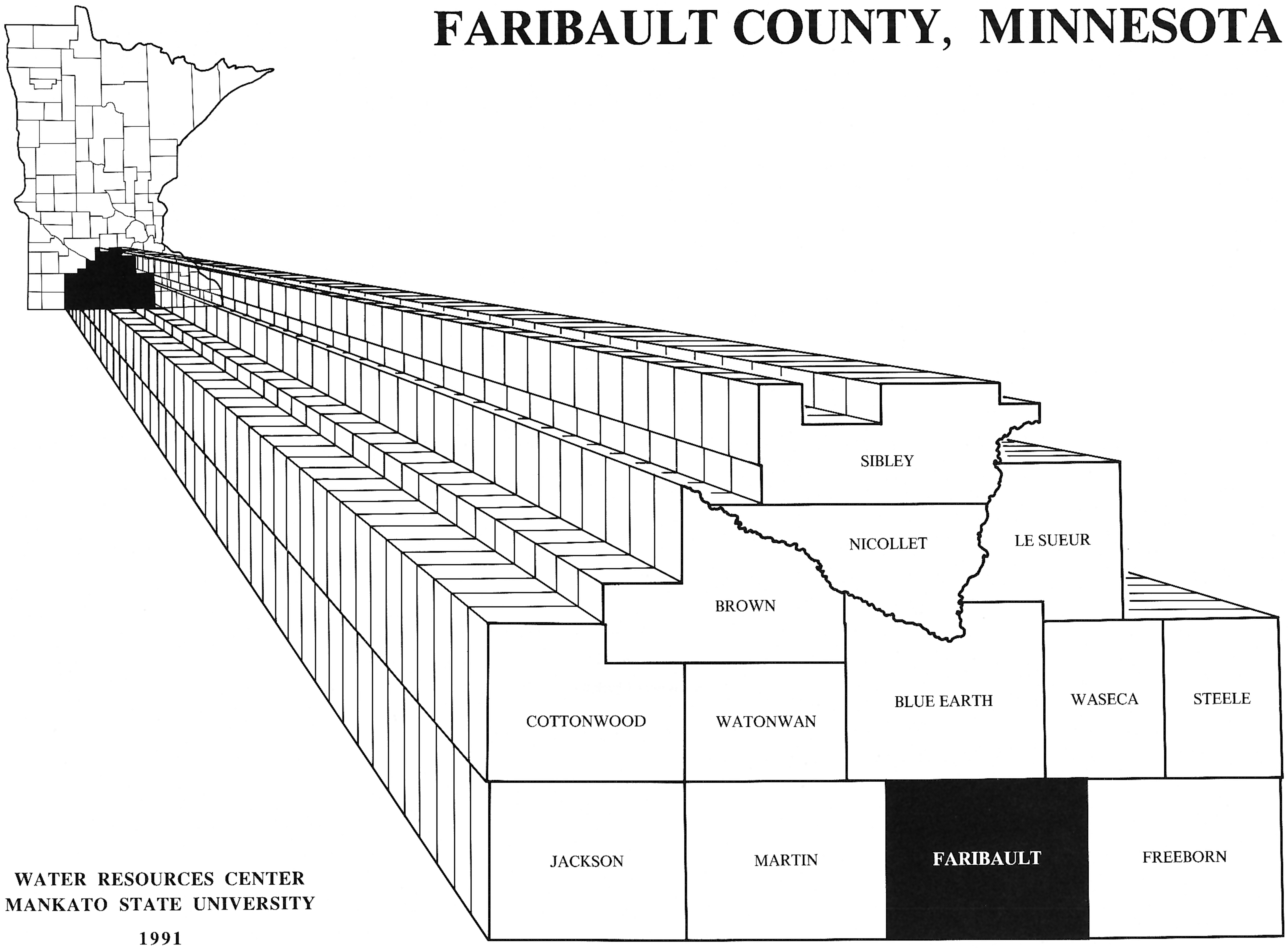
GEOLOGIC ATLAS

FARIBAULT COUNTY, MINNESOTA



WATER RESOURCES CENTER
MANKATO STATE UNIVERSITY
1991

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JULY, 1991

The Faribault County Geologic Atlas was prepared and published with the support of a grant from the Legislative Commission on Minnesota Resources and the Faribault County Board of Commissioners. The project involves the production of county geologic atlases for each of the 13 counties of south central Minnesota and a computerized data base of available water well and groundwater data. Principal investigators for the project are Henry Quade and John Rongstad.

The following people and agencies have provided valuable assistance to this project by providing information, reviewing or contributing to the content, or by making helpful comments. While their contributions are acknowledged, the responsibility for errors or omissions rests with the principal authors.

The Minnesota Geological Survey for providing water well records and other subsurface geophysical data. Particular thanks to Bruce Olsen, Bruce Bloomgren, and Roman Kanivetsky for their guidance and support.

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The building of this atlas involved the contributions of a significant number of students at Mankato State University. The maps in this atlas are, in large part, the result of their loyal support.

Fieldwork: Paul Vogel, Kristen Vogel, Bruce Anderson, Chuck Peterson, and Charles Wohler.

Cartography: Jesse Wohlfeil, Paul Vogel, Cis Berg, Chuck Broste, Quinto Lotti, Tom Kujawa and Eric Hendricksen.

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FARIBAULT COUNTY GEOLOGIC ATLAS

INTRODUCTION

This is one of thirteen geologic atlases that were prepared for the South Central Minnesota Comprehensive County Water Planning Project consisting of Blue Earth, Brown, Cottonwood, Faribault, Freeborn, Jackson, LeSueur, Martin, Sibley, Steele, Waseca, and Watonwan Counties. The basic subsurface data for these atlases have been gathered over a period of years by the Minnesota Department of Health and the Minnesota State Geological Survey. Additional data pertaining to well location and elevation were gathered by the Water Resources Center at Mankato State University during preparation of the geologic mapping project. The subsurface geologic atlases are the first of two reports on the water resources of southcentral Minnesota. Surface water resources are the subject of a 13 county atlas series that is now in preparation.

The Faribault County Geologic Atlas presents available subsurface geologic and hydrologic data in a descriptive form. The maps in this atlas present an interpretation of the subsurface data on a county wide scale. The scale (1:150,000), and hence the size of the atlas maps, was chosen because it shows both geologic and hydrogeologic interpretation at a manageable level, and it represents the size at which the atlas can be printed economically. Detailed, site-specific, information cannot be shown on the maps presented in this atlas. The accompanying text is designed to present only general concepts.

The subsurface maps and cross sections that are presented in this atlas show both the vertical relationship and areal distribution of important water-yielding bedrock units in Faribault County. This atlas is intended to be used as a guide to the subsurface geologic conditions and groundwater resources in Faribault County. The amount of geologic information that is required for decision making will vary considerably. For this reason, more detailed site-specific information is available in readily accessible electronic files at the Water Resources Center, Mankato State University.

ATLAS MAPS

Preparation of the maps presented in this atlas required the evaluation of information concerning the present land surface and subsurface. The Bedrock Topography Map and Bedrock Structure Maps were constructed independently; they were directly created from the data itself. These maps provided the necessary reference lines from which all succeeding geologic boundary lines were drawn. All other geologic maps in the atlas were derived through combinations of the Surface Topography, Bedrock Topography, and Bedrock Structure Maps. This sequence of atlas map construction is designed to present a consistent picture of the bedrock geology on a county wide scale.

SURFACE TOPOGRAPHY MAP was produced for each of 13 counties included in the South Central Minnesota Comprehensive County Water Planning Project. These maps were compiled from US Geological Survey 7.5 Minute Topographic Quadrangles. The USGS quadrangle maps were photographically reduced in scale from 1:24,000 to 1:62,500, and a photo mosaic was constructed to provide a county base surface topography map for each county. These maps provided a standard base from which the maps for all 13 county geologic atlases were developed.

DATA BASE MAP (Page 3) shows the location, distribution, and type of subsurface data used to develop this atlas. The Data Base Map is designed to be used as a guide to interpreting the accuracy of atlas maps.

BEDROCK TOPOGRAPHY MAP (Page 8) was directly created from the data contained in water well drillers' logs. The map provides a means by which the top of the bedrock can be traced continuously over the entire county.

BEDROCK STRUCTURE MAPS (Page 16 thru 18) were directly created from geophysical logs. These maps show the structural configuration of key bedrock units and provide a means by which these bedrock units may be traced continuously over wide areas.

DEPTH TO BEDROCK MAP (Page 9) combines the Surface Topography Map and Bedrock Topography Map to show variations in the thickness of sediments that cover the bedrock surface.

BEDROCK GEOLOGY MAP (Page 7) combines the Bedrock Topography Map and Bedrock Structure Maps to show the distribution of bedrock units as they would appear if the overlying sediments were removed and the bedrock exposed at the surface.

GEOLOGIC CROSS SECTIONS (page 11 thru 15) combine the Surface Topography, Bedrock Topography, and Bedrock Structure Maps to construct cross sectional profiles for Faribault County. The cross section profiles are arranged as a grid system to provide county wide cross section coverage.

BEDROCK AQUIFER MAPS (page 20 and 21) were developed directly from the data contained in the hydrologic portions of water well drillers' logs, including static water level and casing length.

GENERAL GEOLOGY

The characteristics of the present land surface in Faribault County, including the topography and nature of surficial materials, are the result of the action of glacial ice and flowing water. The surficial materials are chiefly glacial deposits, collectively called drift, of the continental glaciers that covered Faribault County during the last million years. The continental glaciers were centered over southern Canada and extended into southern Minnesota. These continental glaciers expanded and contracted several times and the interval between glacial episodes may have been sufficient to allow deep erosion and weathering of the drift and bedrock surfaces.

The glacial drift is composed mainly of glacial till, which is characterized by a matrix of sand, silt, and clay with scattered pebbles, cobbles, and some boulders. The drift deposits overlie the bedrock surface and range in thickness from less than 50 feet to over 250 feet. Before glaciation, erosion of the bedrock surface produced deep valleys, all of which are now filled with glacial drift. The nature of thickening and thinning of the glacial deposits is largely influenced by buried bedrock valley cuts.

The bedrock that underlies Faribault County is part of a sequence of Late Cambrian to Middle Ordovician sedimentary rock which consists of three major rock types: sandstone, shale, and carbonates. The bedrock was deposited under tectonically stable geologic conditions in shallow marine waters that flooded southern Minnesota about 500 million years ago. The lithology of individual bedrock units is nearly uniform throughout Faribault County due to the continuous nature of the geological processes that formed them.

In the southeastern three-fourths of Faribault County, limestone forms the bedrock surface beneath the glacial drift. This limestone represents the youngest bedrock units and gives way to progressively older shales, sandstones, and dolomites to the northwest. This pattern reflects the general dip of the bedrock structure toward the southeast. Deep erosion of the bedrock surface, prior to glaciation, also influence this pattern.

Structural faulting and uplift is known to have occurred in Minnesota during Precambrian time. The tectonic activity that contributed to the Precambrian faulting is thought to have ceased before Cambrian time. This interpretation suggests that the Cambrian and Ordovician aged bedrock sediments were deposited on top of inactive Precambrian aged fault blocks, and assumes that individual bedrock formations are not deformed internally. For the purpose of this study, each bedrock unit is treated as a continuous layer and mapped accordingly.

WELL CONSTRUCTION PRACTICES

WATER WELL PRACTICES

In Faribault County, water well drilling and water well construction will vary from place to place, due to variations in bedrock geologic conditions. In 1974, implementation of the Minnesota water well code standardized water well construction practices. Since 1974, all water well drillers are required to be licensed by the Minnesota Department of Health. Licenses are issued on the basis of one's knowledge of the regulations governing well construction and proof of drilling experience. All water wells drilled since 1974 may use from only one aquifer, and each well must meet minimum standards of depth, minimum distances from possible sources of contamination, and have had a water sample analysis that confirms potability.

Before the Minnesota water well code was implemented in 1974, well construction practices were used that are no longer allowed. Water well casings were often not seated firmly into the bedrock and few were properly sealed to prevent the downward movement of groundwater between the well casing and the borehole. High-capacity wells were often cased only to the uppermost bedrock unit and left as an open borehole between two or more bedrock aquifers, sometimes crossing a confining bed. These wells interconnect aquifers and aquifer systems, allowing the movement of groundwater and serve as conduits for spreading pollution into otherwise unspoiled groundwater supplies.

Since 1974, all newly constructed wells must use standardized well construction materials and installation procedures. Each well casing should extend at least 15 feet into the bedrock aquifer being used with the casing grouted and seated firmly into the bedrock. Water wells that penetrate more than one bedrock aquifer or that penetrate a confining bed must have the entire casing grouted. If multiple strings of casings are used, the inner casing must be separated from the outer casing by at least two inches of space to accommodate cement grout between them. Grouting of the well casing is done to insure that the well does not interconnect aquifers along the space between two casings or between the well casing and the borehole into which it is set.

WATER WELL DRILLERS' LOGS

The largest source of information used to develop the geologic and hydrogeologic maps in this atlas are drillers' logs from water wells. The preparation of water well data, for mapping, was a two step process; first to verify the location and determine the elevation of each water well, and second to evaluate the geologic data contained in each water well drillers' log. The location of each water well was determined by visiting the well site and marking its position onto a USGS 7.5 minute topographic map. The position of each water well has been described by Public Land Survey coordinates to an accuracy of half an acre. The elevation at the top of each water well was determined, from USGS topographic maps, to an accuracy of five feet.

The two most difficult tasks a well driller performs during drilling operations are to record the physical characteristics of the penetrated rock and the depth at which these characteristics change significantly. Most of the geologic portions of well drillers' logs are only tolerably accurate; however, many can be re-evaluated by comparing them with more dependable subsurface data. The geologic portion of each well drillers' log was re-evaluated and adjusted by comparing them against the information contained in geophysical logs. The geophysical logs provided standardized data against which all well driller data was compared.

Information contained in each well drillers' log should include the following: a description of the main rock types encountered during drilling, their thickness and depth; a description of the well casing including diameter, length, and screened zones; hydrologic data, such as the static water level in a well after drilling is completed and a report of a production test; and the direction and distance to the nearest sources of possible contamination. In actuality, many of the drillers' logs have only a portion of the above information. An example of the information contained in a typical well drillers' log is given in FIGURE 1, together with interpretation.

RECORD OF WATER WELL CONSTRUCTION

WELL NO.	: 217027	CASING	: 006 INCH TO 318 FEET
* COUNTY	: FARIBAULT	WATER LEVEL	: 28 FT. (EL. 1059 FT.)
* TOWNSHIP	: 102 NORTH	DATE	: 03/41
* RANGE	: 27 WEST	AQUIFER (S)	: PLATTEVILLE - ST. PETER
* SECTION	: 8/CACAAB		
* QUADRANGLE	: BLUE EARTH		
COMPLETED	: 03/41		
DEPTH	: 415 FT.		
* ELEVATION	: 1087 FT.		
* WELL USE	: PUBLIC		

PUMPAGE TEST		TEST 1	TEST 2
HOURS	:	12 HRS.	---
RATE (GPM)	:	600 GPM	---
PUMPING LEVEL	:	51 FT.	---

GEOLOGIC LOG

WELL DRILLER'S DESCRIPTION					INTERPRETATION
DEPTH (FEET) FROM	TO	LITHOLOGY	COLOR	HARD-NESS	STRATIGRAPHIC UNIT
0	4	SOIL	BLACK	SOFT	RECENT
4	30	CLAY	YELLOW	SOFT	PLEISTOCENE
30	55	CLAY	GRAY	SOFT	PLEISTOCENE
55	60	CLAY & STONE	GRAY	-----	PLEISTOCENE
60	69	SANDY CLAY	GRAY	SOFT	PLEISTOCENE
69	76	SAND & GRAVEL	-----	SOFT	PLEISTOCENE
76	112	CLAY	BLUE	SOFT	PLEISTOCENE
112	124	SAND	GRAY	SOFT	PLEISTOCENE
124	144	LIMESTONE & SAND	-----	-----	GALENA
144	189	BROKEN LIMESTONE	TAN	MED	GALENA
189	219	LIMESTONE	BROWN	HARD	GALENA
219	247	LIMESTONE & SHALE	BROWN & GREEN	HARD	GALENA
247	297	SHALE	BLUE	MED	DECORAH
297	312	SHALE ON CAPROCK	-----	HARD	DECORAH
312	330	LIMESTONE	WHITE	HARD	PLATTEVILLE
330	338	SHALE	GREEN	HARD	GLENWOOD
338	360	SANDSTONE & SHALE	WHITE	SOFT	ST. PETER
360	409	SANDSTONE	WHITE	HARD	ST. PETER
409	449	SANDSTONE & SHALE	WHITE	SOFT	ST. PETER
449	451	LIMESTONE	-----	HARD	PRAIRIE DU CHIEN

* Information that was verified or obtained from a field investigation at the well site.

Figure 1. The sample water well record shows information that was provided by the well contractor and information that was verified or obtained from a field investigation at the well site. The geologic portion of the water well record illustrates the sequence of paleozoic bedrock deposits and the unconsolidated nature of the overlying glacial deposits.

DATA BASE

DATA BASE MAP

The Data Base Map shows the location, distribution, and type of subsurface data used to develop this atlas. For the preparation of atlas maps every data point represents an area. This area is usually a circle, whose radius depends on the density of the data. When estimating the range of validity for individual atlas maps, it is important to take into account the uneven distribution of the data. The data quality and the depth penetrated by each control point will also affect the accuracy of each map. The Data Base Map is designed to be used as a guide to interpreting the accuracy of atlas maps.

The location of all points on the Data Base Map have been recorded onto USGS 7.5 minute quadrangle maps. The data for each point is stored in both manual and electronic files at the Water Resources Center, Mankato State University. Individual files can be accessed by Unique Well ID Number or by the Public Land Survey coordinates that correspond to individual well data points.

DATA

The subsurface data used to develop this atlas is a compilation of all water well drillers' logs, geophysical logs, and cutting sample logs that are currently available in the files of the Minnesota State Geological Survey. The water well drillers' logs contain the water well contractor's description of the geologic and hydrologic conditions encountered at a specific well site, and a description of the materials used to complete the well. A geophysical log can be an electrical log or gamma-ray log. An electric log records differences in the electrical resistance that is measured along the length of an open borehole. A gamma-ray log records the amounts of natural gamma radiation occurring in the strata of the earth. Cutting sample logs consist of drilling samples that were collected from selected well sites. Cutting samples provide physical examples of subsurface materials.

Information from each water well drillers' log should include the following: a physical description of the main rock types that are encountered during drilling along with their thickness and depth; a description of the well casing, including diameter and length; hydrologic data, such as the static water level and a report of a production test. In actuality, many logs have only a portion of the above information.

The gamma-ray logs are records of the measured amount of natural gamma radiation that is emitted by various rocks. The intensity of gamma radiation in sandstone, limestone, and dolomite is relatively low while clay, shale, and siltstone have the highest values. Probably the most important application of gamma-ray logs is to identify the amount of shale content in the bedrock sediments. Consequently, the upper and lower boundaries of shale units are identified and marked at the highest gamma-ray value, the shaley sandstone and carbonate units occupy positions of intermediate values, while the clean sandstone and carbonate units occupy areas of lowest gamma-ray values.

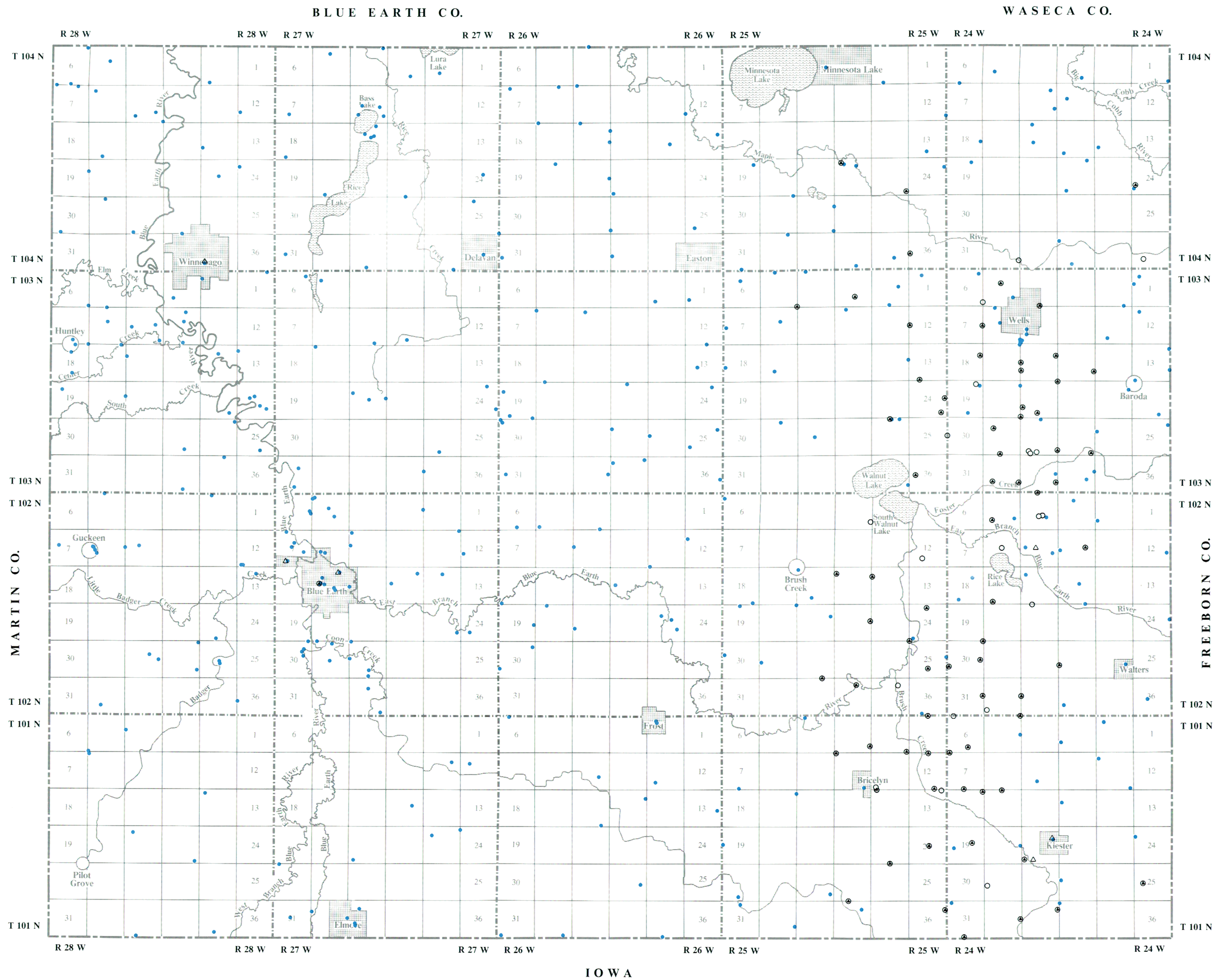
An electric log records differences in the electrical resistance that is measured along the length of an open bore hole. Similar to the gamma-ray log, the electric log is used to detect changes in the bedrock lithology for the purpose of determining the boundaries of bedrock units.

