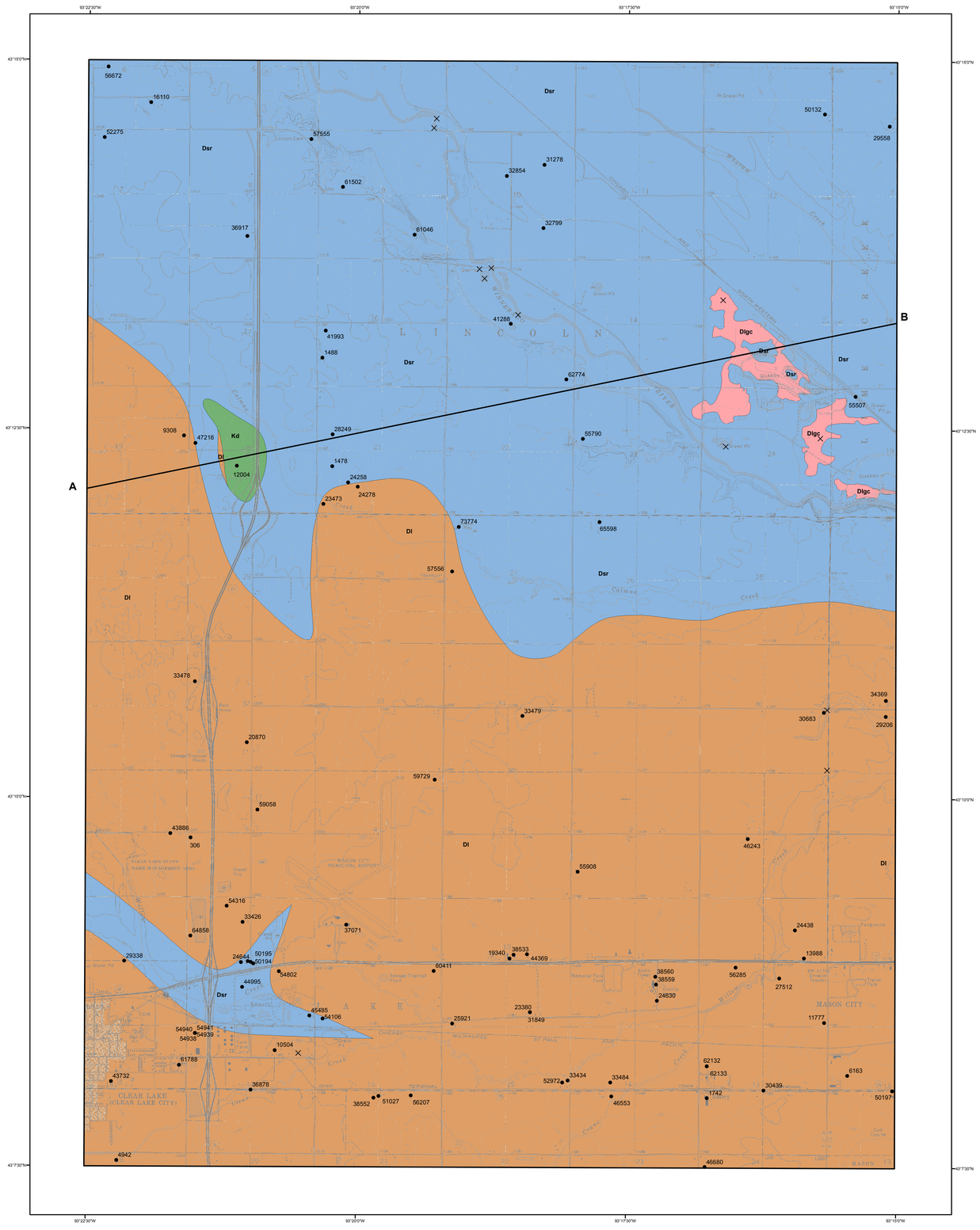
Bedrock Geology of the Clear Lake East (Iowa) 7.5' Quadrangle



