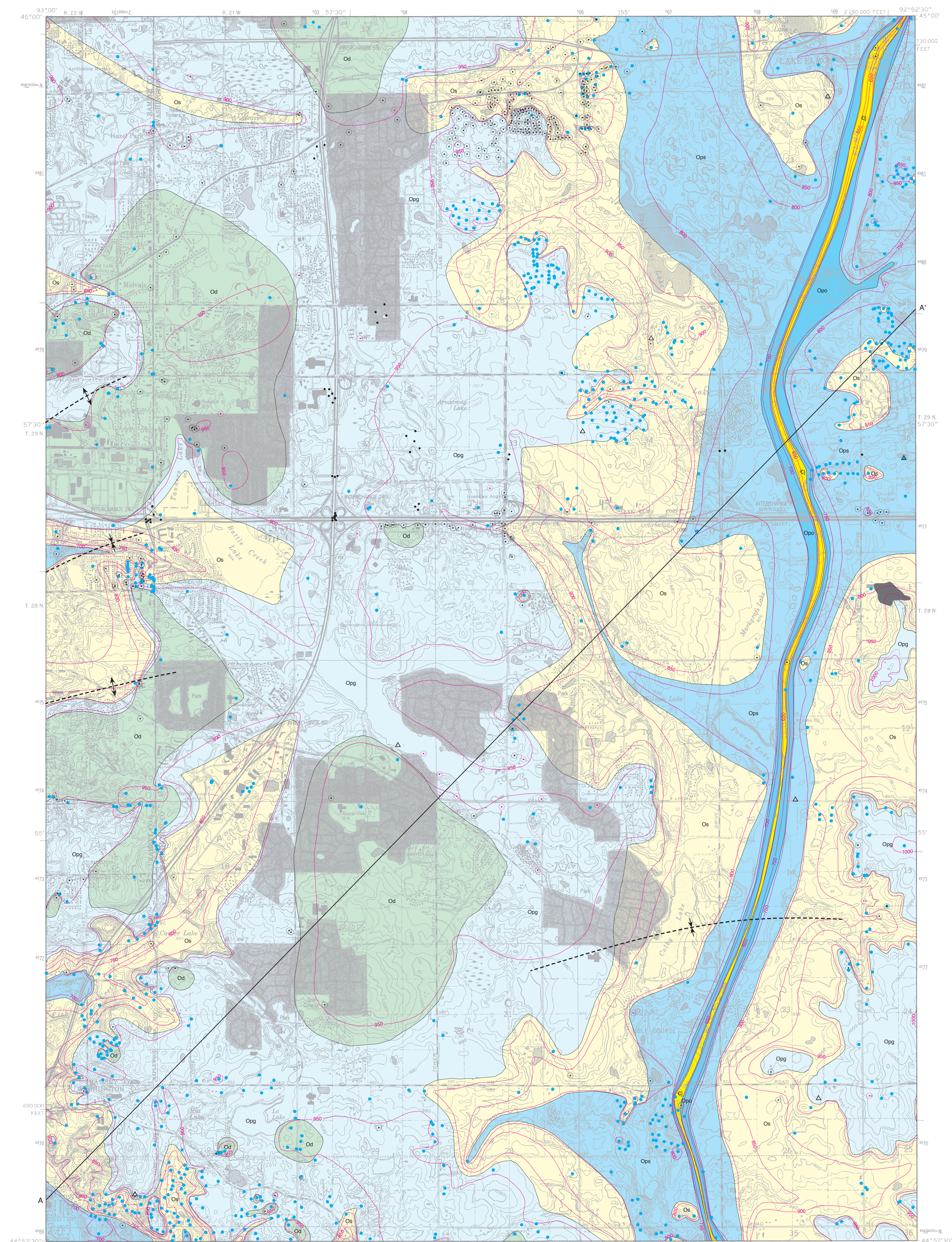
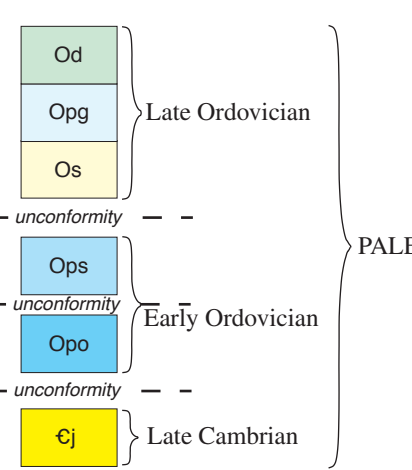


