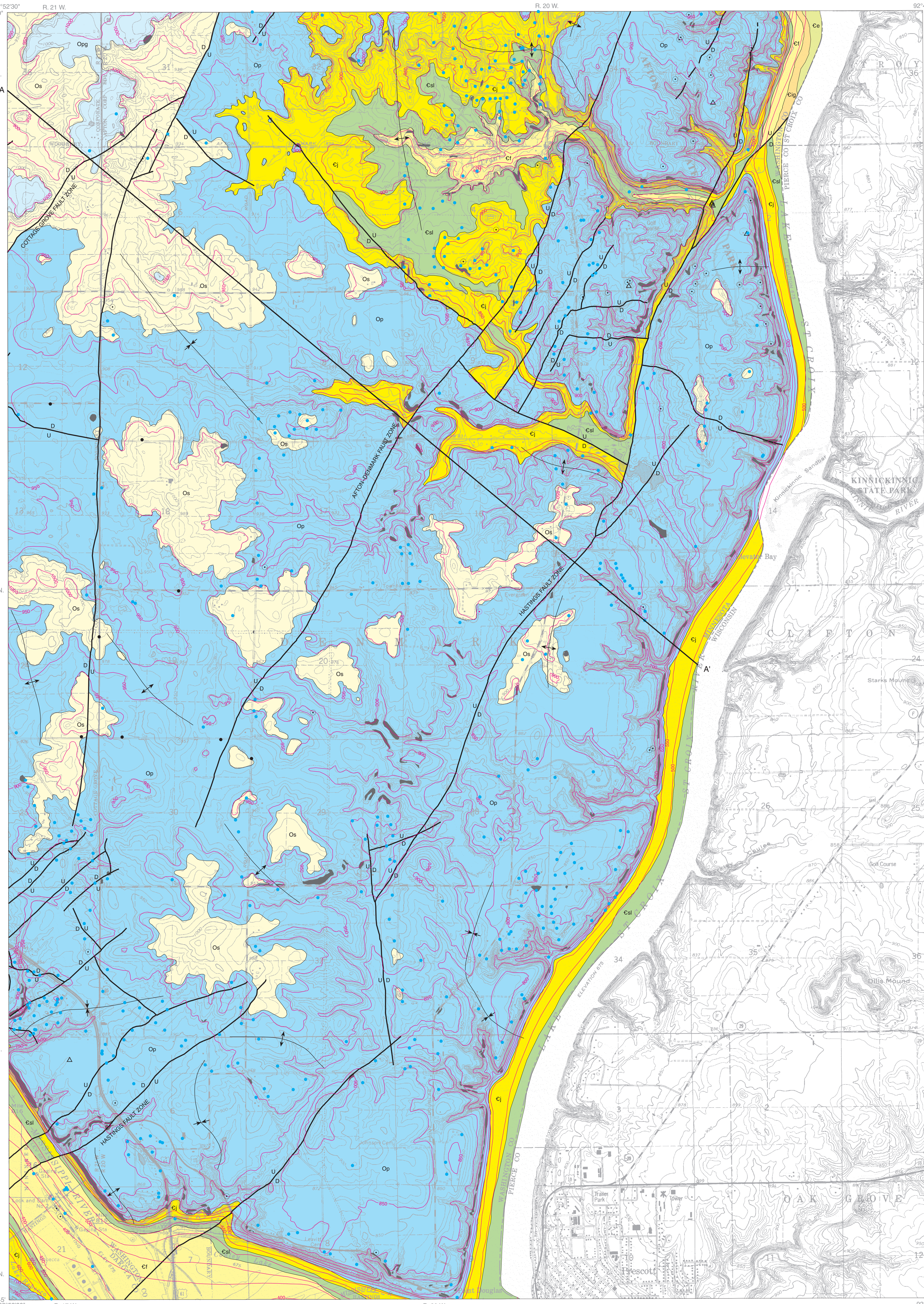
UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
Harvey Thorleifson, Director

Prepared and Published with the Support of
THE U.S. GEOLOGICAL SURVEY AS PART OF THE 2005 STATE GEOLOGIC MAPPING PROGRAM ELEMENT (STATEMAP)
OF THE NATIONAL GEOLOGIC MAPPING PROGRAM

