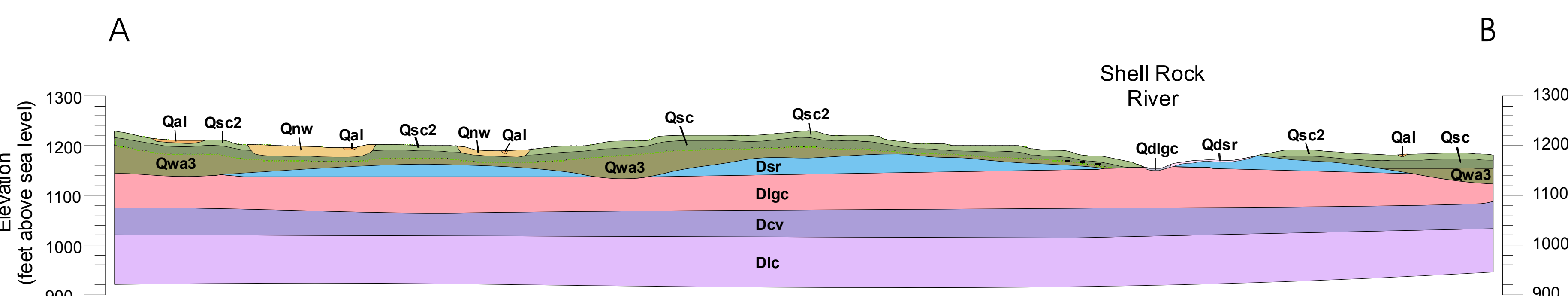
- Dsr** - **Limestone, Dolomite, and Shale** (Shell Rock Formation) Upper Devonian. This formation is the major top bedrock unit in the quad, usually with a thickness of 12 to 18 m (40-60 ft). It is characterized by fossiliferous carbonates with some shale. Layers with abundant subpherical and tabular stromatoporoids, which may be replaced by calcite crystal masses, commonly occur in the lower part of the formation. Around southwest part of the quad, this formation is dominated by argillaceous dolomite and dolomitic limestone, and the thickness can be up to 30 m (100 ft).
- Dlgc** - **Dolomite, Limestone, and Shale** (Lithograph City Formation) Middle to Upper Devonian. Maximum thickness of this map unit is up to 30 m (100 ft), consisting of dolomite 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.
- Dcv** - **Limestone and Dolomite** (Coralville Formation) Middle Devonian. Thickness of this formation varies between 10 and 18 m (35-60 ft), and 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 cross-section, not on map.
- Dlc** - **Dolomite and Limestone** (Little Cedar Formation) Middle Devonian. Thickness of this formation ranges from 27 to 36 m (90-120 ft) in this area. It is dominated by slightly argillaceous to argillaceous dolomite and dolomitic limestone, usually vuggy and partially laminated and/or cherty. This unit is commonly fossiliferous and brachiopods are especially abundant in lower portion. This unit is shown only on cross-section, not on map.

Drill Holes

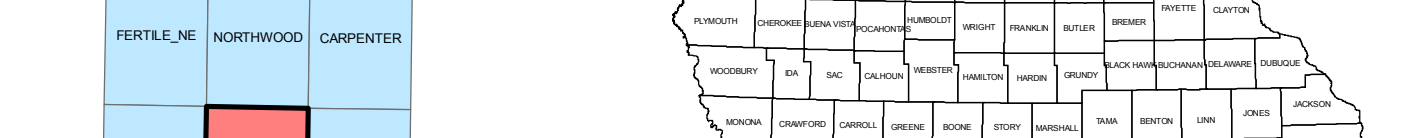
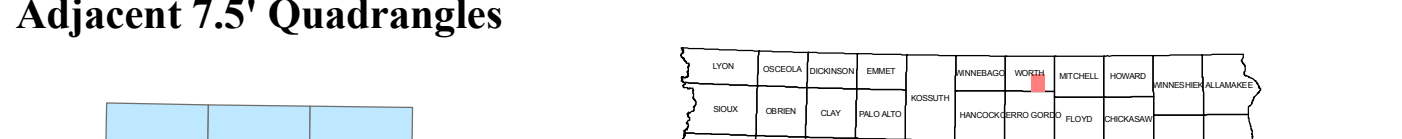
Correlation of Map Units



GEOLOGIC CROSS-SECTION A-B



Location Map



Base map from USGS Manly 7.5' Digital Raster Graphic (IGS GIS file DRG229.tif) which was scanned from the Manly 7.5' Topographic Quadrangle map, published by US Geological Survey in 1972. Topographic contours and land features based on 1971 aerial photography, field checked in 1972 and elevation contours 10' intervals.

Iowa Geological Survey digital cartographic file Manly_Surfgeology_2010.mxd, version 10/04/10 (ArcGIS 9.2)
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.