UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
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COUNTY ATLAS SERIES
ATLAS C-14, PART A
Plate 7—Illustrated Geology

ILLUSTRATED GEOLOGY

By
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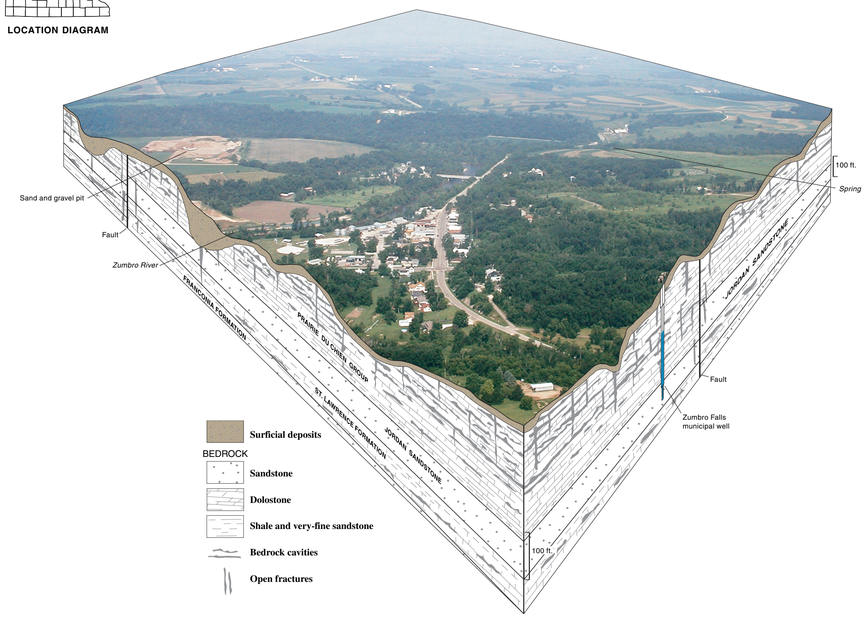
2001

LOCATION DIAGRAM

INTRODUCTION

The Zumbro Falls area represents a typical geologic setting in Wabasha County. The bedrock consists of flat-lying layers of sandstone, shale, and carbonate rock (limestone or dolostone). The bedrock is either exposed at the land surface, or more commonly is covered by a variable thickness of surficial deposits (unconsolidated sand, gravel, and clay). Surficial deposits are generally less than 25 feet thick, except where they fill old river valleys. These materials and the landforms associated with them are described in greater detail and mapped as part of Plates 2 (Bedrock Geology), 3 (Surficial Geology), and 4 (Bedrock Topography).



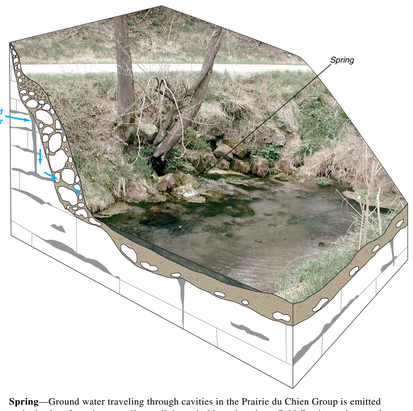
KARST FEATURES

Much of Wabasha County is a karst terrain. Karst terrains typically develop on bedrock such as limestone or dolostone that is relatively easily dissolved by natural, mildly acidic water. Cavities develop as water dissolves the bedrock, and they can sometimes be seen on the land surface as caves, springs, and sinkholes. Much of the karst terrain in Wabasha County is developed on the dolostone of the Prairie du Chien Group where the bedrock is covered only by a thin mantle of surficial deposits.

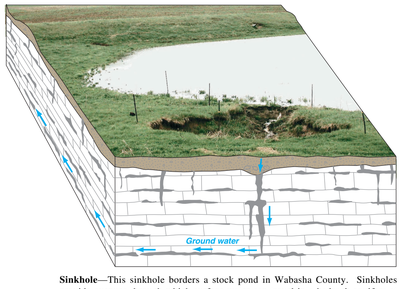
Karst terrains interest environmental managers because the terrains are susceptible to rapid infiltration of contaminated surface water. Surface water enters bedrock cavities with relative ease by filtering through thin surficial sediments across much of the county. Surface water enters bedrock cavities more rapidly through depressions on the land surface called sinkholes. Interconnected cavities in the bedrock allow the water to disperse rapidly over considerable distances. This water may be emitted from the Prairie du Chien Group at a spring, or eventually pass downward into the underlying Jordan Aquifer through fractures.

Additional information about karst can be found on Plate 5, Karst Features.

Bedrock cavities—This exposure in a quarry wall is an example of the cavities in Prairie du Chien Group bedrock that partially filled with unconsolidated sand, silt, and clay, and are likely present beneath many sinkholes. Surface water carried unconsolidated surficial deposits into the cavities.



Spring—Ground water traveling through cavities in the Prairie du Chien Group is emitted at the land surface along a valley wall through this spring along Cold Creek, northwest of Zumbro Falls. Springs are surface expressions of the high volume and rapid rates at which water can be transmitted through cavities in karst aquifers. Many springs are known to contain water that enters the ground through sinkholes.