MISCELLANEOUS MAP SERIES
MAP M-167
Bedrock Geology, Prescott Quadrangle



Base from U.S. Geological Survey Prescott 1:24,000 quadrangle, 1967.
Universal Transverse Mercator grid, zone 15
1983 North American Datum

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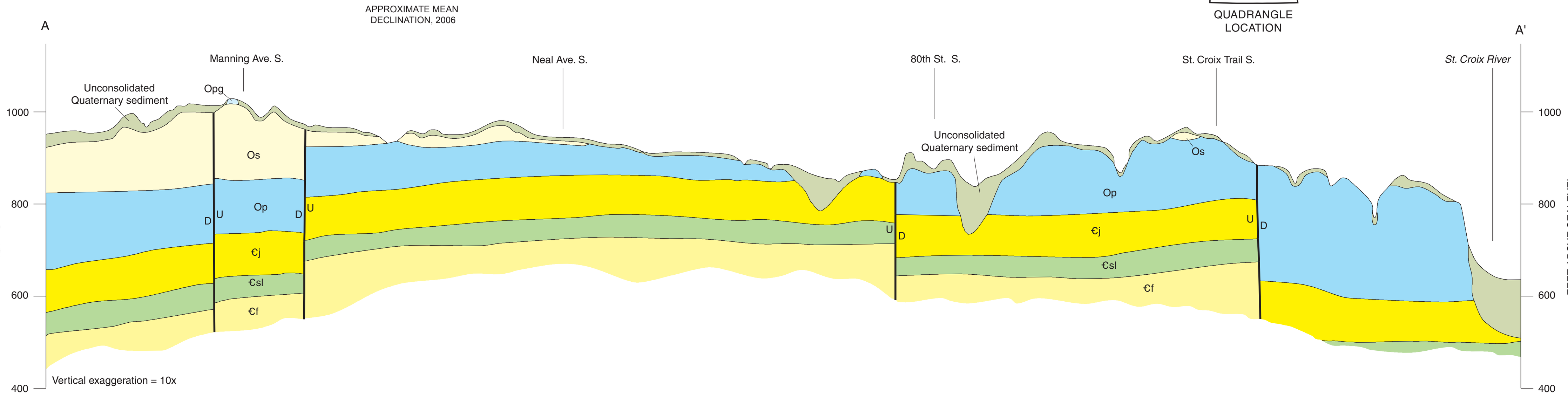
TRUE NORTH
MAGNETIC NORTH
0°51'
APPROXIMATE MEAN DECLINATION, 2006

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

QUADRANGLE LOCATION

GIS compilation by R.S. Lively
Edited by Lori Robinson



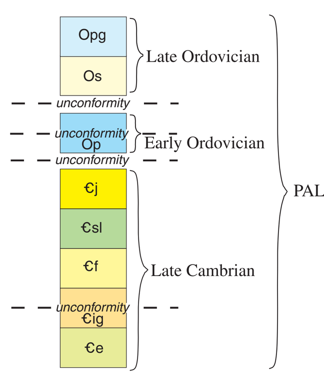
BEDROCK GEOLOGY OF THE PRESCOTT QUADRANGLE, WASHINGTON AND DAKOTA COUNTIES, MINNESOTA

By

John H. Mossler

2006

CORRELATION OF MAP UNITS



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).

Fault—Faults in Paleozoic rocks are interpreted to be dip-slip. Letters indicate relative vertical displacement, U up, D down. Faults are concealed by Quaternary sediment and recent alluvium and are inferred from subsurface geologic data supplemented by aeromagnetic data. Contrasts in magnetic intensity on the aeromagnetic map (Fig. 2) are the expression of faults in the underlying Proterozoic volcanic and sedimentary rocks. These faults were rejuvenated during post Proterozoic time and the variations in magnetic values associated with them correspond locally to apparent offsets in Paleozoic strata (Figs. 2, 3).

Fold—Axial trace of anticline, syncline; inferred from subsurface data.

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**

Soil boring—Drilled by the Minnesota Geological Survey for an aggregate resource inventory (Meyer and Mossler, 1999).

Bedrock exposure—Mapped by the Minnesota Geological Survey for aggregate resource inventories (Meyer and Jirsa, 1984; Meyer and Mossler, 1999).

