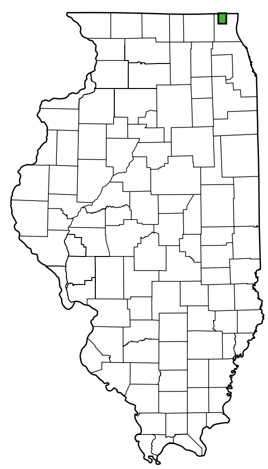
Illinois Preliminary Geologic Map
IPGM Antioch-3D

Three-Dimensional Model: Surficial Geology of Antioch Quadrangle

Lake County, Illinois and Kenosha County, Wisconsin

Ardith K. Hansel

2005



Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief
Natural Resources Building
615 East Peabody Drive
Champaign, IL 61820-6964

http://www.isgs.uiuc.edu

Introduction

To understand and illustrate the surficial (Quaternary) geology of the Antioch Quadrangle, we created a 3-D model of the glacial materials above bedrock. The characterization, distribution, and geometry of these materials have important implications for regional planning and groundwater protection. Because surface exposures on the quadrangle are rare, shallow, and short-lived and the glacial drift is thick (about 200 to 320 feet), we selected borehole records from geological archives, drilled new boreholes to provide key stratigraphic control, and geophysically logged water wells to help map the subsurface geology.

The Quaternary materials are grouped into map units called lithostratigraphic units, which are sediment layers that can be differentiated because of their distinct lithology and stratigraphic position. These layers result from different sedimentary environments. For example, stratified layers of well-sorted sands and gravels or silts and clays represent proglacial meltwater deposits, whereas poorly sorted mixtures of clay, silt, sand, and rocks (diamictons) represent tills and ice-marginal sediments deposited beneath or adjacent to glacial ice. The stratigraphic framework used in the Antioch model was established when we generated a preliminary 3-D model based on key data for a 6-quadrangle area in Lake and McHenry counties (Hansel et al. 2001). Stratigraphic nomenclature is from Hansel and Johnson (1996).

Because the ice margin advanced and melted back multiple times across the Antioch Quadrangle during the last (Wisconsin) glacial episode (Hansel and Johnson 1992, 1996), the proglacial and glacial deposits form sequences that overlie one another. In the model, some sediment layers represent a combination of lithostratigraphic units, because either too few data were available to distinguish between these units or the quality of some data was insufficient to consistently differentiate between geologic materials (e.g., fine-grained laminated sediment from diamicton). The physical characteristics and position of the layers determined whether they are aquifers (water-producing) or not.

Methodology

The 3-D model is based on 354 records, 285 within the quadrangle boundary (fig. 1) and an additional 69 records within a 1-mile buffer adjacent to the quadrangle. The data in the model include 8 stratigraphic test borings (6 drilled for this study, each with accompanying natural gamma log), 273 water wells (25 with a natural gamma log and an additional 16 with drill cuttings taken at 5-ft intervals), and 4 synthetic data logs, which are based on information from combining records in areas where data are sparse. Eighty-two records used in the model penetrated bedrock. Because fewer drill holes penetrate the lower units in the model, the reliability of the model decreases with depth. The locations of all drill holes were verified.

To choose data for the model, thousands of water-well records were evaluated and a representative sample of what was deemed to be of the highest quality in each section was chosen. Initially, 454 records were selected and entered into RockWorks99 software. Each log was examined to classify materials into map units. Hundreds of cross sections (like those shown in figure 2) were constructed to help pick lithostratigraphic contacts, check correlations among units, and sort out records that were difficult to interpret or clustered in the same area. High-quality data from stratigraphic test borings and natural gamma logs were used to help interpret records of lower quality. In some logs it was necessary to interpolate a contact between two units, and these logs are indicated in figure 1. For wells that reached bedrock, a total thickness of 20 feet was assigned to the bedrock layer to make a uniform thickness for the base layer of the model.