Sinkhole—This sinkhole borders a stock pond in Wabasha County. Sinkholes provide avenues through which surface water can travel into bedrock aquifers at rapid rates, bypassing natural filtration that reduces contaminants. Such water may eventually emerge at the land surface at a spring, or be drawn out of the ground by a water well (see Well Construction).

Sinkhole, rapid development—Unconsolidated surficial deposits have collapsed into cavities developed in the underlying bedrock of the Prairie du Chien Group. This 2 meter wide sinkhole was first observed in 2001, and probably developed (or redeveloped) during heavy rain and snowmelt in the spring of that year. Rapid development of sinkholes in this manner is common in southeastern Minnesota. (Boulders of bedrock above the sinkhole are rip-rap used to hinder streambank erosion).

ILLUSTRATED GEOLOGY

A geologic investigation such as the Wabasha County Atlas project provides the citizens of the area with important scientific information about its rocks, unconsolidated sediments (such as soil and aggregate), and water. The results have practical applications for environmental management and the evaluation of natural resources such as sand and gravel deposits for economic uses. In addition, this investigation provides a better understanding of the diverse geologic history of the rocks and landforms that characterize the county.

This plate combines information from each of the individual plates that compose the Wabasha County Atlas. The introduction (left) is the starting point for using this plate, and shows a typical geologic setting in Wabasha County. Specific features that are particularly common in such a setting, of special interest, or of economic and environmental importance, are highlighted using local photographs to illustrate how they relate to one another, and how they are associated with the day to day activities of the people of the county. Additionally, the illustrations demonstrate the manner in which the geologic atlas provides information of practical value for Wabasha County.

SURFICIAL GEOLOGY

Surficial geology is the study of landforms and largely unconsolidated sediment that was deposited on top of bedrock during the "ice age" of North America, which began about 2 million years ago. Flat-lying bedrock in southeastern Minnesota was at times scraped by glaciers, and cut by rivers that carried glacial meltwater. Many of the bedrock valleys today are larger than the streams within them because they were eroded by much larger rivers carrying a great volume of meltwater. Surficial deposits include sand and gravel that partly filled many of the river valleys, such as the one beneath the present-day Zumbro River near downtown Zumbro Falls (see Introduction). Upland areas between the river valleys are covered by a thin layer of surficial material that includes patches of till, a mixture of clay, sand, and gravel deposited out of melting ice, windblown silt called loess, and sand and gravel deposited by meltwater streams. Together, these processes of erosion and deposition are responsible for much of the landscape we see today in Wabasha County.

Additional information about the character and distribution of surficial sediments, and the landforms and river history in Wabasha County can be found on Plate 3 (Surficial Geology), and Plate 4 (Bedrock Topography). Plate 4, Depth to Bedrock, shows the thickness of surficial materials across the county.

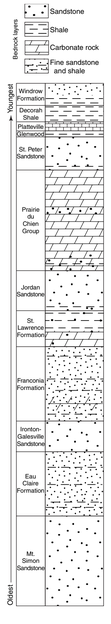
Surficial deposits—A thin layer of mostly unconsolidated sand, gravel, silt, and clay lies on top of the bedrock in upland areas between the major river valleys across most of the county. This sediment was blown by wind and carried by meltwater from glaciers.

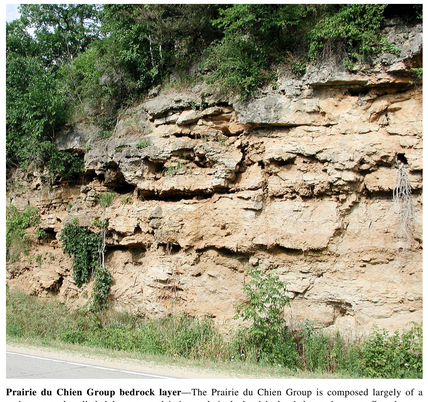
BEDROCK GEOLOGY

The bedrock in Wabasha County is the consolidated sandstone, shale, and carbonate rock commonly exposed on the bluffs along the Mississippi River and its tributaries, in rock quarries, and along road cuts. It originated as sediment that was deposited as layers in a shallow, tropical sea that covered much of North America about 520 to 450 million years ago. These layers of sediment later were buried and lithified (cemented) to become layers of sandstone, shale, and carbonate rock (limestone and dolostone) that today extend across much of southeastern Minnesota. Individual layers composed chiefly of a specific kind of bedrock are given formal names based on places where the layer is or was at one time well exposed. For example, the Jordan Sandstone is a layer of mostly coarse-grained sandstone named for the city of Jordan, Minnesota. The bedrock layers in Wabasha County are mostly flat-lying, and stacked on top of one another. Locally, however, they are displaced along fractures in the rock called faults, such as those shown near Zumbro Falls (see Introduction).

Plate 2, Bedrock Geology, describes the bedrock layers in greater detail and shows their distribution across the county. Plate 4, Bedrock Topography, is a depiction of the shape of the bedrock surface.

