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MISCELLANEOUS MAP SERIES
MAP M-135
Bedrock Geology, Mankato West Quadrangle

BEDROCK GEOLOGY OF THE MANKATO WEST QUADRANGLE, BLUE EARTH, LE SUEUR, AND NICOLLET COUNTIES, MINNESOTA

by

John H. Mossler
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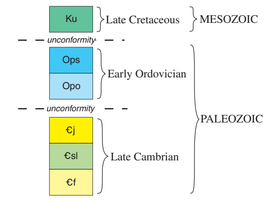
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Ku **Cretaceous rocks, undivided (Late Cretaceous)**—Sandstone and clay. The sandstone is light gray to pale brown, fine- to medium-grained quartz. It is friable but has variable iron-oxide staining or cementation. Thin lenses of grayish-green shale are interbedded in the sandstone and scattered clasts of kaolinite occur in some sandstone beds. The sandstone is poorly stratified, with faint sub-horizontal stratification. There is a thin basal conglomerate that is composed of pebbles of Paleozoic chert and vein quartz. Similar, thin lenses of conglomerate occur higher up in the unit. In neighboring quadrangles the basal conglomerate is cemented by iron oxide that stains it dark reddish-brown.

Gravel at the base of the Quaternary sequence, that also is cemented by iron oxide and occupies a similar stratigraphic position with respect to underlying Paleozoic units, resembles the Cretaceous conglomerate. However, the Quaternary gravel is not monomineralic and contains a variety of lithic types such as granite-gneiss, carbonate, shale, and diabase that are not found in the Cretaceous conglomerate. The Cretaceous sandstone occurs as scattered erosion remnants that are generally less than 5 to 10 feet (1.5 to 3 meters) thick and rarely are more than 20 feet (6 meters) thick.

The Cretaceous sandstone is lithically similar to sandstone described in southwestern Minnesota (Setterholm, 1990) that is correlative with the Dakota Formation. The basal conglomerate is similar to the Ostrander conglomerate of southeastern Minnesota. These lithostratigraphic units are considered to be lower Late Cretaceous in age (Sloan, 1964).

The lower part of the Cretaceous unit consists of kaolinitic clay that is present mainly as fracture and sinkhole fillings in the karsted, heavily iron-oxide encrusted dolostone surface of the Ordovician Oneota Dolomite (Zanko and others, 1998). Pisolitic kaolinite is observed at some outcrops (Humphrey, 1958; Parham, 1970). Because this basal unit is fracture filler in karsted carbonate rock, it is not possible to accurately depict its distribution on a map with limited subsurface data. It is inferred to occur extensively in the subsurface where Prairie du Chien Group carbonate rocks are present. Kaolinitic clay is found throughout most of Minnesota at the base of the Cretaceous rock sequence and is interpreted to represent an in situ or transported weathering product of older feldspathic bedrock units (Parham, 1970).

The Cretaceous sedimentary rocks overlie the Jordan Sandstone and Prairie du Chien Group dolostone unconformably, typically at elevations between 800 and 850 feet (244 to 259 meters) above sea level (Zanko and others, 1998).

Prairie du Chien Group (Early Ordovician)—Dominantly dolostone interlayered with lesser amounts of quartz sandstone. The group is divided into two formations: the Shakopee Formation and Oneota Dolomite. The Shakopee Formation is eroded from the map area except along the eastern border where it is inferred to be present in the subsurface in a few places from its distribution on the adjoining Mankato East quadrangle.

Ops ***Shakopee Formation***—Light brown to grayish-orange, thin- to medium-bedded sandstone and dolostone. The sandstone is fine- to medium-grained quartz. The dolostone is generally sandy and commonly contains intraclasts and microbial or stromatolitic structures.