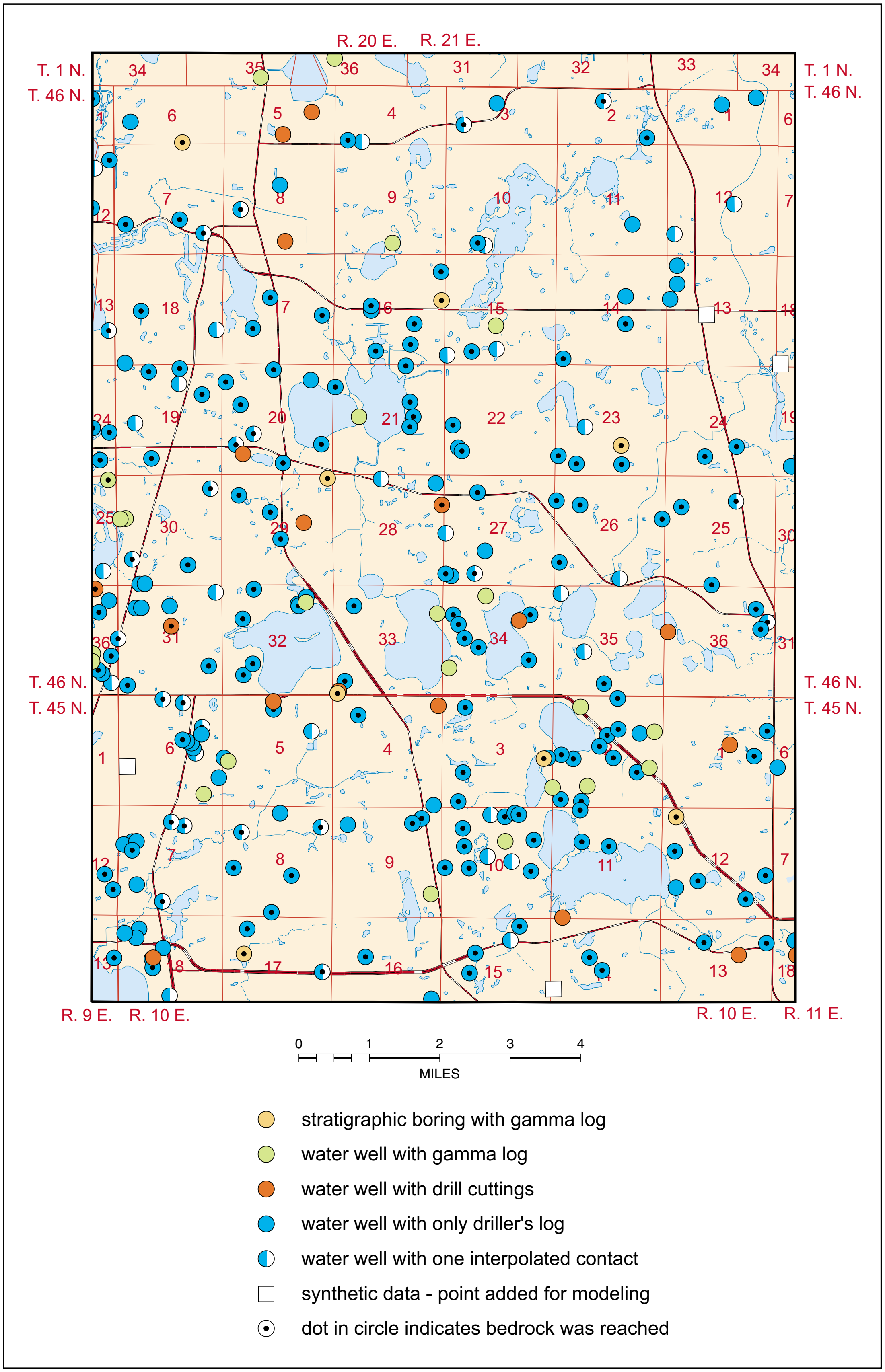


Figure 1 Distribution and type of borehole data used to construct the model.

