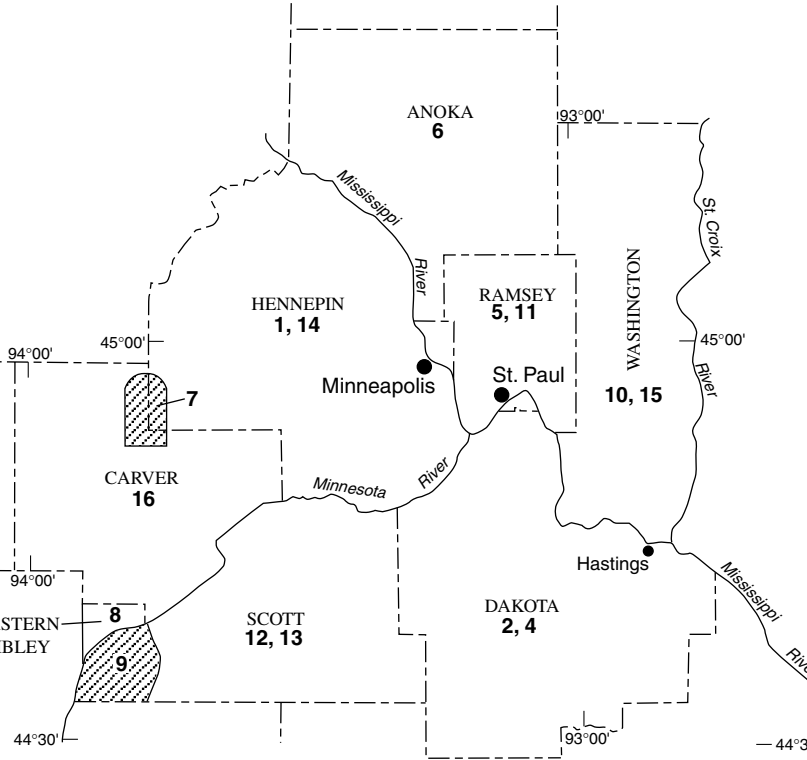


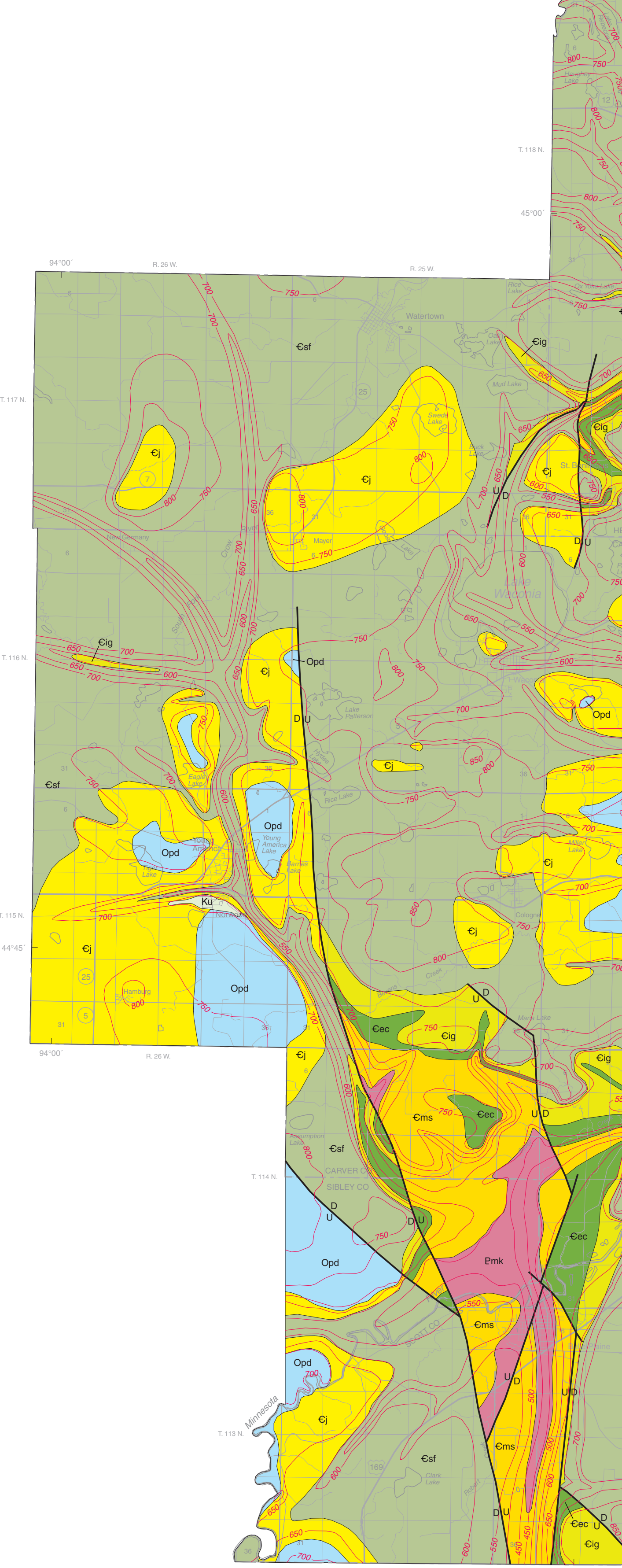
**SOURCES OF GEOLOGIC DATA**  
(Numbers refer to entries in index map below)