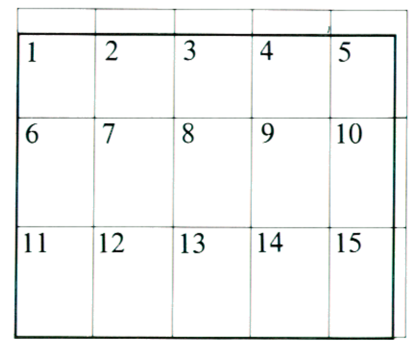
DATA BASE MAP

By

John M. Rongstad and Quinto J. Lotti

1991



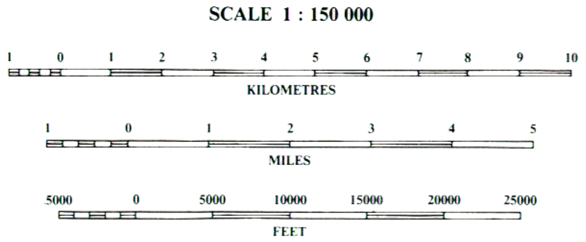


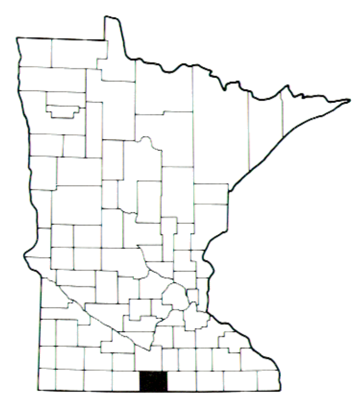
INDEX TO U.S. GEOLOGICAL SURVEY 1 : 24 000 - SCALE TOPOGRAPHIC MAPS

1. Winnebago
2. Delavan
3. Easton
4. Minnesota Lake
5. Matawan
6. Huntley
7. Blue Earth
8. Oza Tanka Lakebed
9. Brush Creek
10. Wells
11. Pilot Grove
12. Elmore
13. Frost
14. Bricelyn
15. Kiester

EXPLANATION

- • Record of water-well construction
- ○ Borehole (geophysical log)
- △ Cutting samples
- ⊙ Cutting samples and geophysical log





LOCATION DIAGRAM

BEDROCK GEOLOGY

GEOLOGIC HISTORY

The bedrock that underlies Faribault County is part of a sequence of Late Cambrian to Early Ordovician sedimentary rock which consists of three major rock types: sandstone, shale, and carbonates. The bedrock was deposited layer upon layer in shallow marine waters that flooded southern Minnesota about 500 million years ago. The ancient intruding sea followed a shallow depressional lowland, now called the Hollandale Embayment, that extended into southern Minnesota from a larger basin to the south.

In a shallow marine environment, the material that is transported by water is sorted according to the weight and size of the individual particles. Because of different settling rates, coarse (heavy) materials are deposited in turbulent water while the finer (light weight) materials are transported by waves, currents, or winds and deposited in quiet waters.

The relationship between sandstone, shale, and carbonate deposits correspond to a seaward gradation of sediment size. Sand is deposited along the turbulent shoreline environment, where it becomes cemented into sandstone over time. Clay and silt are transported by wave and current action to a deeper, lower energy environment where they are deposited to form shale. Still farther off shore, where sand and clay are not transported by wave and current action, calcite is precipitated to form limestone.

The rise of sea level, during Late Cambrian time, resulted in a progressive overlap of sediment types. As the sea advanced landward, sandy beach deposits were overlain by offshore muds which were in turn overlain by carbonates. Thus, the advancing sea is recorded in bedrock layers by the sequence: sandstone overlain by shale overlain by carbonates. The lithologic character of the bedrock varies with such factors as sediment source, distance from the shore line, depth of the water, and the transporting agent (waves, currents, and winds).

The Cretaceous time period saw the rise of sea level from the west, which resulted in a different kind of progressive overlap. Sediments resulting from this overlap may be lacustrine and alluvial fan deposits as well as marine sediments. The western border of Faribault County is thought to represent the eastern shoreline of the advancing sea while the central and eastern portions of the county are viewed as being a coastal plane that was crisscrossed by rivers and streams. In Faribault County the Cretaceous age sediments overlie the much older Cambrian and Ordovician age bedrock units and are limited to isolated patches of loosely consolidated clays and sands that were primarily derived from the weathering of the underlying bedrock surface.

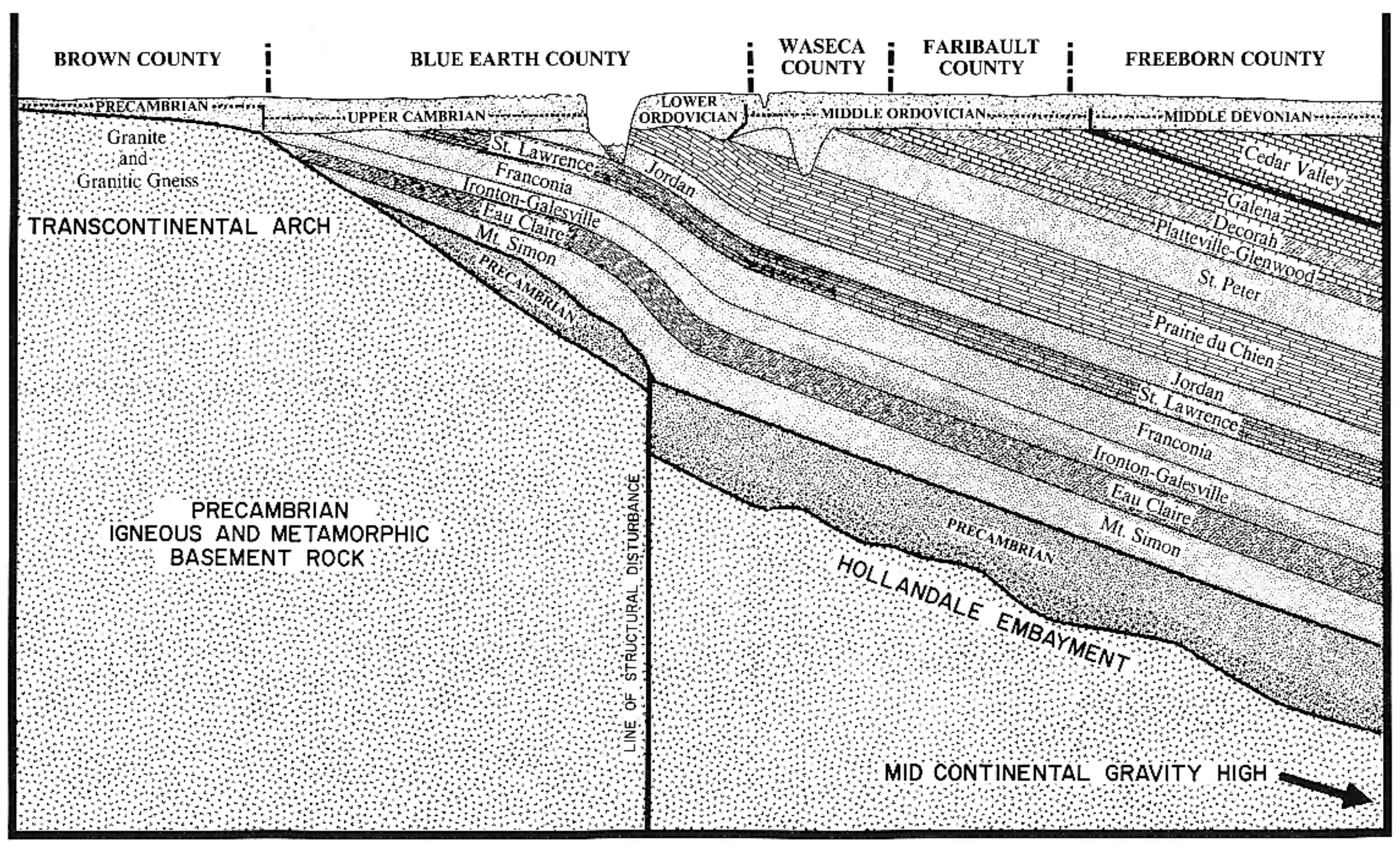


FIGURE 2. Highly generalized cross section showing the variation of subsurface conditions along a line extending from Brown County to Freeborn County Minnesota. The above diagram illustrates the lateral variations and distribution of sediments in the Hollandale Embayment. The geologic structure is much more complex than shown here. Note: the vertical scale is grossly exaggerated; if drawn at true scale the thickest part of the sedimentary basin would be 0.05 inches thick.

BEDROCK UNITS

The following descriptions of the bedrock units that underlie Faribault County are primarily derived from water well drillers' logs but supplemented by more detailed descriptions presented by Mossler (1987). For the purpose of this study, some of the stratigraphic units currently recognized as individual geologic units are combined.

MT. SIMON FORMATION-- is the lowest mapped unit of bedrock, several hundred feet thick. The Mt. Simon is generally characterized as a medium to coarse-grained quartzose sandstone. The upper parts of the Mt. Simon contain varying amounts of siltstone and shale while the middle part is primarily quartzose sandstone. Its base marks a major erosional surface with the underlying Precambrian age Hinckley sandstone. The Mt. Simon sandstone marks the advance of the Late Cambrian sea into southern Minnesota.

EAU CLAIRE FORMATION-- is typically greater than 100 feet thick. The Eau Claire consists primarily of shale and siltstone with minor amounts of fine-grained, glauconitic sandstone. Its contact with the underlying Mt.Simon sandstone is transitional. The fine-grained sediments of the Eau Claire Formation suggest a low energy environment of sedimentation, either relatively deep and quiet water or shallow water tidal flats.

IRONTON-GALESVILLE GROUP-- generally 80 to 90 feet thick, is a medium to coarse-grained quartz sandstone with some glauconite and minor amounts of silt. The Ironton and Galesville sandstones are normally classified as separate bedrock formations; however, the two sandstone units are difficult to separate in driller's logs and both are sources of groundwater. For the purpose of this study, the Ironton and Galesville sandstones are treated as a single geologic unit and for convenience called the Ironton-Galesville sandstone. The Ironton-Galesville sandstone may indicate the return to a higher energy nearshore or beach environment of sedimentation.

FRANCONIA FORMATION-- is generally about 100 to 120 feet thick. The Franconia is commonly characterized as a fine-grained, glauconitic sandstone. The upper part of the Franconia Formation may contain shale and dolomitic layers that are similar to those found in the overlying St.Lawrence Formation. The similarity of rock type makes it difficult to distinguish the Franconia from the overlying St. Lawrence Formation in well drillers' logs. The fine-grained glauconitic sandstone suggests a low-energy sedimentary environment. Glauconite forms on the sea floor in oxygen-poor water where the rate of sedimentation is vary slow.

ST. LAWRENCE FORMATION-- is generally between 90 and 120 feet thick. The St. Lawrence contains several rock types including dolomite, siltstone, shale, sandstone, and glauconite. It is usually characterized by layers of shale, siltstone, and dolomite. Its transition with the underlying Franconia rock is gradational. The dolomitic units of the St. Lawrence Formation would signify a low energy depositional environment; however, the interbedded clay, silt, and sand indicates an environment with fluctuating conditions.

JORDAN FORMATION-- varies between 60 and 100 feet in thickness. The Jordan Formation is characterized as a medium to coarse-grained quartzose sandstone. The base of the Jordan sandstone may contain minor amounts of shale. The Jordan sandstone indicates the return to a high-energy, nearshore sedimentary environment, perhaps a beach.

PRAIRIE DU CHIEN GROUP-- will vary greatly in thickness, from a feather edge at its erosional limits to as thick as 280 feet. The Prairie du Chien consists primarily of dolomite and sandy dolomite with some thin shale layers and a few units of quartz sandstone. The massive nature of the Prairie du Chien dolomite indicates a low-energy sedimentary environment where carbonate deposition was the dominant rock forming process. Carbonate deposits were terminated by the retreat of the shallow sea from the continent. The retreat of the shallow sea exposed the Prairie du Chien dolomite to the forces of erosion. Consequently, the top of the Prairie du Chien Group represents a major erosional surface and its thickness may vary greatly from place to place.

ST. PETER FORMATION-- measured as thick as 100 feet. The St. Peter Formation is primarily a medium-grained pure quartz sandstone. The lower part of the St. Peter may contain beds with varying amounts of silt or shale. The St. Peter sandstone marks the advance of the Middle Ordovician sea into southern Minnesota. The sandstone was deposited along the turbulent shoreline of the advancing sea. The St. Peter sandstone was deposited on top of the Prairie du Chien dolomite and its base marks a major erosional unconformity.

PLATTEVILLE-GLENWOOD FORMATIONS-- are generally about 30 feet thick. The Platteville and Glenwood Formations are classified as separate bedrock formations based on major differences in lithologic characteristics. Each of the formations is very thin and difficult to separate at the scale used in atlas map production. For the purpose of this study, the Platteville and Glenwood formations are treated as a single geologic unit and for convenience called the Platteville-Glenwood Formations. The Glenwood Formation is a 15 to 20 foot thick shaley unit that directly overlies the St. Peter sandstone. The Glenwood shale represents a low energy sedimentary environment, offshore from the beaches where the St. Peter sandstone was being deposited. The Platteville Formation is a 20 to 30 foot thick bed of limestone that contains thin shale partings at its top and base. The Platteville limestone represents a more seaward sedimentary environment of the Glenwood shale. The Platteville was probably deposited in a shallow marine environment, similar to the modern Bahama bank.

DECORAH FORMATION-- about 60 feet thick. The Decorah is primarily a uniform bed of gray-green shale. The top and bottom of the Decorah shale consists of alternating layers of limestone and shale that mark the transition between the underlying Platteville limestone and overlying Galena limestones. The Decorah shale indicates a quiet water sedimentary environment, probably shallow water tidal flats.

GALENA GROUP-- recorded as thick as 260 feet. The Galena is a carbonate unit that consists mostly of limestone and dolomite with some silty, sandy, and shaley units. During the Galena time period, carbonate rock forming processes dominated the sedimentary environment.

MAQUOKETA GROUP--may be as thick as 80 feet. The Maquoketa Group is a carbonate unit, mostly limestone and dolomite that is often shaley or contains shale layers. It is difficult to distinguish the Maquoketa Group from the underlying Galena or the overlying Cedar Valley groups in water well drillers' logs.

CEDAR VALLEY GROUP-- limited to erosional remnants along the eastern edge of Faribault County. The Cedar Valley is primarily a carbonate rock, fine-grained limestone or dolomite. The Cedar Valley limestone was deposited during the Devonian age on top of Ordovician age Maquoketa and Galena limestones. Its base marks a major erosional unconformity. Its presence in Faribault County is only inferred from maps prepared for the Freeborn County Geologic Atlas.

CRETACEOUS ROCK-- generally composed of white, red, or brown clay that may represent the weathering of the underlying bedrock. White Cretaceous sand may be reworked St. Peter or Jordan sandstone that was deposited along the advancing shoreline of the Cretaceous Sea.

AQUIFER CHARACTERISTICS OF SEDIMENTARY ROCK TYPES

INTRODUCTION

The most favorable geological structure for groundwater accumulation is found in stratified sedimentary rock like that underlying Faribault County. Sedimentary aquifers range from loose, coarse-grained deposits such as sandstone to hard fractured sedimentary rocks such as limestone or dolomite. A water bearing rock unit may vary locally in texture or composition, either vertically because of bedding planes or horizontally because of changes in sediment type. The lithology of the individual sedimentary bedrock units is nearly uniform throughout Faribault County due to the continuous nature of the geological processes that formed them.

SANDSTONE AQUIFERS

The sandstone bedrock units transmit water from between individual grains. The ability of sandstone to transmit water depends upon the size and amount of pore space between individual sand grains. Pore space is mostly a function of the amount of cementation that is holding the sand grains together. The cementing material consist of very small particles that partly or entirely fill the voids between sand grains. The most common cementing materials are clay minerals, calcite, and quartz. The hydraulic properties of any sandstone, as a whole, can be variable because the cementation may be localized.

CARBONATE AQUIFERS

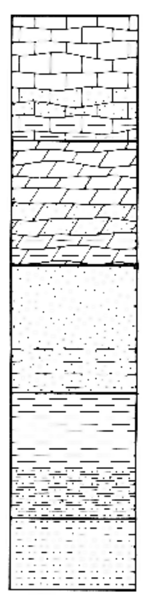
The carbonate aquifers are mostly composed of crystalline limestone and dolomite with some quartz sand and shaley units. In carbonate rock, fractures along bedding planes and pores within the rock provide the primary routes for groundwater flow. The permeability of carbonate rocks depends upon their porosity, which is primarily due to the enlargement of fractures and other openings by erosion through water circulation.

The ability of dolomite to transmit water is usually lower than that of most limestone. The openings between the crystals in dolomite are small and the rate of erosion by solution is less than in limestone. Dolomite is a hard and very brittle rock and may have wide zones of fracturing that result in increased permeability. Limestone has a higher solubility than dolomite, which leads to more spacious fractures and much wider solution channels. Observations in quarries that are excavated in limestone or dolomite show that openings along bedding planes tend to remain open and transport water.

SHALE & SILTSTONE AQUITARDS

Shale and siltstone are composed of fine-grained particles that constitute the finest of the clastic sedimentary materials. The effective porosity of shale and siltstone result in a much more reduced permeability than that found in sandstone and carbonate bedrock units. Consequently, siltstone and shale yield little groundwater and function as aquitards in the sequence of bedrock sedimentary deposits. Although an aquitard may not yield water in usable quantities, it can hold appreciable amounts of water.

EXPLANATION



LIMESTONE
SANDY
SHALY
DOLOMITE
SANDY
SHALY
SANDSTONE
SHALY
SHALE
SILTY
SILTSTONE

EROSIONAL UNCONFORMITY

DISCONFORMITY

STRATIGRAPHIC CLASSIFICATION				DESCRIPTION OF ROCK UNITS		DESCRIPTION OF AQUIFERS		
SYSTEM / SERIES	GROUP OR FORMATION NAME	MAP SYMBOL	GRAPHIC COLUMN	THICKNESS	DOMINANT ROCK TYPES	AQUIFER SYSTEM	AQUIFER	AQUIFER CHARACTERISTICS
MIDDLE DEVONIAN	CEDAR VALLEY GROUP	Dcv		Limited to erosional remnants	Carbonate rock, fine-grained; limited to erosional remnants; base marks erosional unconformity	CEDAR VALLEY - MAQUOKETA - GALENA AQUIFER SYSTEM	CEDAR VALLEY LIMESTONE	Limited to erosional remnants in southeastern part of the county. Its presence is only inferred.
MIDDLE ORDOVICIAN	MAQUOKETA GROUP	Oma		Uncertain; as thick as 80 feet	Carbonate rock, fine-grained; limestone, shaly-limestone and shale. Its base is gradational.		MAQUOKETA LIMESTONE	Carbonate rock; has direct hydrogeologic connection with surficial glacial deposits. Yields water for domestic use.
	GALENA GROUP	Oga		Occurs primarily as present bedrock surface; recorded as thick as 260 feet	Carbonate rock, fine-grained; white, yellow, and yellowish gray; primarily limestone and dolomitic limestone, may contain some sandy, shaly or silty beds. Contact with overlying Maquoketa is gradational; elsewhere its top forms the bedrock surface.		GALENA LIMESTONE	Carbonate rock; comes in direct hydrogeologic connection with surficial glacial deposits. Yields water through solution cavities, fracture zones, and crevices. Provides water for domestic, commercial, industrial, and municipal supplies.
	DECORAH FORMATION	Odc		50 to 60 feet	Shale; greenish gray; uniform throughout; may include carbonate beds at the base.	CONFINING LAYER	DECORAH SHALE	Shales are generally not water yielding; act as confining bed at the base of the Cedar Valley-Maquoketa-Galena aquifer system.
	PLATTEVILLE & GLENWOOD FORMATIONS	Opg		20 to 30 feet	Carbonate rock over shale; contact may be gradational or well defined.	AQUIFER & NON AQUIFER	PLATTEVILLE & GLENWOOD	Limestone can yield small quantities of water. Shales not water yielding; act as confining bed.
	ST. PETER FORMATION	Osp		90 to 100 feet	Quartzose sandstone; white or yellow; may be thin shale or siltstone beds in lower part of formation. Basal contact with Prairie du Chien is unconformal.	ST. PETER - PRAIRIE DU CHIEN - JORDAN AQUIFER SYSTEM	ST. PETER SANDSTONE	Highly permeable quartzose sandstone; has direct hydrogeologic contact with surficial glacial deposits. Yields large volumes of water where overlain by the Decorah confining layer; provides moderate supplies where the St. Peter forms the bedrock surface.
LOWER ORDOVICIAN	PRAIRIE DU CHIEN GROUP	Opc		Upper contact with St. Peter is unconformal; ranges from feather edge at erosional limits to as thick as 280 feet	Dolomite and sandy dolmite with beds of quartzose sandstone; may contain thin beds of soft shale or sediment filled crevaces. The top of the Prairie du Chien marks a major erosional unconformity; it disappears as an erosional edge in extreme northwestern part of the county.		PRAIRIE DU CHIEN DOLOMITE	Carbonate rock, dolomite; has direct hydrogeologic connection with surficial glacial deposits. Wide zones of fractures and crevices generally yield small to moderate quantities of water. Well-creviced dolomite can provide local high water yields. Limited shaly layers may form localized confining conditions. The top of the Prairie du Chien marks a major erosional unconformity; it may vary greatly in thickness.
UPPER CAMBRIAN	JORDAN FORMATION	Cj		60 to 100 feet	Quartzose sandstone; white or yellow; fine to coarse grained, soft-poorly cemented.		JORDAN SANDSTONE	Highly permeable quartzose sandstone; has direct hydrogeologic contact with surface and shallow groundwater systems. Contributes water for municipal and industrial supplies.
	ST. LAWRENCE FORMATION	Csl		90 to 120 feet	Data sparse; primarily dolomite, siltstone, and shale. Transition with the underlying Franconia may be gradational.	CONFINING LAYER	ST. LAWRENCE DOLOMITE SILTSTONE	Rocks of low permeability; act as confining bed at the base of the St. Peter-Prairie du Chien-Jordan aquifer system.
	FRANCONIA FORMATION	Cfn		100 to 120 feet	Fine-grained quartzose sandstone; glauconitic; may contain thin beds of dolomite, siltstone, or shale.	FRANCONIA - IRONTON - GALESVILLE AQUIFER SYSTEM	FRANCONIA SANDSTONE	Sandstone, glauconitic; has no direct hydrogeologic contact with surface and shallow groundwater systems. Contributes water for municipal and industrial supplies.
	IRONTON & GALESVILLE FORMATIONS	Cig		80 to 90 feet	Quartzose sandstone; data sparse. Poorly cemented sandstone.		IRONTON & GALESVILLE SANDSTONE	Highly permeable quartzose sandstone; has no direct hydrogeologic contact with surface and shallow groundwater systems. Contributes water for municipal and industrial supplies.
	EAU CLAIRE FORMATION	Cec		Typically greater than 100 feet	Mainly shale and siltstone with some beds of sandstone; transition with the underlying Mt. Simon is gradational.	CONFINING LAYER	EAU CLAIRE SHALE	Shales are generally not water yielding; act as confining bed at the base of the Franconia-Ironton-Galesville aquifer system.
	MT. SIMON FORMATION	Cmt		Unknown; probably attains several hundred feet	Quartzose sandstone; may contain shale and siltstone. Transition with the overlying Eau Claire is gradational; its base marks a major erosional unconformity.	MT. SIMON - HINCKLEY AQUIFER SYSTEM	MT. SIMON SANDSTONE	Quartzose sandstone, data sparse; has no direct hydrogeologic contact with surface and shallow groundwater systems. Aquifer use is minimal.
PRECAMBRIAN	HINCKLEY & FOND DU LAC FORMATIONS	Pc		Unknown; may exceed 1000 feet	Driller data unavailable; other sources suggest mainly quartzose sandstone and shale. Its base marks a major disconformity.		HINCKLEY SANDSTONE	Data absent; water contribution for aquifer use is unknown.
	METAMORPHIC IGNEOUS	Pc		Unknown; several miles	Igneous and metamorphic rocks; undifferentiated.	BASEMENT ROCK	NOT AN AQUIFER	Not water bearing rock; represents the base of all aquifers and aquifer systems.