BEDROCK GEOLOGY OF THE LAKE ELMO QUADRANGLE, RAMSEY AND WASHINGTON COUNTIES, MINNESOTA

By
Julia Anderson
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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).
- 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)
- Borehole geophysical log
- Cuttings sample
- Cuttings sample with borehole geophysical log
- Soil boring—Completed by the Minnesota Department of Transportation.
- Bedrock exposure

INTRODUCTION

This geologic map shows the distribution of the uppermost bedrock units that lie directly beneath unconsolidated Quaternary deposits in the Lake Elmo quadrangle. Quaternary deposits are dominated by sandy till, sand bodies, and recent stream deposits (Meyer and others, 1990). They are generally 70 to 120 feet (21 to 36 meters) thick, but reach thicknesses up to 250 feet (76 meters) within deeply buried bedrock valleys. Bedrock outcrops are limited to a few small exposures of upper St. Peter Sandstone, and Glenwood and Platteville Formations in the eastern part of the map area. Due to the thick Quaternary deposits and lack of outcrop exposure, bedrock geologic mapping for the Lake Elmo quadrangle is based chiefly on subsurface geologic data, which include water well records, engineering test borings, drillers' well cuttings, and borehole geophysical logs (on file at the Minnesota Geological Survey). Previous geologic maps within the Lake Elmo quadrangle and surrounding areas (Mossler and Bloomgren, 1990, 1992; Patterson and others, 1990; Meyer and Mossler, 1999; Mossler, 2005a, b, 2006a, b) were also consulted for their geologic interpretations and descriptions of map units in areas where better exposure exists.

Bedrock units are sedimentary, marine rocks of Paleozoic age that are gently tilted less than one-half degree to the west. Distribution of bedrock units is primarily influenced by the location of deeply incised bedrock valleys that cut through the nearly flat-lying strata. Paleozoic bedrock units lie on a thick package of deeply buried Mesoproterozoic rocks of the Midcontinent Rift. Previous work in nearby areas (Sims and Zeitz, 1967; Chandler and others, 2004; Mossler, 2005a, b, 2006a, b) has shown that Proterozoic-age faults along the Midcontinent Rift were likely reactivated during the early Paleozoic era, affecting the deposition and distribution of bedrock units. The area covered by the Lake Elmo quadrangle is mainly located to the northwest of these fault zones that span the eastern edge of the rift. Faults are inferred to be uncommon, and none were mapped. Several minor fold structures were mapped based on the contoured stratigraphic top of the Jordan Sandstone (Fig. 1). Smaller faults and folds may exist where sparse subsurface data do not allow them to be recognized.

The accompanying cross section illustrates the variable thickness of the Quaternary deposits as well as the stratigraphic relationships of the underlying bedrock units. The geologic formations are thin in relation to their areal extent and would only be a tenth as thick as shown on the cross section if no vertical exaggeration were used. The exaggeration needed to show the thin rock formations also gives the appearance of steeper slopes on the land surface and buried bedrock topography. Deeply buried Paleozoic and Proterozoic strata below the Jordan Sandstone 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 deposits because sufficient flow can be acquired there.