- Blomgren, B.A., Clendinning, J.M., and Olson, B.M., 1989. Depth to bedrock and bedrock topography, pt. 4 in Blalaban, N.H., ed., Geologic atlas of Hennepin County, Minnesota. Minnesota Geological Survey County Atlas Series Atlas C-4, scale 1:100,000.
- Blomgren, B.A., Hobbs, H.C., Mossler, J.H., and Patterson, C.J., 1990. Depth to bedrock and bedrock topography, pt. 4 in Blalaban, N.H., and Hobbs, H.C., eds., Geologic atlas of Dakota County, Minnesota. Minnesota Geological Survey County Atlas Series Atlas C-4, scale 1:100,000.
- Jrsk, M.A., Olson, B.M., and Blomgren, B.A., 1988. Bedrock geologic and topographic maps of the seven-county Twin Cities Metropolitan Area, Minnesota. Minnesota Geological Survey Miscellaneous Map Series Map M-95, 2 sheets, scale 1:125,000.
- Mossler, J.H., 1990. Unpublished mapping, Anoka County, Minn. Minnesota Geological Survey County Atlas Series Atlas C-7, scale 1:100,000.
- Mossler, J.H., 2000. Unpublished mapping, southern Hennepin County and adjoining north-central Carver County, Minn. Minnesota Geological Survey County Atlas Series Atlas C-7, scale 1:100,000.
- Mossler, J.H., 2000. Unpublished mapping, western Scott County, Minn. Minnesota Geological Survey County Atlas Series Atlas C-7, scale 1:100,000.
- Mossler, J.H., 2000. Unpublished mapping, western Scott County, Minn. Minnesota Geological Survey County Atlas Series Atlas C-7, scale 1:100,000.
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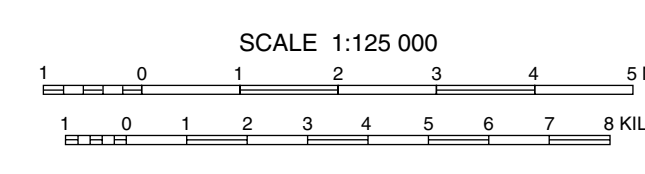
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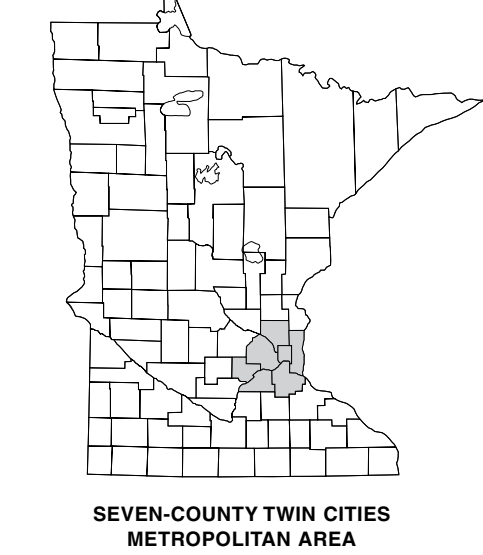
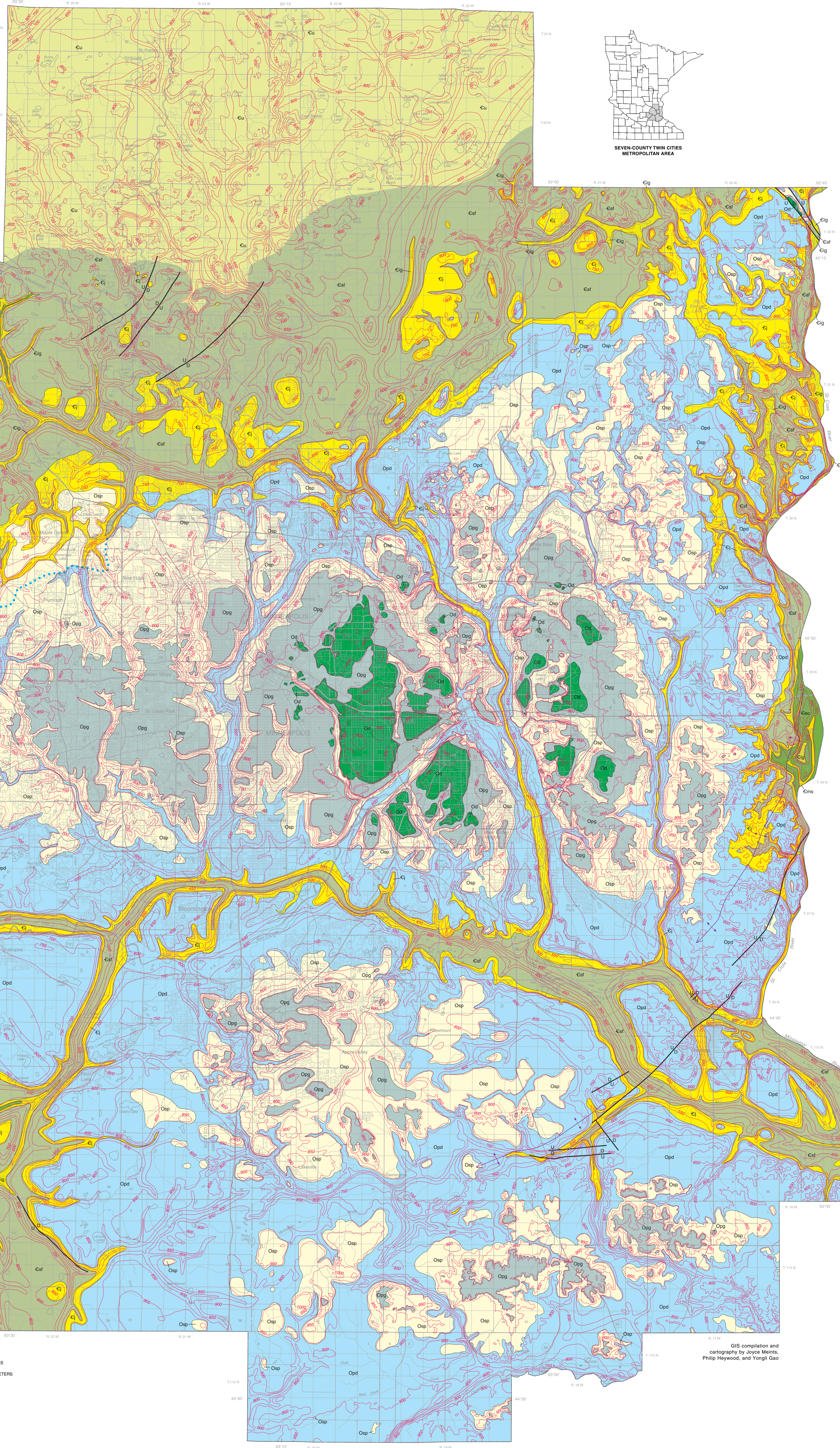
**INDEX SHOWING SOURCES OF GEOLOGIC DATA**  
(Numbers refer to entries in Sources of Geologic Data)



