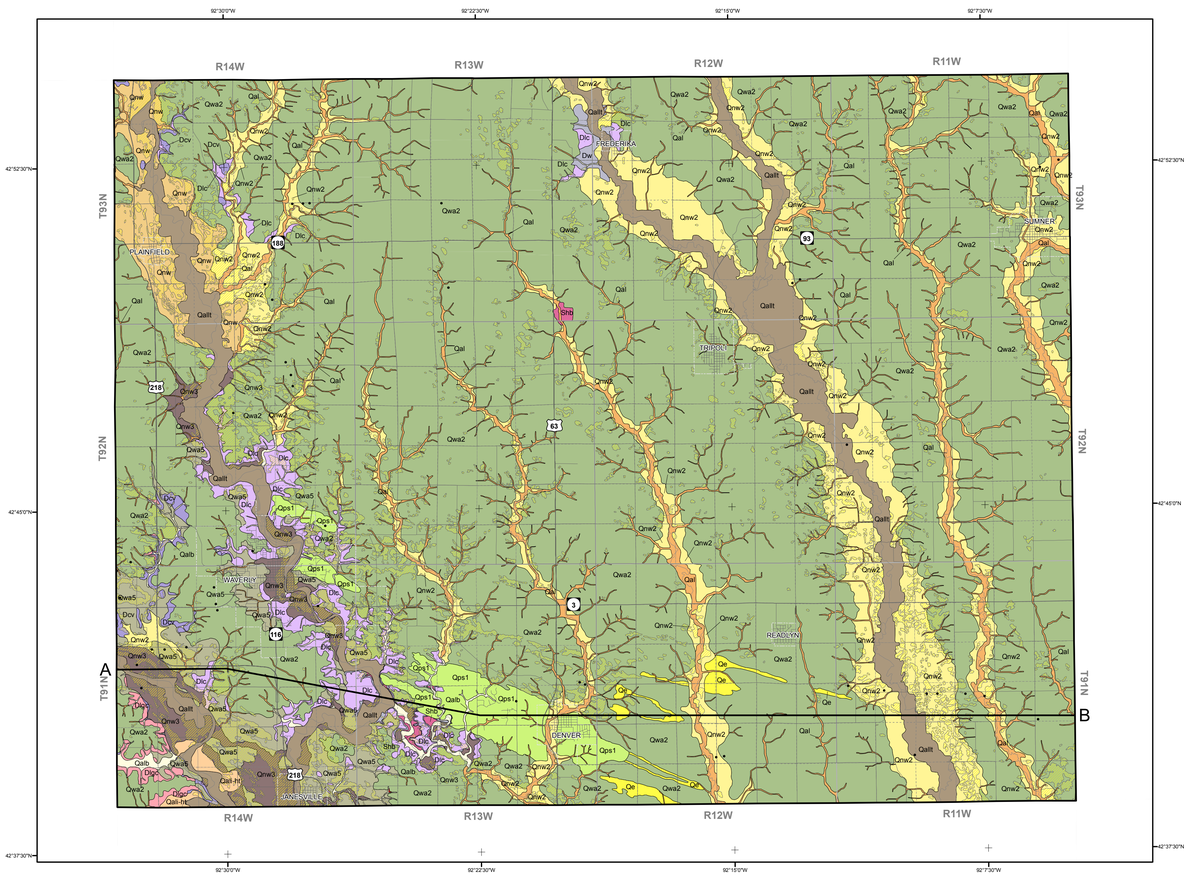
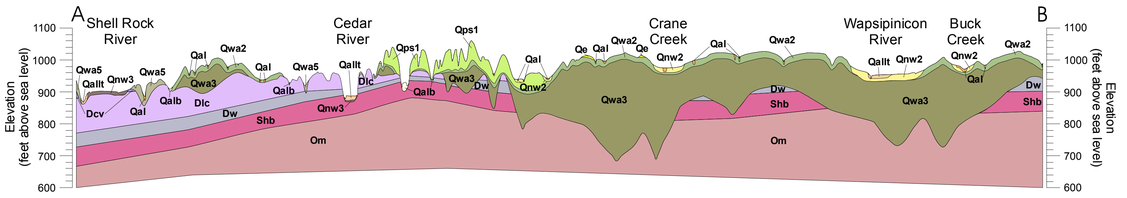
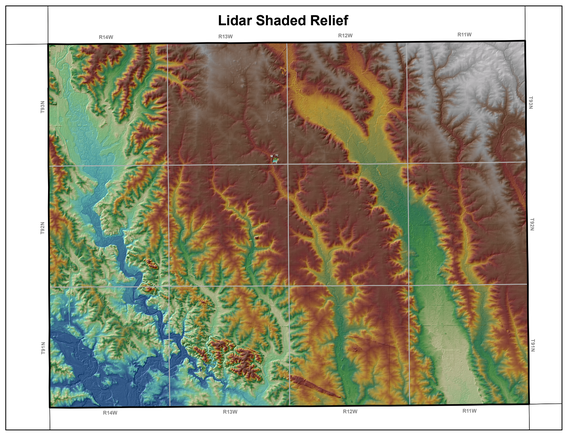
Surficial Geology of Bremer County, Iowa



