Three-Dimensional Geologic Mapping in Rapid-Growth Areas: A Case Study from Lake County, Northeastern Illinois

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In regions experiencing rapid suburban growth, the currently available information on the geology is often at a scale that is too small to aid decision-makers and a level of complexity that is not easily interpreted by non-geologists. Lake County, Illinois, is located in the northern portion of the Chicago metropolitan area and is part of a group of counties experiencing rapid development. The county borders on Lake Michigan, which is a source of water for much of the county's population (Figure 1). However, the most rapidly developing areas are predominantly outside of the Lake Michigan water allocation area, and it is here where information is most urgently needed about the near-surface geology and shallow aquifers. Better knowledge of the occurrence, geometry, and characteristics of the aquifers will allow their increased utilization.

Lake County has written its new regional development plan, so that as new geologic information becomes available it can quickly be integrated into the planning framework, and the county and municipalities can modify their plans as needed. The geologic information will provide a basis for revising zoning maps that govern the type of development permitted. Such revisions can then immediately impact density and type of housing, transportation network development, and other infrastructure allowed. Many current zoning laws are not sufficiently detailed to be able to control the types of development now being proposed.

Current information on the aquifers is based on limited data at small scales (Figures 2 and 3). Lake County and the Illinois State Geological Survey are working closely to develop large-scale, derivative, geology-based products to assist in county planning and development with respect to population growth and resource utilization. The initial step is to develop a detailed three-dimensional (3-D) model of the sediments that can be used as a framework for developing derivative products, particularly those that address the location and wise use of aquifers.

As part of the Central Great Lakes Geologic Mapping Coalition, we are developing 3-D stratigraphic models for each 1:24,000-scale quadrangle in Lake County. A larger, more regional perspective will be gained as models of adjacent areas are merged. Our first quadrangle for detailed 3-D mapping was the Antioch 7.5' Quadrangle. Here the drift ranges from about 150-300 feet thick and consists of tills and proglacial fluvial and lacustrine sediments of three late Wisconsin glacial events. Because the ice margin advanced and retreated across the quadrangle at least once during each event, the tills and ice-marginal facies (predominantly diamictons) are intertongued with the proglacial facies (predominantly fine silt and sand to coarse sand and gravel). The latter contain important drift aquifers. In the Antioch Quadrangle, more than 90% of all wells are screened in glacial drift.

Figure 4 shows the 3-D stratigraphic model of the Antioch Quadrangle. The stratigraphic units consist of 1) lithologically distinct till units (shown in greens), which consist predominantly of diamicton and resedimented proglacial facies (flows and lake sediments), and 2) coarse-grained sand and gravel facies (shown in yellows and golds). These units overlie Silurian bedrock (predominantly dolomite). The model was generated from about 275 borehole records. These records were selected from over 4000 drillers' logs (25 with natural gamma logs) and 10...
stratigraphic borings (8 with natural gamma logs). We
Figure 4. Three-dimensional stratigraphic model for the Antioch Quadrangle viewed from the southwest (clayey units are shown in greens and pink, sand and gravels in yellows and golds, bedrock in gray): a) block model, b) logs used in the model, and c) sediment layers of the model (discontinuous surficial units not shown.)
used RockWorks99 software to make stratigraphic picks and generate a datasheet for import into RockWorks2002, which we used to create the model. Hundreds of cross sections were drawn in RockWorks99 to check the picks. The locations of all data used in the model were verified using tax-parcel records, street address information, plat-books, and/or field checking.

We plotted the position of well screens for all 4000+ water wells on our model units to visually inspect which units are being tapped for water (Figure 5). This inspection is continuing and will likely result in further refinement of the model. We also constructed pie charts by section to illustrate spatial variation across the quadrangle with respect to which units are being used as aquifers (Figure 6). As we progress with our modeling, the detailed 3-D model will ultimately cover the majority of the county and will provide the framework for developing derivative products (e.g., isopach maps, engineering properties maps, hydrostratigraphic models) related to suburban development, resource extraction, aquifer capabilities, and recharge areas.

![Figure 5. Positions of well screens in the Antioch Quadrangle with respect to the sand and gravel units (shown in yellows and golds), surface (shown in light tan), and top 20 feet of bedrock (shown in medium gray). View is from the south. Key shown in Figure 4.](image)
Figure 6. Pie charts for each square-mile section showing spatial variation in units being tapped for water across the Antioch Quadrangle.