UNIVERSITY OF MINNESOTA

MINNESOTA GEOLOGICAL SURVEY
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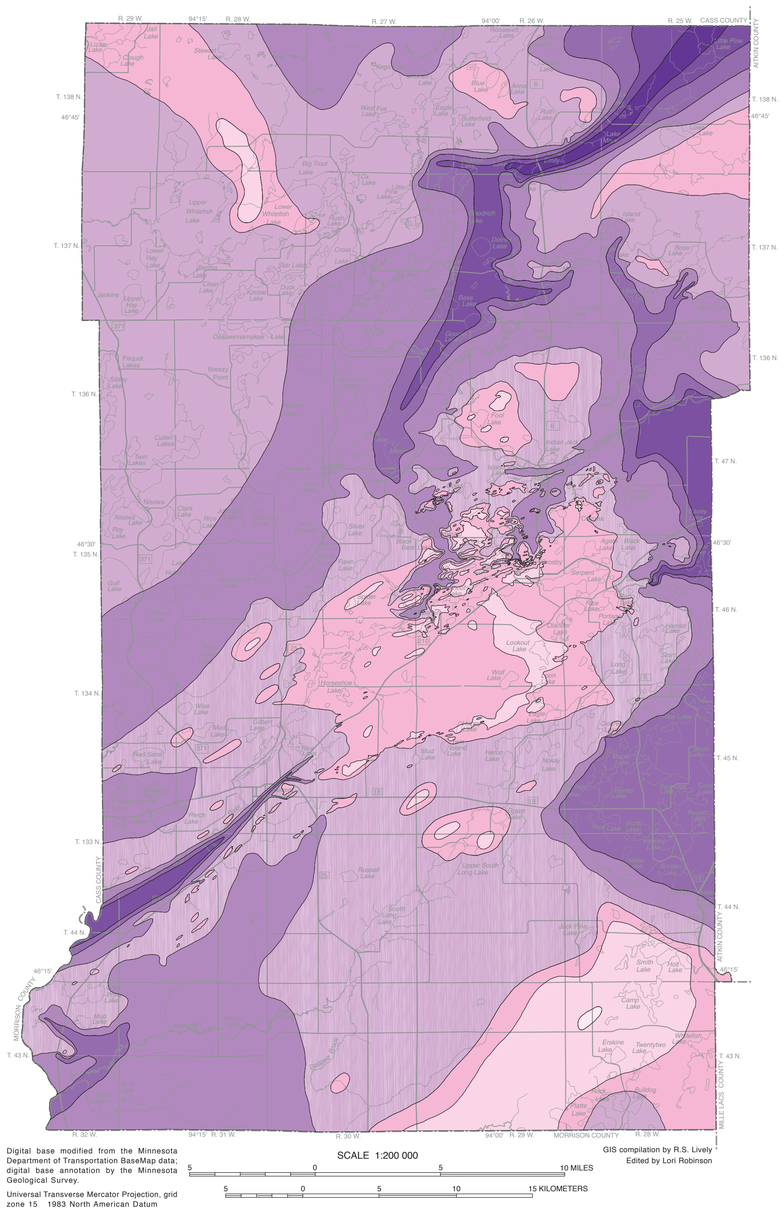
COUNTY ATLAS SERIES
ATLAS C-16, PART A
Plate 5—Bedrock Topography,
Depth to Bedrock, *and*
Quaternary Subsurface Geology



Digital base modified from the Minnesota Department of Transportation BaseMap data; digital base annotation by the Minnesota Geological Survey.

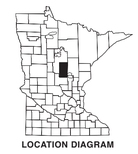
Universal Transverse Mercator Projection, grid zone 15 1983 North American Datum