INTRODUCTION

This geologic map shows the bedrock formations that are either exposed at the land surface or lie beneath unconsolidated Quaternary deposits of variable thickness. Quaternary and Holocene glacial deposits, colluvium, and alluvium cover the bedrock across most of the Prescott quadrangle, although in many places those deposits are very thin or absent. Bedrock outcrops are common in the bluffs along the St. Croix and Mississippi Rivers. They are also present along Trout Brook and the many smaller drainageways in the quadrangle as flat, low-lying outcrops. Quaternary and Holocene sediments tend to be thickest in the valleys of major rivers and their tributaries (see cross section).

Buried stream channels that are incised into several rock formations are the primary influences on the map distribution of bedrock geologic units. The Hastings and Cottage Grove faults are near-surface manifestations of inferred Proterozoic faults along the Mesoproterozoic Midcontinent Rift (Sims and Zeitz, 1967) that were reactivated during the Ordovician period and later. They transect the quadrangle and affect the pattern of bedrock geology. Because the bedrock is generally concealed by Quaternary sediment, the fault pattern is based principally on subsurface geologic data supported by aeromagnetic data (Sims and Zeitz, 1967; Chandler and others, 2004). However, the Hastings fault zone is exposed along the Mississippi River just northwest of the Hastings lock and dam where Schwartz (1936), Kohls (1958), and earlier geologists described it. In addition, Kohls (1958) described faults in sections 2, 3, and 10 of Denmark Township based on offsets in elevation of geologic contacts along opposite banks of a north–south trending stream valley. Prior to collection of large quantities of subsurface data in southern Washington County, there was little evidence to support the presence of the many faults shown on the Prescott bedrock geologic map.

The cross section shows the bedrock depth and illustrates stratigraphic relationships. The geologic formations are thin in relation to their areal extent and would only be a tenth as thick as shown in the cross section if no vertical exaggeration was used. The exaggeration needed to show the thin rock formations also gives the appearance of steeper slopes—on the land surface topography, buried bedrock surface, and geologic contacts between rock formations. Deeply buried Paleozoic and Proterozoic formations are not shown on the cross section because information on their depth and thickness is unavailable. Typically, wells drilled for water only penetrate the uppermost rock formations beneath the Quaternary sediment because sufficient flow can be acquired there.

DESCRIPTION OF MAP UNITS

Opg **Platteville Formation and Glenwood Formation (Late Ordovician)**—The Platteville Formation is dominantly limestone and dolostone. The Glenwood Formation is dominantly shale. The formations cap mesas in the northwestern part of the quadrangle. Together they are 25 to 34 feet thick (8 to 10 meters), but generally thinner because the upper surface of the Platteville Formation is an erosional contact with overlying Quaternary sediments.

Platteville Formation—The Platteville Formation is up to 25 to 30 feet (8 to 9 meters) thick. It is composed of yellowish-gray to light brown-gray, thick- to medium-bedded dolostone that overlies yellowish-gray to light gray, thin-bedded limestone. There is a thin bed of sandy, phosphatic dolostone at the base of the formation.

Glenwood Formation—The Glenwood Formation is grayish-green to brownish-gray, calcareous, sandy, phosphatic shale. It is generally from 3 to 5 feet (1 to 1.5 meters) thick.

Os **St. Peter Sandstone (Late Ordovician)**—The St. Peter Sandstone varies from 145 to 180 feet (44 to 50 meters) in thickness in the quadrangle where overlain by the Glenwood and Platteville Formations, but commonly is much thinner where partially eroded. The upper part is white to light gray, medium- to fine-grained quartzose sandstone. Thick beds characterize this part; there is some cross stratification near the top of the unit. It is very friable. The basal part is light to medium gray, fine- to coarse-grained, and poorly sorted quartzose sandstone that is interbedded with shale and feldspathic siltstone of varied colors. The upper part of the formation is exposed in the sides of some mesas in the northwestern part of the quadrangle and some low, nearly flat hillside exposures elsewhere. The basal contact of the formation with the underlying Prairie du Chien Group dolostone (unit Op) is a major unconformity (Smith and others, 1993).

