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

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with contributions by A. Stumpf, A. Pugin, A. Dixon-Warren, and C. Stohr
Talk Outline

- Location and why we are mapping in Lake County
- Geologic complexities of area
- Methodology
- 3-D model
- Refinements
- Applications and delivery challenges
Lake County, Northeastern Illinois

- Northern portion of the Chicago metropolitan area experiencing rapid suburban growth
- Water sources
  - Lake Michigan
  - Shallow (drift) aquifers
  - Deep (bedrock) aquifers
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Lake County regional development plan

- recognized need for detailed information because presently only small-scale maps available
- written so that as new geologic information becomes available it can be quickly integrated into the plan
- detailed geologic information would provide a basis for modifying zoning maps that govern the type of development permitted
Methodology

1. Start with regional picture
2. Evaluate available data (select and verify locations)
3. Obtain key stratigraphic control
4. Create detailed model for Antioch quad that honors data
5. Test/refine model by evaluating more data
6. Decide how to deliver model data
Regional geology
Regional lithostratigraphy

- Intertongued glacial diamictons and proglacial sediments
- Drift aquifers
Data quality extremely variable

- water wells
  - drillers’ descriptions
  - with cuttings
  - with gamma logs

- engineering borings

- stratigraphic test borings with gamma logs
**Water-well drillers' logs**

### Geologic and Water Surveys Well Record

**Property owner:** Durfler, Robert  
**Well No.:** #1  
**Address:** 62400 Cherokee Trail, Grayslake IL

**Well address:**  
**Lot:**  
**Subdivision:**  
**License No.:**  
**Permit No.:**  
**Date:** 08/01/1978

**Water from Limestone County - Lake**  
**at depth:** 225 to 227 ft.  
**Screen DIAM.:** 6 in.  
**Length:** ft., Slot 0  
**Rge. 10 E**  
**Elev.:**  

**Casing and Liner Pipe**  
**Diam. (In.):** 5  
**Kind and Weight:** 200# steel  
**From (ft):** 204  
**To (ft):** 225  

**Size hole below casing: 7.87 in.**  
**Static level:** 60 ft. below casing top which is 2 ft. above ground level. Pumping level: 80 ft. when pumping at 2 gpm for 6 hours.

<table>
<thead>
<tr>
<th>Formations passed through</th>
<th>Thickness</th>
<th>Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>clay</td>
<td>223</td>
<td>223</td>
</tr>
<tr>
<td>broken limestone</td>
<td>2</td>
<td>225</td>
</tr>
<tr>
<td>limestone</td>
<td>2</td>
<td>227</td>
</tr>
</tbody>
</table>

**Household - Private**  
**Lake:** 12-097-32042-00  6-44N-10E

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**Geologic and Water Surveys Well Record**

**Property owner:** Gaines, Don  
**Well No.:**  
**Address:** 697 Satin Ave, Lake Bluff IL

**Well address:**  
**Lot:**  
**Subdivision:**  
**License No.:**  
**Permit No.:**  
**Date:** 09/13/1979

**Water from Limestone County - Lake**  
**at depth:** 226 to 236 ft.  
**Screen DIAM.:** 3 in.  
**Length:** ft., Slot 0  
**Rge. 10 E**  
**Elev.:**  

**Casing and Liner Pipe**  
**Diam. (In.):** 5  
**Kind and Weight:** BLK STL, 14G/14L  
**From (ft):** 0  
**To (ft):** 220  

**Size hole below casing: 9.47 in.**  
**Static level:** 75 ft. below casing top which is 1 ft. above ground level. Pumping level: 166 ft. when pumping at 2 gpm for 2 hours.

<table>
<thead>
<tr>
<th>Formations passed through</th>
<th>Thickness</th>
<th>Bottom</th>
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</thead>
<tbody>
<tr>
<td>yellow clay</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>blue clay</td>
<td>124</td>
<td>141</td>
</tr>
<tr>
<td>sand &amp; gravel</td>
<td>37</td>
<td>179</td>
</tr>
<tr>
<td>gravel &amp; red clay</td>
<td>31</td>
<td>209</td>
</tr>
<tr>
<td>Limestone</td>
<td>2</td>
<td>211</td>
</tr>
<tr>
<td>Limestone gravel</td>
<td>7</td>
<td>226</td>
</tr>
<tr>
<td>Limestone</td>
<td>10</td>
<td>236</td>
</tr>
</tbody>
</table>

**Household - Private**  
**Lake:** 12-097-32043-00  6-44N-10E
More information from water-well cuttings

<table>
<thead>
<tr>
<th>dm: silty clay (15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>dm: silt loam to silty clay loam (5)</td>
</tr>
<tr>
<td>dm: silt loam to silty clay loam (10)</td>
</tr>
<tr>
<td>dm: silt loam to silty clay loam (5)</td>
</tr>
<tr>
<td>sand: fine to medium w/some diamicton and gravel (5)</td>
</tr>
<tr>
<td>sand: fine to coarse (5)</td>
</tr>
<tr>
<td>sand: fine to coarse with fine gravel (5)</td>
</tr>
<tr>
<td>sand: mostly medium (5)</td>
</tr>
<tr>
<td>dm: silt loam (5)</td>
</tr>
<tr>
<td>sand: medium to coarse w/gravel (5)</td>
</tr>
<tr>
<td>sand: coarse to very coarse and gravel fine (20)</td>
</tr>
<tr>
<td>gravel: fine (5)</td>
</tr>
<tr>
<td>sand: mostly medium, some fine and coarse (5)</td>
</tr>
<tr>
<td>dm: silt loam (5)</td>
</tr>
<tr>
<td>sand: fine (86)</td>
</tr>
</tbody>
</table>

clay: brown, with streaks of sand (8)
sand & gravel: and lime (9)
limestone: (3)
Most information when natural gamma logs are obtained
Data quality extremely variable

- water wells
  - drillers’ descriptions
  - with cuttings
  - with natural gamma logs

- engineering borings

- stratigraphic borings
  - previous
  - this study with gamma logs
Stratigraphic borings with natural gamma logs
Model data

- water wells
  - drillers’ descriptions
  - with cuttings
  - with natural gamma logs

- stratigraphic borings
  - without gamma logs
  - with gamma logs
Stratigraphic/lithofacies model

- regional stratigraphic model (6 quads)

- Antioch stratigraphic model

- Antioch stratigraphic/lithofacies model
Regional lithostratigraphic model
Evaluated data by using Rockworks99 to

- make stratigraphic picks
- draw hundreds of cross sections to check calls
Antioch lithostratigraphic model viewed from the southwest
Identifying ice-marginal facies
Cross section with ice-marginal facies
Testing and Refinement

- Explore ways to look at all the water-well data
- Visually look at all well axes
- Superimpose position of well screens on model
- Evaluate and add geophysical data
Created histograms for each section
Created pie charts for each section to show percentage of wells screened in each unit.
View from south of axes of all wells
View from south of axes of all wells
Positions of well screens relative to major aquifers
Collapsed dead-ice features

Contributed by A. Pugin
Tunnel valley

Contributed by A. Pugin

A: Bedrock (dolomite)
B1: Lake sediments ? (sand, silts and clay); B2: Till (diamicton)
B3: Tunnel-channel (gravel, sand and silts)
C1-C2: Till (diamicton)
How do we deliver 3-D model data?

- Paper copy
- CDs
- Web with viewing ability
- Derivative products