Stratigraphic Column—Depicts the layers of bedrock present in Wabasha County. Older layers are at the bottom of the column, younger layers are at the top.





Prairie du Chien Group bedrock layer—The Prairie du Chien Group is composed largely of a carbonate rock called dolostone, and it is a relatively hard bedrock layer that caps flat plateaus between the major river valleys in the county. It represents the accumulation of calcareous skeletons from marine organisms that lived in a shallow tropical sea about 480 million years ago. The rocks of the Prairie du Chien Group are commonly quarried and crushed for use in road construction (see Geologic Endowment of Construction-Aggregate Materials).

The large cavities at this road cut are a common feature in the Prairie du Chien Group. Where the Prairie du Chien Group lies beneath the land surface, such cavities can accommodate large volumes of ground water traveling at relatively rapid rates (see Karst Features).

Jordan Sandstone—The Jordan Sandstone is a poorly cemented layer of quartz sand that was deposited along a coastline about 500 million years ago. Across much of Wabasha County water is extracted from spaces between the grains of sand, making the Jordan Sandstone an important aquifer (see Well Construction and Database).

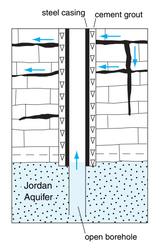
Colluvium—Colluvium is a hillslope deposit that consists of a poorly sorted mixture of angular fragments of bedrock, sand, silt, and clay. Much of this material has collapsed or been washed from the top of bluffs.

Sand and gravel—This sand and gravel was deposited by a glacial-age river in Wabasha County. Many of the individual gravel clasts are composed of rocks common in northern Minnesota, but are otherwise absent in Wabasha County. These clasts were carried by glaciers to southeastern Minnesota and were deposited in streams as the ice melted. The sand and gravel in this photo is cemented together by calcite. Most sand and gravel deposits in the county are unconsolidated.

WELL CONSTRUCTION AND DATABASE

Most of the drinking water for Wabasha County is extracted from layers of bedrock. Several municipalities, including Zumbro Falls, and many private homes draw water from a layer of sandstone bedrock known as the Jordan Aquifer.

The manner in which water wells are constructed can have an impact on the quality of the water in an aquifer. For example, across much of Wabasha County, wells that draw water from the Jordan Aquifer are constructed in a manner whereby ground water in overlying rocks is sealed off so that it cannot enter the well. The purpose of such construction is to prevent contaminated ground water in the surficial deposits and the karstic Prairie du Chien Aquifer from entering the underlying Jordan Aquifer and being extracted for consumption when the well is pumped.



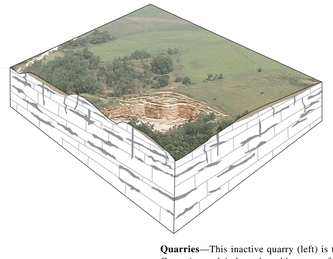
Well diagram—An open borehole at the bottom of this well exposes the Jordan Aquifer, a sandstone that transmits ground water through small spaces between individual grains of sand. Water in the overlying Prairie du Chien Aquifer and in surficial deposits is prevented from entering the well by a steel casing and a clay-rich cement called grout.

Plate 1, Data-Base Map, shows the location of many of the water wells in the county. Drilling records from wells provide important information about the rock layers beneath the land surface, which was used by geologists along with other kinds of data to construct many of the maps in the Wabasha County Geologic Atlas.

GEOLOGIC ENDOWMENT OF CONSTRUCTION-AGGREGATE MATERIALS

Wabasha County is endowed with geologic resources that are useful to its residents. The two most commonly utilized rock resources are carbonate bedrock and surficial sand and gravel deposits. These materials are extracted from quarries and pits scattered across the county. Plate 6 shows the location of these and other geologic resources, and describes the properties that make them suitable for a number of industrial applications.

Sand and gravel pit—As in most pits in Wabasha County, sand and gravel in this pit are extracted from a "terrace," a remnant of an old stream deposit that lies higher than the present river level. At this location the terrace is composed of sand and gravel deposited by the ancestral Zumbro River. Old river terraces such as this one are suitable for mining where they occur near the land surface, lie above the water table, and are composed of a relatively high percentage of gravel-sized material. The extracted deposits are sifted through screens and washed with water to sort into specific particle sizes, and then used as aggregate for road pavements or as fill.



Quarries—This inactive quarry (left) is typical because it was developed where the carbonate rock of the Prairie du Chien Group is overlain by only a thin cover of surficial deposits, and where the water table is lower than the quarry floor.

In this active quarry (right), surficial deposits are stripped from the top of the Prairie du Chien Group, and bedrock is blasted from the quarry walls by explosives. The blasted material is crushed, sifted through screens, and washed to produce carbonate rock fragments of a relatively consistent size. Large pieces of carbonate rock are commonly used as rip-rap to slow erosion in drainages and on steep slopes; smaller, gravel-sized fragments are widely used as surface material on gravel roads in the county, and as aggregate in concrete and bituminous pavement. In addition, some carbonate rock is crushed into powder and used as agricultural lime.

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