Op **Prairie du Chien Group (Early Ordovician)**—The Prairie du Chien Group is from to 260 to 300 feet (79 to 91 meters) thick in water wells east of the Hastings fault zone where overlain by St. Peter Sandstone. Between the Hastings and Cottage Grove faults, along the Hudson–Afton horst, the Prairie du Chien Group is about 100 feet (30 meters) thick where St. Peter Sandstone covers it. It is much thinner where subjected to post-St. Peter Sandstone erosion. It has a maximum thickness of 160 feet (49 meters) west of the Hudson–Afton horst. The variations in thickness indicate that some of the movement that occurred along the faults was contemporaneous with deposition of the Prairie du Chien Group or occurred afterwards but prior to deposition of the St. Peter Sandstone. The Prairie du Chien Group is extensively exposed along bluffs on the Mississippi and St. Croix Rivers. It is also exposed in flat outcrops throughout the quadrangle and in low bluffs along smaller streams. It serves as the main source for rock aggregate in Washington County. The Prairie du Chien Group is typically divided into two formations, however, this subdivision may not always be discernible in the subsurface if there is insufficient information from well cuttings and geophysical logs. The upper formation is the Shakopee Formation. It is a heterolithic unit that contains dolostone, sandy dolostone, and sandstone. It is grayish-orange to yellowish-gray, thinly bedded, and oolitic and sandy in its lower part. The lower formation is the Oneota Dolomite. It ranges from 90 to 105 feet (29 to 32 meters) in thickness in southern Washington County. It is yellowish-gray to pale brown dolostone, typically in medium to thick beds. It is less sandy than the Shakopee Formation except near the base. The contacts between the Shakopee Formation and the Oneota Dolomite and between the Oneota Dolomite and the Jordan Sandstone (unit Cj) are unconformable (Runkel and others, 1999).

Cj **Jordan Sandstone (Late Cambrian)**—Dominantly light gray sandstone characterized by 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 shale and siltstone. The major part of the fine-grained facies forms a regionally continuous interval that gradationally overlies the St. Lawrence Formation (unit Csl), although there are lithically similar intervals intercalated within the quartzose facies at higher stratigraphic intervals. The Jordan Sandstone is generally 85 to 100 feet (26 to 30 meters) thick. It is exposed in the lower parts of the bluffs along the Mississippi River and along Trout Brook and environs.

Csl **St. Lawrence Formation (Late Cambrian)**—The St. Lawrence Formation is principally light gray to yellowish-gray and pale yellowish-green, dolomitic siltstone and shale. Lenses and layers of light gray, finely crystalline, sandy dolostone occur locally. The formation is 45 to 50 feet (14 to 15 meters) thick. The St. Lawrence Formation is exposed along Trout Brook west of the Hastings fault zone.

Cf **Franconia Formation (Late Cambrian)**—The Franconia Formation varies from 120 to 140 feet (37 to 43 meters) in thickness. In Minnesota, it is divided into four members (Berg, 1954); however, only the lower three are known to be present in the Prescott quadrangle. The uppermost non-glauconitic sandstone member, the Mazomanie, is not known to occur in the quadrangle. The Reno Member is pale yellowish-green, very fine- to fine-grained sandstone, with thin greenish-gray shale partings. The sandstone is well sorted, glauconitic, and contains thin intraclastic zones. It is underlain by the Tomah Member, a thin unit composed of interbedded grayish-yellow-green siltstone, very fine-grained sandstone, and pale green shale that is sparsely glauconitic. The basal Birkmose Member is grayish-yellow-green, fine-grained sandstone cemented by dolomite. The majority of sand grains in some intervals of the Birkmose Member are glauconitic. The Franconia Formation crops out along Trout Brook west of the Hastings fault zone.

Cig **Ironton Sandstone and Galesville Sandstone (Late Cambrian)**—These formations are composed of very fine- to coarse-grained, moderately sorted to well sorted, light gray, quartz sandstone. The upper part of the combined Ironton and Galesville Sandstone is fine- to coarse-grained; the lower part is better sorted, is very fine to fine-grained, and becomes progressively finer toward the base. The sandstones are fossiliferous, and brachiopod valves are present locally along bedding planes. The Ironton and Galesville Sandstones are conformable with overlying and underlying formations; however, they are separated from one another by a subtle unconformity marked by a pebbly sandstone layer (Runkel and others, 1998). They are generally treated as a single unit because the unconformity is difficult to distinguish, particularly in the subsurface. The combined thickness of the formations is 50 to 60 feet (15 to 18 meters). These sandstones and underlying formations are known in the Prescott quadrangle and surrounding area mainly from well cuttings and from drill cores obtained by the Northern Natural Gas Company in the Vermillion area southwest of Prescott. Some of these cores are described and illustrated in Mossler (1992).