SCALE 1:200 000

5 0 5 10 MILES

5 0 5 10 15 KILOMETERS

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



BEDROCK TOPOGRAPHY

By

Dale R. Setterholm

2004

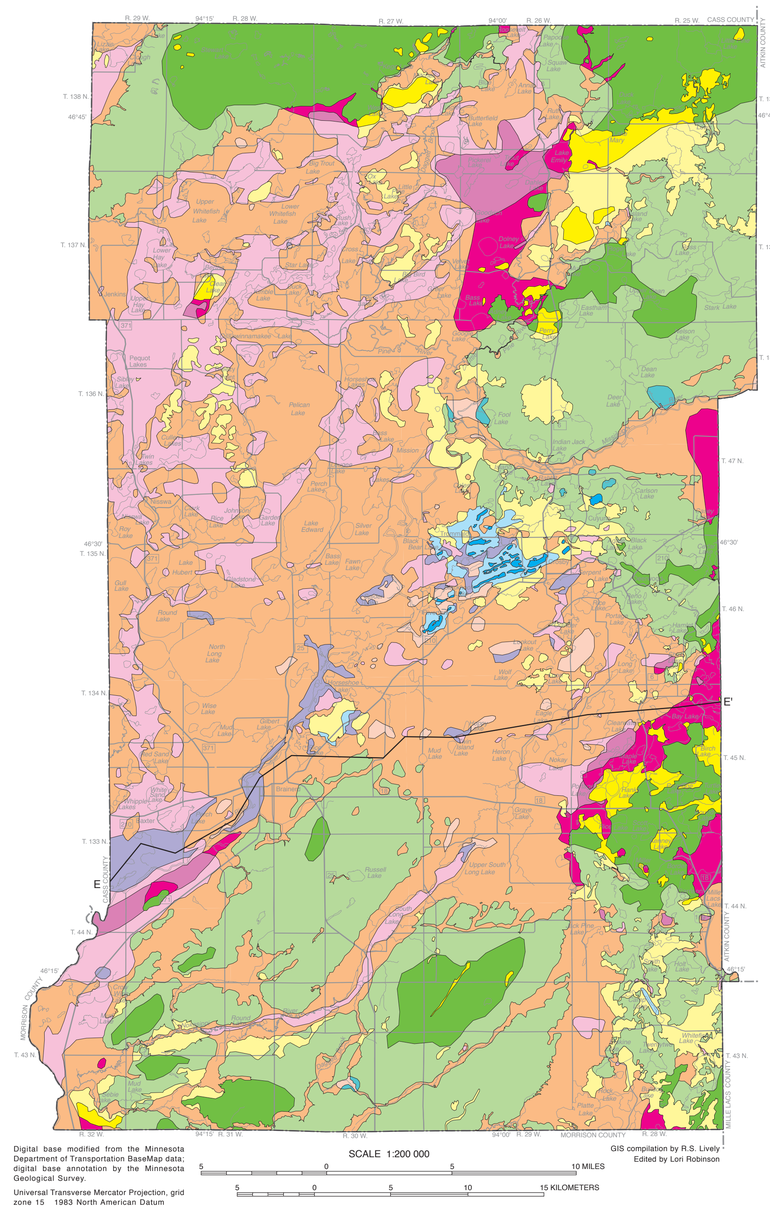
INTRODUCTION TO THE BEDROCK TOPOGRAPHY MAP

The elevation and shape of the bedrock surface in Crow Wing County are represented by colors assigned to 50 foot (15 meter) elevation intervals on the Bedrock Topography map. The position of those elevation intervals was determined from records of water-well construction, mineral-exploration and scientific drilling, and from geophysical investigations. The distribution of data can be seen on the Data-Base Map (Plate 1) and should be considered when assessing the reliability of the map at any particular location. Drilling records that include bedrock intersections are unevenly distributed. Such data are densely distributed in the mining districts, but in other parts of the county some townships do not have any such bedrock elevation data. The mining data report the elevation of the bedrock surface prior to mining. Therefore, within the boundaries of mines the map does not accurately represent current conditions. A few seismic-refraction surveys were used to supplement the drilling records in areas of particular need.

The elevation of the bedrock surface varies from more than 1,200 feet (366 meters) above sea level in southeastern Crow Wing County to less than 900 feet (274 meters) above sea level near the northeast corner of the county. The total relief is greater than 325 feet (99 meters), which is approximately half as much relief as the current land surface. The shape of the bedrock surface is the result of depositional processes, displacement (faulting and warping), weathering, and erosion. The strong correlation between bedrock geology and bedrock topography indicates that composition and structure of the bedrock has strongly affected its topography. Bedrock that is more resistant to erosion tends to create higher parts of the topography and less resistant rock tends to be located in lower areas. This is evident in the Cuyuna and Emily mining districts, where iron-formation forms topographic highs. The shape of the bedrock surface can affect subsequent geologic events, and even current resources. For example, a southwest-trending valley in the bedrock surface near Brainerd and Baxter has been filled with glacially derived sand, and that sand forms the aquifer on which those cities rely for their water supply.

