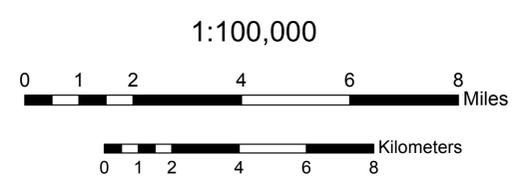
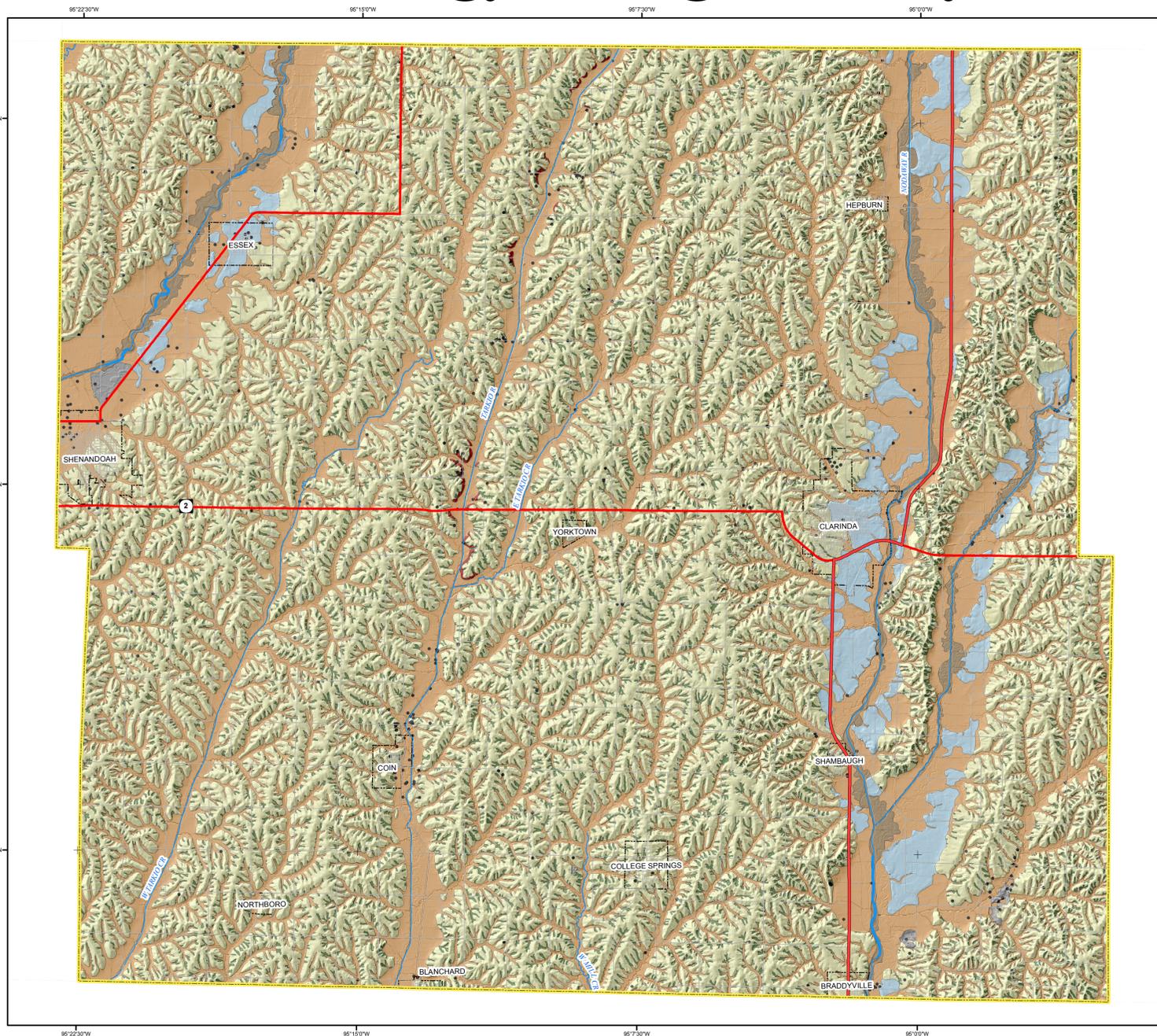


Surficial Geology of Page County, Iowa



Base map from Iowa DOT Road Map Layers 2009. Shaded relief from Iowa Lidar Project 2007-2011.
 PageCo_SurficialGeology2012.mxd, version 10/16/12 (ArcGIS 10.0)
 Map projection and coordinate system based on Universal Transverse Mercator (UTM) Zone 15, datum NAD83.
 The map is 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 PAGE COUNTY, IOWA