Base modified from 1990 Census TIGER/Line Files of U.S. Bureau of the Census. County border files modified from Minnesota Department of Transportation files; digital base annotation by Minnesota Geological Survey.  
Universal Transverse Mercator Projection, grid zone 15  
1983 North American Datum



GIS compilation and cartography by Joyce Meints, Philip Heywood, and Yongqi Gao



**CORRELATION OF MAP UNITS**

Ku	Late Cretaceous	CRETACEOUS	MESOZOIC
Opg	Upper Ordovician		
Opl	Lower Ordovician	ORDOVICIAN	PALEOZOIC
Opl	Early Ordovician		
Cg	Late Cambrian	CAMBRIAN	MESOPROTEROZOIC
Cgk			
Cgk			
Cms			
Enk			

**DESCRIPTION OF MAP UNITS**

- Ku** **Cretaceous rocks, undivided (Upper Cretaceous)**—Sandstone, white to light-gray, very fine grained to fine-grained, interbedded with white to gray shale beds. Generally less than 30 feet thick. The only mapped occurrence of this unit is in T. 115 N., R. 24 W.
- Opg** **Decorah Shale and Cummingsville Formation, undivided (Upper Ordovician)**—The *Decorah Shale* consists of green-gray calcareous shale and lesser amounts of thin-bedded, light-gray limestone. The uppermost limestone bed, marking the top of the formation, contains ferruginous nodules. The Decorah contains abundant fossils, particularly bryozoans, ostracodes, and brachiopods. The *Cummingsville Formation* of the Galena Group consists of fine-grained, light-gray, fossiliferous, thin to medium-bedded limestone and some interbedded green-gray shale. It occurs as patchy remnants less than 20 feet thick that overlie the Decorah Shale. The Decorah crops out in bluffs along the Mississippi River in south and west St. Paul. It may be as much as 90 feet thick but generally occurs as thinner erosional remnants. The Cummingsville crops out in south St. Paul.
- Opl** **Platteville Formation and Glenwood Formation, undivided (Upper Ordovician)**—The *Platteville Formation* is fine-grained, light-gray to yellowish-gray, very thin bedded to thick-bedded, fossiliferous limestone and dolomite; unit thickness is greater than 30 feet; thin gray-green shale beds in upper few feet. Dolomite in basal one to two feet contains sand-sized quartz and colophane (phosphate) grains. The Platteville Formation is exposed in bluffs along the Mississippi River in Minneapolis and St. Paul and caps mesas in southeastern Dakota County and southwestern Washington County. The *Glenwood Formation* is principally gray-green blocky shale that contains sand-size grains of colophane (phosphate) and thin stringers of fine- to coarse-grained quartz sandstone; unit is as thick as 10 feet in southern Dakota County. It is exposed in bluffs along the Mississippi River in Minneapolis and St. Paul beneath the Platteville Formation.
- Opl** **St. Peter Sandstone (Upper Ordovician)**—The St. Peter is divisible into three lithofacies: the *upper sandstone lithofacies* (approximately 100 feet thick) is light-gray, mostly very fine grained to medium-grained quartz sandstone in sedimentation units that coarsen upward. The rock is poorly cemented, lacks well-defined bedding, and generally is massive to thick bedded, but it may be subtly cross-stratified, particularly in the upper part. The *middle and siltstone lithofacies* is a laterally extensive layer of gray-green shale and siltstone about 6 feet thick; it occurs at slightly below the stratigraphic midpoint of the formation. The *lower sandstone lithofacies* (30-60 feet thick) is poorly sorted, fine-grained to very coarse grained, well-sorted sandstone interbedded with multicolored beds of mudstone, siltstone, and shale. The sandstone beds become progressively finer grained upward. The contact between the St. Peter and the underlying Prairie du Chien Group is a disconformity that has significant vertical relief. The St. Peter Sandstone crops out along the lower reaches of bluffs of the Mississippi River in Minneapolis and St. Paul. It is also commonly exposed in side slopes of mesas capped by the Platteville Formation in Washington and Dakota Counties. The formation is 125 to more than 166 feet thick. It is thinnest in southern Dakota County in the southeastern part of the metropolitan area. The shale and siltstone lithofacies is not exposed but is well documented in the subsurface.
