UNIVERSITY OF MINNESOTA

MINNESOTA GEOLOGICAL SURVEY
Harvey Thorleifson, Director

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COUNTY ATLAS SERIES
ATLAS C-17
Plate 5—Bedrock Topography, Depth to Bedrock, Bedrock Models

BEDROCK TOPOGRAPHY, DEPTH TO BEDROCK, AND BEDROCK GEOLOGY MODELS

By

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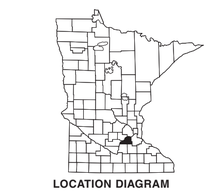
2006

INTRODUCTION

Subsurface geology is represented here as a series of digital elevation models or surfaces, commonly referred to as DEMs. In a DEM, a continuous surface such as the land surface is converted into individual cells, with each cell assigned a number of the average elevation within its extent. In the Scott County geologic atlas, all digital elevation models were constructed with 30-meter by 30-meter cells.

There are several advantages to providing geologic information in a digital elevation model format. First, individual geologic units can be separated and displayed to show their spatial extent and elevation above sea level. Second, surfaces can be combined to make additional calculations. For example, subtracting a digital elevation model of the bottom of a unit from its corresponding top results in the unit thickness. Data in this format are easily transferred between commonly used GIS formats (for example ESRI–ArcGIS). They are "model-ready" because they can be used as inputs for ground-water models or other types of modeling or construction projects that require the elevation of bedrock layers.



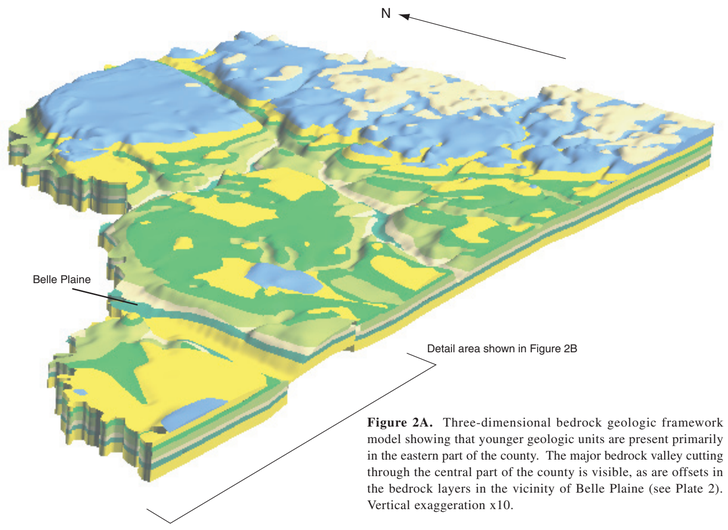
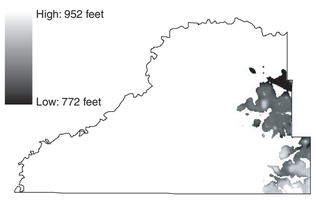
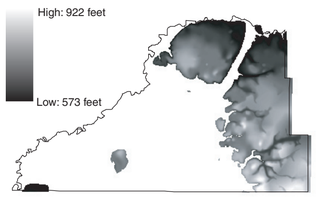


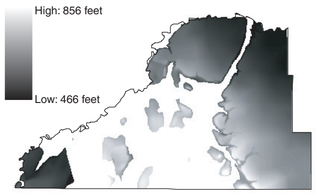
Figure 2A. Three-dimensional bedrock geologic framework model showing that younger geologic units are present primarily in the eastern part of the county. The major bedrock valley cutting through the central part of the county is visible, as are offsets in the bedrock layers in the vicinity of Belle Plaine (see Plate 2). Vertical exaggeration x10.