DESCRIPTION OF MAP UNITS

- Od Decorah Shale (Late Ordovician)**—Dominantly grayish-green shale with thin interbeds of fossiliferous limestone. Prominent fossiliferous, yellowish-brown limestone beds at the base of the Decorah Shale are now recognized as the basal Carimona Member (Mossler, 2008). The Decorah Shale occurs as erosional remnants capping mesas in the western part of the quadrangle. Though no exposures exist in the Lake Elmo quadrangle, water well logs indicate the Decorah Shale has a maximum preserved thickness of 40 feet (12 meters).
- Opg Platteville Formation and Glenwood Formation (Late Ordovician)**—The Platteville Formation is generally tan to gray, fossiliferous limestone and dolostone. The underlying Glenwood Formation is dominantly green-gray, sandy shale. The Platteville Formation is the dominant uppermost bedrock unit across a large expanse of the western two-thirds of the quadrangle subcropping beneath Quaternary deposits. Together the formations are 30 to 35 feet (9 to 11 meters) thick, but locally thinner because the upper part of the Platteville Formation was eroded before deposition of overlying Quaternary sediments.
- Platteville Formation**—The carbonate-dominated Platteville Formation is 25 to 30 feet (8 to 9 meters) thick and is divided into four members in the Twin Cities area: the Pecatonica, Mifflin, Hidden Falls, and Magnolia Members (Mossler, 2008). The Pecatonica Member is a thin bed of yellowish-gray, burrowed to structureless dolostone occurring at the base of the Platteville Formation. It commonly contains fine- to coarse-grained quartz sand and phosphatic grains. The Mifflin Member is a gray, nodular, wavy-bedded, bioturbated limestone with shale partings. It is overlain by a light olive-gray, silty, phosphatic, sparingly fossiliferous dolostone known as the Hidden Falls Member. The Magnolia Member overlies the Hidden Falls Member. It is a yellow to light brown dolostone that is characterized by 1 to 2 inch (2.5 to 5 centimeters) thick coquina layers and pyrite-lined burrows and vugs.
- Glenwood Formation**—The principal lithology of the Glenwood Formation is a grayish-green to brownish-gray, calcareous, sandy, and phosphatic shale that commonly has distinctive blocky fractures. The Glenwood Formation is 3 to 5 feet (1 to 1.5 meters) thick.
- Os St. Peter Sandstone (Late Ordovician)**—Mostly a white to tan, fine- to medium-grained, friable quartzose sandstone. Bedding and structures are generally absent, but cross stratification can be seen near the top of the unit. The lowermost 10 to 20 feet (3 to 6 meters) includes white to light gray, fine- to coarse-grained quartzose sand that is interbedded with white to pale green feldspathic shale and siltstone. The upper St. Peter Sandstone is exposed in an actively quarried sandpit in the east-central part of the quadrangle, but the basal part of the St. Peter Sandstone is concealed beneath Quaternary sediments. The thickness of the St. Peter Sandstone varies from 140 to 160 feet (43 to 49 meters) where overlain by the Platteville and Glenwood Formations, but may be much less where partially eroded. The basal contact of the formation with the underlying Prairie du Chien Group dolostone (unit Opg) is a major erosional unconformity (Smith and others, 1993).
- Prairie du Chien Group (Early Ordovician)**—Dominated by dolostone interlayered with lesser amounts of quartz sandstone. It is divided into two formations: the Shakopee Formation and underlying Oneota Dolomite. Neither formation is exposed in the Lake Elmo quadrangle. Together they range in thickness from 130 to 170 feet (40 to 52 meters) where overlain by the St. Peter Sandstone. These formations were subdivided in the map area based mainly on well cuttings and geophysical logs and to a lesser degree on water well driller's logs.
- Shakopee Formation (Early Ordovician)**—Composed mainly of light brown, thin- to medium-bedded dolostone, sandy dolostone, and sandstone. The formation contains oolite beds, intraclasts, microbial mounds, chert nodules, minor quartz sandstone beds, and green-gray shale partings. It ranges from 80 to 100 feet (24 to 30 meters) in thickness.
- Oneota Dolomite (Early Ordovician)**—Predominantly a yellowish-gray to light brown, medium- to thick-bedded dolostone that except in its lowermost part generally lacks sedimentary features such as oolites and quartz sand characteristic of the Shakopee Formation. The basal 15 feet (4.6 meters) of the formation is a thinly bedded dolostone with abundant fine- to coarse-grained quartz sand. The Oneota Dolomite is about 50 to 70 feet (15 to 21 meters) thick. The contacts between the Shakopee Formation and Oneota Dolomite and between the Oneota Dolomite and the Jordan Sandstone (unit Cj) are unconformable (Smith and others, 1993; Runkel and others, 1999).
- Cj Jordan Sandstone (Late Cambrian)**—Dominantly white to yellow, medium- to coarse-grained, friable quartz sandstone. Cross-stratification and bioturbation structures are common. Feldspathic lenses of very fine-grained, structureless shale and siltstone are intercalated within the quartz sandstone and form a regionally continuous interval overlying the St. Lawrence Formation seen mainly from geophysical logs. The Jordan sandstone is not exposed in the Lake Elmo quadrangle. It ranges in thickness from 80 to 95 feet (24 to 29 meters).