1,201–1,250
1,151–1,200
1,101–1,150
1,051–1,100
1,001–1,050
951–1,000
901–950
874–900

Elevation of the bedrock surface in feet above mean sea level



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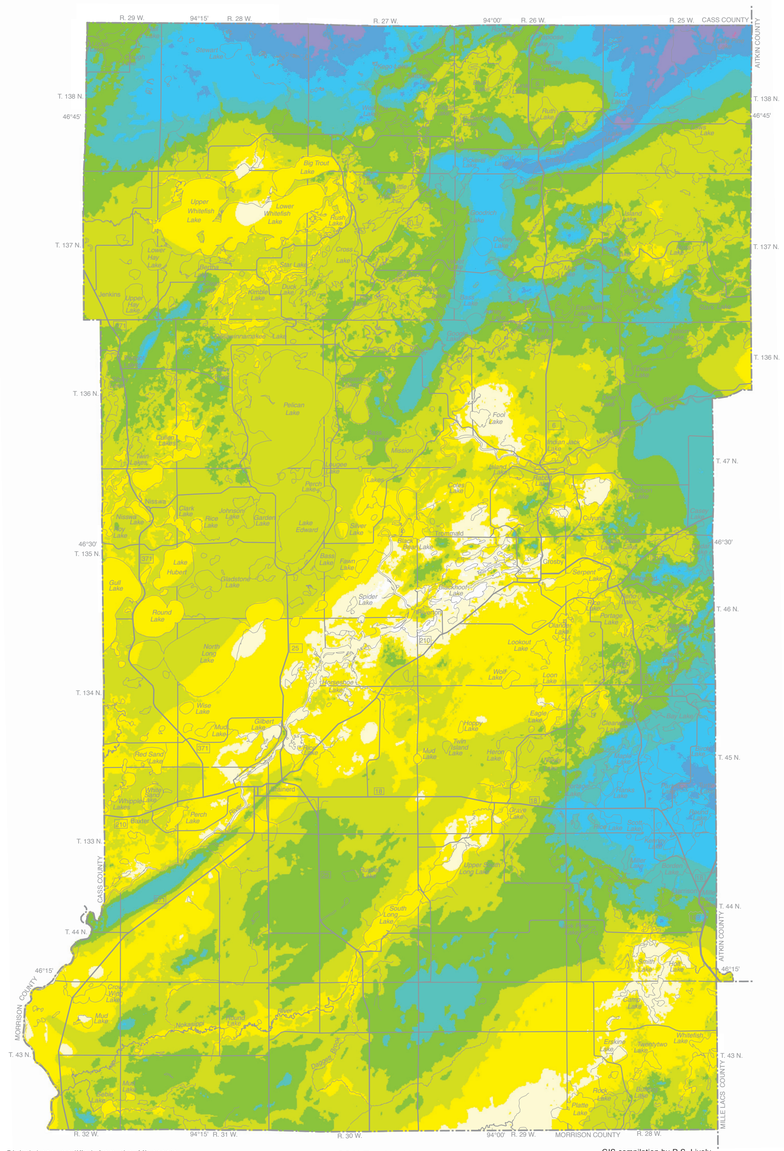

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GIS compilation by R.S. Lively
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DEPTH TO BEDROCK

By

Dale R. Setterholm

2004

INTRODUCTION TO THE DEPTH TO BEDROCK MAP

The bedrock in Crow Wing County is completely covered by unconsolidated Quaternary sediment that varies in thickness from 15 feet to almost 500 feet (5 to 152 meters). The thickness of the sediment is equal to the depth from the land surface to the bedrock surface. To calculate that thickness at any given place in the county, the elevation of the bedrock surface was subtracted from the elevation of the land surface. To accomplish this task a grid of bedrock-surface elevations (30-meter cell size) was subtracted from a similar grid of land-surface elevations. The calculation produced a third grid of derived sediment thickness. That grid was compared with measured sediment thicknesses taken from drilling records. Finally, the values of that grid were contoured digitally to produce the Depth to Bedrock map. Because the surface of a lake is regarded as the land surface elevation, the sediment thickness within lake boundaries includes the depth of the lake water. To calculate the true thickness of sediment beneath the lake it is necessary to subtract the water depth at that location. In places, the thickness of the sediment varies greatly over short distances, and mapping at this scale (1:200,000) is not able to display that detail. For that reason, it is best to consult site-specific data wherever they are available.

The thickest sediment in Crow Wing County is near the northern county boundary where the bedrock surface is relatively low. The thinnest cover is found in the mining districts in central Crow Wing County and the southeastern part of the county where the bedrock surface is relatively high. Most of the details of the Depth to Bedrock map reflect today's landforms because the model of the land-surface topography is of higher resolution and based on more data than the bedrock surface model.

1–50
51–100
101–150
151–200
201–250
251–300
301–350
351–400
401–450
451–500

Depth in feet from the land surface to the bedrock surface

QUATERNARY SUBSURFACE GEOLOGY

By

Gary N. Meyer

2004

INTRODUCTION TO THE QUATERNARY SUBSURFACE GEOLOGY MAP

The entire section of Quaternary sediment between the surface and the bedrock is portrayed in the Quaternary subsurface map. Available stratigraphic data were not sufficient to map subsurface deposits by provenance as in the Surficial Geology map (Plate 3), or to show the areal extent of individual till and sand beds. The sequence of Quaternary deposits in Crow Wing County is the result of many cycles of deposition and erosion by glaciers and their associated meltwater. Even within a single glacial episode the processes and environments of deposition were not laterally continuous. For these reasons it is very difficult to predict what specific materials exist in the subsurface between data points. However, it is possible to describe the general characteristics of the sequence of glacial materials in discrete areas. The units on this map delineate areas with similar sediment sequences, which highlight the distribution of materials with relatively low permeability (such as till and other clay-rich deposits) compared to relatively permeable sand and gravel deposits. As such it describes the general distribution of aquifers.