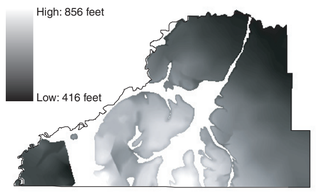
St. Peter Sandstone



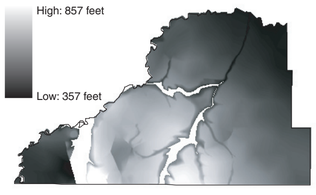
Prairie du Chien Group



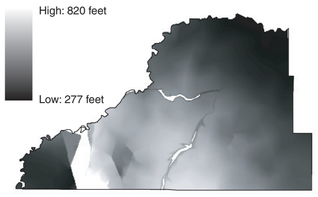
Jordan Sandstone



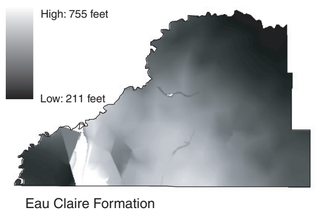
St. Lawrence Formation



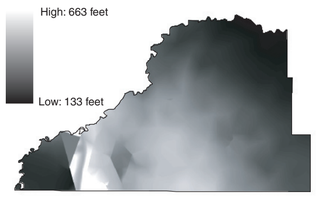
Franconia Formation



Ironton–Galesville Sandstones

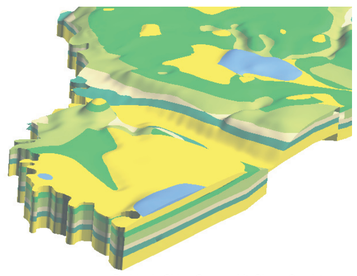


Eau Claire Formation

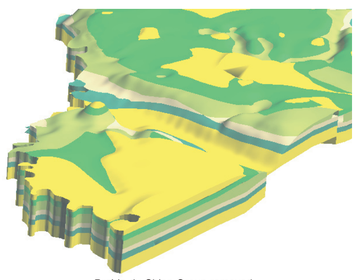


Mt. Simon Sandstone

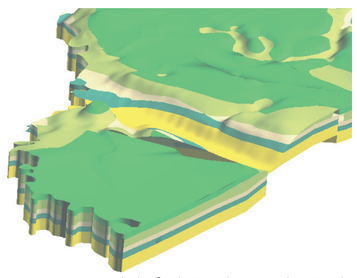
Figure 1. Gray-scale images of individual bedrock unit top digital elevation models, shown in sequence from youngest to oldest. In contrast to the older bedrock units, portions of younger units have been progressively eroded away. Darker shades indicating lower elevations of unit tops to the northeast show the dip of all bedrock units toward the axis of the Twin Cities basin.



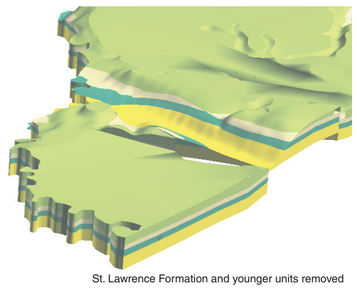
Prairie du Chien Group—Mt. Simon Sandstone



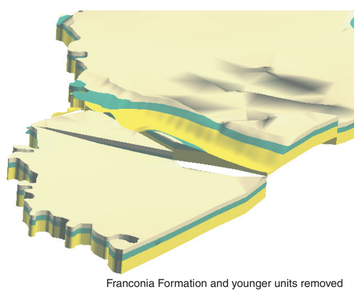
Prairie du Chien Group removed



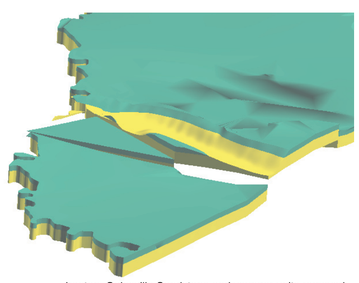
Jordan Sandstone and younger units removed