Opo ***Oneota Dolomite***—Predominantly light brown to grayish-orange, medium- to thick-bedded dolostone. It commonly contains small, unfilled vugs. Meter-scale microbial mounds are common. The dolostone is sandy near its base and contains some shale stringers there. There also is some glauconite at the base. This dolostone is equivalent to the Hager City Member of the Oneota Dolomite in southeastern Minnesota. It has been quarried extensively in the Mankato area for building stone (Stubblefield, 1971). Large (meter-scale), solution enlarged vertical joints and bedding-plane fractures are particularly common in the lowermost part of the Hager City Member. In exposures along the north bank of the Minnesota River (T. 108 N., R. 27 W., secs. 11 and 14) and nearby areas these features are most commonly entirely filled with a gray to white shale and siltstone that appears to be lithically similar to the underlying Blue Earth Siltstone bed. The relatively fine-grained material that fills these cavities may, in combination with that composing the underlying Blue Earth Siltstone bed, provide some degree of hydraulic separation of the Jordan Sandstone from the upper part of the Hager City Member.

The Blue Earth Siltstone is a thin dolomitic siltstone below the dolostone of the Hager City Member. It is feldspathic and contains glauconite. It is equivalent to the upper part of the Coon Valley Member of the Oneota Dolomite of southeastern Minnesota (Mossler, 1987). The Blue Earth Siltstone bed is about 3 feet (1 meter) thick.

A thin interval of medium- to coarse-grained quartzose sandstone from a few inches to 6.5 feet (2 meters) thick that disconformably overlies the Jordan Sandstone and conformably underlies the Blue Earth Siltstone contains an Ordovician-age fauna (Powell, 1935) and is considered to be a basal part of the Oneota Dolomite, equivalent to the lower part of the Coon Valley Member of the Oneota Dolomite in southeastern Minnesota (Runkel and others, 1999). Powell (1935) and Stauffer and Thiel (1941) referred to this sandstone as the Kasota sandstone. Its lithic similarity to the Jordan Sandstone makes it impractical to map as a separate unit.

The Oneota Dolomite is up to 50 feet (15 meters) thick within this quadrangle. The formation is present in the eastern and southern parts of the quadrangle where it is highly dissected by erosion and in many places much thinner than the maximum, uneroded thickness.

Cj **Jordan Sandstone (Late Cambrian)**—Dominantly light gray sandstone; includes coarsening-upward sequences consisting of two interlayered facies, which are not separated on the map. They are medium- to coarse-grained, cross-stratified, generally friable quartz sandstone; and very fine-grained, structureless, commonly bioturbated feldspathic sandstone and lenses of siltstone and shale. Exposures in the upper part of the Jordan Sandstone have extensive silica cementation, particularly in the terrace along the Minnesota River west of Mankato.

The formation is from 70 to nearly 100 feet (21 to 30 meters) thick where the entire unit is preserved; however, it is highly dissected by erosion throughout much of the quadrangle (Fig. 1).

Csl **St. Lawrence Formation (Late Cambrian)**—Much of the formation is yellowish-gray to grayish-orange-pink, dense to finely crystalline, silty dolostone. However, there is light greenish-gray, dolomitic siltstone in the uppermost part.

The dolostone beds in the St. Lawrence Formation commonly have solution features typical of karstic carbonate rock where they are exposed near Judson, Minnesota, west of this study area. Bedding-plane exposures display an anastomosing network of centimeter-scale cavities that likely serve as ground-water conduits in saturated subsurface conditions.

The St. Lawrence Formation is from 45 to 75 feet (14 to 23 meters) thick where it is undissected by erosion. It occurs along the lower parts of bedrock valley walls in the map area but is covered by Quaternary glacial sediment and alluvium and does not crop out on this quadrangle. It does crop out directly to the west on the Judson quadrangle.

Glauconite content in the dolostone increases toward the base of the formation. The contact of the St. Lawrence Formation with the underlying Franconia Formation is conformable. It is characterized by 3 to 7 feet (1 to 2 meters) of interbedded glauconitic, intraclastic dolostone and sandstone.