The colored map units were determined by surface sediment, thickness of surficial sand, and the probability of buried sand aquifers. The unit definitions describe the sequence of sand and till beds in the subsurface. These descriptions are based primarily on water well records, supplemented with other subsurface data where available (Plate 1). The accuracy of the map in any particular area is dependent on the amount and quality of available subsurface data. Organic deposits and open water were ignored in map construction. The location of cross section E–E' from Plate 4 is included for reference.

In our classification, a sand aquifer is considered *thick* if it is at least 10 feet (3 meters) thick, and is considered *buried* if it is overlain by 10 feet (3 meters) or more of clayey sediment. Most of Crow Wing County is underlain by at least one thick buried sand aquifer, but in some areas the aquifers are found only at depths exceeding 150 feet (45 meters). Water-well construction specifications were considered in this classification scheme in that water-table aquifer wells are commonly constructed where surficial sand and gravel exceed 50 feet (15 meters). The Minnesota Department of Health requires well drillers to construct wells at least 50 feet (15 meters) deep, or else set-back distances from potential contaminant sources must be doubled. Wells constructed in buried sand aquifers (provided they are constructed properly) generally provide greater protection from surface contaminants than do wells constructed in the water-table aquifer, depending on depth and other factors such as ground-water gradient and flow direction.

Surface sediment	Number of thick buried sand aquifers: None	One	Two or more
Clayey to sandy till			
Till and clay to gravel complex			
Fine-grained sand to gravel, less than 50 feet (15 meters) thick			
Fine-gained sand to gravel, greater than 50 feet (15 meters) thick			
Bedrock		Not applicable	Not applicable

DESCRIPTION OF MAP UNITS

Mostly till, with one or two older tills below the surficial till in places. Sand aquifers are generally thin or absent; however, thick sand beds may be present in the upper 50 feet (15 meters) in places.

One to several tills over bedrock; generally contains at least one sand aquifer thicker than 10 feet (3 meters) within the till or in between the till and bedrock.

One to 6 or more tills are present below the surficial till, commonly interbedded with at least two sand aquifers thicker than 10 feet (3 meters).

Complex surficial geology including till, bedded sediment, and sediment redeposited by mining. Generally contains no buried sand aquifers thicker than 10 feet (3 meters). Includes areas where surficial sand is an aquifer, where a sand aquifer is buried below less than 10 feet (3 meters) of clayey sediment, and where thick till(s) and other clayey sediment contain thin to no sand aquifers.

Complex surficial geology including till, bedded sediment, and sediment redeposited by mining. Generally contains at least one buried sand aquifer thicker than 10 feet (3 meters). Includes areas where surficial sand is also an aquifer.

Complex surficial geology including till and bedded sediment. Generally contains more than one buried sand aquifer thicker than 10 feet (3 meters). Includes areas where surficial sand is also an aquifer.

Less than 50 feet (15 meters) of fine-grained sand to gravel over till and other clayey sediment containing thin to no sand aquifers, over bedrock. A thin sand bed may be present between the till and bedrock.

Less than 50 feet (15 meters) of fine-grained sand to gravel over one or more beds of till, or in places, clayey lake sediment, over a sand bed generally thicker than 10 feet (3 meters).

Less than 50 feet (15 meters) of fine-grained sand to gravel over multiple beds of till and in places clayey lake sediment, interbedded with more than one sand aquifer generally thicker than 10 feet (3 meters).

Greater than 50 feet (15 meters) of fine-grained sand to gravel over till and other clayey sediment. Sand aquifers generally less than 10 feet (3 meters) thick are present between the till and bedrock in places. Till is very thin to absent in some areas, particularly where the depth to bedrock is less than 100 feet (30 meters).

Greater than 50 feet (15 meters) of fine-grained sand to gravel over one or more beds of till or clayey lake sediment, over at least one sand aquifer generally thicker than 10 feet (3 meters).

Greater than 50 feet (15 meters) of fine-grained sand to gravel over two or more beds of till, or in places, clayey lake sediment, interbedded with more than one sand aquifer generally thicker than 10 feet (3 meters).

Bedrock is exposed in the lower walls and bottoms of iron-mine pits that are now filled with water.

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