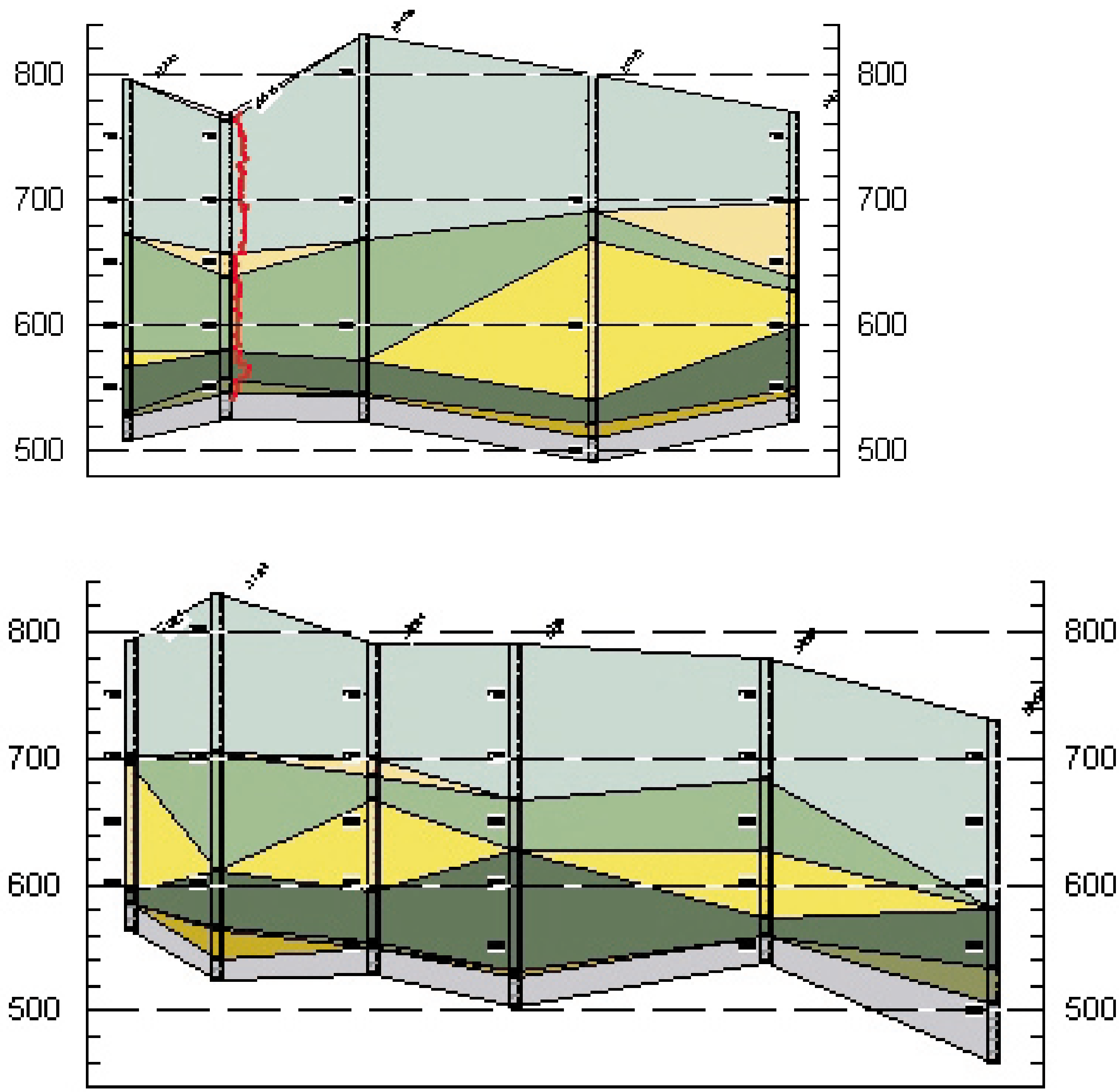


Figure 2 Examples of cross sections constructed from well and boring logs.

We used RockWorks99 software to generate a datasheet and templates for import into RockWorks2002. RockWorks2002 provides improved graphical representation and manipulation (ability to view the model from any perspective) and better vertical slicing capabilities of grid models. Views from the southwest of the model, a view of the interpreted boring logs and the bedrock surface, the different model layers, and north-to-south and west-to-east slices are shown at left.

Figure 3 shows by section the percentage of water wells screened in the different map units of the 3-D model. The pie charts were constructed by first generating histograms of the wells, by elevation (fig. 4), and assigning map units to the various elevations on the basis of constructed cross sections in RockWorks99. Figure 3 shows that in the Antioch Quadrangle many of the wells in glacial drift are screened in the Beverly Tongue of the Henry Formation (gold-yellow). One exception is in the northeastern part of the quadrangle; many wells there are screened either in an unnamed tongue of the Henry Formation (brownish yellow) that is present beneath the Wadsworth Formation, or in bedrock or older drift. In some areas of the quadrangle (near Antioch in sections 8, 17, T46N, R10E), the