Ce **Eau Claire Formation (Late Cambrian)**—The formation is composed of yellowish-gray to pale olive-gray, very fine-grained sandstone, siltstone, and shale. The upper part is predominantly shale and siltstone, the lower part is predominantly glauconitic sandstone and siltstone. The formation is about 90 to 100 feet (27 to 30 meters) thick.

SOURCES USED TO COMPILE THE GEOLOGIC MAP

The Prescott map was compiled from several sources. The author mapped bedrock geology, bedrock topography, and aggregate resources, and described outcrops in the Prescott quadrangle for previous studies (Mossler and Bloomgren, 1990; Patterson and others, 1990; Meyer and Mossler, 1999). Older publications by Schwartz (1936) and Kohls (1958), and U.S. Soil Conservation Service maps (Vinar, 1980) were consulted for areas of shallow bedrock and outcrop. Great reliance was placed on locations and descriptions of bedrock in Kohls (1958) because many of the outcrops that he described are no longer visible, particularly those of the St. Peter Sandstone, because of construction and overgrowth by vegetation. Outcrops were also compiled on 1:24,000-scale maps during an earlier study of aggregate resources by Meyer and Jirsa (1984) and during an unpublished inventory of bedrock outcrops by the author in 1974.

Thick Quaternary glacial deposits and Holocene alluvial deposits overlie most of the area and conceal much of the bedrock geology. Therefore, much of the mapping relied on subsurface data. Drillers' logs for water wells, exploratory test holes, and monitoring wells provided most of those data. Cutting samples and geophysical logs are available from some of the boreholes. Some data were obtained from shallow test borings done for the aggregate resources study by Meyer and Mossler (1999).

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Supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under assistance Award No. 05HQAG0065.