FIGURE 3. Generalized stratigraphic column showing the relationship between individual bedrock units and corresponding water producing intervals. The descriptions of bedrock units, including thickness and rock type, were compiled from the geologic portions of water well drillers' logs and supplemented by more detailed descriptions presented by Mossler (1987). The descriptions of aquifer characteristics for the various bedrock units were derived from the hydrologic portions of well drillers' logs.

BEDROCK GEOLOGY MAP

INTRODUCTION

In Faribault County glacial deposits completely conceal the bedrock surface; thus, the nature of the bedrock surface is known entirely from subsurface data. The Geologic Map shows the distribution of bedrock units, as they would appear, if the bedrock were exposed throughout Faribault County. The geologic boundary lines that separate individual bedrock units describe a gradual change over a few feet or tens of feet, from one rock type to another.

Erosion of the bedrock surface before glaciation produced deep valley cuts in the bedrock surface. Because of past erosion, the thickness of the upper bedrock unit may change abruptly over short distances. The patterns displayed on the geologic map range from narrow bands to extended areas. The steep slopes of deeply eroded bedrock valleys are often expressed as narrow bands of bedrock units that follow along the edges of the valleys; narrow bands that follow along the bottom of these valleys will usually point up stream. In places where a single bedrock formation occupies an extended area, the character of the bedrock surface will be flat and featureless if the formation is thin, but may be deeply eroded if the formation is thick.

METHOD OF CONSTRUCTION

Several structural considerations controlled the construction of the geologic map. Among these were the character of the eroded bedrock surface, the relative thickness of individual bedrock units, and the direction, rate, and degree of dip of the bedrock units. The positioning of geologic boundary lines was accomplished by directly comparing the Bedrock Topography Map (Page 8) with each of the Bedrock Structure Maps (Page 16, 17, & 18). On the Bedrock Geology Map, the geologic boundaries were located by interpolating between points where bedrock topographic contours and bedrock structure contours of equal value intersect.

The geologic boundary line that separates the Decorah shale from the overlying Galena limestone was located by interpolating between points where Decorah structure contours intersect bedrock topography contours of equal value. Likewise, the boundary line that separates the St. Peter sandstone and the overlying Platteville-Glenwood formations was located by interpolating between points where St. Peter structure contours intersect bedrock topographic contours of equal value. The boundary line separating the Platteville-Glenwood and overlying Decorah shale was located by projecting the average thickness of the Platteville-Glenwood above the St. Peter, using the Bedrock Topography Map as a guide for positioning the line. Similarly, the boundary line separating the St. Peter sandstone and underlying Prairie du Chien Group was located by projecting the average thickness of the St.Peter sandstone below its top, using the Bedrock Topography Map as a guide for positioning the line. The positioning of the boundary line that separates the Galena and Maquoketa limestones was determined by applying a maximum thickness limit to the Galena limestone. The thickness limit for the Galena was projected onto the Decorah Structure Map and the Bedrock Topography Map was used as a guide for positioning the line. The boundary line that defines the extent of the Cedar Valley limestones was positioned through inferences made from maps prepared for the Freeborn County Geologic Atlas.

The Bedrock Geology Map presents a picture of the bedrock surface that supports a close relationship to the Bedrock Topography Map and Bedrock Structure Maps that were prepared for this atlas. This method of geologic map construction is designed to present a consistent picture of the bedrock on a county wide scale.

BEDROCK TOPOGRAPHY MAP

INTRODUCTION

The bedrock topography map presents a three-dimensional picture of the bedrock surface by means of contour lines that connect points of equal elevation. The topographic rendition of the bedrock surface was designed to describe an ancient landscape characterized by broad uplands that are cut by a sinuous pattern of river and stream valleys. In Faribault County the bedrock surface is completely covered by glacial deposits; thus, the nature of the bedrock surface is known entirely from subsurface data.

The configuration of the bedrock surface is a product of preglacial, glacial, and interglacial erosion of the bedrock strata. Preglacial erosion produced deep bedrock valley cuts that were excavated by river and stream erosion prior to continental glaciation, which began about 2 million years ago. Glacial erosion of the bedrock surface may have widened or deepened the bedrock valleys by ice scouring from advancing glaciers or by meltwater flows from retreating glaciers. Interglacial erosion may have modified the bedrock surface slightly, however, repeated ice advances gradually filled the bedrock valleys and covered the bedrock surface with glacial debris. The majority of the bedrock channels are interpreted to have been eroded prior to glaciation of the region.

METHOD OF CONSTRUCTION

The Bedrock Topography Map is a compilation of all available data from wells that penetrated the glacial drift and reached bedrock. This information was acquired from water well drillers' logs and is taken to be reliable. Where the data is dense, the map is more detailed; where the data is sparse, the map is more generalized. The location and distribution of these data points are shown on the Bedrock Topography Map.

The elevation of the bedrock surface was calculated for each well drillers' log and the data plotted onto a map sheet. The map sheet was contoured to agree with the plotted elevations and to develop any distinctive landforms resulting from geomorphic processes that were wearing down the bedrock surface prior to recent continental glaciation. The placing of contours is intended to reveal a pattern of erosion much like that produced by present day river valleys and their tributaries. The map illustrates that only large valleys and tributaries are identifiable from existing data. In most instances, the valleys and their tributaries are probably not as straight nor wide as indicated.

On the Bedrock Topography Map, the closely spaced contours indicate steep slopes and widely spaced contours indicate flat or gently sloping areas. The spacing of contour lines and the nature of connecting or guiding each contour through elevation points is based upon factors concerning the type of bedrock sediments that underwent erosion. Resistant rock types such as limestone or dolomite tend to form plateaus while softer rock such as shale and sandstone form gently sloping areas. The soft shales or sandstones may contribute to steep valley walls where overlain by more resistant limestones or dolomites.

DEPTH TO BEDROCK MAP

INTRODUCTION

The characteristics of the present land surface in Faribault County, including the topography and nature of surficial materials, is the result of the action of glacial ice and flowing water. The surficial materials are chiefly glacial deposits, collectively called drift, of the continental glaciers that covered Faribault County during the last million years. The glacial deposits overlie the bedrock surface and range in thickness from slightly less than 50 feet to over 250 feet. The nature of thickening and thinning is largely influenced by buried bedrock valley cuts.

The glacial drift is composed mainly of glacial till, which is characterized by a matrix of sand, silt, and clay with scattered pebbles, cobbles and boulders. The glacial till is interbedded with sand and gravel that was released by the melting glaciers. These sand and gravel units are scattered and discontinuous in the shallow drift; but thick deposits of sand and gravel can occur where the drift is thick.

The Depth to Bedrock Map, by means of isopach contours, shows variations in the thickness of glacial deposits. The topography of the bedrock surface has a direct bearing on the thickness of the drift deposits. Where the elevation of the bedrock surface is low, as within major bedrock valleys, the glacial deposits are thick. Where the bedrock surface is high, the drift deposits are generally thin. In the vicinity of buried bedrock valleys, the thickness of the glacial deposits may change abruptly over short distances. Hills and valleys on the present land surface may present small irregularities in drift thickness.

METHOD OF CONSTRUCTION

The thickness of glacial deposits is shown on the Depth to Bedrock Map by isopach lines that connect points of equal thickness. The Depth to Bedrock Map was constructed by combining the Surface Topography Map and the Bedrock Topography Map. The Surface Topography Map was compiled from USGS 7.5 Minute Topographic Quadrangles. The Bedrock Topography Map was produced for this atlas and is shown on page 8. The Bedrock Topography Map is somewhat generalized and therefore limits the accuracy of the depth to bedrock mapping.

Construction of the Depth to Bedrock Map was accomplished by superimposing the Surface Topography Map onto the Bedrock Topography Map in order that the two could be directly compared. The drift thickness was determined at any contour intersection by subtracting the lower value (bedrock elevation) from the higher value (surface elevation). The isopach lines were drawn to agree with the difference in elevation between the two maps.

The method of depth to bedrock map construction was designed to present a picture of drift thickness that is consistent with that suggested by the Surface Topography Map and Bedrock Topography Map prepared for this atlas. On the Depth to Bedrock Map, narrow bands of thick glacial deposits follow the deep bedrock valleys presented on the Bedrock Topography Map. This pattern illustrates the close relationship between drift thickness and the topography of the bedrock surface.

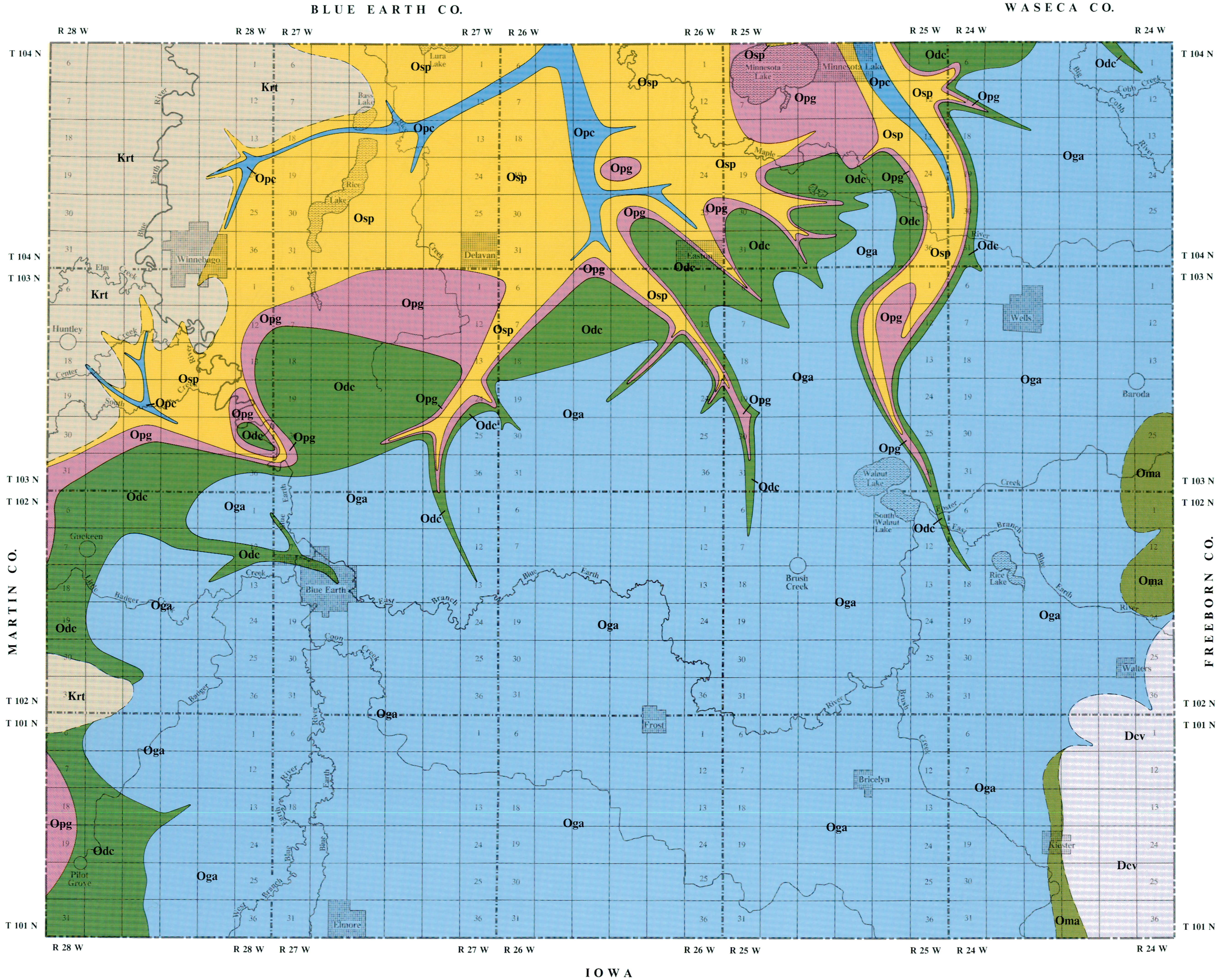
The scale of atlas maps and the generalized nature of the Bedrock Topography Map limits the amount of detail that can be shown on the Depth to Bedrock Map. When determining the nature of drift thickness for a small area at large scale, the original data base and staff at the Water Resources Center, Mankato State University, should be utilized.

BEDROCK GEOLOGY

By

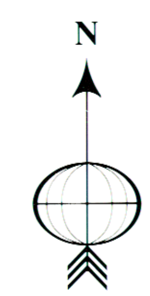
John M. Rongstad and Paul A. Vogel

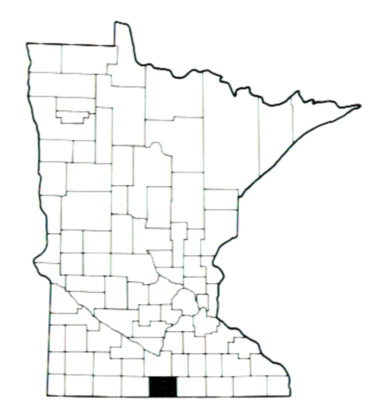
1991



CRETACEOUS SYSTEM	Krt	The Cretaceous sediments are generally composed of white, red, or brown clay that may represent the weathering of the underlying bedrock. White Cretaceous sand may be reworked St. Peter or Jordan sandstone that was deposited along the advancing shoreline of the Cretaceous Sea.

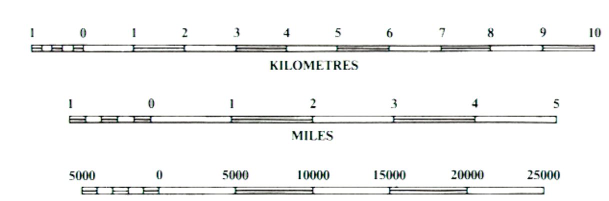
STRATIGRAPHIC CLASSIFICATION				DESCRIPTION OF ROCK UNITS	
SYSTEM / SERIES	GROUP OR FORMATION NAME	MAP SYMBOL	GRAPHIC COLUMN	THICKNESS	DOMINANT ROCK TYPES
MIDDLE DEVONIAN	CEDAR VALLEY GROUP	Dcv		Limited to erosional remnants	Carbonate rock, fine-grained; limited to erosional remnants; base marks erosional unconformity
MIDDLE ORDOVICIAN	MAQUOKETA GROUP	Oma		Uncertain; as thick as 80 feet	Carbonate rock, fine-grained; limestone, shaly-limestone and shale. Its base is gradational.
	GALENA GROUP	Oga		Occurs primarily as present bedrock surface; recorded as thick as 260 feet	Carbonate rock, fine-grained; white, yellow, and yellowish gray; primarily limestone and dolomitic limestone, may contain some sandy, shaly or silty beds. Contact with overlying Maquoketa is gradational; elsewhere its top forms the bedrock surface.
	DECORAH FORMATION	Odc		50 to 60 feet	Shale; greenish gray; uniform throughout; may include carbonate beds at the base.
	PLATTEVILLE & GLENWOOD FORMATIONS	Opg		20 to 30 feet	Carbonate rock over shale; contact may be gradational or well defined.
	ST. PETER FORMATION	Osp		90 to 100 feet	Quartzose sandstone; white or yellow; may be thin shale or siltstone beds in lower part of formation. Basal contact with Prairie du Chien is unconformal.
LOWER ORDOVICIAN	PRAIRIE DU CHIEN GROUP	Opc		Upper contact with St. Peter is unconformal; ranges from feather edge at erosional limits to as thick as 280 feet	Dolomite and sandy dolmite with beds of quartzose sandstone; may contain thin beds of soft shale or sediment filled crevaces. The top of the Prairie du Chien marks a major erosional unconformity; it disappears as an erosional edge in extreme northwestern part of the county.





LOCATION DIAGRAM

SCALE 1 : 150 000



BEDROCK TOPOGRAPHY

By

John M. Rongstad and Jesse D. Wohlfeil

1991

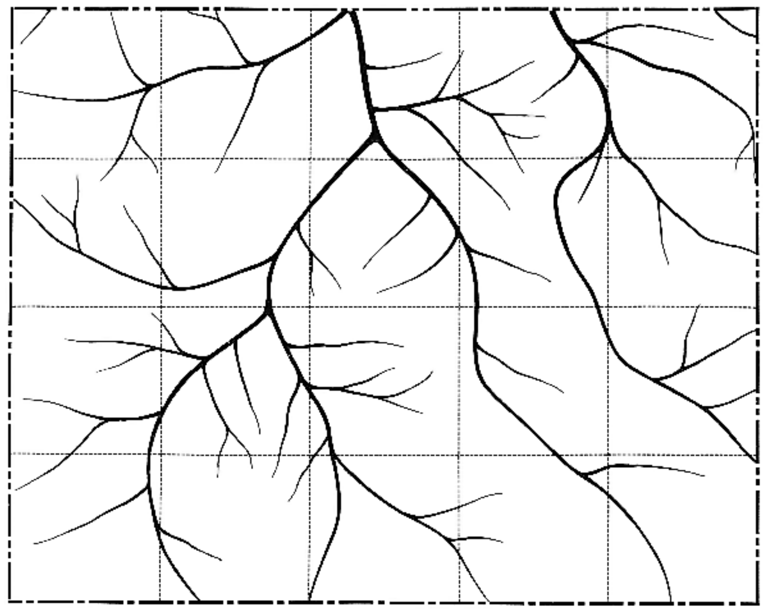
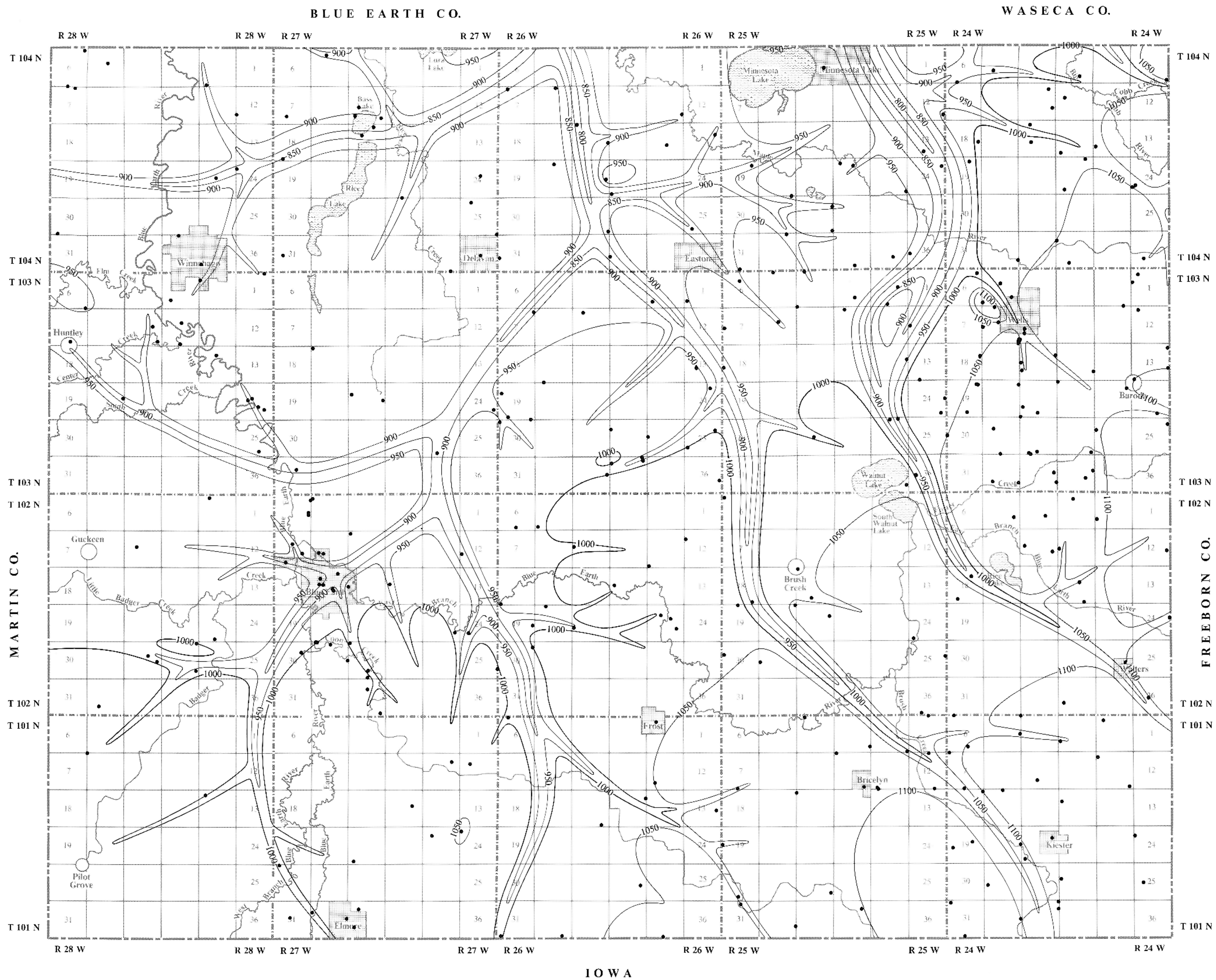


FIGURE 4. The sinuous system of buried bedrock valleys is shown in solid black. This pattern is suggested by the contours on the Bedrock Topography Map.



EXPLANATION

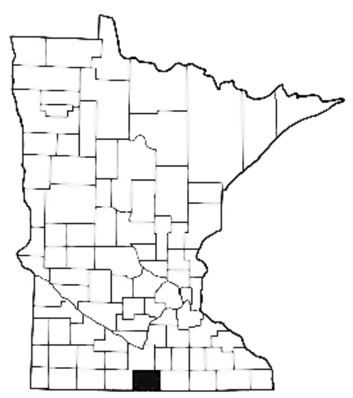
Topographic contours in feet above sea level.