Iowa Geological and Water Survey
 Open File Map OFM-12-06
 September 2012

prepared by
 Stephanie Tassier-Surine¹, James Gigliano¹, Deborah Quade¹, and E. Arthur Bettis, III²

Iowa Geological and Water Survey, Iowa City, Iowa



Iowa Department of Natural Resources, Chuck Gipp, Director
 Iowa Geological and Water Survey, Robert D. Libra, State Geologist

Supported in part by the U.S. Geological Survey
 Cooperative Agreement Number G11AC20247
 National Cooperative Geologic Mapping Program (STATEMAP)

ACKNOWLEDGMENTS

Recognized for contributions to production of the map: Andrew Asell, Chris Kahle, Casey Kohrt, Brian Witzke, Ray Anderson, Bill Bunker, and Mary Pat Heltman. New subsurface geologic data was mostly generated by Michael Bounk of the Iowa Geological and Water Survey (IGWS). Jason Vogelgesang (IGWS) and Carolyn Koebel (University of Iowa) prepared well samples for stratigraphic logging.

¹Iowa Geological and Water Survey, Iowa City, Iowa 52242
²Department of Geoscience, The University of Iowa, 121 Trowbridge Hall, Iowa City, Iowa 52242

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, stratified silty clay loam, clay loam, loam to sandy loam alluvium and colluvium in stream valleys, on hill slopes and in closed depressions. May overlie Pre-Illinoian glacial till of the Wolf Creek or Alburnett formations or Pre-Holocene fine-grained alluvium. Associated with low-relief modern floodplain, closed depressions, modern drainageways or to slope positions on the landscape. Unit also includes colluvial deposits derived from adjacent map units. Seasonal high water table and potential for frequent flooding.
- Qallt - River Channel Belt - 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 East Nishnabota, Nodaway, and East Nodaway river valleys. Overlies Pre-Holocene fine-grained alluvium. Occupies lowest position on the floodplain, modern and historic channel belts. Ox-bow lakes and meander scars are common features associated with this terrace level. Mapped primarily using aerial imagery and county soil survey data. Seasonal high water table and frequent flooding potential.

HUDSON AND WISCONSIN EPISODE

WISCONSIN EPISODE

- Qpt - Loess Mantled Terrace** (Peoria Formation-silt and/or sand facies) 2 to 7 m (7-23 ft) of yellowish brown to gray, massive, jointed, calcareous or noncalcareous, silt loam and intercalated fine to medium, well sorted, sand. May grade downward to poorly to moderately well sorted, moderately to well stratified, coarse to fine feldspathic quartz sand, loam, or silt loam alluvium (Late Phase High Terrace) or may overlie a Farmdale Geosol developed in Pisgah Silt which in turn overlies a well-expressed Sangamon Geosol developed in poorly to moderately well sorted, moderately to well stratified, coarse to fine sand, loam, or silt loam alluvium (Early Phase High Terrace).
- Qps - Loess** (Peoria Formation-silt facies) Generally 2 to 8 m (6 to 25 ft) of yellowish to grayish brown, massive, jointed calcareous or noncalcareous silt loam to silty clay loam. Limited areas of fine eolian sand may be present near major river valleys. Overlies a grayish brown to olive gray silty loam to silty clay (Pisgah Formation-eroded Farmdale Geosol) which is less than 1.5 m (5 ft) thick. The Farmdale may be welded to an older Sangamon Geosol developed in loamy glacial till of the Wolf Creek or Alburnett formations. This mapping unit encompasses upland divides, ridges and convex sideslopes. Well to somewhat poorly drained landscape.

PRE-ILLINOIS EPISODE

- Qwa3 - Till** (Wolf Creek or Alburnett formations) Generally 15 to 90 m (49-295 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) and intervening clayey Farmdale/Sangamon Geosol. This mapping unit encompasses narrowly dissected interfluvial and side slopes, and side valley slopes. Drainage is variable from well drained to poorly drained.

Other Mapping Units

- Bedrock**- Undifferentiated Paleozoic rock. May be mantled with up to 2 m (6 ft) of Quaternary materials from the adjacent mapping unit.
- Qpq - Pits and Quarries** Sand and gravel pits and rock quarries. Extent mapped as shown in county soil surveys and as identified on aerial imagery.
- Water Features** Rivers, lakes and small ponds formed by blockage of drainageways and river channels. Extent mapped as shown in county soil surveys and as identified on aerial imagery.
- Drill Holes**

Introduction to the Surficial Geology of Page County, Iowa

Page County lies within the Southern Iowa Drift Plain (Prior and Kohrt, 2006) landform region of Iowa. Surficial materials consist of a mix of eolian deposits (loess), glacial till outcrop, alluvium, and limited areas of bedrock outcrop. Multiple periods of Quaternary glaciation and substantial erosion have led to the landscape we see today. Generally speaking, the map area consists of loess of variable thickness overlying Pre-Illinoian glacial sediments. These deposits are regionally extensive.