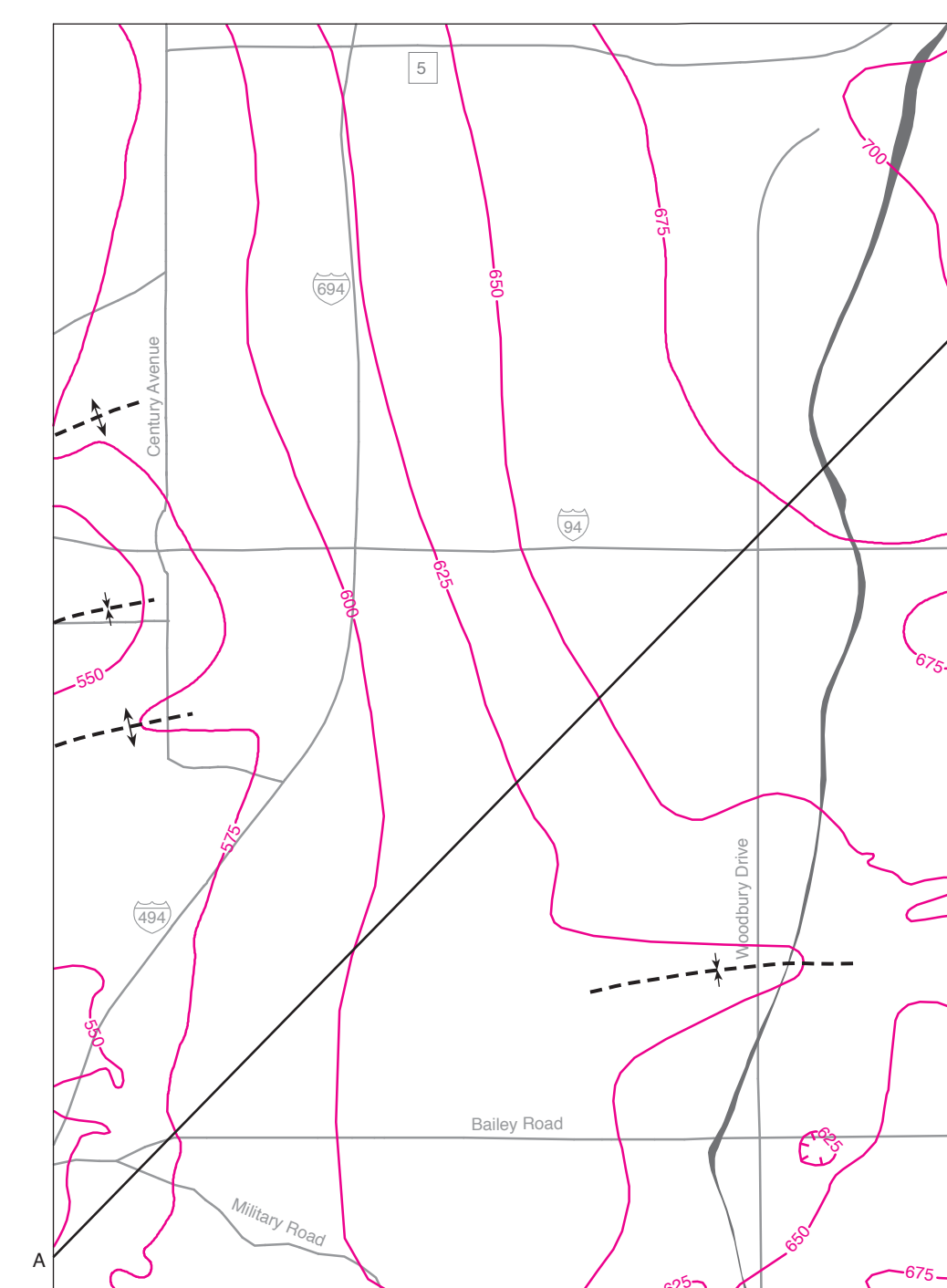
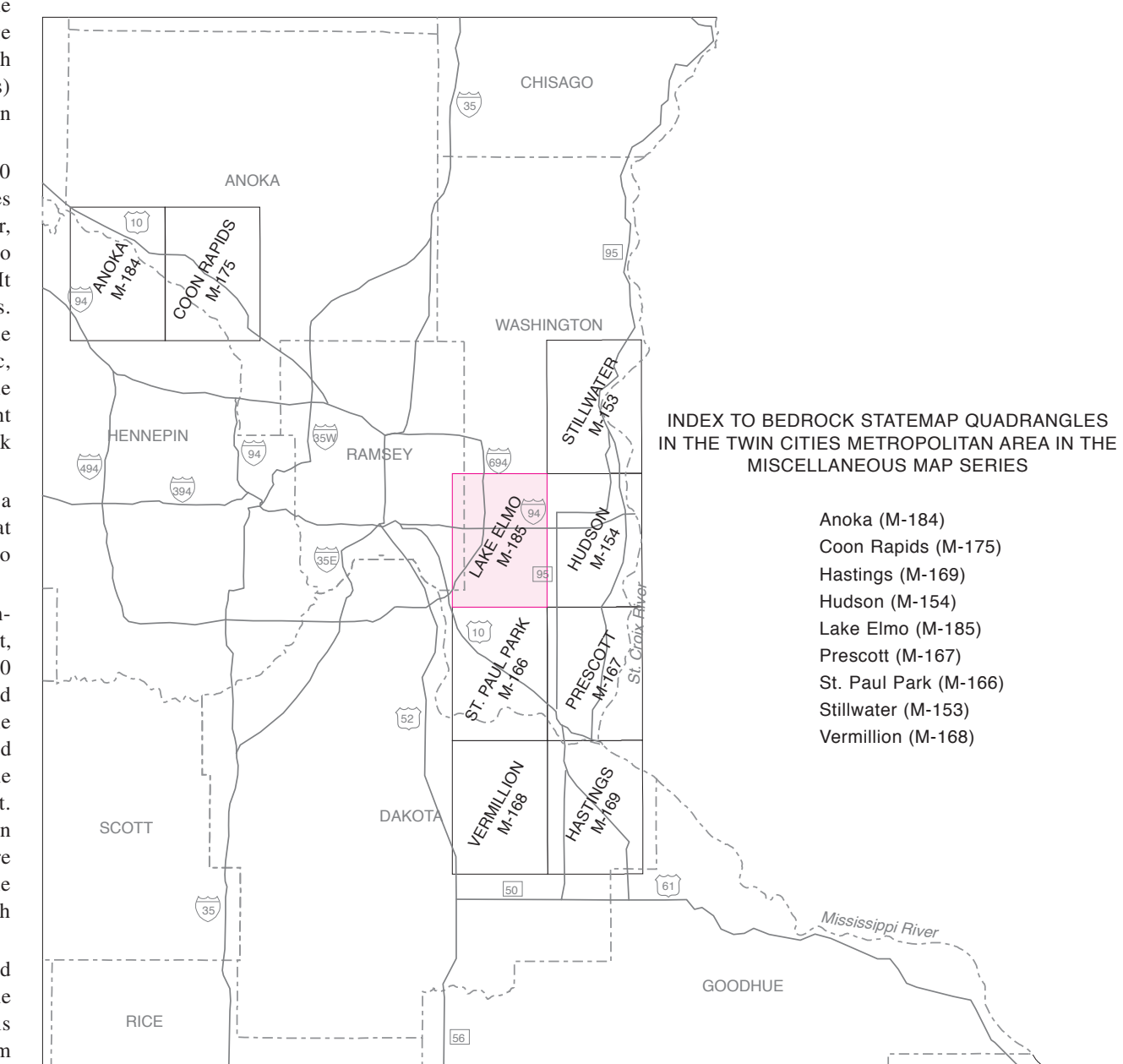