- Opl** **Prairie du Chien Group (Lower Ordovician)**—Dominantly dolomite interlayered with lesser amounts of quartz sandstone. The group is divided into two formations (Shakopee Formation and Onesta Dolomite) that are not separated on this map. The *Shakopee Formation* is light-brown to pale-yellow-brown, thin to medium-bedded dolomite interlayered with thin beds of fine- to medium-grained quartz sandstone and green-gray shale. The dolomite contains stromatolite layers and locally chert nodules. The Shakopee Formation is separated from the underlying Onesta Dolomite by a disconformity. The *Onesta Dolomite* is light-brown to grayish-orange, medium to thick bedded dolomite. Commonly silty or sandy in the lower 12-13 feet, although thin sandy layers may be missing in some places of eastern Washington County and northeastern Dakota County. The upper part of the Prairie du Chien where exposed at the bedrock surface is rubby and contains karst solution features. In eastern Dakota and southern Washington Counties, Prairie du Chien dolomite is exposed along river bluffs, in quarries, and in many flat, low outcrops where bedrock is near the land surface. The Prairie du Chien also is exposed along low bedrock terraces of the Minnesota River in northeastern Scott County. It is as thick as 308 feet in southeastern Dakota County but thinner in the northwestern part of Hennepin County, where it was removed before deposition of overlying St. Peter Sandstone. The Prairie du Chien also is thin significantly beneath the St. Peter Sandstone in northern Washington County.
- Cg** **Jordan Sandstone (Late Cambrian)**—Dominantly light-gray sandstone; includes numerous coarsening-upward sequences consisting of two interlayered facies. The two facies are not portrayed separately on the map. They are (1) medium- to coarse-grained, cross-bedded, friable quartz sandstone and (2) very fine grained, structureless, commonly bioturbated feldspathic sandstone and lenses of siltstone and shale. Some calcic, mostly as nodular concretions, is present near the top of the formation. The Jordan is 66-125 feet thick in the metropolitan area. Jordan Sandstone is exposed along the Mississippi River in Washington and northeastern Dakota Counties, along the St. Croix River in Washington County, and along the Minnesota River in northwestern Scott County.
- Cgk** **St. Lawrence Formation and Franconia Formation, undivided (Upper Cambrian)**—Variably colored red-brown to gray-green or light-gray dolomite, siltstone, and dolomite that overlies fine- to coarse-grained quartz sandstone, very fine grained to fine-grained glauconitic sandstone, and fine-grained nonglauconitic sandstone, dolomite, siltstone, and shale. The *St. Lawrence Formation* is composed of silty, finely crystalline, generally thin bedded, tan to pink dolomite interlayered with thin intervals of siltstone or, rarely, beds of very fine grained glauconitic sandstone or maroon to green shale. The formation is fossiliferous and contains trilobites and graptolites. In Scott and Carver Counties, the St. Lawrence is as much as 75 feet thick; thickness decreases to 34-59 feet in Ramsey and Washington Counties. It is exposed along steep tributary valleys in the St. Croix valley, mainly by waterfalls. A few small outcrops are present in St. Lawrence Township (T. 114 N., R. 24 W.) in west-central Scott County. The upper 40-50 feet of the *Franconia Formation* north of Stillwater in northern Washington County, Anoka County, and in northern Hennepin County is light gray thin-bedded and cross-bedded (ripple cross-laminated), fine- to coarse-grained, dolomite-cemented quartz sandstone. The quartz sandstone overlies and interfingers with greenish-gray, medium bedded, very fine grained to fine-grained, dolomite-cemented, glauconitic and feldspathic sandstone. In the southern and central parts of the map area, where the quartz sandstone is absent, the glauconitic and feldspathic sandstone is as thick as 100 feet. The lower part of the formation consists of green-gray to light green interbedded shales, siltstone, and lesser amounts of very fine grained feldspathic sandstone as thick as 30 feet, which overlies dark green, very fine grained, medium to thick beds of highly glauconitic sandstone interlayered with thin beds of gray-orange to pink sandy glauconitic dolomite, also as thick as 30 feet. The quartz sandstone beds in the upper part of the Franconia Formation crop out extensively along bedrock terraces of the St. Croix River in northern Washington County—for example, Boon hollow north of Stillwater and around Marine on St. Croix. The lower glauconitic beds rarely crop out in the map area, although some formerly did near Alton in Washington County. The contact with the underlying Ironton Sandstone is sharply defined but apparently conformable. The Franconia Formation is as thick as 165 feet and is generally thickest in the northeastern part of the map area. The St. Lawrence and Franconia Formations have a combined thickness of 180-240 feet.