Previous surficial geologic mapping of the area is limited to the Des Moines 4° x 6° Quadrangle at a scale of 1:1,000,000 (Hallberg et al., 1991). Compilation mapping near the project area in Adams County was completed in 2010 (Tassier-Surine et al.). Calvin (1900) first described the Quaternary and mapped the Paleozoic bedrock geology of Page County and discussed the stratigraphy of the Pennsylvanian and Cretaceous strata that comprise the county's bedrock geology. Statewide bedrock geologic maps by Hersey (1969), and most recently, by Witzke, Anderson, and Pope (2010), depict the increased understanding of the distribution of geologic units at the bedrock surface across this region, including Page County.

Early researchers believed there were only two episodes of Pre-Illinoian glaciation in Iowa: Kansan and Nebraskan (Chamberlin, 1894, 1895; Bain, 1896; Shimek, 1909; Kay and Apfel, 1928; Rube, 1969). Later regional studies determined that the original concept of Kansan-Altonian-Nebraskan was grossly oversimplified and flawed. It is now recognized that there were at least seven episodes of Pre-Illinoian glaciation that occurred in this region from approximately 2.2 to 0.5 million years ago (Boellstorff, 1978a, 1978b; Hallberg, 1980a, 1986). Episodic erosion during the last 500,000 years has led to the destruction of pre-existing glacial landforms associated with these glaciations. Boellstorff (1978a, 1978b) and Hallberg (1980a, 1980b, 1986) undertook regional-scale projects that involved detailed outcrop and subsurface investigations including extensive laboratory work and synthesis of previous studies. These studies led to the abandonment of the classic glacial and interglacial terminology: Kansan, Altonian, and Nebraskan. This study marks a shift from the use of time-stratigraphic terms to lithostratigraphic classification. The result of Boellstorff's and Hallberg's studies was the development of a lithostratigraphic framework for Pre-Illinoian till. They developed a general stratigraphic framework for Iowa and eastern Nebraska based on physical stratigraphy, mineralogical criteria as well as magnetostratigraphy and tephrochronology. In western Iowa and eastern Nebraska three lithologically distinctive till assemblages were identified as the 'A', 'B', and 'C' tills, with paleosols sometimes delimiting multiple till units within the A and B till assemblages. Recent work by Balco and Rowley (2010) suggests that a single ice advance around 2.4 Ma deposited the C till and that the A and B till assemblages accumulated between about 1.3 and 0.5 Ma.

The Loveland Loess (Daniels and Handy, 1959; Rube, 1969; Bettis, 1990) is the only Illinoian or late middle Pleistocene deposit that is currently recognized in western Iowa. Where observed in outcrop, the Sangamon Geosol is developed in the upper part of the Loveland. The Loveland Loess thins away from the Missouri River and the Sangamon Geosol merges with the thick and more weathered Yarmouth-Sangamon Geosol in southern Iowa (Rube, 1967).

In Page County, the highly eroded and dissected Pre-Illinoian upland and older terraces are mantled by Wisconsin loesses of variable thickness (Rube, 1969; Prior, 1976). The Wisconsin loesses are the youngest regionally extensive Quaternary materials and were deposited between 30,000 and 12,000 years ago. Two loess units were deposited across Iowa during Wisconsin time, the older Pisgah Formation and the younger Peoria Loess. The Pisgah is thin and includes loess and related slope sediments that have been altered by colluvial hillslope processes, pedogenic and periglacial processes. The upper part of the unit is modified by development of the Farmdale Geosol. It is not uncommon to see the Farmdale developed throughout the Pisgah and incorporated into the underlying older Sangamon Geosol. The Pisgah Loess was deposited on the western Iowa landscape from about 55,000 to 26,000 years ago (Bettis et al., 2003). The Pisgah Formation is typically buried by Peoria Formation loess. The Peoria Formation loess accumulated on stable landscapes in western Iowa from 23,000 to 12,000 years ago.

Surficial deposits of the map area are composed of four formations: DeForest, Noah Creek, Peoria and undifferentiated Pre-Illinoian tills. 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 Corington members. The Noah Creek Formation includes coarser grained deposits associated with large valleys which are overlain by finer-grained alluvial material or eolian silt and sand. Peoria Formation eolian materials consist of wind-blown silt that may be up to 8 meters (25 feet) in thickness. Limited areas of eolian sand may be present adjacent to river valleys. Additional eolian materials may be intermittently present mantling Wisconsin Episode terraces. Pre-Illinoian glacial deposits are exposed in the map area along drainages and where loess cover is thin. Based on existing well data, Pre-Illinoian deposits may be as thick as 300' in bedrock valleys.