GEOLOGIC CROSS-SECTION A-B





Base map from Iowa DNR NRGIS Library (Bremer County GIS files) derived from USGS 1:100,000 scale DLGs, Census Bureau TIGER line files and IGS PLSS files.

Iowa Geological Survey digital cartographic file BremerCo_surficial10.mxd , version 10/4/10 (ArcGIS 9.3). Map projection and coordinate system based on Universal Transverse Mercator (UTM) Zone 15, datum NAD83.

Map and cross-sections 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.

LEGEND

CENOZOIC

QUATERNARY SYSTEM

HUDSON EPISODE

Qal - Alluvium (DeForest Formation-Undifferentiated) Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous to calcareous, 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 Alburnett formations or fractured Devonian or Silurian 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 and Silurian 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.

Qallt - Low Terrace (DeForest Formation-Camp Creek Mbr. and Roberts Creek Mbr.) 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 Shell Rock, Cedar and Wapsipinicon river valleys. Overlies the Noah Creek Formation. Occupies lowest position on the floodplain, ie. modern channel belts. Seasonal high water table and frequent flooding potential.

Qali-ht - Intermediate-High Terrace (DeForest Formation-Gunder Mbr.) Variable thickness of less than 1 to 5 m (3-16 ft) of very dark gray to brown, noncalcareous, silty clay loam to loam alluvium or colluvium that overlies the Noah Creek Formation. Occupies terrace and valley margin positions 1 to 2 m (3-7 ft) above the modern floodplain. May be mantled with 2 to 3 m (7-10 ft) of well sorted medium to fine sand derived from wind reworking of the alluvium. Seasonal high water table and low to moderate flooding potential.

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 sand and gravel (Noah Creek Formation) or reworked unnamed loamy sediments associated with the Iowan Erosion Surface and/or it may overlie yellowish to grayish brown, often calcareous and fractured clay loam to loam diamicton of the Wolf Creek and Alburnett formations. Hatched pattern indicates areas with thin (generally less than 1 m) eolian sand.

Qnw2 - Sand and Gravel (Noah Creek Formation) Generally 2 to 8 m (6-26 ft) along the Wapsipinicon River and up to 18 m (59 ft) in the northwest part of Bremer County near Horton Creek and Dry Run- 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. A thin mantle of loess, reworked loess or fine-grained alluvium 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 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 with the potential for recent Holocene deposition and organic rich deposits. Seasonal high water table and some potential for flooding.

WISCONSIN EPISODE

Qnw - Sand and Gravel (Noah Creek Formation) 3 m (10 ft) to more than 20 m (66 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.

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 3 m (10 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 Alburnett formations. Deposits may be slightly thicker along the Cedar River.

Qps1 - Loess and Intercalated Eolian Sand (Peoria Formation-silt facies) Generally 3 to 14 m (10-46 ft) of yellowish brown to gray, massive, fractured, noncalcareous grading downward to calcareous silt loam and intercalated fine to medium, well sorted, sand. Sand is most abundant in the lower part of the eolian package. Overlies massive, fractured, loamy glacial till of the Wolf Creek or Alburnett formations with or without intervening clayey Farmdale/Sangamon Geosol.

Qwa2 - Loamy and Sandy Sediment Shallow to Glacial Till (Unnamed erosion surface sediment) Generally 2 to 8 m (6-26 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 2 m (7 ft) of Peoria Formation materials (loess and eolian sand). Overlies massive, fractured, firm glacial till of the Wolf Creek and Alburnett formations. Seasonally high water table may occur in this map unit. Deposits are thinner on the eastern portion of county near the Wapsipinicon River Valley.