1000

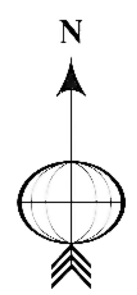
Contour interval 50 feet

•

Datum Point



LOCATION DIAGRAM



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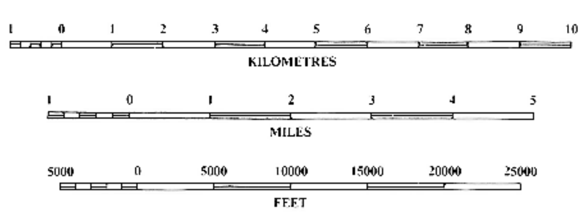

DEPTH TO BEDROCK

By

John M. Rongstad

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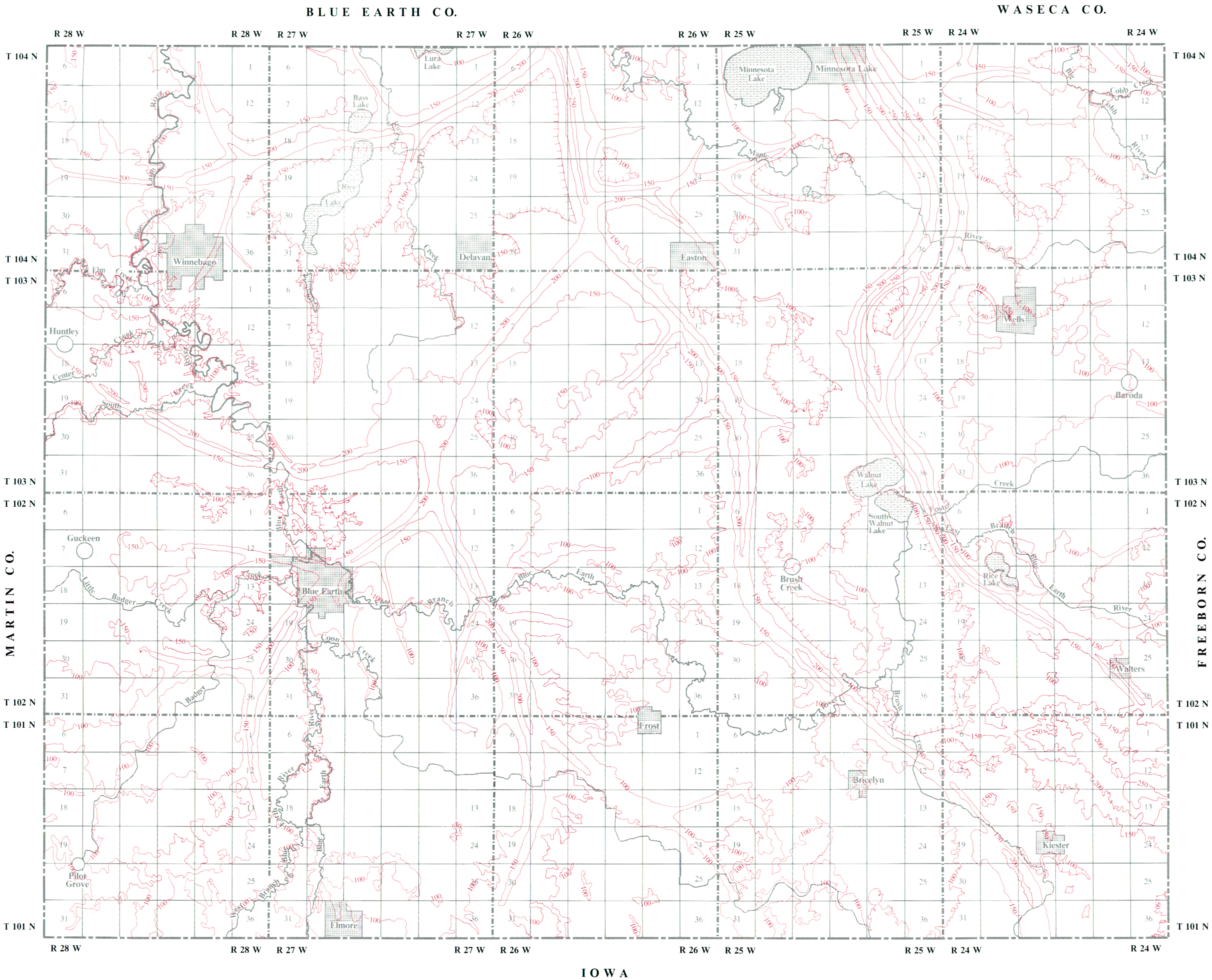
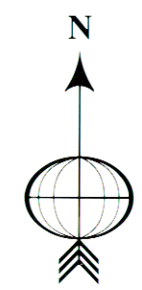
1991

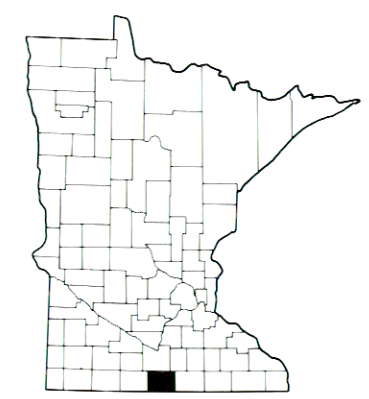


EXPLANATION

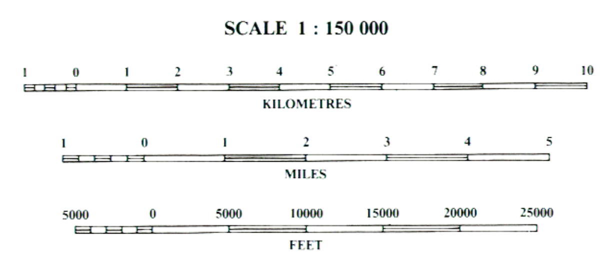
Isopach lines connect points of equal thickness
Contour interval 50 feet

Hachures show closed areas of less thickness





LOCATION DIAGRAM



GEOLOGIC CROSS SECTIONS

INTRODUCTION

The Geologic Cross Sections in this atlas combine the Surface Topography Map, Bedrock Topography Map, and the Bedrock Structure Maps to develop cross section profiles of Faribault County. The cross section profiles were prepared at three mile intervals; one set trending west-east and a second set trending north-south. The cross sections were constructed along each Township and Range line, and along section lines that pass through the center of each township (FIGURE 5). The cross section profiles are arranged as a grid system to provide county wide cross section coverage.

The cross section profiles of Faribault County are arranged in stacks on pages 11 through 15 in this atlas. Those cross sections that trend from west to east are stacked and labeled from north to south (A-A to I-I'). Those cross sections that trend from north to south, are stacked and labeled from east to west (J-J' to T-T'). On each cross section the location of intersecting cross sections and natural features such as rivers, streams, and lakes are labeled; the approximate location for cities and towns are also shown for reference. The individual bedrock units are separated by solid or dashed boundary lines and labeled with their respective names.

INDEX TO GEOLOGIC CROSS SECTIONS

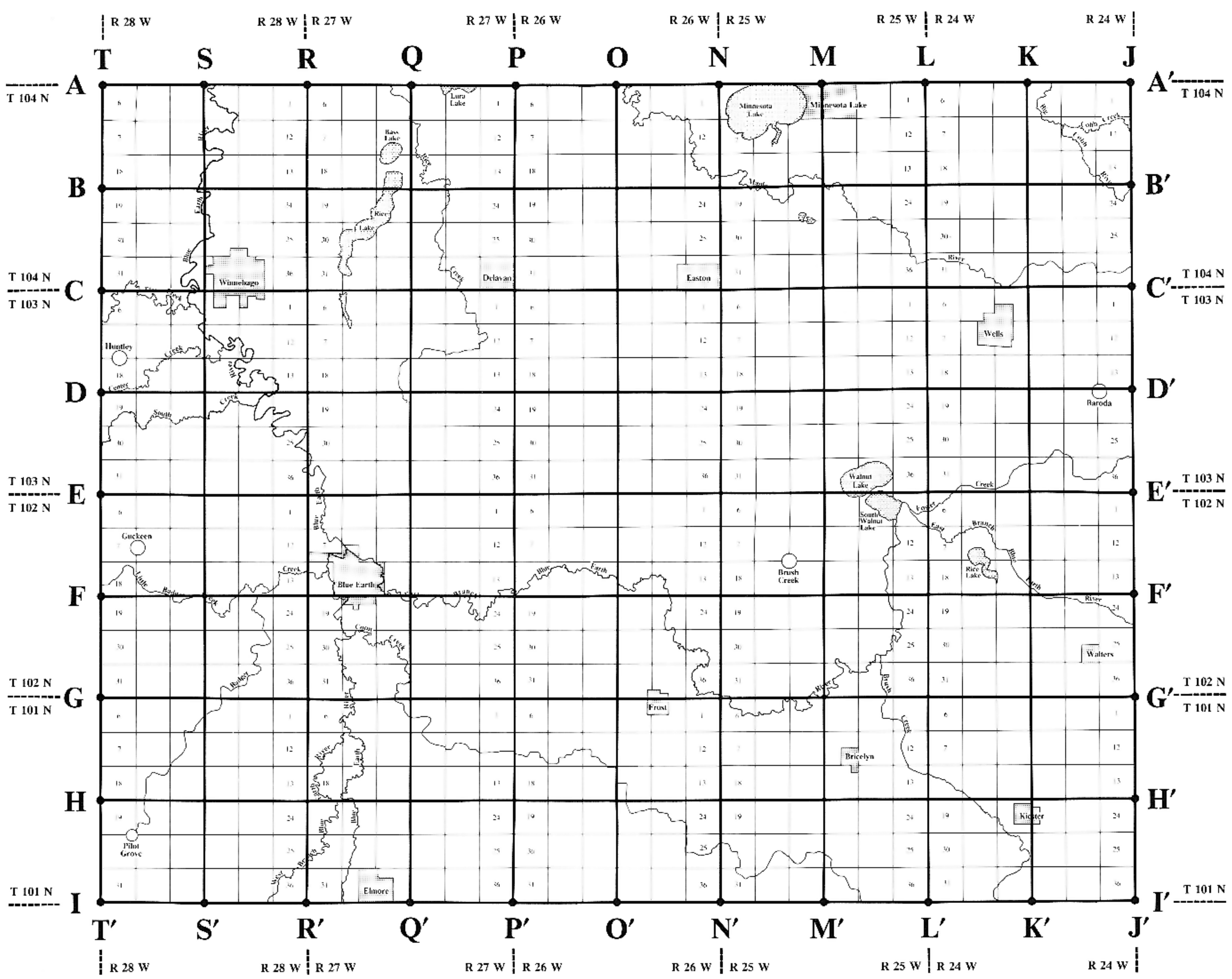


FIGURE 5. The above diagram describes the pattern of cross section profiles that were prepared for the atlas. The cross sections were prepared along Public Land Survey boundary lines: Township, Range, and Section lines.

The cross sections graphically illustrate the close relationship between the thickness of glacial deposits and the location of buried bedrock valleys. The cross sections show that thicker glacial deposits are associated with deep bedrock valleys while the thinnest glacial deposits occur over bedrock uplands. The hills and valleys on the land surface profiles are shown to present comparatively small irregularities in drift thickness.

The cross sections illustrate the relationship between individual bedrock units and bedrock aquifer systems. The four major bedrock aquifer systems and the individual bedrock aquifers that combine to form them are shown on the cross sections. The regional confining layers that separate bedrock aquifer systems have been filled with a distinguishing pattern to make them easy to recognize; the individual bedrock aquifers have been left clear or white.

METHOD OF CONSTRUCTION

The positioning of boundary lines on each cross section was accomplished by transferring the elevation contour data from the Surface Topography Map, Bedrock Topography Map, and Bedrock Structure Maps. The boundary lines that divide individual bedrock units may describe a gradual change over a few feet or tens of feet, from one rock type to another. Solid lines were used where the contact between bedrock units is usually abrupt. Dashed lines were used where the contact between bedrock units represents an erosional unconformity or where the contact is gradational.

The surface profile for each cross section was constructed by using the Surface Topography Map as a guide. The profile for the top of the bedrock was constructed using the Bedrock Topography Map as a guide. The Bedrock Structure Maps were used as guides to plot profiles for the top of the Decorah, St. Peter, and Jordan formations onto each of the cross sections. The geologic boundary lines for the Decorah, St. Peter, and Jordan formations provided structural reference lines from which the boundary lines of all other bedrock units were located onto the cross section profiles.

The upper boundary of the Galena Group is the top of the bedrock throughout the southern half of Faribault County. The boundary line that separates the Galena and Maquoketa Groups was located by plotting the maximum thickness of the Galena Group above the top of the Decorah Formation. The boundary line that defines the Cedar Valley Group was positioned through inferences made from maps prepared for the Freeborn County Geologic Atlas. The top of the Platteville-Glenwood Formation was located by plotting its average thickness above the top of the St. Peter Formation. The top of the Prairie du Chien Group was located by plotting the average thickness of the St. Peter Formation below its upper boundary. The boundaries of all other bedrock units were located by projecting the average thicknesses (accumulative) for each of the underlying bedrock units below the top of the Jordan Formation.

The cross sections show bedrock structural conditions more accurately above the Jordan Formation that below it. Above the Jordan Formation, structure maps for the Decorah and St. Peter Formations control the accuracy of the cross sections. The Jordan Formation is the lowest bedrock unit for which a bedrock structure map was constructed. Thus, as the depth increases below the Jordan Formation, information about the structural nature of individual bedrock units decreases. Eventually, depths are reached below which little or no information is available. At these depths the accuracy of the cross sections is limited.

GROUNDWATER

The cross sections show the relationship between water producing intervals and bedrock formations. The sandstones and limestones function as aquifers while the shales and siltstones function as aquitards in the sequence of bedrock sedimentary deposits. The bedrock aquifers are shown to extend continuously and uniformly over extended areas beneath Faribault County.

The direction of groundwater movement cannot be shown on the cross sections in this atlas. Groundwater does not flow in a straight line and the direction of groundwater flow can change significantly over very short distances. For groundwater work, study area boundaries should be established and cross sections developed that are parallel and perpendicular to the direction of inferred groundwater flow.

The cross sections indicate the vertical extent of bedrock aquifer materials and their connection with bedrock structure, bedrock topography, bedrock confining layers, and other factors that may control the movement of groundwater. In the vicinity of buried bedrock valleys, the emergence and subsequent termination of bedrock units may be abrupt. In these areas, bedrock aquifers may change from confined conditions to unconfined conditions over very short distances.

SCALE

The horizontal scale of each cross section is identical to the horizontal scale on all other atlas maps (1:150,000). However, the vertical scale of each cross section has been exaggerated twenty times the horizontal scale. The vertical scale was magnified so that the thin bedrock units would have adequate dimension for mapping. Exaggeration of the vertical scale affects primarily the vertical dimensions of a bedrock formation but it also affects, in a certain way, the horizontal dimensions of a bedrock formation. In the vertical direction the bedrock formation is actually expanded; in the horizontal direction it is apparently contracted. Persons not accustomed to exaggerated cross sections are apt to forget the fact of exaggeration and will gain a mental picture of acute structural relief when, in fact, the structural relief may be very mild.

CONVERSION OF APPARENT DIP TO TRUE DIP

Vertical Exaggeration × 20

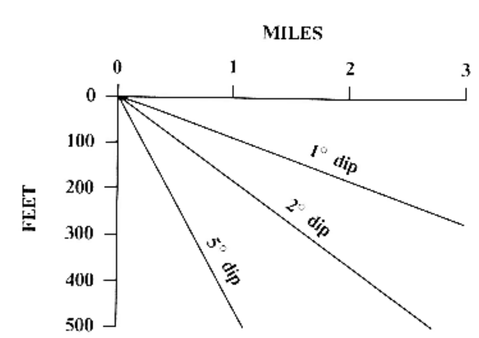


FIGURE 6. The above diagram illustrates the conversion of apparent dip to true dip. One is provided on each page of cross sections. The dip conversion diagram is designed to give the user a mental picture of the relief distortion that is caused by the vertical exaggeration.

GEOLOGIC CROSS SECTIONS A-A′ TO E-E′

EXPLANATION

Unconsolidated surficial deposits, chiefly glacial drift; alluvial silts, sands, and gravels commonly present along streams.

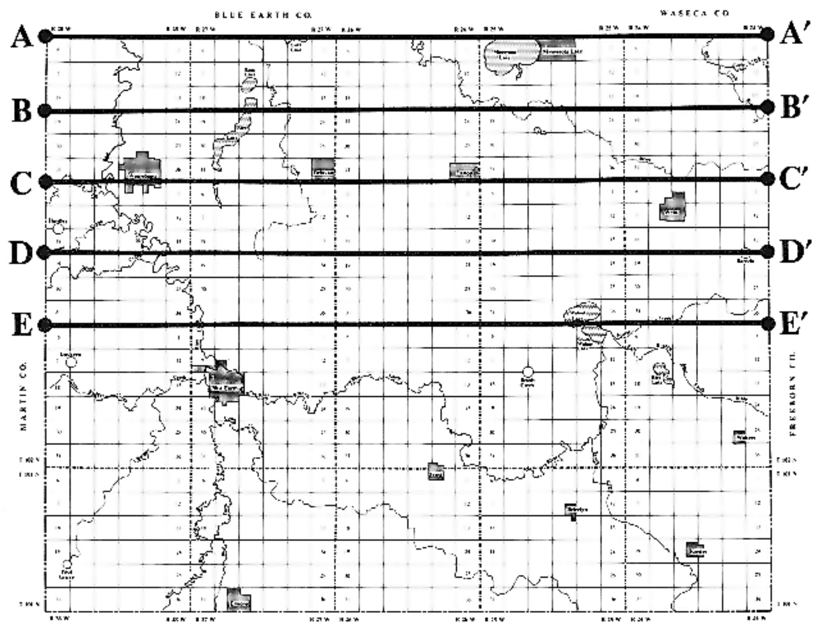
Confining layer, chiefly shale and siltstone; separates bedrock aquifer systems.

Bedrock aquifer, chiefly sandstone, limestone, and dolomite; water yielding unit of an aquifer system.

- - - - - - - - - - - - - - - -

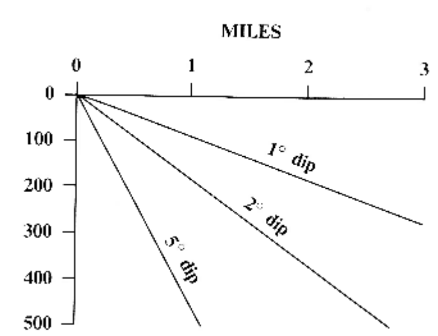
Contact between bedrock units is approximately located; dashed where inferred between lithologically similar units, erosional unconformities, or where contact is gradational.