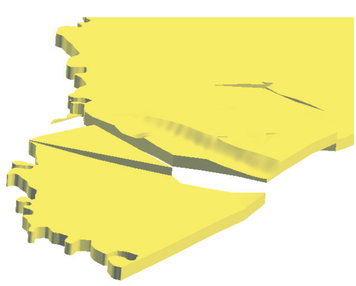
St. Lawrence Formation and younger units removed



Franconia Formation and younger units removed



Ironton–Galesville Sandstone and younger units removed



Eau Claire Formation and younger units removed

Figure 2B. Illustrations of the bedrock geologic framework model for the western part of Scott County near Belle Plaine. Younger bedrock units are successively removed. Offsets due to faults, unit thicknesses, and extent of the bedrock units are shown. Vertical exaggeration x10.

BEDROCK GEOLOGY MODELS

ELEVATION OF INDIVIDUAL BEDROCK SURFACES

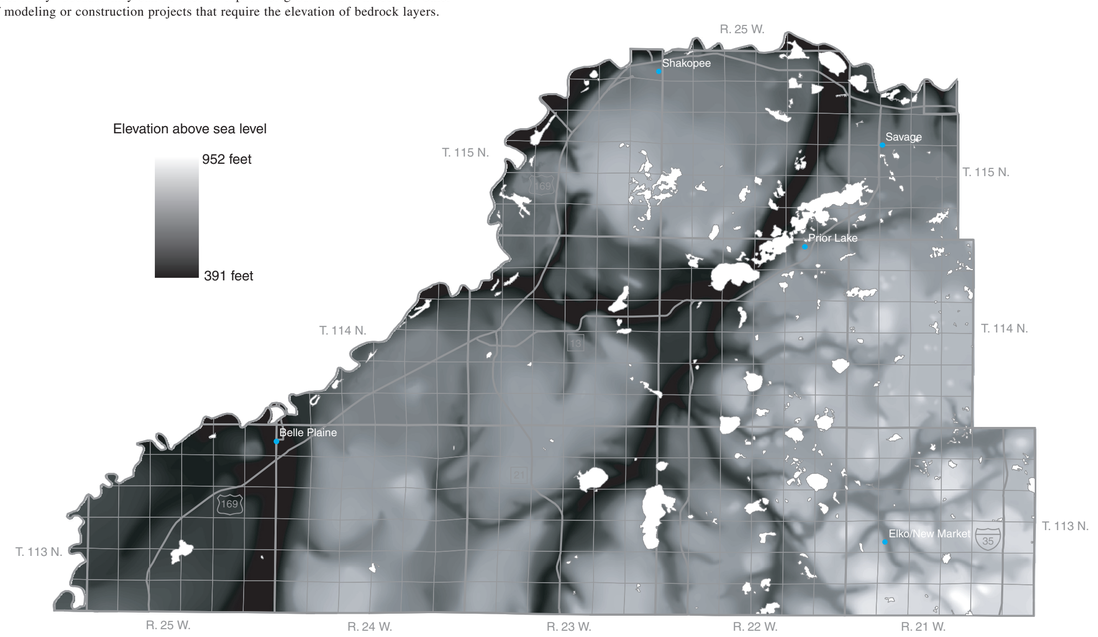
Digital elevation models of individual bedrock layers are shown in Figure 1. The pieces used to construct the three-dimensional bedrock surfaces included contoured bedrock topography and structural contours of uneroded tops of the Jordan Sandstone and Ironton–Galesville Sandstones. The Jordan and the Ironton–Galesville Sandstones tops were chosen because their contact with overlying bedrock is easily recognized by well drillers, and as a consequence, is recorded in the driller's record. Similarly, these contacts are prominent in borehole gamma logs, which provide a clear record of the elevations of unit tops (see Plate 1). Structure contours of the Ironton–Galesville Sandstones provide structural information in the western part of the county, where the full thickness of the Jordan Sandstone is largely absent.