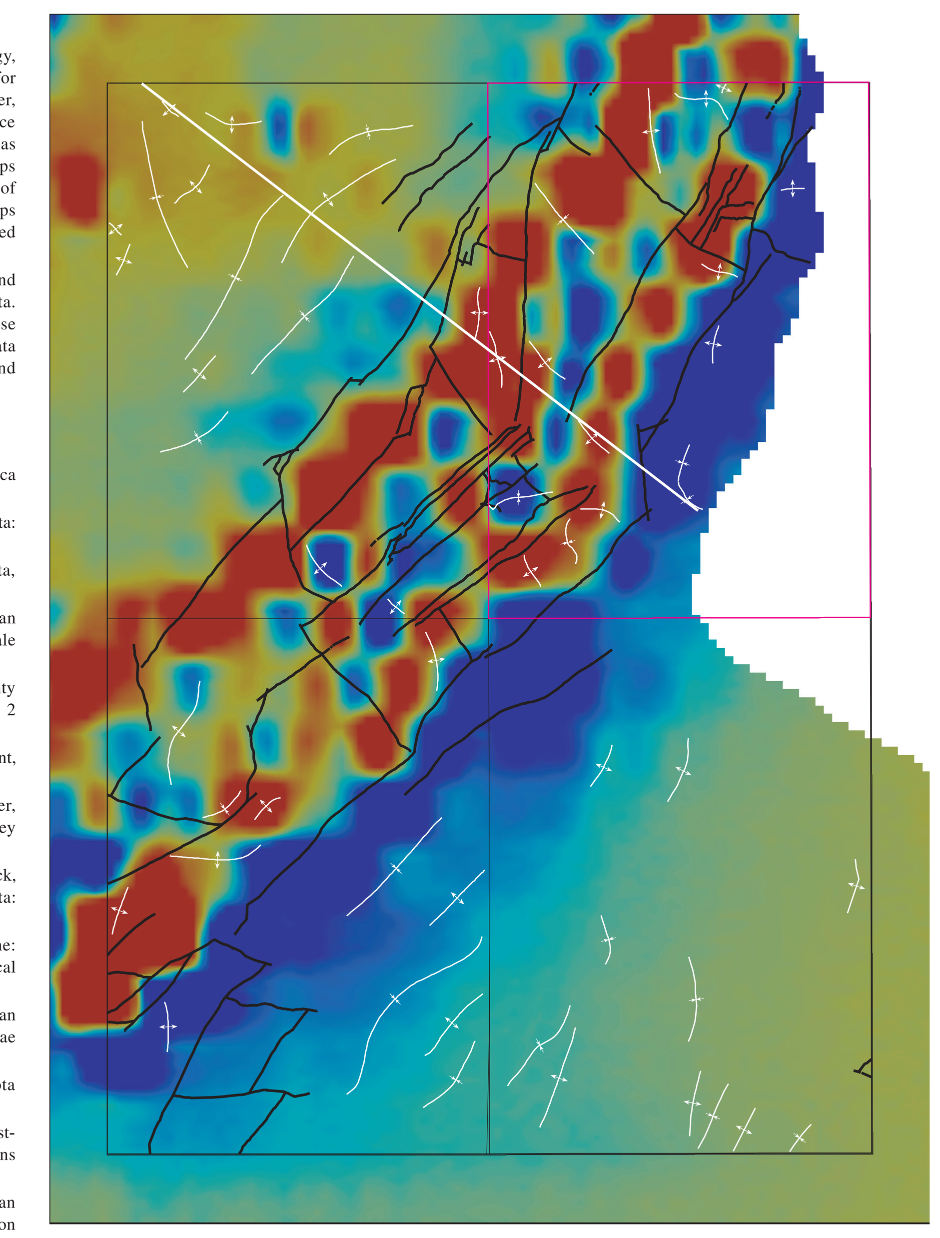


Figure 2. Faults mapped in Paleozoic strata in the St. Paul Park, Prescott, Vermillion, and Hastings quadrangles superimposed on first derivative aeromagnetic anomaly data (Chandler and others, 2004). The faults in the Paleozoic rocks are inferred to be rejuvenated Proterozoic faults that flank a horst developed in the volcanic and sedimentary rocks of the Midcontinent Rift (Sims and Zeitz, 1967). Highly magnetic Proterozoic volcanic rocks (red) underlie the horst; sedimentary rocks with low magnetic values (blue) underlie the flanking basins. Fold axes and the line of section for Figure 3 are shown in white; scale 1:150,000.

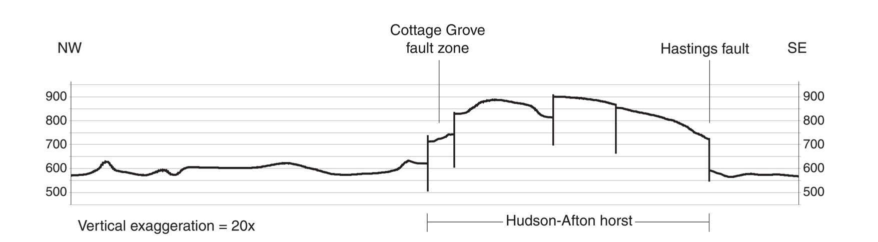


Figure 3. This northwest to southeast profile of the elevation of the top contact of the Jordan Sandstone through the St. Paul Park and Prescott quadrangles shows the changes in elevation across the Hudson–Afton horst caused by movement along the rejuvenated Proterozoic faults of the Midcontinent Rift that displaced Paleozoic strata. The line of section is shown on Figure 2.