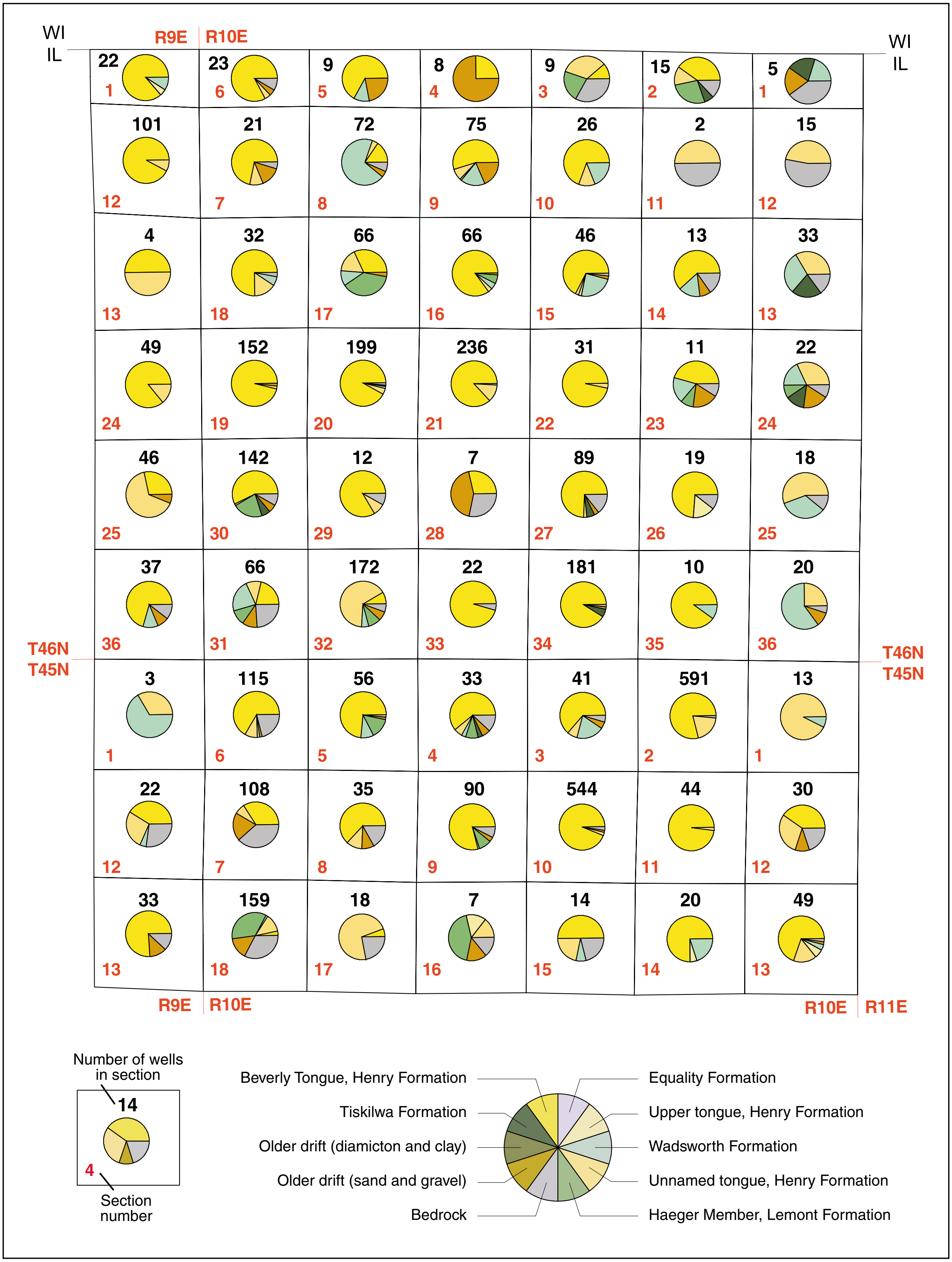


Figure 3 Percentage of water wells screened in the different map units. Refer to the pull-apart 3-D model, well distribution, and spatial continuity and thickness of sediment layers at left to better understand the variability in material units in which wells are screened.