1:24,000

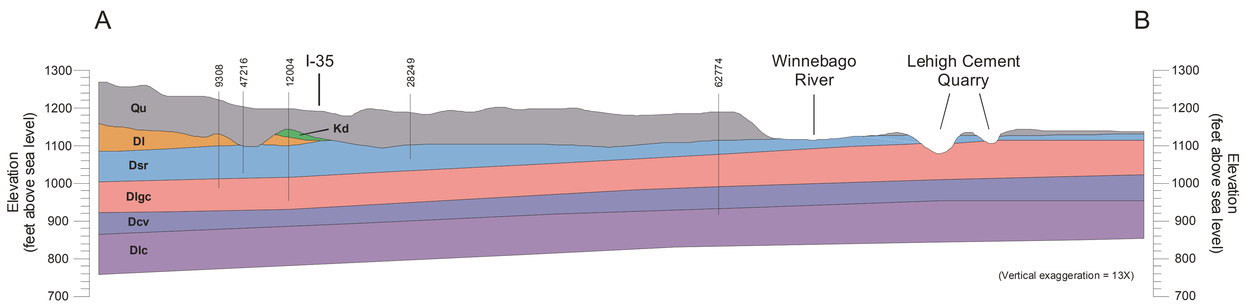
0 0.5 1 2 3 4 Miles

0 0.5 1 2 3 4 Kilometers

MN 0.7°

WMM 2010 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

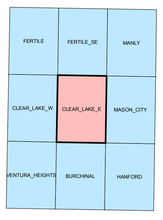
GEOLOGIC CROSS-SECTION A-B



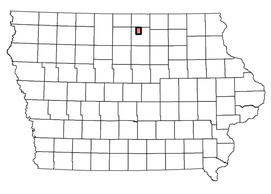
Correlation of Map Units

AGE (Ma)	SYSTEM	SERIES	STAGE	MAP UNIT
2.588	QUATERNARY			Qu
145.0	CRETACEOUS			Kd
382.7	DEVONIAN	Upper	Frasnian	Dl, Dsr, Dlgc
		Middle	Givetian	Dcv, Dlc
387.7			Eifelian	
393.3				

Adjacent 7.5' Quadrangles



Location Map



BEDROCK GEOLOGY OF THE CLEAR LAKE EAST 7.5' QUADRANGLE, CERRO GORDO COUNTY, IOWA

Iowa Geological and Water Survey
Open File Map OFM-13-1
September 2013

prepared by

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Introduction to the Bedrock Geology of Clear Lake East 7.5' Quadrangle, Cerro Gordo County, Iowa

The Clear Lake East quad lies along the border area of the Des Moines Lobe landform region, which was the last area covered by a Quaternary glacial advance in Iowa, and the Iowan Surface landform region, which was modified by various episodes of erosion before Wisconsinan glacial events (Prior, 1991). Because of the extensive glacial and erosional activities, the land surface in this area has a relatively low topographic relief except for the Winnebago River valley in northern part of the quad.

The land surface of the mapping area is mostly covered by Quaternary deposits. Most of the quad lies within the Iowan Surface landform region where the thickness of undifferentiated Quaternary deposits varies between 5 and 18 m (15 to 60 ft). The western area of the quad lies within or is close to the Des Moines Lobe landform, and the Quaternary is significantly thicker, with a maximum thickness about 43 m (140 ft). Bedrock outcrops exist only along the Winnebago River in the northern and Willow Creek in the southern parts of the quad. Several rock quarries are located along these two streams. These quarries and bedrock outcrops provided significant information concerning regional bedrock stratigraphy. Subsurface information was mostly derived from the analysis of water well cutting samples reposited at the Iowa Geological and Water Survey (IGWS). Lithologic and stratigraphic information from these samples are stored in the online GEOSAM database of IGWS. Geologic information from a total of 12 outcrops and more than 90 private and public wells within the mapping area were used for bedrock geological mapping purposes. Stratigraphic information from the surrounding area, including bedrock outcrops, quarries, and well samples, was also utilized for this mapping project

Paleogeographically, the mapping area is within the northern portion of the Devonian Iowa Basin, a region of thickened shelf carbonate and shale deposits. Middle and lower Upper Devonian rocks form the major bedrock surface and upper bedrock aquifer in this area. Because of its stratigraphic completeness, the stratigraphy and depositional environments of the Devonian Iowa Basin have been intensively studied (e.g., Belanski, 1927, 1928; Koch, 1970). Recent geological and stratigraphic studies of this basin include Witzke and Bunker (1984), Anderson (1984), Bunker and others (1986), Witzke and others (1988), Bunker (1995), Anderson and Bunker (1998), and Groves and others (2008). Devonian stratigraphy at Mason City, Iowa, has also been discussed by McKay and Liu (2012). The bedrock surface of the surrounding area was recently mapped by Witzke and others (2010) and Liu and others (2010a & b, 2011a & b, 2012). Results from these studies provided an important stratigraphic framework for this bedrock geologic map. The bedrock stratigraphic nomenclature and correlation for this map follows the stratigraphic framework proposed by Witzke and others (1988).