Cf **Franconia Formation (Late Cambrian)**—Sandstone and dolostone. The sandstone is yellowish-gray to gray-yellow-green to light olive-gray, very fine- to fine-grained, silty, feldspathic, and glauconitic. It is generally friable and poorly cemented, but has some dolomite cement. Interbedded, thin grayish-green shale partings are common.

The basal 10 to 12 feet (3 to 4 meters) of the Franconia Formation is grayish-orange-pink, medium crystalline, glauconitic dolostone.

The Franconia Formation ranges from 110 to 130 feet (34 to 40 meters) in thickness. It subcrops in deeper parts of major buried valleys and does not outcrop on the quadrangle. It overlies the medium- to coarse-grained Ironton Sandstone with a sharp but apparently conformable contact.

The Ironton and Galesville Sandstones and older Cambrian formations do not crop out on this quadrangle.

MAP SYMBOLS

Geologic contact—Approximately located.

Line of equal elevation of the bedrock surface—In feet above sea level; contour interval is 50 feet (15 meters). Supplemental 25-foot (8-meter) contour is shown at 825 feet (shown locally south of the Minnesota River in areas of sufficient data coverage).

Drill holes—Not all intersect bedrock.

- **Record of water-well construction (well driller's log)**
- **Cutting sample**
- **Borehole geophysical log**
- **Cutting sample with borehole geophysical log**
- **Engineering test boring**—City of Mankato
- **Engineering test boring**—Minnesota Department of Transportation
- **Engineering test boring**—Army Corps of Engineers

Detailed mapping of bedrock exposure

Large area of bedrock exposure

Folds—Based largely on the structure contour map of the Jordan Sandstone (Fig. 1).

Anticline—Shows trace of axial surface and plunge of fold where known.

Syncline—Shows trace of axial surface and plunge of fold where known.

SOURCES USED TO COMPILE THE GEOLOGIC MAP

The Mankato West map was compiled from several sources. The author mapped and described bedrock outcrops. Theses by Humphrey (1958), Austin (1971), and Stubblefield (1971) provided additional descriptions for some outcrops on the quadrangle. Most of the area is overlain by thick Quaternary glacial deposits or by thick Holocene alluvium. Outcrops are found only along deeply incised stream valleys or on bedrock terraces. Therefore, mapping for most of the area relied principally on subsurface information derived from water wells and other borings. Drillers' logs for water wells and monitoring wells provided much of the data. Well cutting sample sets and geophysical logs are available for some of these boreholes. Additional data were provided by engineering test borings and diagrams from the Army Corps of Engineers for flood control levees along the Minnesota and Blue Earth Rivers, Minnesota Department of Transportation borings for highway and bridge projects, and City of Mankato and private engineering firms' borings for street and building construction. Anthony Runkel provided information on the permeability and hydrologic characteristics of the Jordan Sandstone and St. Lawrence Formation.

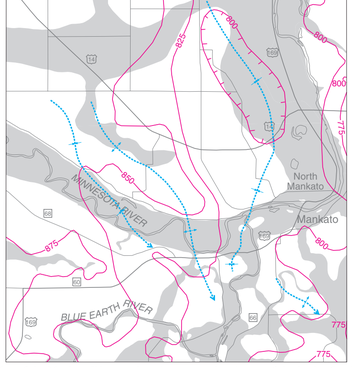


Figure 1. Map of the Mankato West quadrangle contoured at the top of the Jordan Sandstone showing geologic structure; scale 1:100,000. Contour interval for the top of the Jordan Sandstone is 25 feet (8 meters). Approximate area where the Jordan Sandstone is missing because of erosion is shaded; contours in those areas are inferred from projection using known thicknesses of the formation.

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Base from U.S. Geological Survey Mankato West 1:24,000 quadrangle, 1974, revised 1993.

Universal Transverse Mercator grid, zone 15
1983 North American Datum

GIS compilation and cartography by
Joyce Meints and Philip Heywood
Edited by Lori Robinson

SCALE 1:24 000

1 1/2 0 1 MILE

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

2°24'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2003

QUADRANGLE LOCATION