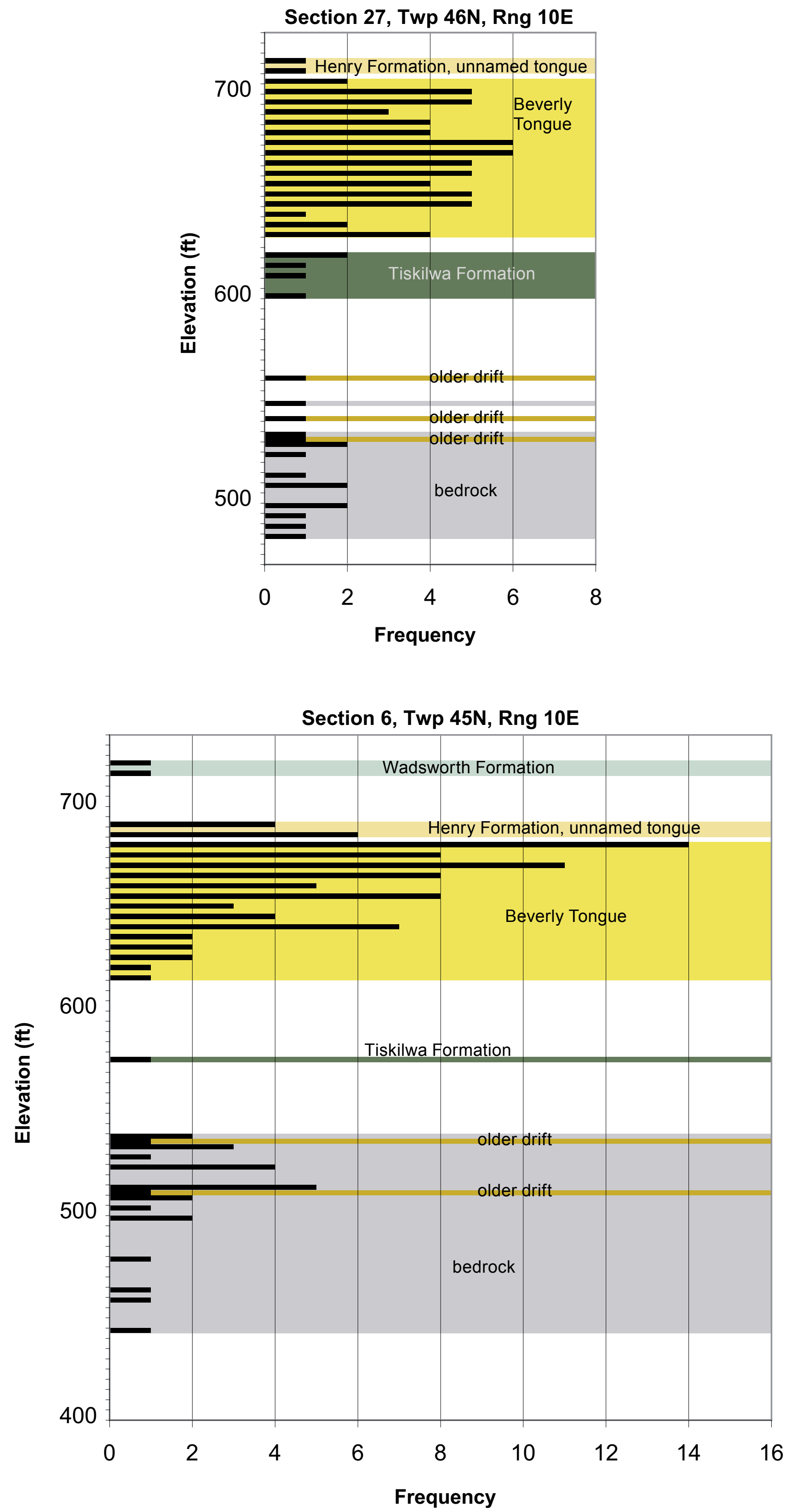


Figure 4 Examples of histograms used to generate pie charts.

Wadsworth Formation contains sand and gravel lenses in which wells are screened. In the southwestern and western parts of the quadrangle, the bedrock and an unnamed tongue of the Henry Formation are important water-bearing units.

References

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ISGS geologists M. Barnhardt and A. Stumpf acquired, described and discussed cores for stratigraphic tests. C. Stohr and A. Dixon-Warren acquired natural gamma logs for ISGS cores and water-well drill holes. B. Stiff assisted with the database and modeling.

ISGS drillers and student interns provided assistance in obtaining and verifying the location of data. In addition, V. Amacher assisted in data entry and location verification of water wells, K. Massey generated the histograms and pie charts for figures 3 and 4. The County of Lake Department of Public Works and the County Forest Preserve provided assistance and access to county property for drilling.