The youngest bedrock unit within the mapping area is the Cretaceous Windrow/Dakota Formation, which usually occurs as a few meters thick, iron-rich, reddish, erosional outliers or shaly/silty sandstone in north-central Iowa (Witzke *et al*., 2010). The Devonian rocks comprise carbonates, varying between limestone and dolomite, and shale. Based on lithologic features and fossils, the Devonian strata comprising the bedrock surface in the mapping area can be subdivided into, in descending order, the Lime Creek Formation, Shell Rock Formation, and Lithograph City Formation. The Lime Creek Formation dominates most of the bedrock surface in the southern part of the mapping area and is characterized by calcareous shale and carbonates. The middle and upper portions of the Lime Creek Formation have extremely abundant fossils, especially brachiopods. Lime Creek Formation has the maximum thickness of 42 m (140 ft), but is usually less than 40 m (131 ft) in the mapping area. The Shell Rock Formation forms most of the bedrock surface in northern part of the quad, and is comprised of fossiliferous limestone, dolomitic limestone and dolomite, with minor shale. Commonly, a 2-meter-thick stromatoporoid-rich biostrome facies occurs near the base of the formation in this area. Shaly and/or argillaceous carbonates dominate the middle and upper portions of the Shell Rock Formation. Thickness of the Shell Rock Formation is normally about 12-18 m (40-60 ft), but can be up to 36 m (120 ft) toward the west of the mapping area. The Lithograph City Formation is characterized by laminated lithographic and sublithographic limestone and dolomite. "Birdseye," vugs, and calcite vug-fills are common in this formation. Some layers of this formation are fossiliferous with brachiopods and stromatoporoids. The Lithograph City Formation occurs at the bedrock surface only in quarries where the overlying Shell Rock Formation has been removed by mining. The maximum thickness of the Lithograph City Formation is about 34 m (110 ft) in this area. Older Cedar Valley Group strata of the Coralville and Little Cedar formations are found in wells only and do not occur at the bedrock surface in the map area.

Cited References:

Anderson, R.R., and Bunker, B.J. (eds), 1998: Fossil shells, glacial swells, piggy smells, and drainage wells: the geology of the Mason City, Iowa, area. Geol. Soc. of Iowa Guidebook No. 65, 71 p.

Anderson, W.I. (ed), 1984: General Geology of north-central Iowa. Guidebook for the 48th Annual Tri-State Geol. Field Conf., 150 p.

Belanski, C.H., 1927: The Shellrock Stage of the Devonian. American Midland Naturalist, v. 10, p. 316-370

Belanski, C.H., 1928: The Shellrock Stage of the Devonian; Description of some typical fossils of the Shellrock Stage. American Midland Naturalist, v. 11, p. 165-212.

Bunker, B.J., Witzke, B.J. and Day, J.E., 1986: Upper Cedar Valley Stratigraphy, North-Central Iowa, Lithograph City Formation. Geol. Soc. of Iowa Guidebook No. 44, 41 p.

Bunker, B.J. (ed), 1995: Geology and hydrogeology of Floyd-Mitchell counties, north-central Iowa. . Geol. Soc. of Iowa Guidebook No. 62, 114p.

Groves, J.R., Walters, J.C., and Day, J. (eds), 2008: Carbonate platform facies and faunas of the Middle and Upper Devonian Cedar Valley Group and Lime Creek Formation, northern Iowa. Iowa Geological Survey Guidebook No. 28, 96 p.

Koch, D.L., 1970: Stratigraphy of the Upper Devonian Shell Rock Formation of north-central Iowa. Iowa Geological Survey Report of Investigations 10, 123 p.

Liu, H., McKay, R.M., Quade, D., Tassier-Surine, S., and Giglierano, J.D., 2010a: Bedrock Geology of the Manly 7.5' Quadrangle, Worth and Cerro Gordo Counties, Iowa, scale 1:24,000. Iowa Geological and Water Survey Open File Map OFM-10-3.

Liu, H., McKay, R.M., Quade, D., Tassier-Surine, S., and Giglierano, J.D., 2010b: Bedrock Geology of the Fertile SE 7.5' Quadrangle, Worth and Cerro Gordo Counties, Iowa, scale 1:24,000. Iowa Geological and Water Survey Open File Map OFM-10-5.

Liu, H., McKay, R., Rowden, R., Quade, D., Tassier-Surine, S., and Giglierano, J., 2011a: Bedrock Geology of Fertile NE 7.5' Quadrangle, Worth County, Iowa, scale 1:24,000. Iowa Geological and Water Survey Open File Map OFM-11-1.

Liu, H., McKay, R., Rowden, R., Quade, D., Tassier-Surine, S., and Giglierano, J., 2011b: Bedrock Geology of Northwood 7.5' Quadrangle, Worth County, Iowa, scale 1:24,000. Iowa Geological and Water Survey Open File Map OFM-11-2.