INDEX TO GEOLOGIC CROSS SECTIONS

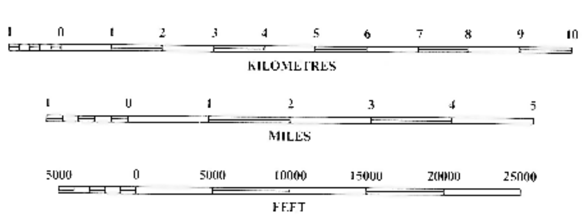


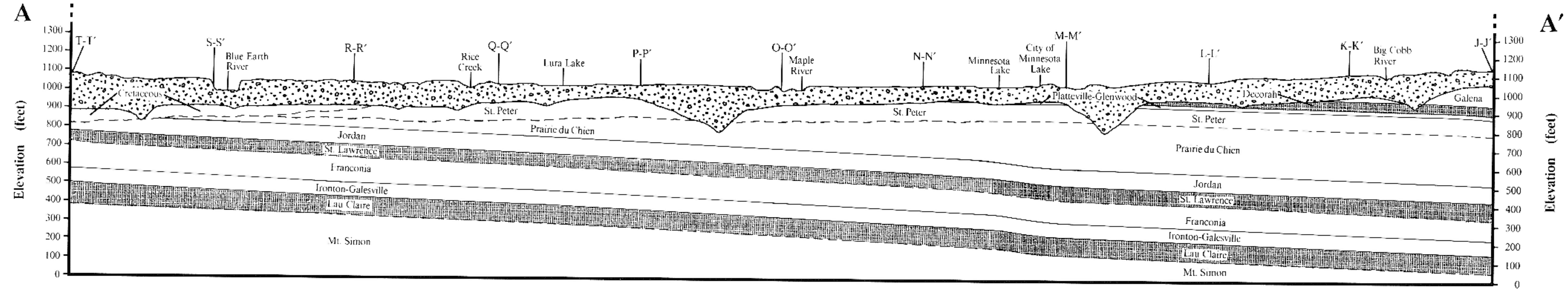
CONVERSION OF APPARENT DIP TO TRUE DIP

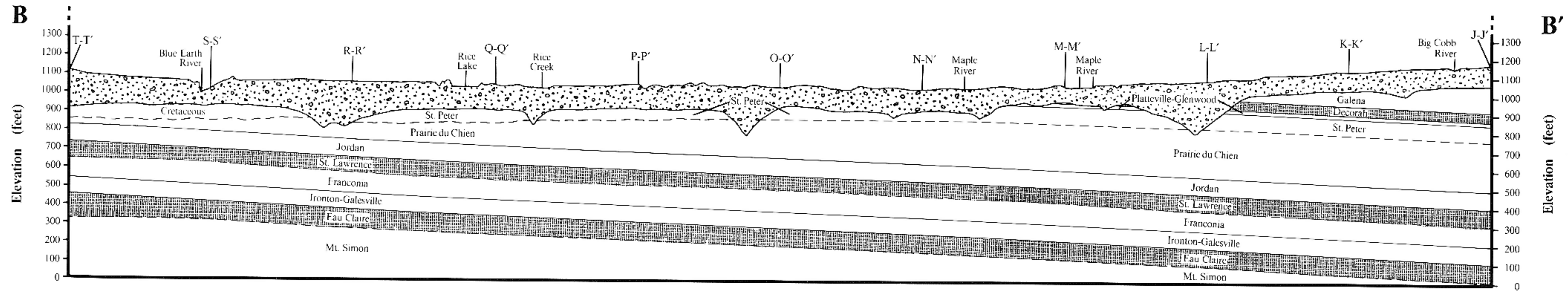
Vertical Exaggeration × 20

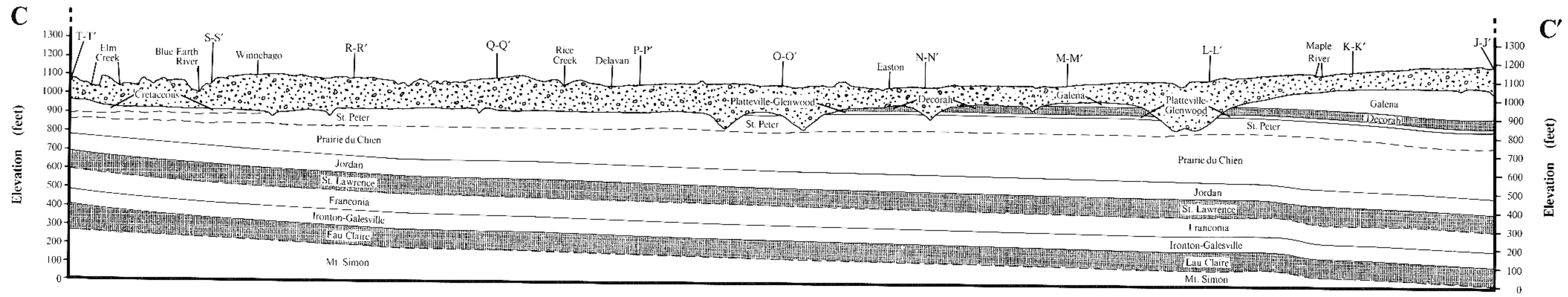


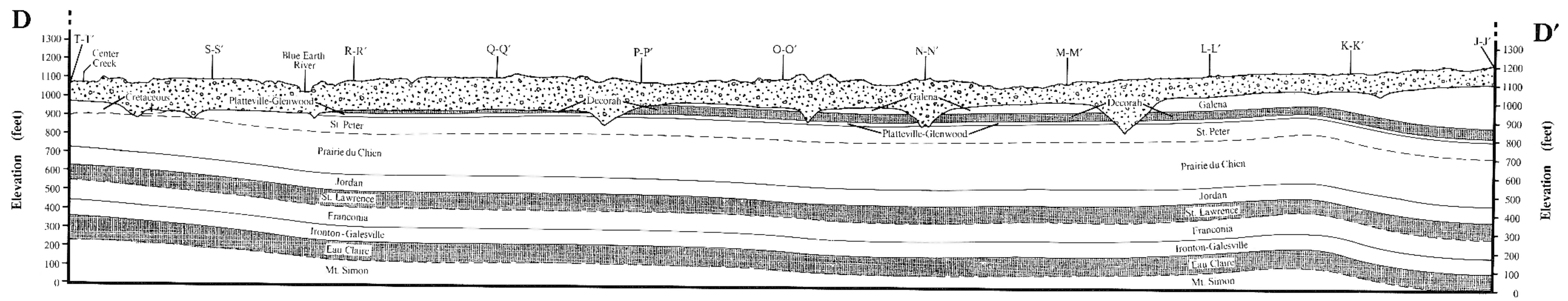
HORIZONTAL SCALE

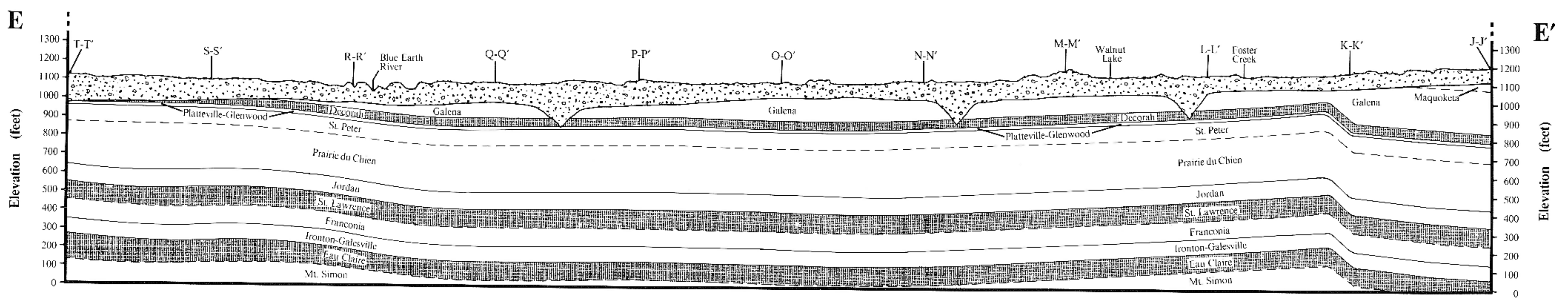




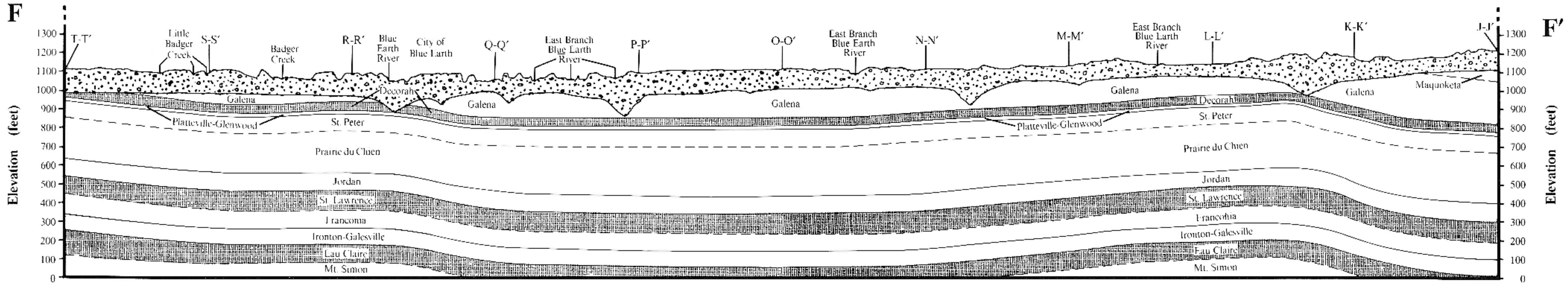


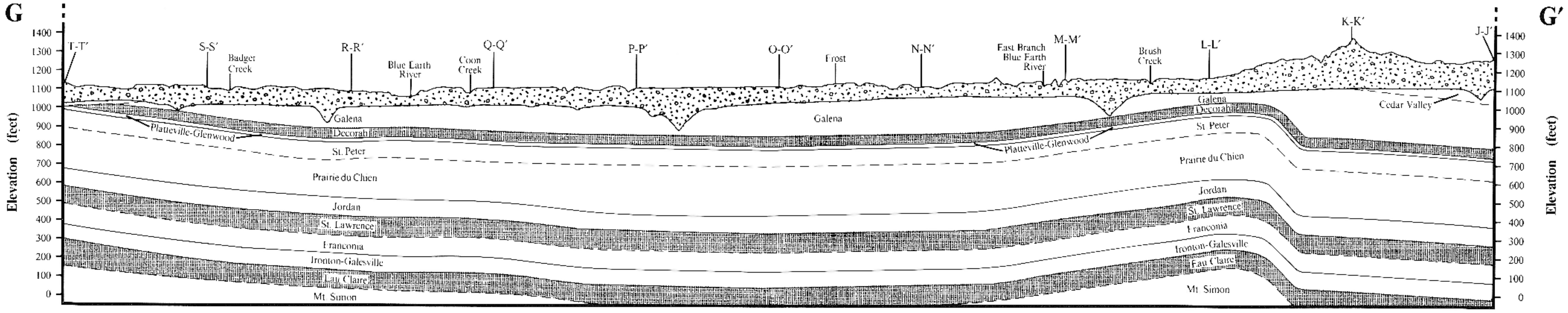


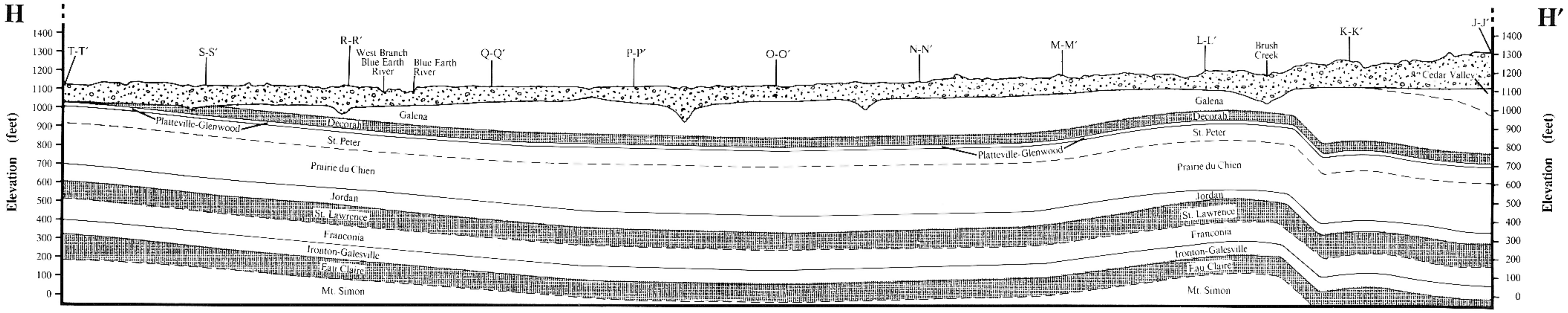


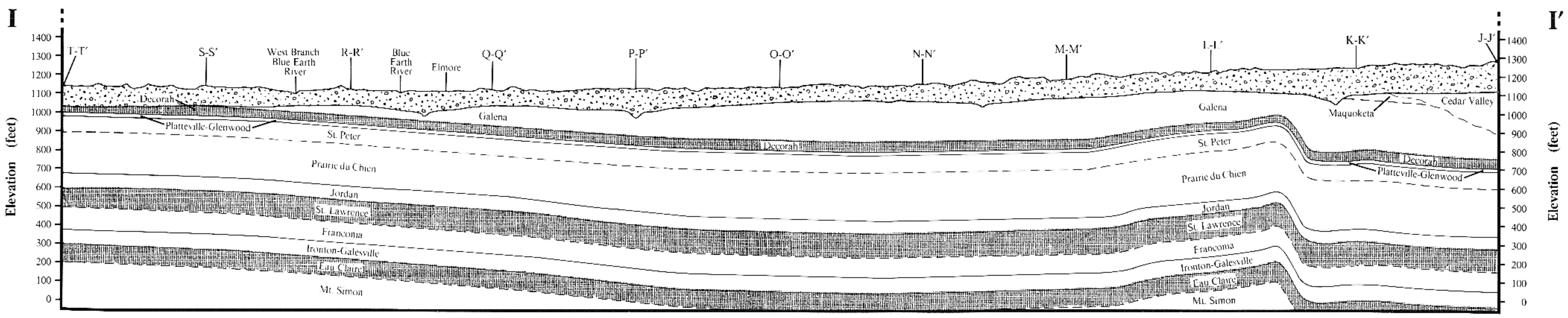


GEOLOGIC CROSS SECTIONS F-F′ TO I-I′









EXPLANATION

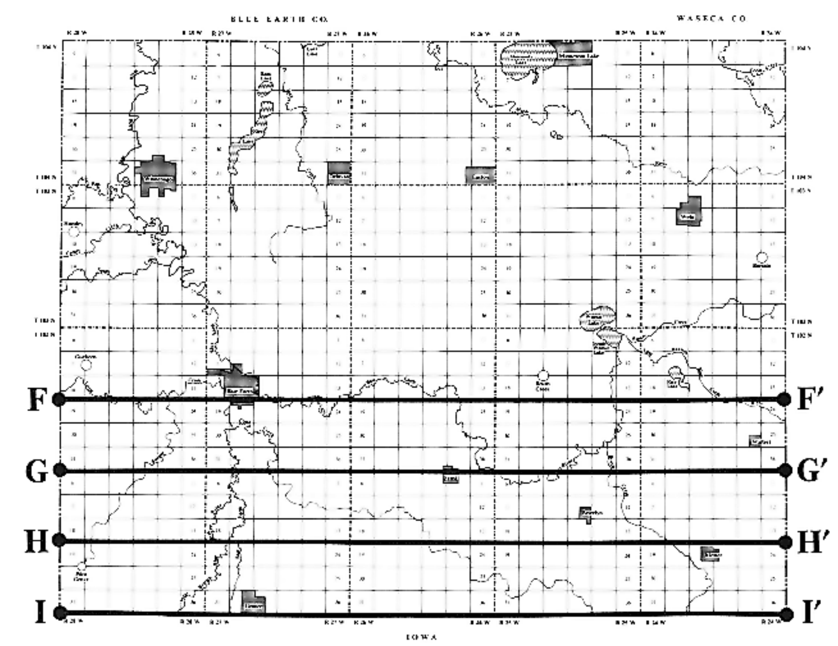
Unconsolidated surficial deposits, chiefly glacial drift; alluvial silts, sands, and gravels commonly present along streams.

Confining layer, chiefly shale and siltstone; separates bedrock aquifer systems.

Bedrock aquifer, chiefly sandstone, limestone, and dolomite; water yielding unit of an aquifer system.

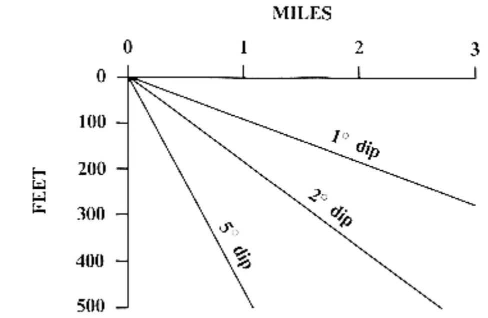
Contact between bedrock units is approximately located; dashed where inferred between lithologically similar units, erosional unconformities, or where contact is gradational.

INDEX TO GEOLOGIC CROSS SECTIONS

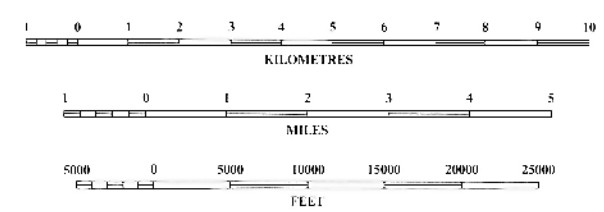


CONVERSION OF APPARENT DIP TO TRUE DIP

Vertical Exaggeration × 20



HORIZONTAL SCALE



GEOLOGIC CROSS SECTIONS
J-J′ TO M-M′

EXPLANATION

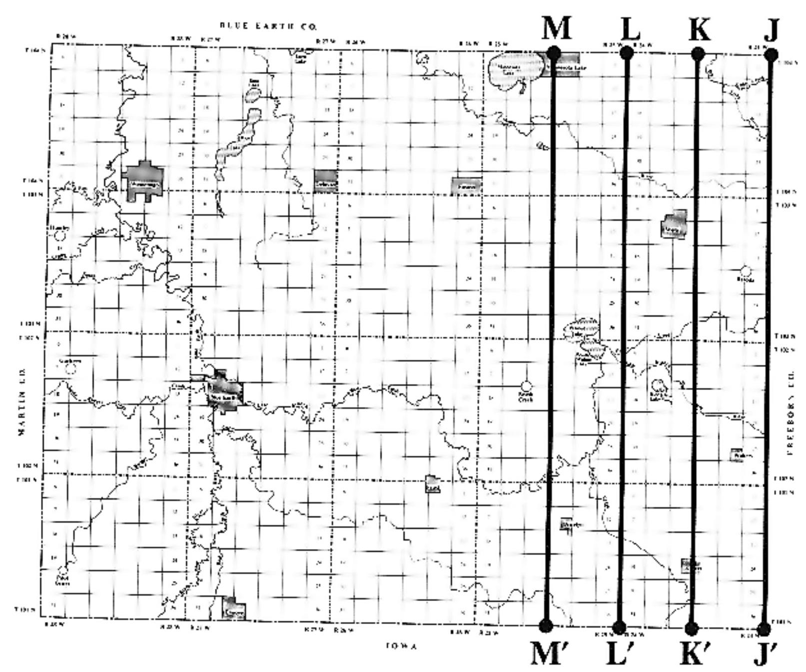
Unconsolidated surficial deposits, chiefly glacial drift; alluvial silts, sands, and gravels commonly present along streams.

Confining layer, chiefly shale and siltstone; separates bedrock aquifer systems.

Bedrock aquifer, chiefly sandstone, limestone, and dolomite; water yielding unit of an aquifer system.

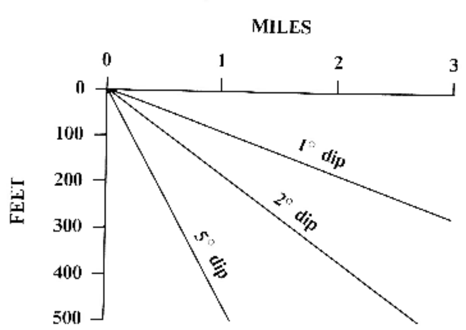
Contact between bedrock units is approximately located; dashed where inferred between lithologically similar units, erosional unconformities, or where contact is gradational.