Figure 1. Map of the Lake Elmo quadrangle contoured at the stratigraphic top of the Jordan Sandstone showing geologic structure; scale 1:75,000. Contour interval is 25 feet (8 meters). Inferred fold traces are shown. The approximate area where some of the Jordan Sandstone is missing because of erosion within a north-south bedrock valley is shaded.



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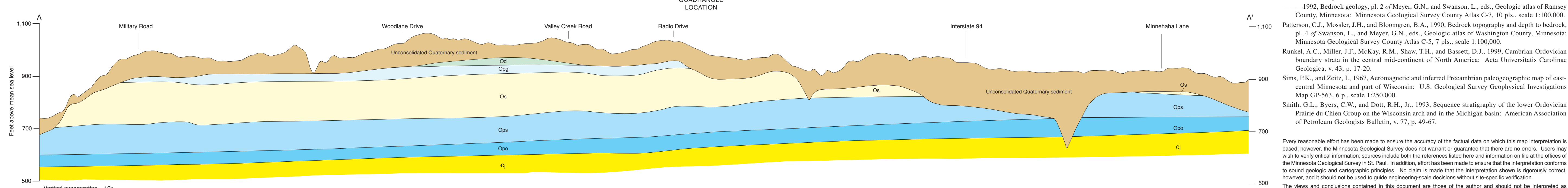
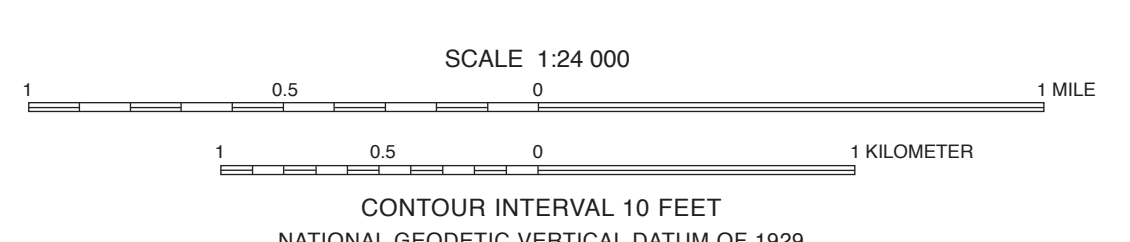
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Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.

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



Vertical exaggeration = 10x