- Cgk** **Cambrian rocks, undivided (Upper Cambrian)**—Primarily the Franconia, Ironton, Galesville, Eau Claire, and Mt. Simon formations but may include small outcrops of the St. Lawrence and Jordan formations. The Cambrian formations in northern Anoka County are not formally subdivided because most domestic wells in the area penetrate only a few feet of bedrock. Water-well cuttings and geophysical logs from deep wells are scarce. The *Ironton Sandstone and Galesville Sandstone, undivided (Upper Cambrian)*—The Ironton Sandstone and Galesville Sandstone consist of light-gray, very fine to fine-grained feldspathic sandstone and medium- to coarse-grained and very coarse-grained, commonly cross-laminated quartz sandstone interlayered with scattered thin beds of maroon or green shale. Although separated by a disconformity representing a hiatus of long temporal duration, the two formations cannot be distinguished with certainty where geologic control consists of water-well cuttings alone. The Ironton and Galesville Sandstones do not crop out in the map area. Total combined thickness of the two formations commonly is 42-56 feet, but it reaches a maximum of 75 feet in the area of the map. The *Eau Claire Formation (Upper Cambrian)*—The formation can be divided into three broad intervals, but they are not portrayed separately on the map. The *upper one-third to one-fourth of the formation* is feldspathic sandstone that is light gray to yellow gray, very fine to fine grained, finely laminated to ripple cross-laminated, and slightly glauconitic; it is interlayered with scattered thin partings of gray-green shale. The *middle one-fourth to one-third of the formation* is light gray siltstone, very fine grained, slightly glauconitic, feldspathic sandstone, and gray-green shale. Shale and sandstone generally alternate in wavy to lenticular beds. Some shale beds, particularly those at the bottom of the interval, are as thick as several feet. Overall, the middle and upper parts of the Eau Claire form a coarsening-upward sequence. The *basal one-third to one-half of the formation* forms a coarsening-upward sequence of gray-green, very fine grained to fine-grained, glauconitic, feldspathic sandstone and glauconitic, feldspathic siltstone. The finely laminated to ripple cross-laminated, and slightly bioturbated interval is marked by scattered gray-green shale partings, especially near the base. The Eau Claire Formation has a conformable contact with the underlying Mt. Simon Sandstone. The formation ranges in thickness from 63 to 118 feet but is most commonly 65-80 feet thick. The *Mt. Simon Sandstone (Upper Cambrian)*—The *upper one-fifth of the formation* consists of medium to thick, locally cross-stratified beds of fine- to medium-grained, moderately sorted to well-sorted quartz sandstone interbedded with lesser beds of gray-green shale, very fine grained feldspathic sandstone and siltstone, and fine- to coarse-grained, silty, poorly sorted, thick bedded to massive quartzose to feldspathic sandstone that is intensively worm burrowed by *Syllolites*. The *middle one-third to two-fifths of the formation* consists of (1) thick, crudely parallel or cross-stratified beds of fine- to coarse-grained, moderately sorted quartz sandstone interlayered with (2) thin to very thick (as thick as 8 feet) beds of very fine grained to fine-grained, well-sorted, feldspathic sandstone. The feldspathic sandstone is, in turn, interlayered with thin intervals of green-gray, silty shale. Gravel-sized grains of quartz or, rarely, interclasts of siltstone and very fine grained sandstone define the lower parts of the thick, coarser grained sandstone beds. The *lower one-half of the formation* consists of medium to thick cross-stratified beds of medium- to very coarse-grained, moderately sorted to well-sorted quartz sandstone. The interval contains thin lenses of red granule- to pebble-sized quartz and scattered thin beds of light-gray siltstone and red-brown to pale-to green-gray shale. A basal conglomerate as thick as 6 feet marks the base of the formation. In the map area, the Mt. Simon Sandstone is less than 150 feet to more than 335 feet thick. It is thinnest in the west and northwest and thickest toward the southeast.
- Enk** **Solor Church Formation (Keweenaw Supergroup) (Mesoproterozoic)**—Intercalated intervals of red, maroon, or brown shale and fine- to coarse-grained quartz and lithic sandstone. The formation includes locally abundant conglomerate layers that contain clasts of mafic igneous derivation.

- Geologic contact—Approximately located; unshown.
- Fault—Approximately located; U, upthrown side; D, downthrown side.
- Approximate erosional edge of Prairie du Chien Group.
- Line of equal elevation of the bedrock surface—In feet above mean sea level; contour interval 50 feet.
- Anticline—Showing crest line and general direction of plunge of fold.

**BEDROCK GEOLOGY AND STRUCTURE OF THE SEVEN-COUNTY TWIN CITIES METROPOLITAN AREA, MINNESOTA**

By  
John H. Mossler and Robert G. Tipping  
2000

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 topographically correct; however, such it should not be used to guide engineering-scale decisions without site-specific verification.