Qwa5 - Loamy and Sandy Sediment Shallow to Rock (Unnamed erosion surface sediment) Generally 1 to 6 m (3-19 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). Eolian sand may lie directly on top of bedrock in isolated areas. Overlies fractured Devonian and Silurian carbonate rocks. Seasonal high water table may occur in this map unit.

PRE-ILLINOIS EPISODE

Qwa3 - Till (Wolf Creek or Alburnett formations) Generally 3 to 91 m (10-300 ft) of very dense, massive, fractured, loamy glacial till of the Wolf Creek or Alburnett formations with or without a thin loess mantle (Peoria Formation—less than 2 m) or thin loamy sediment mantle. An intervening clayey Farmdale/Sangamon Geosol may separate these units. This mapping unit is shown only in the cross-section and may be buried by unnamed erosion surface sediments, loess or alluvium.

PALEOZOIC

DEVONIAN SYSTEM

Dlgc - Dolomite, Limestone, and Shale (Lithograph City Formation) Middle to Upper Devonian. Maximum thickness of this map unit is up to 15 m (45 ft), consisting of, in ascending order, Osage Springs Member which is dominated by dolomite and dolomitic limestone, in part argillaceous and fossiliferous; Thunder Woman Shale Member which is characterized by green-gray shale, slightly dolomitic and silty; and partial Idlewild Member which is characterized by interbeds of laminated lithographic and sublithographic limestone and dolomitic limestone with scattered to abundant brachiopods and/or stromatoporoids.

Dcv - Limestone and Dolomite (Coralville Formation) Middle Devonian. Thickness of this formation varies between 0 and 10 m (0-32 ft), and is dominated by limestone, dolomitic limestone, and dolomite, in part laminated and argillaceous; brachiopods and corals are usually abundant in the limestone facies.

Dlc - Dolomite and Limestone (Little Cedar Formation) Middle Devonian. The thickness of this formation ranges from 27 to 36 m (90-120 ft) in this quad. 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.

Dw - Dolomite, Limestone, Shale, and minor Sandstone (Wapsipinicon Group) Middle Devonian. This map unit usually contains the Pinicon Ridge Formation only, with a total thickness that varies between 6 and 12 m (18-40 ft) in the mapping area. It is dominated by laminated or brecciated, unfossiliferous limestone and dolomite that is sometimes sandy and cherty at its base.

SILURIAN SYSTEM

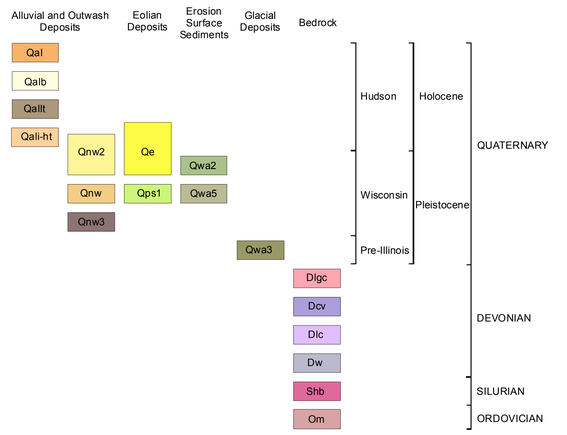
Shb – Dolomite with Chert (Hopkinton and Blanding formations) Lower Silurian. Total thickness up to 20 m (65 ft). Fossil-moldic to vuggy dolomite, and cherty to very cherty with nodular to bedded chert in the upper part of the Blanding. Fossils include corals, brachiopods and stromatoporoids.

ORDOVICIAN SYSTEM

Om – Shale and Dolomite (Maquoketa Formation) Upper Ordovician. Total thickness up to 78 m (250 ft). Interbedded green to gray dolomitic shale and shaly dolomite with minor limestone; variably cherty and variably fossiliferous with brachiopods and graptolites; thin brown to brown-gray dolomitic shale layers occur in lower 10 m (33 ft). This mapping unit is shown only in the cross-section.

Drill Holes

Correlation of Map Units



SURFICIAL GEOLOGY OF BREMER COUNTY, IOWA

Iowa Geological and Water Survey
Open File Map OFM-10-02
September 2010

prepared by

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INTRODUCTION

Bremer County lies within the Iowan Erosion Surface (IES) Landform Region (Prior and Kohrt, 2006). This area has been subjected to multiple periods of Quaternary glaciations and subaerial erosion. Generally speaking, the map area consists of unnamed loamy sediments (IES materials) of variable thickness overlying 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 in the southwestern portion of the county.