Liu, H., McKay, R., Rowden, R., Quade, D., Tassier-Surine, S., and Giglierano, J., 2012: Bedrock Geology of Worth County, Iowa. Iowa Geological and Water Survey Open File Map OFM-12-1.

McKay, R.M. & Liu, H., 2012: Cedar Valley Group: the Lithograph City – Shellrock Formation contact at Mason City, Iowa. Geol. Soc. of Iowa Guidebook No. 90, 12 p.

Prior, J.C., 1991: Landforms of Iowa. Univ. of Iowa Press, Iowa City, 154 p.

Witzke, B.J. and Bunker, B.J., 1984: Devonian stratigraphy of north-central Iowa. Iowa Geological Survey Open File Report 84-2, p. 107-149.

Witzke, B.J., Bunker, B.J., and Rogers, F.S., 1988: Eifelian through lower Frasnian stratigraphy and deposition in the Iowa area, central midcontinent, U.S.A. *in* McMillan, N.J., Embry, A.F, and Glass, D.J. (eds.): Devonian of the World, Canadian Soc. of Petroleum Geologists, Memoir 14, vol. I, p. 221-250.

Witzke, B.J., Anderson, R.R., and Pope, J.P., 2010: Bedrock geologic map of Iowa, 1:500,000. Iowa Geolgocical and Water Survey Open File Map OFM-10-1.

LEGEND

CENOZOIC

QUATERNARY SYSTEM

Qu – Undifferentiated Unconsolidated Sediment Consists of loamy soils developed in loess, glacial till, and colluvium of variable thickness, and alluvial clay, silt, sand, and gravel. The total thickness of the Quaternary deposits varies between 5 and 18 m (15 to 60 ft) in the eastern part of the quad, but can be thicker than 43 m (140 ft) in the southwestern part of the mapping area. This unit is shown only on the cross-section, not on the map.

MESOZOIC

CRETACEOUS SYSTEM

Kd – Sandstone, Mudstone, and Siderite Pellets (Windrow/Dakota 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 shaly sandstone with siderite pellets. The thickness of this unit is variable, but usually less than 6 m (20 ft).

PALEOZOIC

DEVONIAN SYSTEM

Dl – Shale, Limestone, and Dolomite (Lime Creek Formation) Upper Devonian. This map unit comprises most of the bedrock surface in the southern part of the mapping area. Because of erosion, the thickness of this unit varies between 0 to 42 m (0-140 ft). The unit can be subdivided into three parts: a lower unfossiliferous green-gray to gray calcareous shale, a middle fossiliferous calcareous shale, and an upper fossiliferous limestone, dolomitic limestone, and dolomite. The middle and upper parts of the unit are characterized by extremely abundant brachiopods and other fossils.

Dsr - Limestone, Dolomite, and Shale (Shell Rock Formation) Upper Devonian. This map unit comprises most of the bedrock surface in the northern part of the mapping area, and usually has a thickness of 12 to 18 m (40-60 ft), but can thicken to 36 m (120 ft) toward the west of the mapping area. The unit is characterized by fossiliferous carbonates with some grey to light green shale and/or argillaceous carbonates. 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.

Dlgc - Dolomite, Limestone, and Shale (Lithograph City Formation) Middle to Upper Devonian. This map unit attains a maximum thickness of up to 34 m (110 ft) in the mapping area. It consists of dolomite and dolomitic limestone, partially characterized by interbeds of laminated lithographic and sublithographic limestone and dolomitic limestone, in part argillaceous or with little shale. "Birdseye," vugs and calcite vug-fills are common. Some intervals are fossiliferous and stromatoporoid-rich. This map unit is only present at the bedrock surface in some of the quarries in the mapping area.

Dcv - Limestone and Dolomite (Coralville Formation) Middle Devonian. The thickness of this map unit varies between 11 and 18 m (35-60 ft). It is dominated by limestone, dolomitic limestone, and dolomite, in part, laminated and argillaceous. Brachiopods, echinoderm debris and corals usually occur in the limestone facies. This unit is shown only on the cross-section, not on the bedrock surface of the quad.

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

9308 ● **Water Well Logs** with IGWS well number (records available at *www.igs.uiowa.edu/geosam*)

× **Outcrops**

Base map from USGS Clear Lake East 7.5' Digital Raster Graphic (IGS GIS file DRGD28c.TIF) which was scanned from the Clear Lake East 7.5' Topographic Quadrangle map, published by US Geological Survey in 1972
Land elevation contours (10' interval).

Iowa Geological and Water Survey digital cartographic file ClearLakeE_BedrockGeology.mxd, version 9/15/13 (ArcGIS 10.1)
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.