INDEX TO GEOLOGIC CROSS SECTIONS

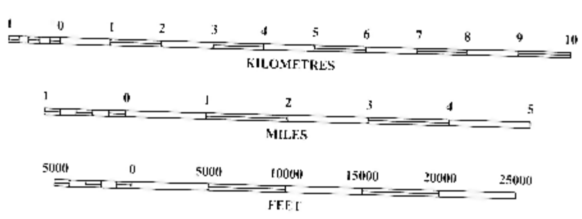


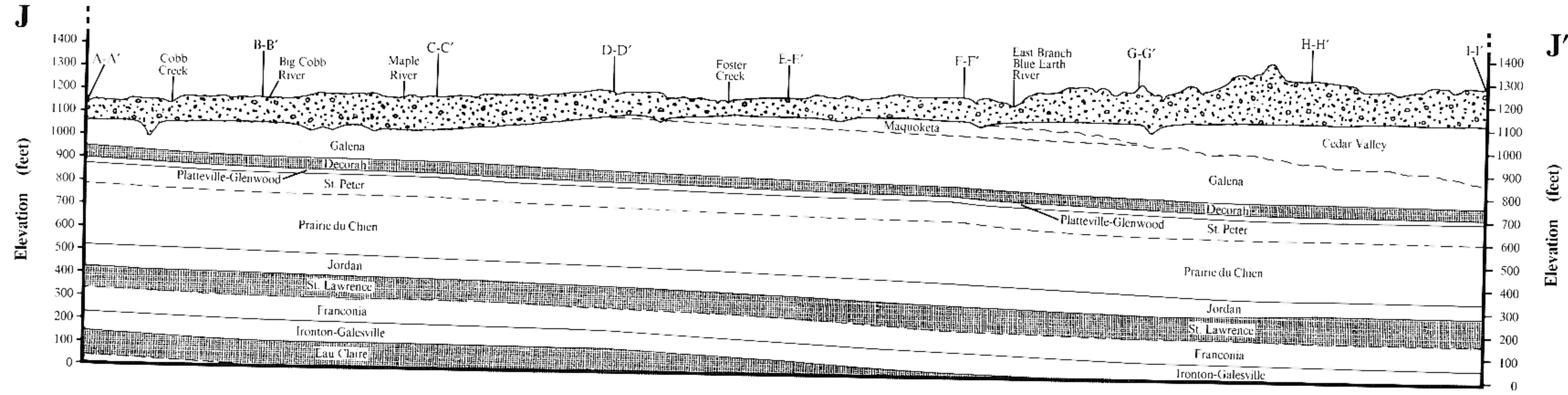
CONVERSION OF APPARENT DIP TO TRUE DIP

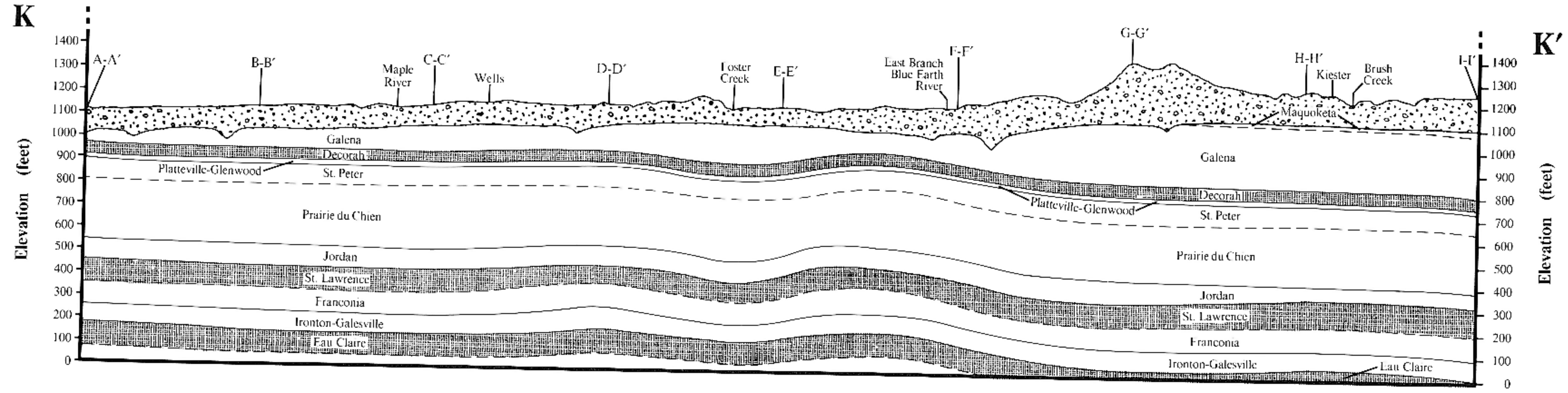
Vertical Exaggeration × 20

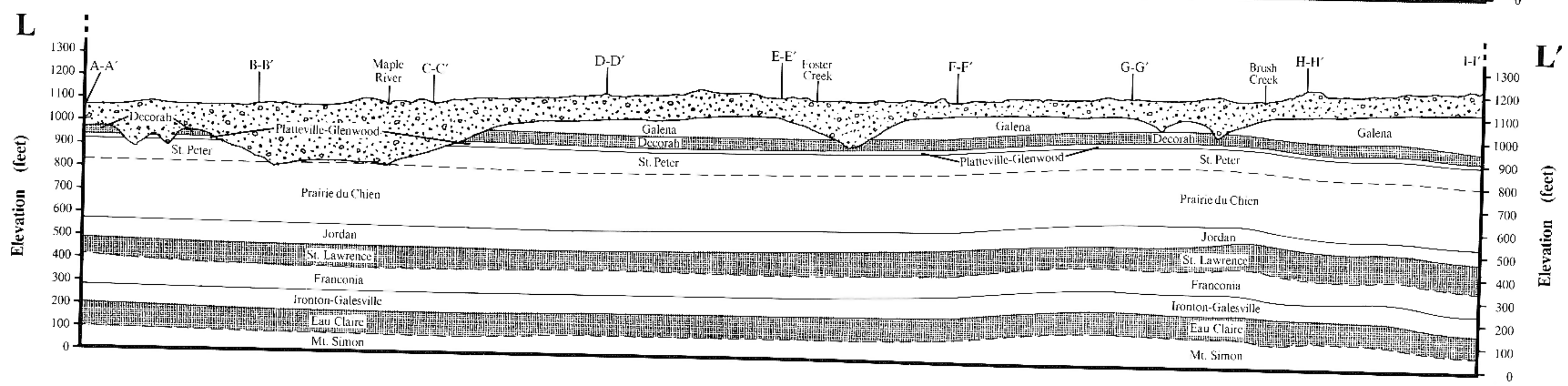


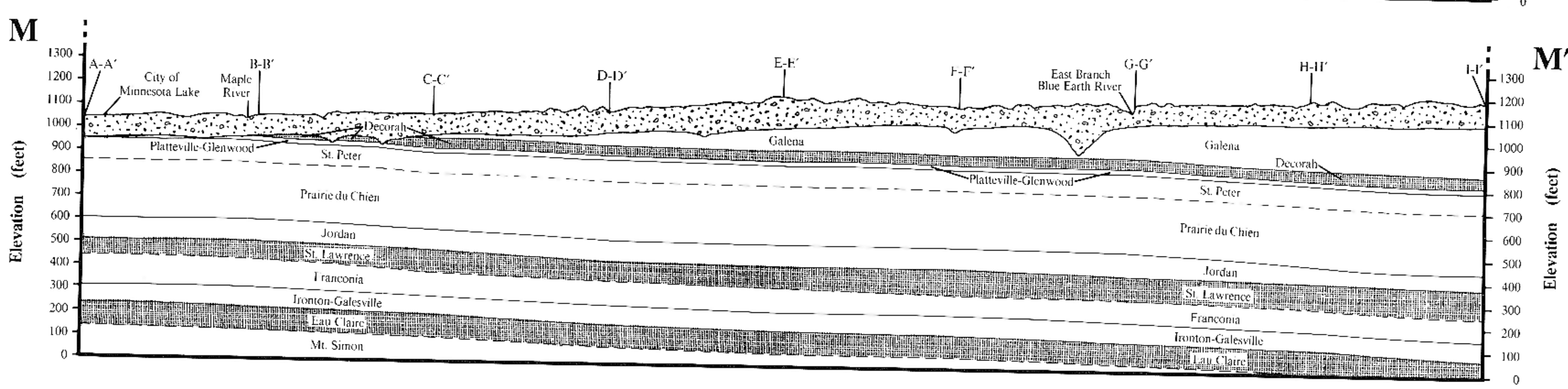
HORIZONTAL SCALE



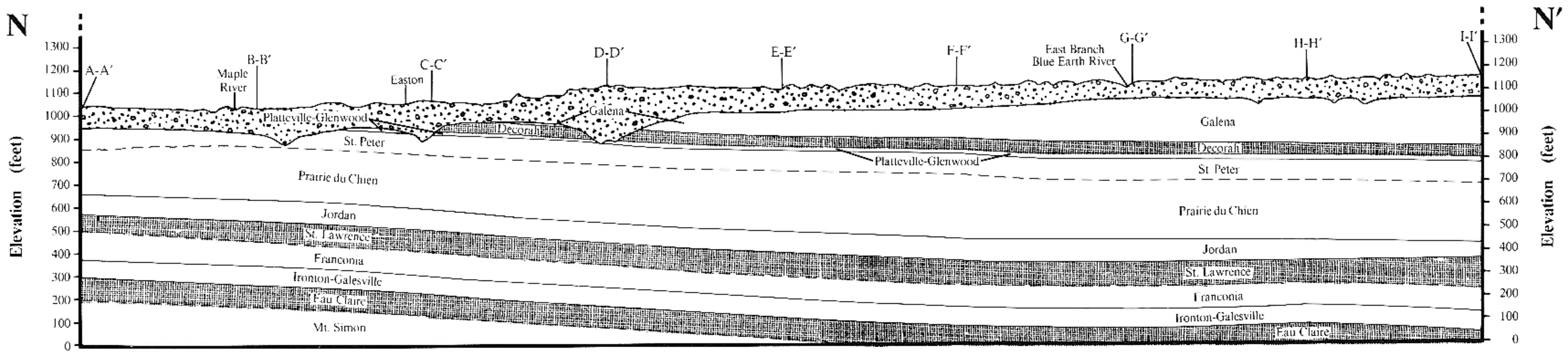


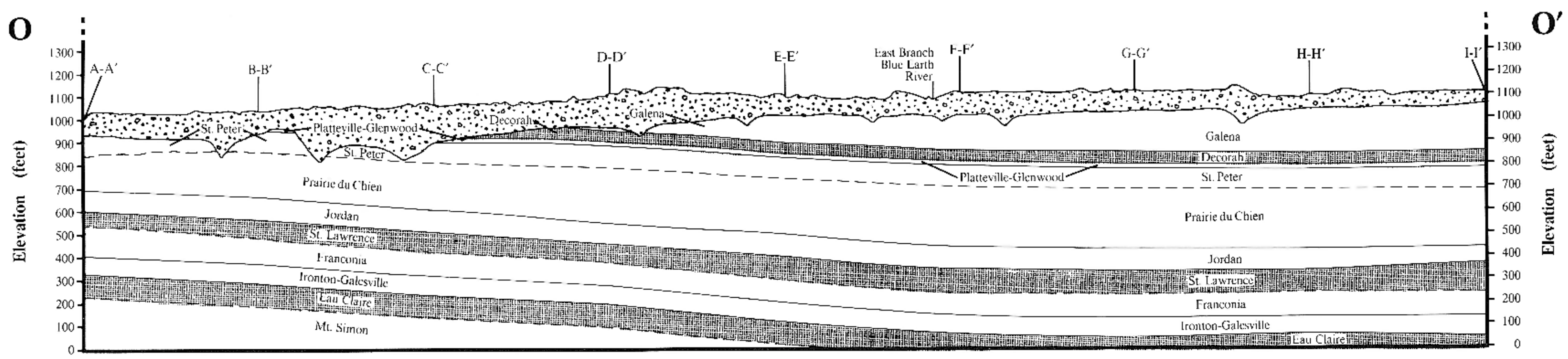


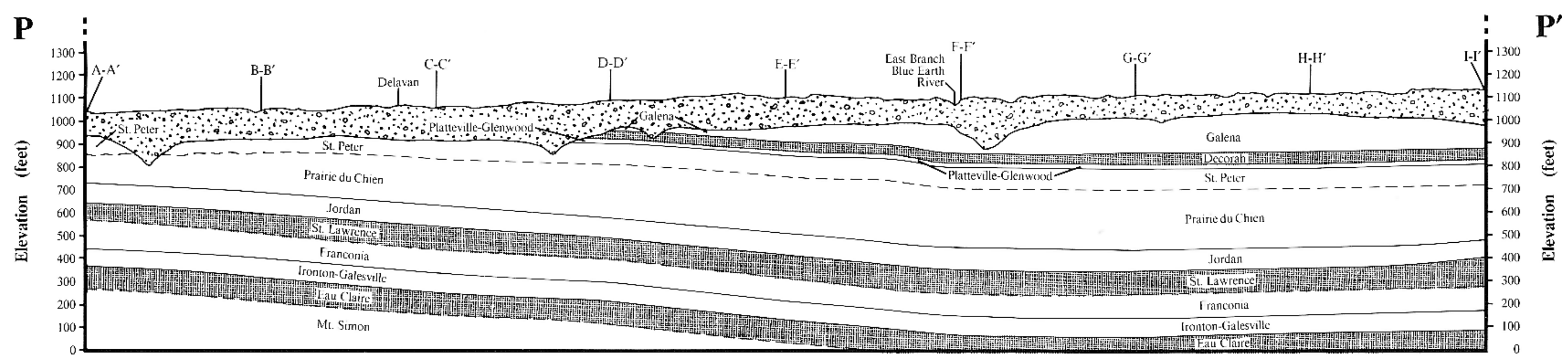


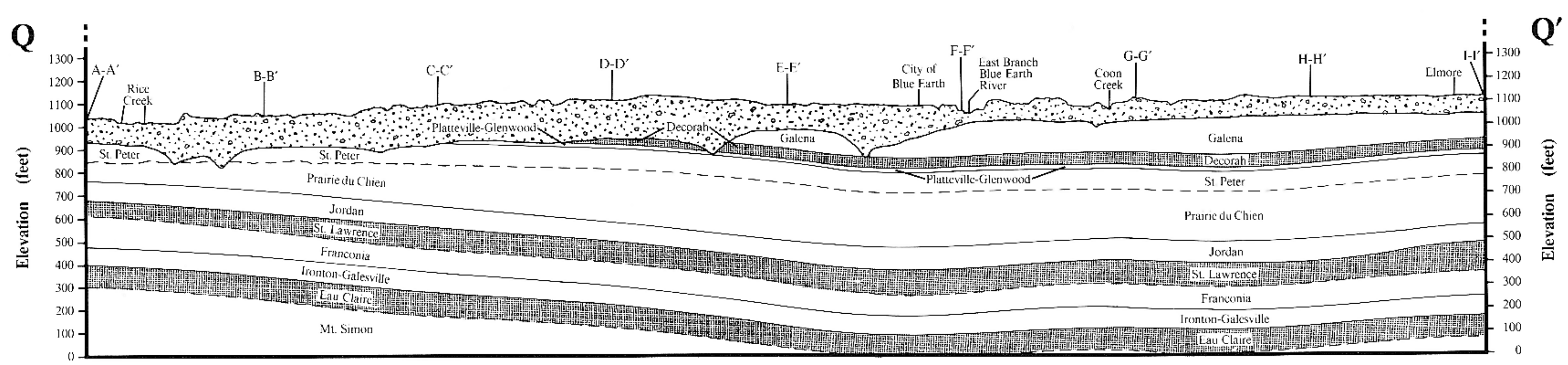


GEOLOGIC CROSS SECTIONS
N-N′ TO Q-Q′









EXPLANATION

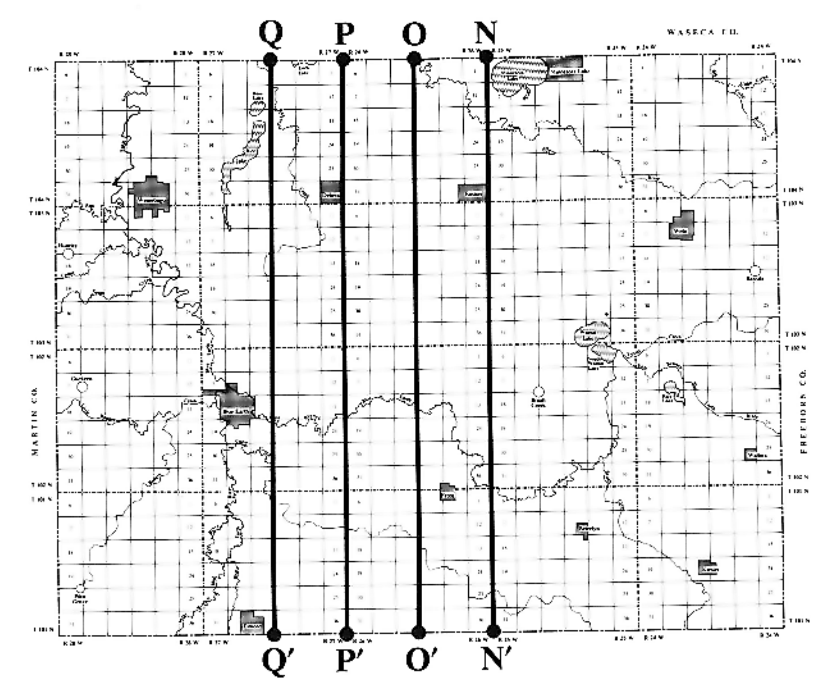
Unconsolidated surficial deposits, chiefly glacial drift; alluvial silts, sands, and gravels commonly present along streams.

Confining layer, chiefly shale and siltstone; separates bedrock aquifer systems.

Bedrock aquifer, chiefly sandstone, limestone, and dolomite; water yielding unit of an aquifer system.

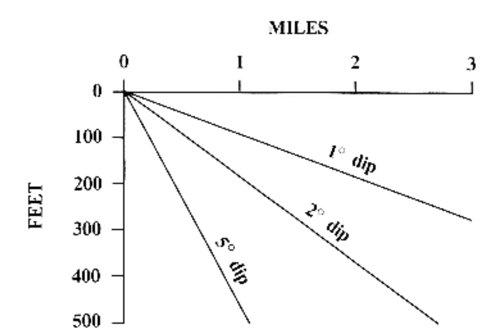
Contact between bedrock units is approximately located; dashed where inferred between lithologically similar units, erosional unconformities, or where contact is gradational.

INDEX TO GEOLOGIC CROSS SECTIONS

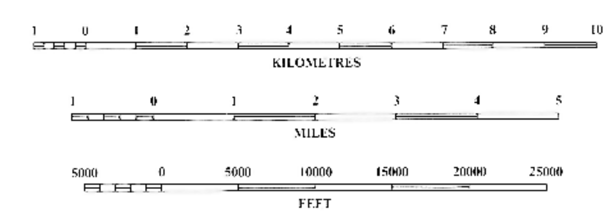


CONVERSION OF APPARENT DIP TO TRUE DIP

Vertical Exaggeration × 20



HORIZONTAL SCALE



GEOLOGIC CROSS SECTIONS R-R′ TO T-T′

CROSS SECTIONS A-A' TO E-E'

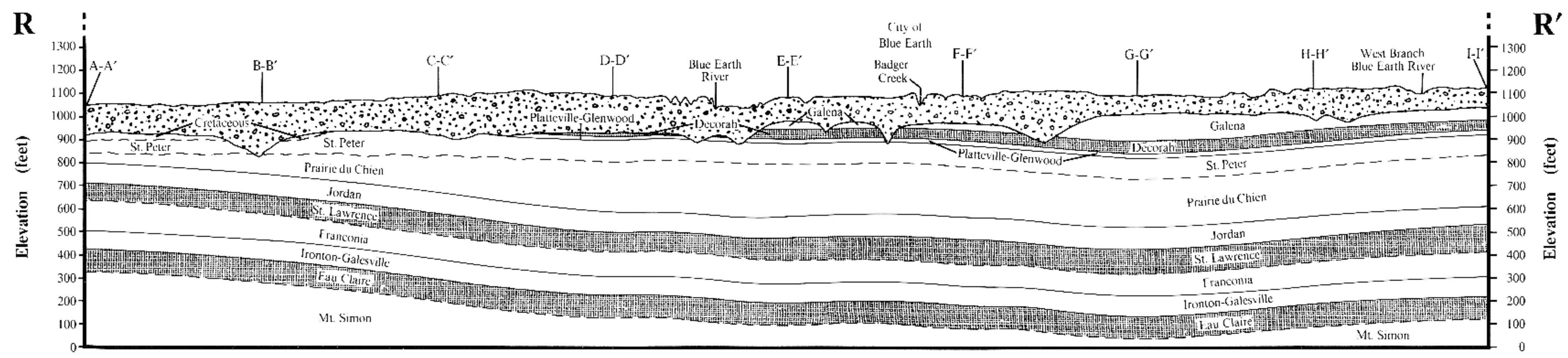
The cross sections illustrate that in northern Faribault county thicker glacial deposits are associated with bedrock valleys while the thinnest glacial deposits occur over bedrock uplands; surface highs and lows have relatively little effect on drift thickness. The cross sections illustrate that the Galena aquifer is not available in northern Faribault County. The confining conditions of the Decorah Formation, which are present throughout much of southern Faribault County, become less extensive in the central part of the county, and are almost completely missing along the northern border. In the northern row of townships the St. Peter-Prairie du Chien-Jordan aquifer system represents the uppermost bedrock aquifer available. All three bedrock units that coalesce to form the aquifer system are present, nearly in their entirety throughout the county. The cross sections show that the Franconia-Ironton-Galesville and the Mt.Simon-Hinckley aquifer systems are protected by confining bedrock layers throughout Faribault County.

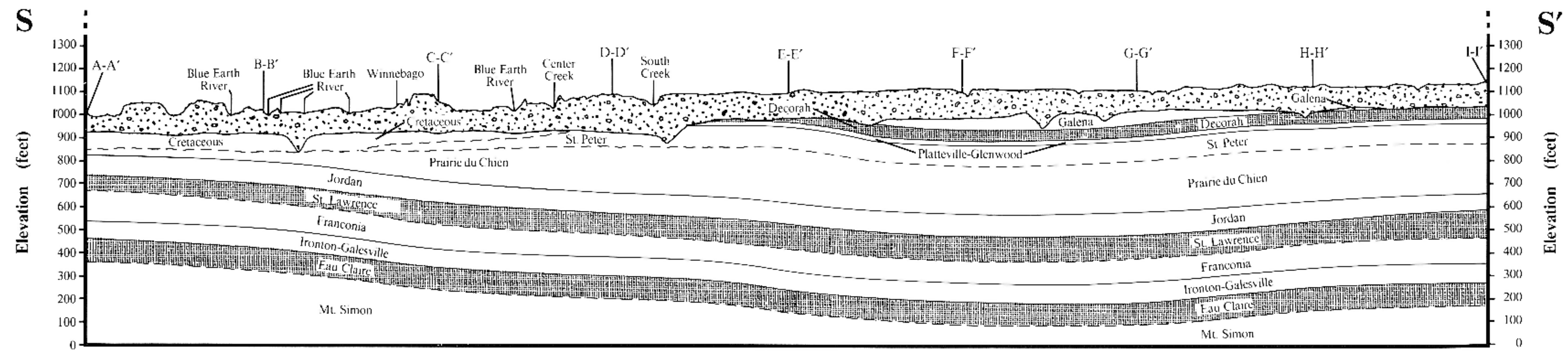
CROSS SECTIONS F-F' TO I-I'

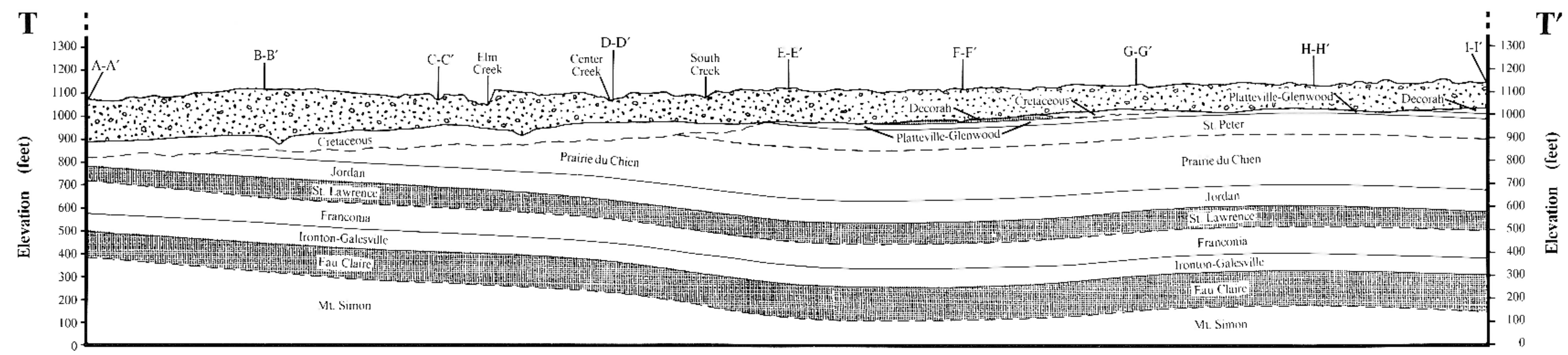
This set of cross sections illustrate the high rate of dip presented on the bedrock structure maps for the bedrock units in the southeastern corner of Faribault County. The tectonic activity that contributed to the development of this structure is thought to have ceased prior to the time when the bedrock units were being deposited. Consequently, the bedrock layers are described in the cross section as having been deposited over the top of a pre-existing faulted block. This interpretation assumes a lack of internal deformation of the individual bedrock units; thus, each bedrock unit is mapped as a continuous layer. The influence of the structural condition is greatest in section I-I', less prominent in sections H-H' and G-G', and nearly absent in section F-F'.

CROSS SECTIONS N-N' TO Q-Q'

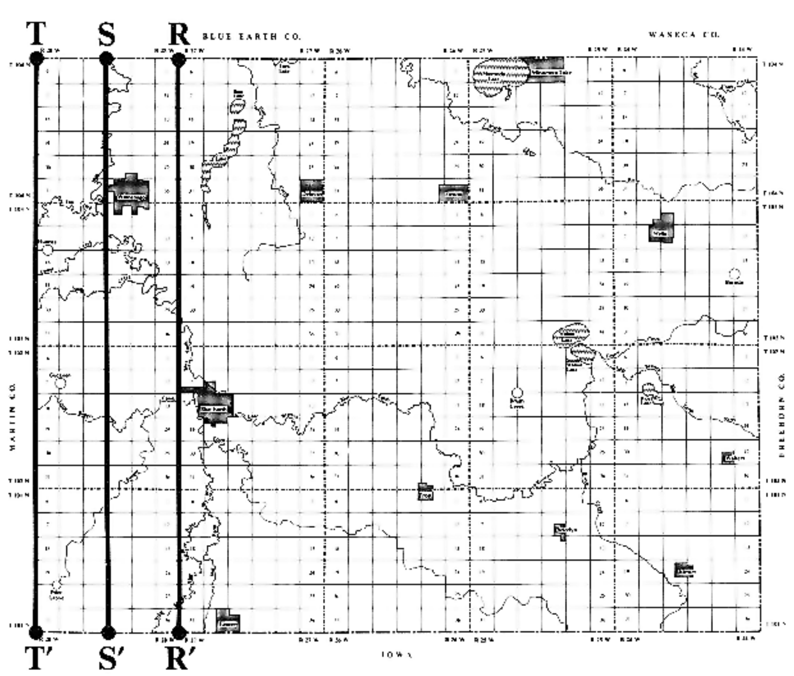
In the areas covered by this set of cross sections , the variation in thickness and subsequent termination of the upper bedrock unit is largely influenced by the dip of the bedrock strata from north to south and by erosional features on the bedrock surface. The bedrock structure generally dips toward the southcentral part of the county and the center of a small basin structure; the basin structure is presented on the bedrock structure maps in this atlas. The small basin structure is part of a much larger basin structure called the Hollandale Embayment. The Hollandale Embayment is the main regional structural feature in which the bedrock layers were deposited.



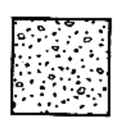




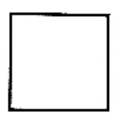
INDEX TO GEOLOGIC CROSS SECTIONS



EXPLANATION

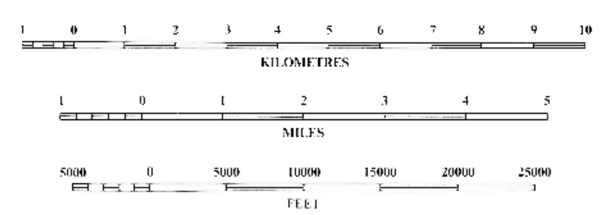

Unconsolidated surficial deposits, chiefly glacial drift; alluvial silts, sands, and gravels commonly present along streams.


Confining layer, chiefly shale and siltstone; separates bedrock aquifer systems.


Bedrock aquifer, chiefly sandstone, limestone, and dolomite; water yielding unit of an aquifer system.

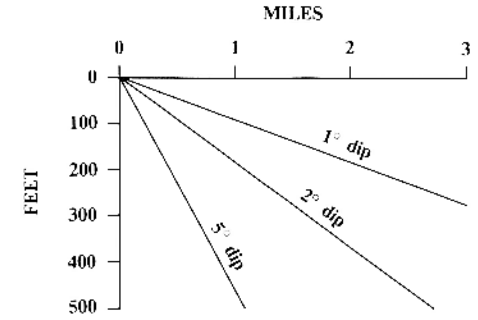
Contact between bedrock units is approximately located; dashed where inferred between lithologically similar units, erosional unconformities, or where contact is gradational.