Norton (1906) first described and mapped the Quaternary and Paleozoic bedrock geology of the county, and discussed the stratigraphy of Devonian and Silurian strata that were exposed at the land surface. He also noted the presence of Ordovician strata at the bedrock surface in areas covered by thick glacial deposits. 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 Bremer County. Previous surficial geologic mapping at 1:24,000 scale has been completed as part of the STATEMAP program (Tassier-Surine et al., 2007, 2009). The only other 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).

At least seven episodes of Pre-Illinoian glaciations occurred in this region between approximately 2.2 and 0.5 million years ago (Boellstorff, 1978a,b; Hallberg, 1980, 1986). Episodic erosion during the last 500,000 years has led to the destruction of pre-existing glacial landforms associated with Pre-Illinoian glaciations. 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 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 unerroded topographic highs of loess 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 upland landscape and adjacent to streams are remnants of solifluction lobes dating to this period. Associated with the formation of the IES, thick wedges of sediment were transported downslope. Downstream of the town of Shell Rock, bedrock exposures are common along the valley and alluvial deposits are relatively thin. On slopes near this area, the colluvial cover is the only protection for local groundwater resources.

Surficial deposits of the map area are composed of five formations: DeForest, Noah Creek, Peoria, Wolf Creek, and Alburnett formations as well as unnamed erosion surface sediments. Hudson age deposits associated with fine-grained alluvial and colluvial sediments include the DeForest Formation which is subdivided into the Camp Creek, Roberts Creek, Gunder and Corrington 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 peri-glacial activity during the Wisconsin ice advance. Thick areas of Peoria Formation eolian materials are present north of Waverly and near Denver. Eolian materials may also be intermittently present mantling most other mapping units, and are more abundant near stream valleys. Pre-Illinoian glacial deposits in northeast Iowa consist of two formations: the younger Wolf Creek Formation and the Alburnett Formation. The Wolf Creek 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 (Devonian Lithograph City, Coralville, Little Cedar and Wapsipinicon formations; and the Silurian Hopkinton and Blanding formations) are exposed as outcrop in the map area. Bedrock exposed at the land surface is restricted to the northern and western portions of the county and all rock outcrops and quarries are located in close proximity to surface topographic lows coincident with the modern drainages of the Shell Rock River, the Cedar River and its tributaries Baskins Run and Quarter Section Run, and Crane Creek, and the Wapsipinicon River. Throughout the remainder of the county bedrock is covered by thick deposits of glacial sediments, and bedrock formation distribution is known solely from water well cuttings 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.

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., Lineback, J.A., Mickelson, D.M., Knox, J.C., Goebel, J.E., Hobbs, H.C., Whitfield, J.W., Ward, R.A., Boellstorf, J.D., and Swinehart, 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, H. G., 1969, Geologic map of Iowa: Iowa Geological Survey, scale 1:500,000 (out of print).

Norton, W. H., 1906, Geology of Bremer County: Iowa Geological Survey, Annual Report, v. 16, p. 319-406.

Prior, J.C., 1976, Landforms of Iowa: Iowa City, University of Iowa Press, 154 p.

Prior, J.C. and Korht, C.J., 2006, The Landform Regions of Iowa, Iowa Geological Survey, digital map, available on IDNR GIS Library-ftp://ftp.igsb.uiowa.edu/gis_library/ia_state/geologic/landform/landform_regions.zip; http://www.igsb.uiowa.edu/nrgislibx/

Tassier- Surine, S., Quade, D.J., Giglierano, J.D., and Bettis, E.A., III, 2007, Surficial Geology of the Bremer (Iowa) 7.5" Quadrangle: Iowa Geological Survey Open File Map OFM-07-5, 1:24,000 scale map sheet.

Tassier-Surine, S., Quade, D., Liu, H., McKay, R. and Giglierano, J., 2009, Surficial Geology of the Shell Rock 7.5' Quadrangle, Butler, Black Hawk and Bremer counties: Iowa Geological Survey Open File Map OFM 09-5, 1:100,000 scale map sheet.

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.

Witzke, B.J., Anderson, R.R. 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.