Soil series units from the Soil Survey of Page County, Iowa (Clark and McWilliams, 1978) were categorized into surficial geologic units based on soil data and available subsurface geologic data from the Iowa Geological and Water Survey's IGWSM database (water well log database) as well as other existing subsurface data for this compilation map project. Modeling and mapping of the glacial till outcrops was completed using ArcGIS 10.0, gvSIG open source GIS program, and the Sextante landscape classification subprogram.

* We disagree with the younger 0.2 Ma age estimate for Pre-Illinoian glaciations presented by Balco and Rowley (2010) and suggest 0.5 Ma is more consistent with regional data and stratigraphic relationships.

References

Bain, H.F., 1896, Relations of the Wisconsin and Kansan drift sheets in central Iowa, and related phenomena. Iowa Geological Survey Annual Report v. 6, p. 429-476.
 Balco, G. and Rowley, C.W., 2010, Absolute chronology for major Pleistocene advances of the Laurentide Ice Sheet. *Geology*, v. 38, p. 795-798.
 Bettis, E.A., III, 1990, Holocene alluvial stratigraphy of western Iowa. In Bettis, E.A., III ed., Holocene alluvial stratigraphy and selected aspects of the Quaternary history of western Iowa. Midwest Friends of the Pleistocene Field Trip Guidebook, p. 1-72.
 Bettis, III, E.A., Mink, D.R., Roberts, H.M., and Witzke, A.G., 2003, Last glacial loess in the conterminous U.S.A.: Quaternary Science Reviews, v. 22, p. 1907-1946.
 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.
 Calvin, S., 1900, Geology of Page County. Iowa Geological Survey Annual Report, v. 11, p. 393-460.
 Chamberlin, T.C., 1894, in Geology, J. (ed.) The Great Ice Age, 3rd edition, p. 733-764. Stanford, London.
 Chamberlin, T.C., 1895, The classification of American glacial deposits. *Journal of Geology*, v. 3, p. 270-277.
 Clark, L.A. and McWilliams, K.M., 1978, Soil Survey of Page County, Iowa: United States Department of Agriculture, Soil Conservation Service, 84p.
 Daniels, R.B. and Handy, R.L., 1959, Suggested new type section for the Loveland Loess in western Iowa. *Journal of Geology*, v. 67, p. 114-119.
 Hallberg, G.R., 1980a, Pleistocene stratigraphy in east-central Iowa. Iowa Geological Survey Technical Information Series 10, 16pp.
 Hallberg, G.R., 1980b, Illinoian and Pre-Illinoian stratigraphy of southern Iowa and adjacent Illinois. Iowa Geological Survey Technical Information Series 11, 20pp.
 Hallberg, G.R., 1986, Pre-Wisconsin glacial stratigraphy of the central plain region in Iowa, Nebraska, Kansas, and Missouri. In Richmond, G.M. and Hillstrom, D.S., eds., Quaternary Glaciation in the United States of America, Report of the International Correlation Programme-Project 24. In Sibuya, V., Bowen, D.O., and Richmond, G.M., eds., Quaternary Science Reviews, Quaternary Glaciation in the Northern Hemisphere, v. 5, p. 11-15.
 Hallberg, G.R., Linebeck, J.A., Mickelson, D.M., Knox, J.C., Gobel, J.E., Hobbs, H.C., Whitfield, J.W., Ward, R.A., Boellstorff, J.D., and Swindhart, 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.
 Hersey, H.C., 1969, Geologic Map of Iowa, 1:500,000 scale. Iowa Geological Survey, Iowa City.
 Kay, G.F. and Apfel, E.T., 1928, The Pre-Illinoian Pleistocene geology of Iowa. Iowa Geological Survey Annual Report v. 34, p. 1-304.
 Prior, J.C., 1976, Landforms of Iowa. Iowa City, University of Iowa Press, 154 p.
 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.igis.iowa.edu/igislib/> or http://ip.igis.iowa.edu/gis_library/state/geologic/landform/landform_regions.zip.
 Rube, R.V., 1969, Quaternary Landscapes in Iowa. Iowa State University Press, Ames, Iowa, 255p.
 Rube, R.V., Daneck, R.B., and Cady, J.G., 1967, Landscape evolution and soil formation in southwestern Iowa. U.S. Department of Agriculture Technical Bulletin 1349, 242p.
 Shimek, B., 1909, Altonian sand and gravels in western Iowa. *Bulletin of the Geological Society of America*, v. 20, p. 399-408.
 Tassier-Surine, S.A., Gigliano, J.D., Quade, D.J., and Bettis, E.A., III, 2011, Surficial Geology of Adams County, Iowa: Iowa Geological and Water Survey Open File Map OFM-11-9, 1:500,000 scale map sheet.
 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 OFM10-1.

Correlation of Map Units