HORIZONTAL SCALE



CONVERSION OF APPARENT DIP TO TRUE DIP

Vertical Exaggeration × 20



BEDROCK STRUCTURE
JORDAN FORMATION

By

John M. Rongstad and Paul A. Vogel

1991

JORDAN STRUCTURE MAP

INTRODUCTION

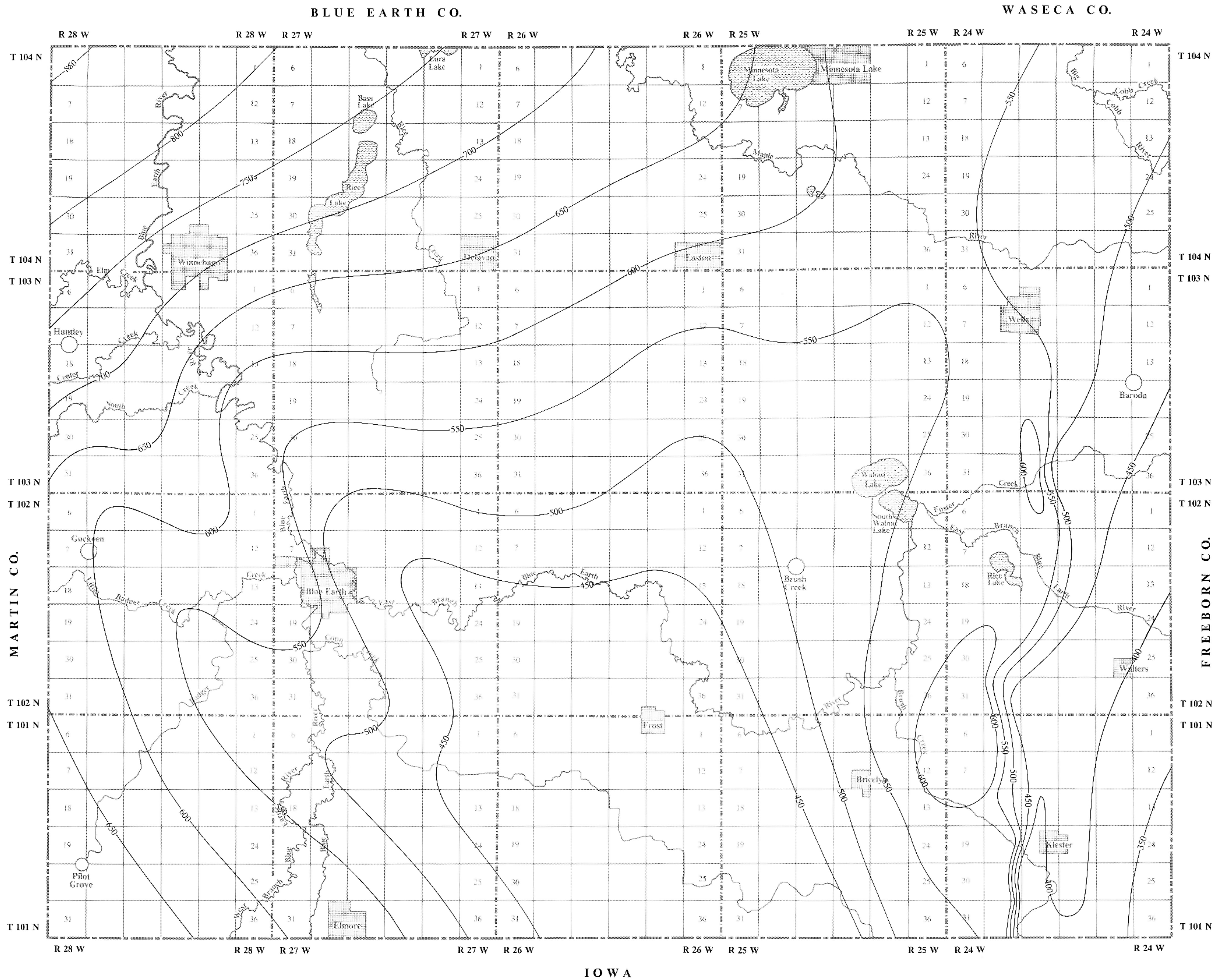
A structure map was constructed for the top of the Jordan Formation because of the abundance of available data and because the uneroded top of the Jordan sandstone can be traced continuously throughout Faribault County. The Jordan structure contours were drawn solely on the basis of data supplied by the geophysical logs and cutting sample logs that are shown on the Data Base Map (Page 3). The structure map was contoured to convey the probable forms of any geologic structures that might be suggested by the data.

The structure map for the top of the Jordan Formation gives the most complete view of the bedrock structure in Faribault County. The bedrock that underlies Faribault County was deposited in sheet-like layers under tectonically stable geologic conditions over a wide area in southern Minnesota. The Jordan Structure Map was designed to act as a regional mapping horizon for the bedrock in Faribault County. The structure map was used as an aid in the interpretation of the geologic portions of water well drillers' logs. The structure map was also used as a guide from which the top of the Jordan Formation was plotted onto each of the Geologic Cross Sections.

In Faribault County, the bedrock structure generally dips toward the southcentral part of the county and the center of a small basin structure. The small basin structure is part of a much larger basin structure called the Hollandale Embayment. The Hollandale Embayment is the main regional structural feature in which the bedrock layers were deposited.

METHOD OF CONSTRUCTION

The Jordan structure contours were drawn solely on the basis of data contained in the geophysical logs and cutting sample logs shown on the Data Base Map (Page 3). The structure map was contoured to convey the probable forms of any geologic structures that might be suggested by the data. There are no technical errors in the contouring of the structure map but it may fail to give a true picture of the bedrock structure in southeastern Faribault County. In the southeast corner of the county, the trend of the bedrock structure is inconsistent with the general trend of the bedrock structure presented elsewhere on the structure map. In the southeast, the structure contours are pinched together into one area while they are widely spaced in other parts of the county. Although it is possible for such as structural condition to exist, it is not probable. The suggested interpretation is that the higher rate of dip in the southeast is caused by the draping of sediments over an uplifted area and the close spacing of contours is, therefore, maintained parallel to the uplifted area.

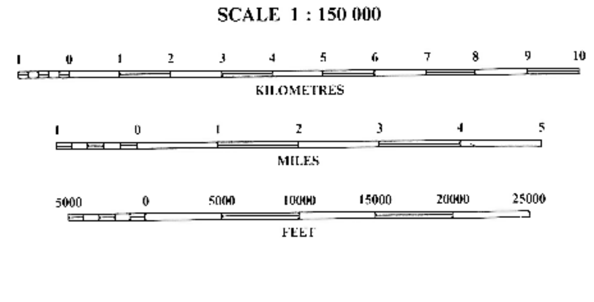


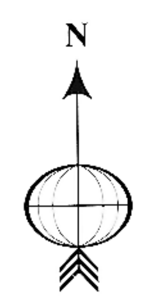
EXPLANATION

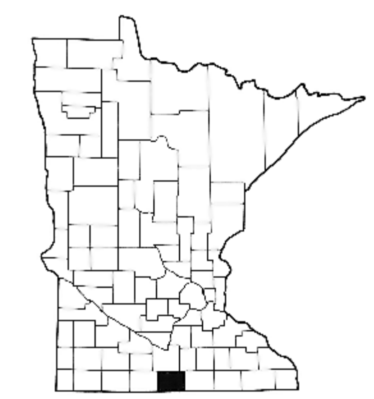
Structure contours in feet above sea level.

550

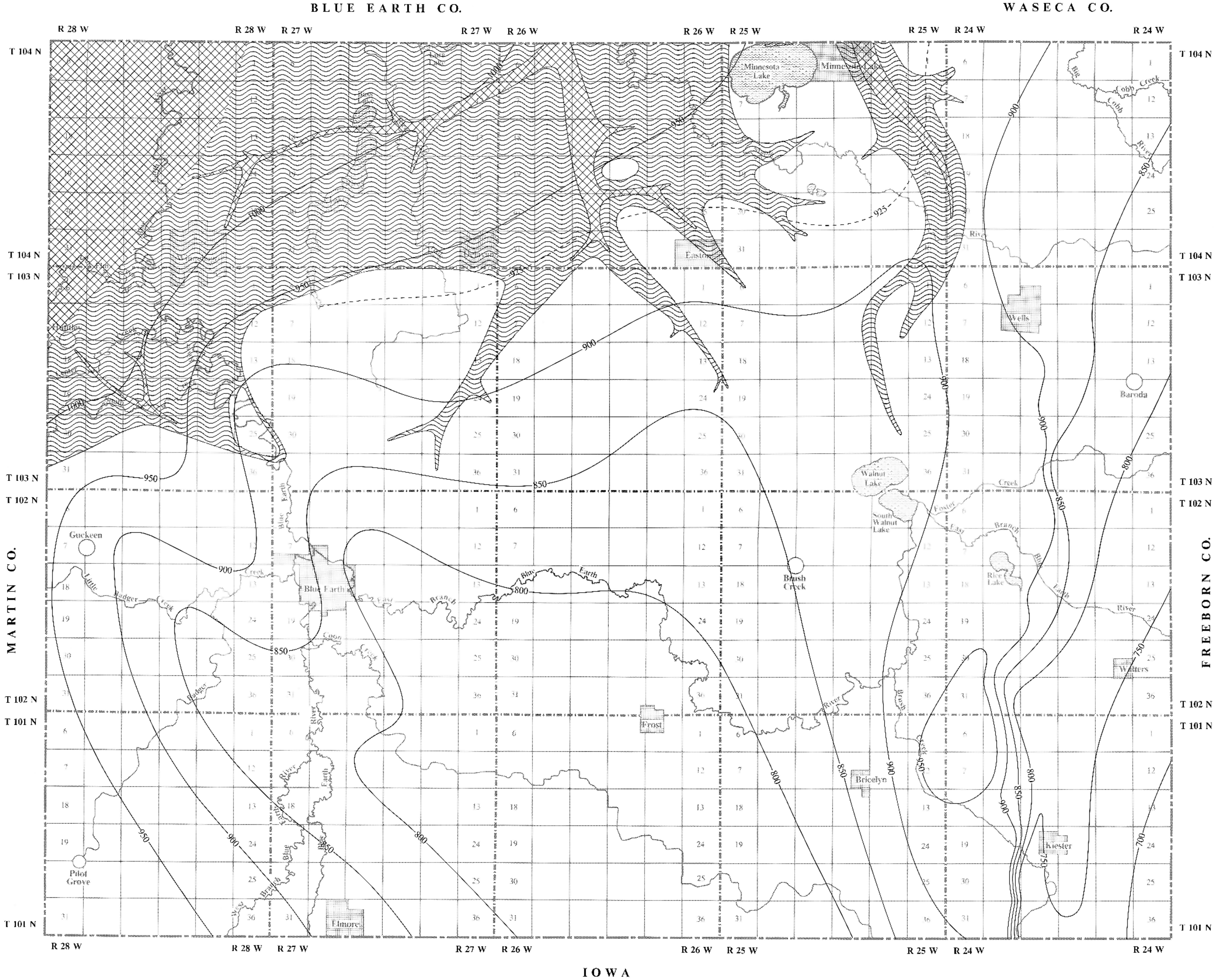
Contour interval 50 feet

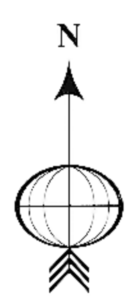


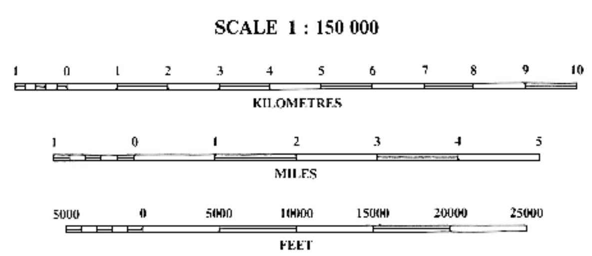


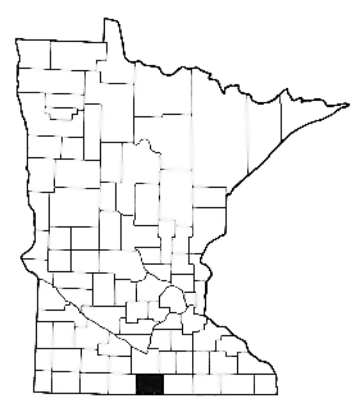


LOCATION DIAGRAM









LOCATION DIAGRAM

BEDROCK STRUCTURE ST. PETER FORMATION

By

John M. Rongstad and Paul A. Vogel

1991

INTRODUCTION

The St. Peter Structure Map describes the present configuration and extent of the St. Peter sandstone in Faribault County. A structure map was created for the top of the St.Peter Formation because of the abundance of available data, because of its importance as a regional aquifer, and because the contact between the St. Peter sandstone and the overlying Glenwood shale is usually abrupt and easily recognized in the geologic portions of water well drillers' logs.

The St. Peter Structure Map presents a more subdued relief of the bedrock structure than does the Jordan Structure Map. The difference in structural relief may be due to the erosional unconformity that separates the Prairie du Chien dolomite from the overlying St.Peter sandstone. The erosion of the Prairie du Chien may have modified the bedrock surface prior to St. Peter deposition.

METHOD OF CONSTRUCTION

The St. Peter structure contours were drawn solely on the basis of data supplied by geophysical logs and cutting sample logs shown on the Data Base Map (Page 3). The structure map was contoured to convey the probable forms of any geologic structures that might be suggested by the data. In areas where the top of the St. Peter sandstone has been truncated by erosion, the placement of contours was based upon the reconstruction of the original thickness of the St. Peter. In areas where the St. Peter is absent, the contours are discontinued.

The St. Peter Structure Map was designed to act as a regional mapping horizon for the bedrock in Faribault County. The structure map was used as an aid in the interpretation of the geologic portions of the water well drillers' logs. The structure map was used in combination with the Bedrock Topography Map to position the geologic boundary line that separates the St.Peter Formation from the overlying Platteville-Glenwood Formation on the Bedrock Geology Map. The structure map was also used as a guide from which the top of the St. Peter was plotted onto each Geologic Cross Sections.

EXPLANATION

- Area where St. Peter Formation is present.
- Area where St. Peter Formation is present but top eroded.
- Area where St. Peter Formation is not present.

Structure contours in feet above sea level.

900 — Contour interval 50 feet

925 - - - Contour interval 25 feet

BEDROCK STRUCTURE DECORAH FORMATION

By

John M. Rongstad and Paul A. Vogel

1991

INTRODUCTION

A structure map was constructed for the top of the Decorah Formation because of the abundance of available data, because of its importance as a regional confining layer, and because the contact between the Decorah shale and the overlying Galena limestone is usually abrupt and easily recognized in the geologic portions of water well drillers' logs. The Decorah shale forms an aquitard that hydrologically separates the Galena aquifer from the St.Peter-Prairie du Chien-Jordan aquifer system.

The Decorah Structure Map describes the present configuration and extent of the Decorah shale in Faribault County. The structure map defines areas where the absence of overlying bedrock has exposed the shale to past erosion. In these areas, the upper boundary of the Decorah shale is the top of the bedrock. The structure map marks the erosional limits of the Decorah Formation. Beyond its erosional limits the Platteville limestone forms the upper bedrock unit.

METHOD OF CONSTRUCTION

The Decorah structure contours were drawn solely on the basis of data contained in the geophysical logs and cutting sample logs shown on the Data Base Map (Page 3). The structure map was contoured to convey the probable forms of any geologic structures that might be suggested by the data. In areas where the top of the Decorah shale has been truncated by erosion, the placement of contours is based upon the reconstruction of the original thickness of the Decorah. In areas where the Decorah is absent, the contours are discontinued.

The Decorah Structure Map was designed to act as a regional mapping horizon for the bedrock in Faribault County. The structure map was used as an aid in the interpretation of the geologic portions of the water well drillers' logs. The Decorah Structure Map was used in combination with the Bedrock Topography Map to position the boundary line that separates the Decorah shale from the overlying Galena limestone on the Bedrock Geology Map. The structure map was also used as a guide from which the top of the Decorah was plotted onto each of the Geologic Cross Sections.

EXPLANATION

Area where Decorah Formation is present.

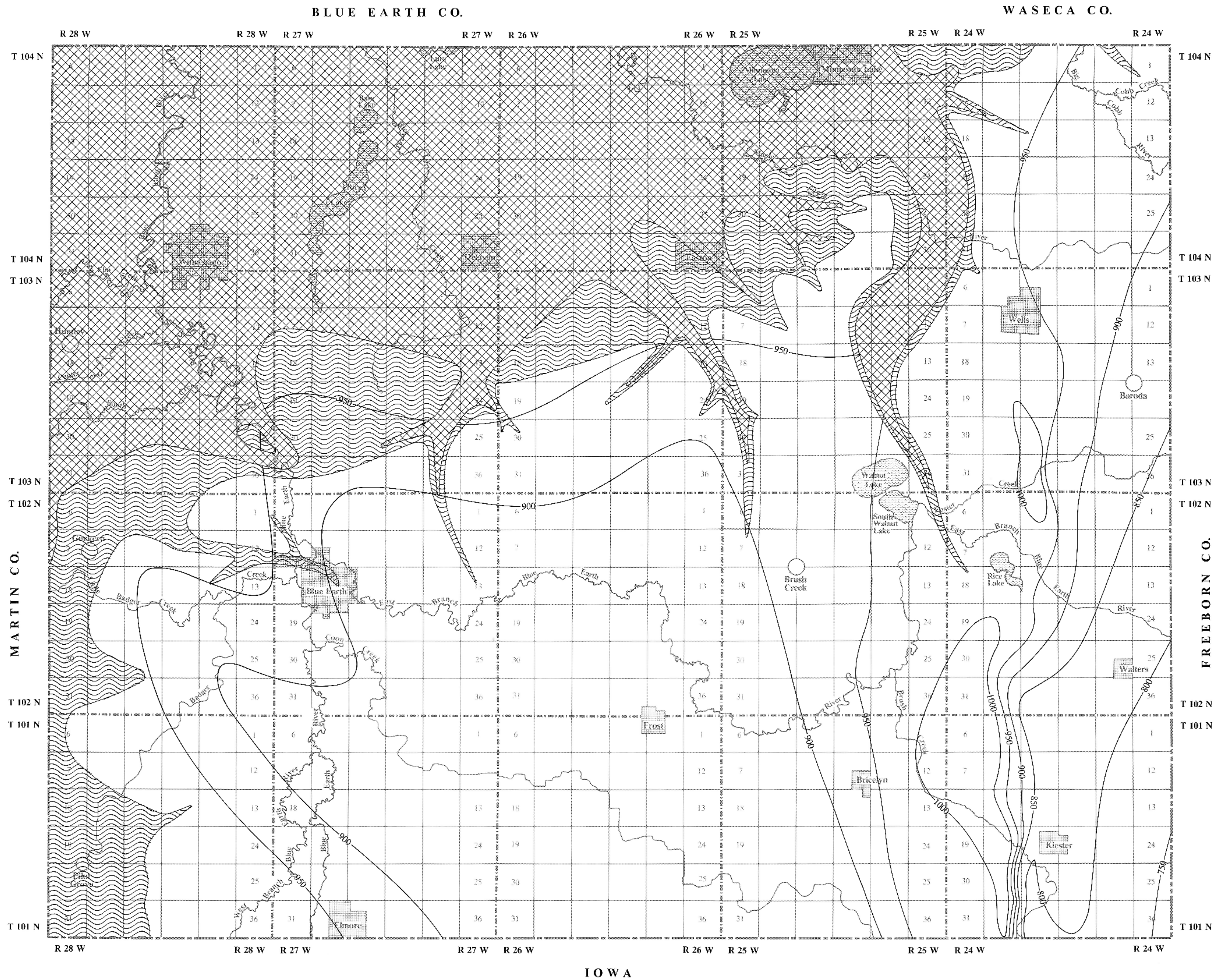
Area where Decorah Formation is present but top eroded.

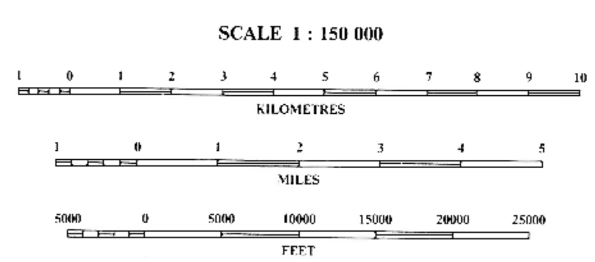
Area where Decorah Formation is not present.

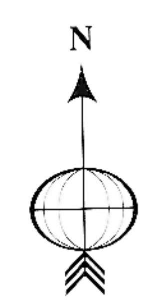
Structure contours in feet above sea level.

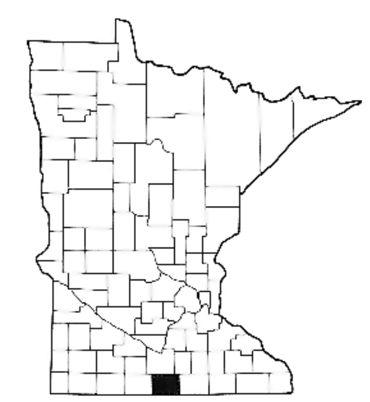
900

Contour interval 50 feet









LOCATION DIAGRAM

BEDROCK HYDROGEOLOGY

BEDROCK AQUIFER SYSTEMS

Four major bedrock aquifer systems, separated on the basis of hydrogeologic properties, are present in Faribault County. They are the Cedar Valley-Maquoketa-Galena aquifer system, the St.Peter-Prairie du Chien-Jordan aquifer system, the Franconia-Ironton-Galesville aquifer system, and the Mt.Simon-Hinckley aquifer system.

A bedrock aquifer is a geologic formation that is capable of storing and yielding fresh water in usable quantities. A bedrock aquifer system is a multiaquifer system that is composed of two or more bedrock aquifers that are bound on the top and bottom by aquitards. Individual bedrock aquifers range from coarse-grained deposits such as sandstone to hard fractured sedimentary rocks such as limestone or dolomite. A bedrock aquifer system is a connected set of individual bedrock aquifers that act hydrologically as a single unit. The data suggests that there is good hydraulic connection between the bedrock units within each of the four aquifer systems in Faribault County.

Of the three bedrock units that form the Cedar Valley-Maquoketa-Galena aquifer system, only the Galena and Maquoketa are commonly present in Faribault County. The Galena limestone is generally limited to the southeastern three-fourths of Faribault County where it directly underlies the glacial drift. The Cedar Valley and Maquoketa limestone is limited to the southeastern edge of Faribault County. The presence of the Cedar Valley is only inferred from mapping done for the Freeborn County Geologic Atlas. Although the Cedar Valley and Maquoketa may have one day covered the entire county, they have since been worn down by erosion. Rock of low permeability of the Decorah Formation underlies the Galena limestone and separates the Cedar Valley-Maquoketa-Galena aquifer system from the underlying St. Peter-Prairie du Chien-Jordan aquifer system.

The St. Peter-Prairie du Chien-Jordan aquifer system is present throughout Faribault County. The major bedrock aquifers in this system are the St. Peter and Jordan sandstones which yield water from between individual grains, and the Prairie du Chien dolomites which yield water through fractures and crevices. These three bedrock units function as a single aquifer system because all three are sources of groundwater with no regional confining bed separating them. The Decorah confining bed overlies the St.Peter-Prairie du Chien-Jordan aquifer system throughout the southeastern three-fourths of Faribault County. The St. Peter sandstone directly underlies the glacial drift in the northwest quarter of the county, where it forms the bedrock surface. Rock of low permeability of the St. Lawrence Formation underlies the Jordan sandstone and separates the St. Peter-Prairie du Chien-Jordan aquifer system from the underlying Franconia-Ironton-Galesville aquifer system.