Together, contours of the Ironton–Galesville and Jordan Sandstones' uneroded tops define the bedrock structure of the county, including the presence of anticlines, synclines, or faults. Additional bedrock surfaces were calculated based on estimated unit thicknesses, and then adjusted based on gamma logs, drillers' logs, or bedrock outcrop. Improvements in modeling techniques applied as part of this county atlas allow a more accurate depiction of offsets in elevations due to faulting than previous modeling efforts (Mossler and Tipping, 1996).

BEDROCK GEOLOGIC FRAMEWORK MODEL

The digital surfaces can be combined into a complete bedrock geologic framework model (Fig. 2). The model is generally similar to the bedrock map (Plate 2). Differences in the shapes and sizes of subcrop areas, particularly for the St. Peter and Jordan Sandstones, are due to methods used to construct the model and restrictions in the level of detail the model can provide. For example, the bedrock map is closely linked to information from the water well data-base, and slight changes in the elevation of bedrock units or changes in unit thickness as indicated by drillers' logs may reflect minor structural variation that is beyond the resolution of the bedrock model. As a result, the model is useful for defining overall bedrock structure and unit thicknesses, but should not be used for identifying the uppermost bedrock. Instead, the bedrock geology map (Plate 2) should be used for this purpose because it provides a better representation of site-specific conditions as reported by drillers.

Digital files for these products along with the rest of the Scott County geologic atlas are available at the Minnesota Geological Survey web site: <http://www.geo.umn.edu/mgs/>.



BEDROCK TOPOGRAPHY

The bedrock topography map portrays the elevation of the upper surface of the bedrock of Scott County. It shows the land surface as it would appear if viewed from above and all the overlying unconsolidated materials were stripped away. Higher elevations are shown as lighter shades of gray.

The eroded surface of bedrock in Scott County is characterized by relatively flat plateaus of significant geographic extent, cut by narrow, sinuous valleys. The plateaus are at elevations generally restricted to about 750 to 850 feet (229 to 259 meters) and are capped by relatively resistant carbonate-rich rock of the Prairie du Chien Group and St. Lawrence Formation. The base of the valleys are locally more than 300 feet (91 meters) lower than the plateau surfaces, typically exposing the Franconia Formation and older rock units.

Bedrock topography was mapped by compiling and contouring elevations of the bedrock surface in boreholes (mostly water wells) and bedrock outcrops**.** Contours were converted into a digital elevation model, referred to here as the bedrock elevation model, in order to provide a continuous digital surface of bedrock elevation over the entire county.

DEPTH TO BEDROCK

The depth to bedrock map portrays the thickness of unconsolidated material overlying the bedrock surface. It appears in many places to be a negative image of the bedrock topographic surface. The thickest deposits, shown in dark blue, occur within bedrock valleys, except where the sediment in these buried valleys was thinned by the erosion of modern rivers. In addition, the abrupt drop in bedrock elevation and resulting increase in depth to bedrock is shown west of the Belle Plaine fault system in the westernmost part of the county (Plate 2). The depth to bedrock in Scott County ranges from 0 to greater than 550 feet (168 meters).

This map was constructed by calculating the difference in elevation between the land surface and the bedrock surface. In a GIS environment, this is calculated by subtracting the bedrock elevation model from the land surface elevation model. In this case, the land surface elevation model used was the U.S. Geological Survey National Elevation 30-meter Dataset (U.S. Geological Survey, 2006).

REFERENCES

Mossler, J.H., and Tipping, R.G., 1996, Digital elevation models for the tops of the St. Peter Sandstone, Prairie du Chien Group, Jordan Sandstone and St. Lawrence/St. Lawrence-Franconia Formations within the seven-county metropolitan area, *in* Minnesota Pollution Control Agency, Metropolitan area groundwater model—The metro model: St. Paul, Minn., <http://www.pca.state.mn.us/water/groundwater/metromodel.html>, scale 1:100,000.

U.S. Geological Survey, 2006, National elevation dataset, factsheet 148-99: Reston, Va., <http://erg.usgs.gov/isb/pubs/factsheets/fs14899.html>.

Edited by Lori Robinson