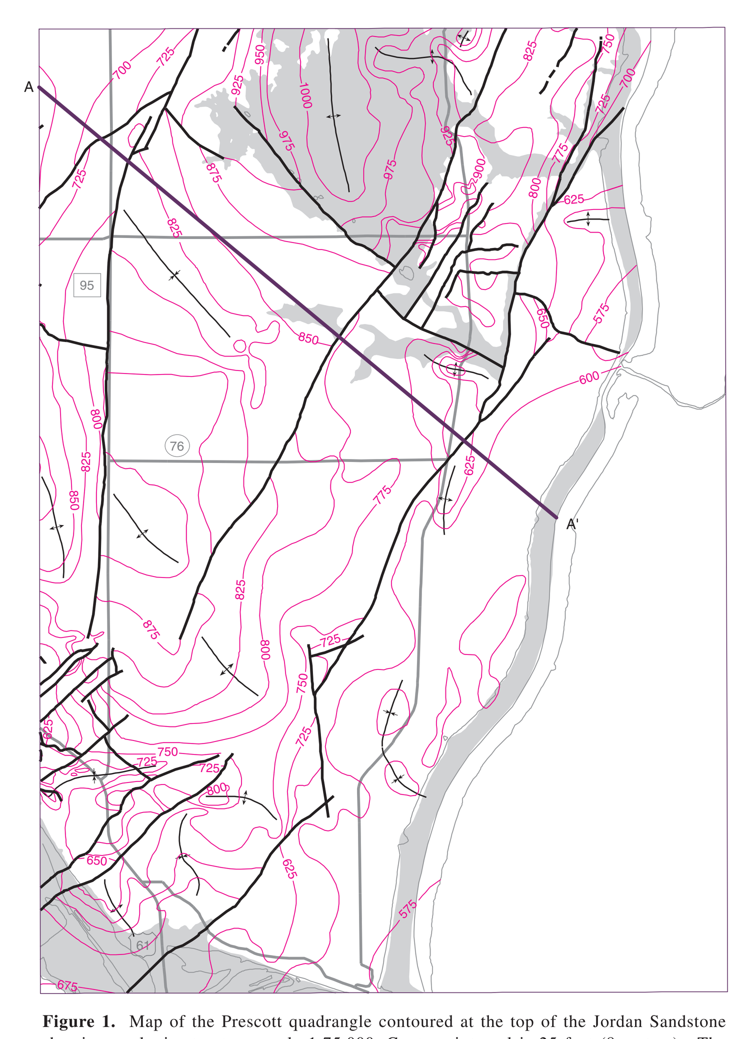
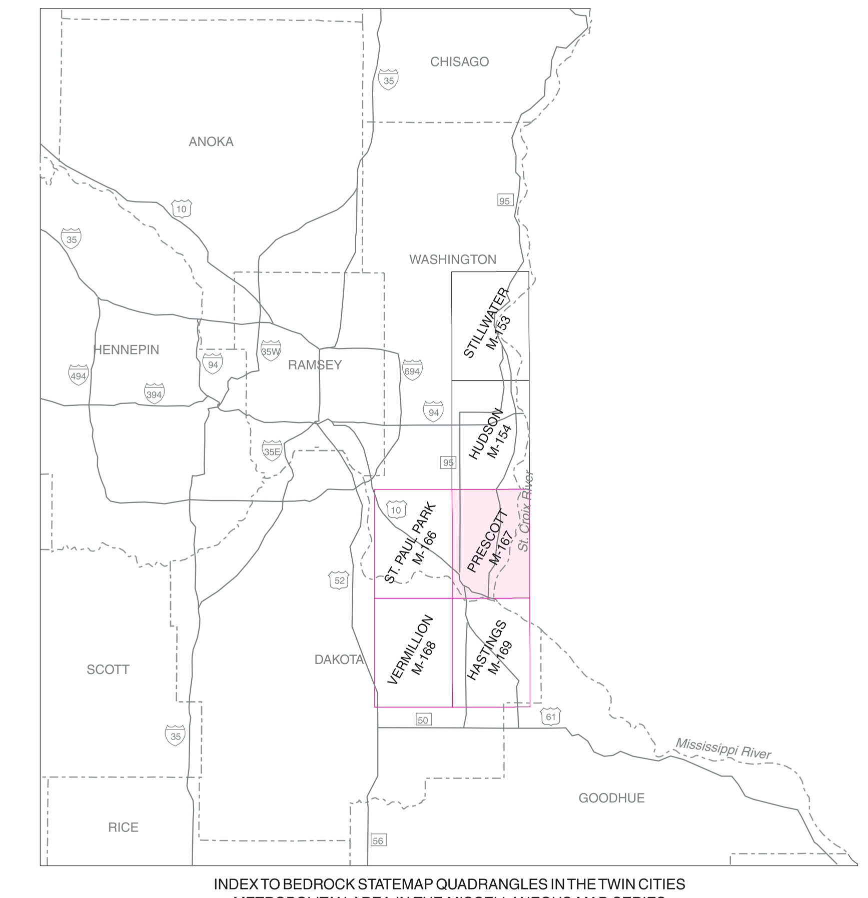


Figure 1. Map of the Prescott quadrangle contoured at the top of the Jordan Sandstone showing geologic structure; scale 1:75,000. Contour interval is 25 feet (8 meters). The approximate area where some or all of the Jordan Sandstone is missing because of erosion is shaded; contours in those areas are inferred from projection using the estimated thickness of the formation.



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