The Franconia-Ironton-Galesville aquifer system is overlain by the St. Lawrence confining bed throughout Faribault County. The upper aquifer unit in this system is the Franconia glauconitic sandstone which yields moderate supplies of groundwater. The lower aquifer unit in this system is the Ironton-Galesville sandstones which are generally a more productive aquifer than the overlying Franconia. Rock of low permeability of the Eau Claire Formation directly underlie the Ironton-Galesville sandstone. The Eau Claire separates the Franconia-Ironton-Galesville aquifer system from the Mt.Simon-Hinckley aquifer system.

The Mt.Simon-Hinckley aquifer system is deepest of the four bedrock aquifer systems in Faribault County. These deep sandstone aquifers are overlain by the confining conditions of the Eau Claire formation. Very little information is available on the geology and hydrology of the Mt.Simon-Hinckley aquifer system because it is reached by only a few deep water wells.

SHALLOW BEDROCK AQUIFER SYSTEMS

The shallow bedrock aquifer systems consist of those bedrock units that commonly directly underlie the glacial drift and are recharged locally. The major bedrock aquifer units in the shallow bedrock aquifer systems are the Maquoketa and Galena limestones. The Maquoketa and Galena aquifers occupy the shallow bedrock aquifer position throughout the southeastern three-fourths of Faribault County. The St.Peter sandstone directly underlies the glacial drift and occupies the shallow bedrock aquifer position in the northwestern quarter of Faribault County. The confining conditions of the Decorah Formation cap the St. Peter-Prairie du Chien-Jordan aquifer system throughout much of Faribault County.

The shallow bedrock aquifers are the primary source of groundwater due to their proximity to the land surface. Ease of drilling and lower drilling and operating costs are advantages of using from the shallow bedrock aquifers. The shallow bedrock has the advantage of local and rapid recharge, particularly in areas where the overlying drift is thin, or where there are permeable materials within the drift that are in direct hydrologic connection with the bedrock and will permit the downward movement of water into the bedrock. The disadvantages of the shallow bedrock aquifers include the susceptibility to contamination from waste disposal and other sources. Variability in the quality of the water may limit the use of a shallow bedrock aquifer when the aquifer is near the surface.

DEEP BEDROCK AQUIFER SYSTEMS

The deep bedrock aquifer systems consist of those bedrock units that are covered by confining bedrock conditions. The St. Peter-Prairie du Chien-Jordan aquifer system is overlain by the Decorah confining bed except in the northwest quarter of the county. The St. Lawrence confining bed covers the Franconia-Ironton-Galesville aquifer system throughout Faribault County. Similarly, rock of low permeability of the Eau Claire Formation separates the deeper Mt.Simon-Hinckley aquifer system from the overlying Franconia-Ironton-Galesville aquifer system. Four major sandstone aquifers are present in the deep bedrock aquifer systems; the St. Peter (mostly), Jordan, Ironton-Galesville and the Mt. Simon sandstones.

STATIC WATER LEVELS

Groundwater is usually held in a bedrock aquifer, at significant pressure, by the presence of a confining bed above the aquifer. High water pressure is sometimes the result of continuous bedrock strata with recharge areas at higher elevations. Water pressure will change in response to varying patterns of recharge, discharge, and pumping. In Faribault County, the water pressure in bedrock aquifers is not sufficient to lift the water above land surface.

In water well drillers' logs, groundwater pressure is recorded as static water level measurements that represent the non-pumping water level in a well. These water well records represent data that has been collected over many years through every season. The data is usually a one time measurement of the static water level that was made during well installation.

To precisely map water levels in the bedrock aquifers, static water level data would have to be collected at about the same time of the year from many control points. When data points are few and unequally spaced, only limited confidence can be placed in the resulting map. On the bedrock aquifer maps, static water levels are shown by means of contours. The static water level contours are drawn on the basis of data from water wells for which static water levels have been recorded. The direction of groundwater movement is approximately perpendicular to the static water level contours. In Faribault County, current water well driller data are only sufficient to demonstrate the general direction of groundwater movement.

BEDROCK AQUIFER MAPS

Bedrock aquifer maps were constructed for the Cedar Valley-Maquoketa-Galena aquifer and the St. Peter-Prairie du Chien-Jordan aquifer system because of the abundance of available hydrologic data. More water wells are drilled into the upper bedrock units than into the lower ones. Consequently, the hydrologic conditions are not as well known for the deep aquifer systems.

A bedrock aquifer map for the Franconia-Ironton-Galesville aquifer system was not constructed because nearly all well driller records for water wells drilled into that aquifer system are uncased into the overlying St. Peter-Prairie du Chien-Jordan aquifer system. Consequently, the static water level data for wells finished in the Franconia-Ironton-Galesville aquifer system reflect the water levels in the overlying St. Peter-Prairie du Chien-Jordan aquifer system. Thus, a bedrock aquifer map for the Franconia-Ironton-Galesville aquifer system would not provide anymore insight into the confined conditions present within the aquifer system. The hydrologic conditions of these wells are represented on the St. Peter-Prairie du Chien-Jordan Bedrock Aquifer Map.

A bedrock aquifer map for the Mt. Simon-Hinckley aquifer system was not constructed because so little hydrologic data is available for this aquifer system. Few wells need to penetrate so deep to find adequate water supplies in Faribault County.

WATER WELL CONSTRUCTION

In 1974, implementation of the Minnesota water well code standardized water well construction practices. Before the Minnesota water well code was implemented, well construction practices were used that are no longer allowed.

Prior to 1974, a water well requiring high pumping capacity would often be cased into the uppermost bedrock aquifer and left as an open borehole through the underlying bedrock layers until adequate water supplies were available to support the required yields. When soft sediments were encountered during drilling, pieces of well casing would often be inserted to prevent portions of the well wall from collapsing into the open borehole and plugging the hole. These open boreholes serve as conduits that interconnect individual bedrock aquifers or pierce a confining bed and interconnect separate aquifer systems. These wells serve as conduits for spreading pollution into otherwise unspoiled supplies of groundwater.

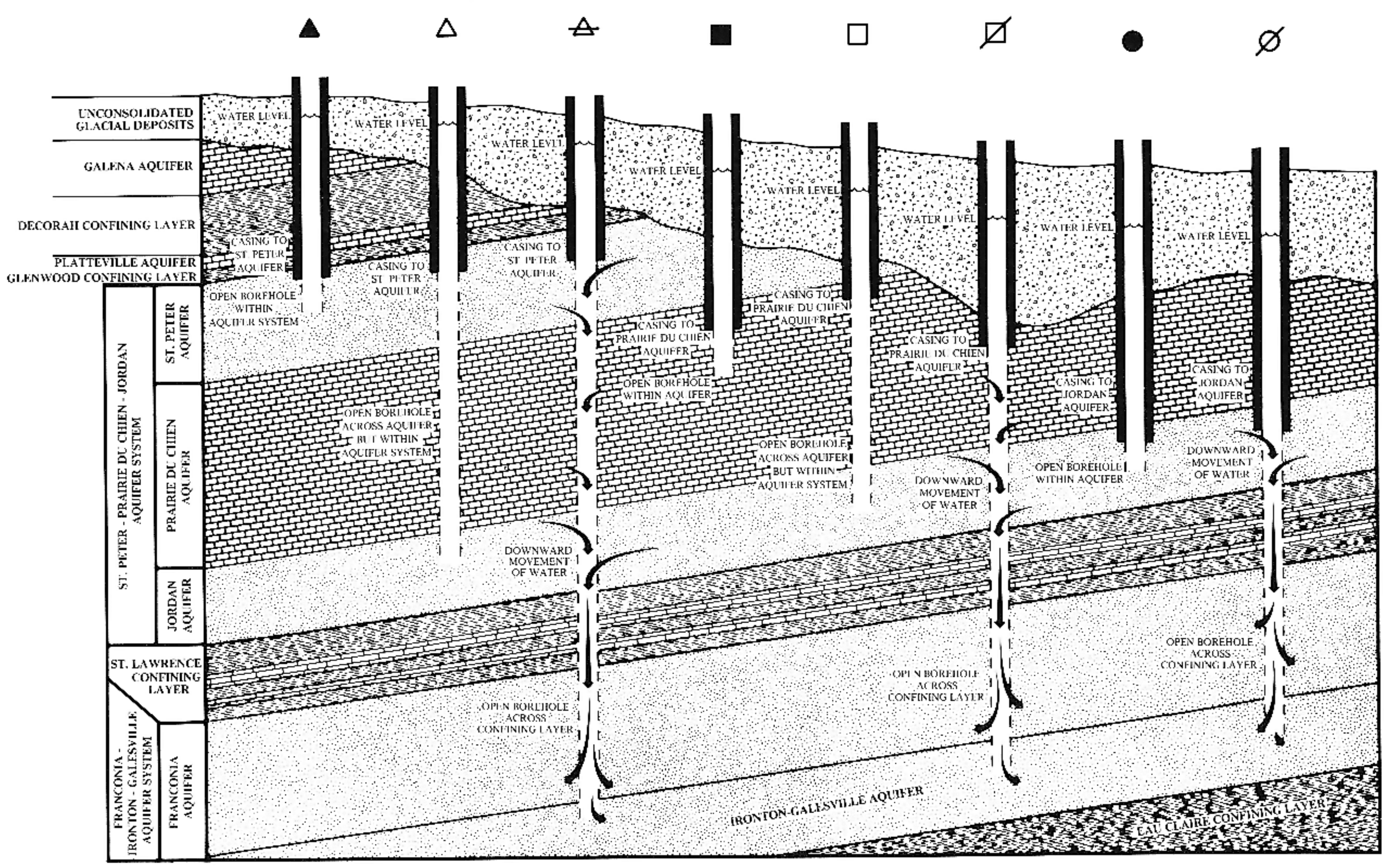


FIGURE 7. The illustration shows various combinations of casing length versus total depth of open borehole for wells finished in the St. Peter-Prairie du Chien-Jordan aquifer system. Triangle shaped symbols are used to represent wells that are cased into the St. Peter sandstone, square shaped symbols represent wells cased into the Prairie du Chien dolomite, and circles represent wells cased into the Jordan sandstone. Solid symbols represent wells for which both well casing and open borehole are finished in the same bedrock aquifer. Open symbols represent wells for which the well casing is finished in one bedrock aquifer but the open borehole penetrates into a lower bedrock aquifer; these wells are still limited to the St.Peter-Prairie du Chien-Jordan aquifer system. Open symbols with a slash through them represent wells for which the well casing is finished in the St.Peter-Prairie du Chien-Jordan bedrock aquifer system but the open borehole extends through the St.Lawrence confining layer and into the underlying Franconia-Ironton-Galesville aquifer system or may even penetrate the Eau Claire confining layer to the Mt.Simon-Hinckley aquifer system.

CEDAR VALLEY - MAQUOKETA - GALENA AQUIFER SYSTEM

By

John M. Rongstad

1991

EXPLANATION

Possible variations in Maquoketa aquifer use.

- Well casing and open hole finished in the Maquoketa aquifer.
- Well casing finished in the Maquoketa aquifer; open hole to Galena aquifer.
- Well casing finished in the Maquoketa aquifer; open hole to underlying aquifer system.

Possible variations in Galena aquifer use.

- Well casing and open hole finished in the Galena aquifer.
- Well casing finished in the Galena aquifer; open hole to underlying confining bed.
- Well casing finished in the Galena aquifer; open hole to underlying aquifer system.

Area where the upper boundary of the aquifer system is the top of the bedrock.

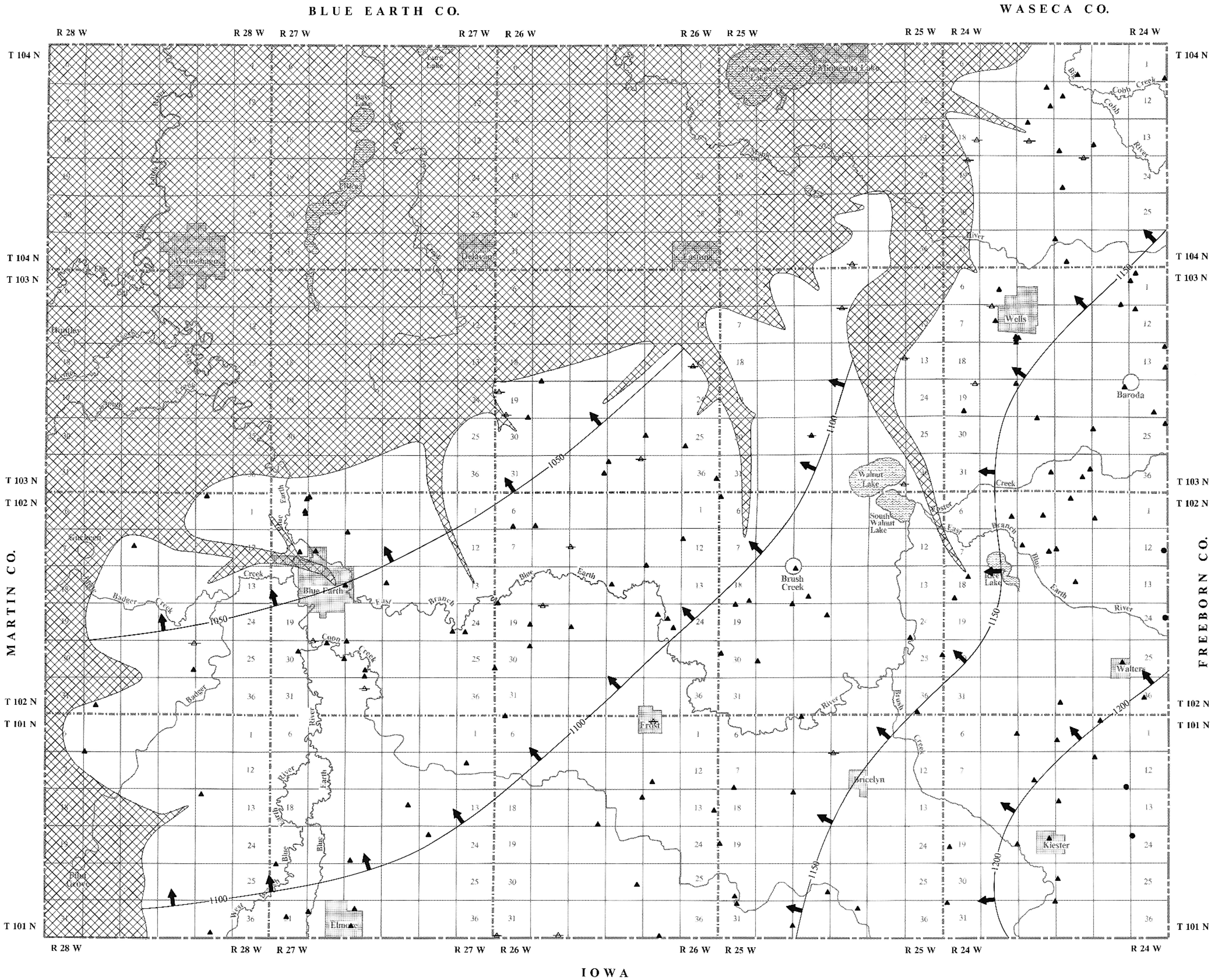
Area where the aquifer system is absent.

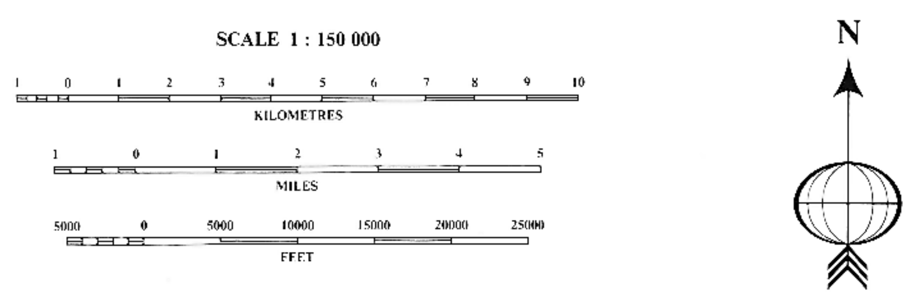
1150

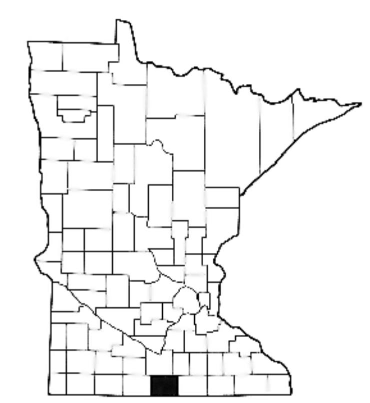
Contour interval 50 feet.

Shows average elevation in feet above mean sea level of the static water level in water wells that are finished in the Maquoketa-Galena aquifer system.

Arrow points in general direction of groundwater movement.







LOCATION DIAGRAM

ST. PETER - PRAIRIE DU CHIEN - JORDAN AQUIFER SYSTEM

By

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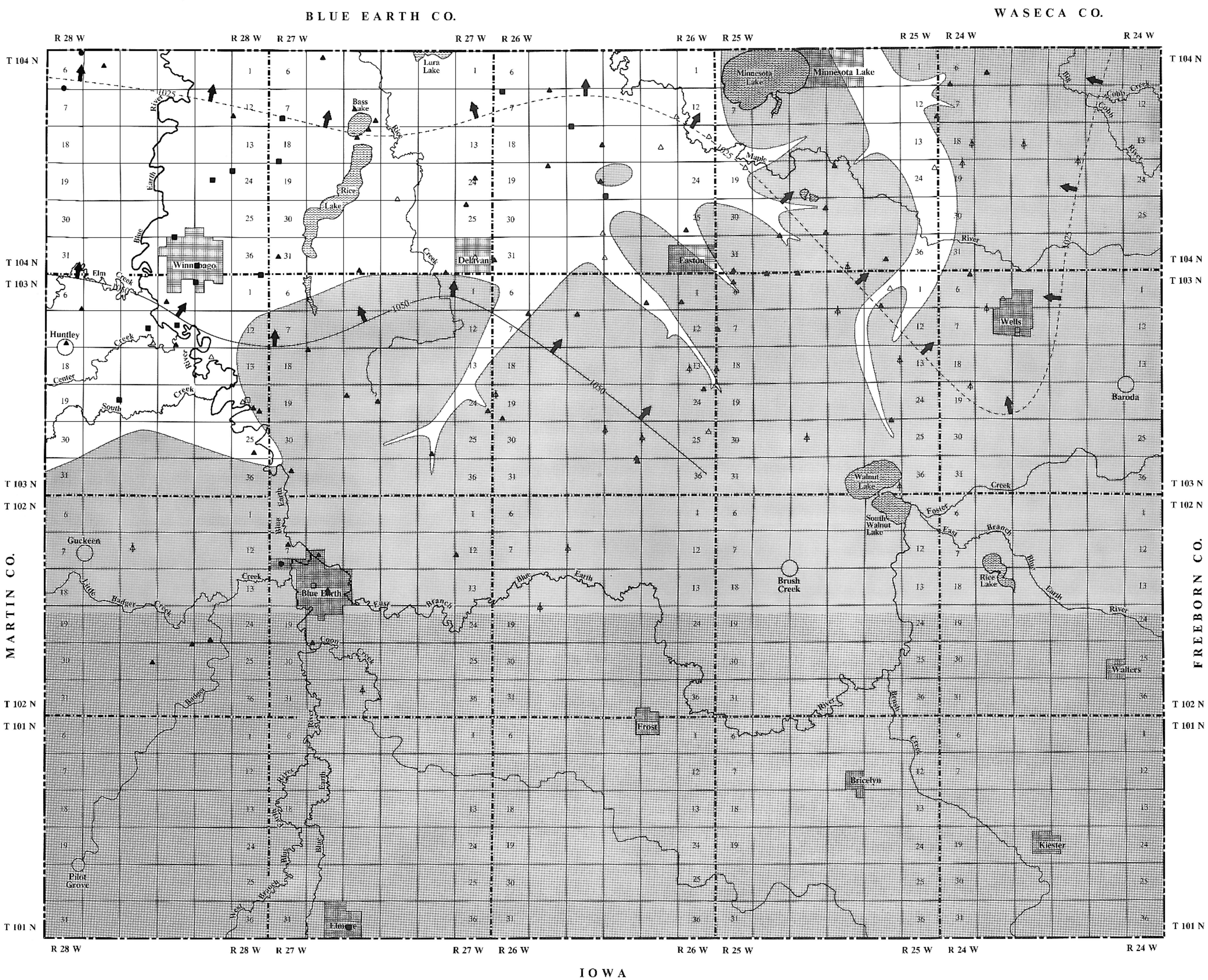
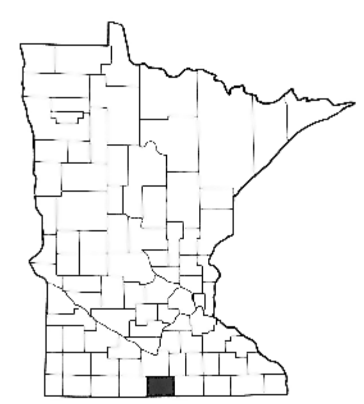
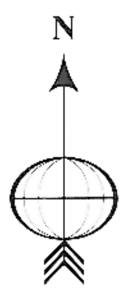
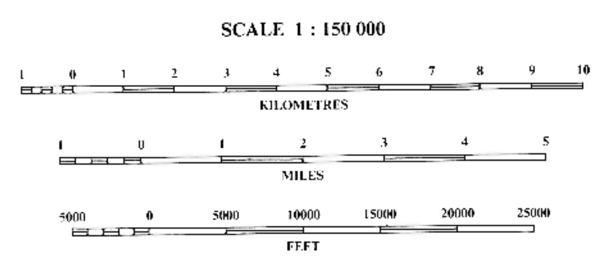
1991





LOCATION DIAGRAM





EXPLANATION

Possible variations in St. Peter aquifer use.

- ▲ Well casing and open hole finished in the St. Peter aquifer.
- △ Well casing finished in the St. Peter aquifer; open hole to Prairie du Chien or Jordan aquifer.
- Well casing finished in the St. Peter aquifer; open hole to underlying aquifer system.
- Well casing finished in the St. Peter aquifer; open hole to overlying aquifer system.

Possible variations in Prairie du Chien aquifer use.

- ■ Well casing and open hole finished in the Prairie du Chien aquifer.
- □ Well casing finished in Prairie du Chien aquifer; open hole to Jordan aquifer.
- Well casing finished in Prairie du Chien aquifer; open hole to underlying aquifer system.

Possible variations in Jordan aquifer use.

- ● Well casing and open hole finished in the Jordan aquifer.
- Well casing finished in the Jordan aquifer; open hole to underlying aquifer system.

Area where the aquifer system is overlain by a confining bed.

Area where the upper boundary of the aquifer system is the top of the bedrock.

1025

Contour interval 25 feet.

1050

Contour interval 50 feet.

Shows average elevation in feet above mean sea level of the static water level in water wells that are finished in the St. Peter-Prairie du Chien-Jordan aquifer system.

Arrow points in general direction of groundwater movement.