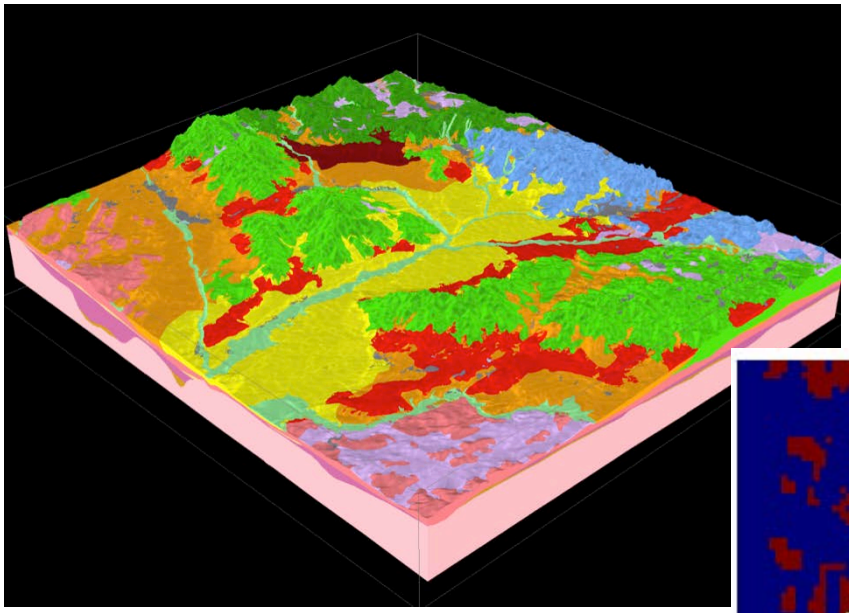

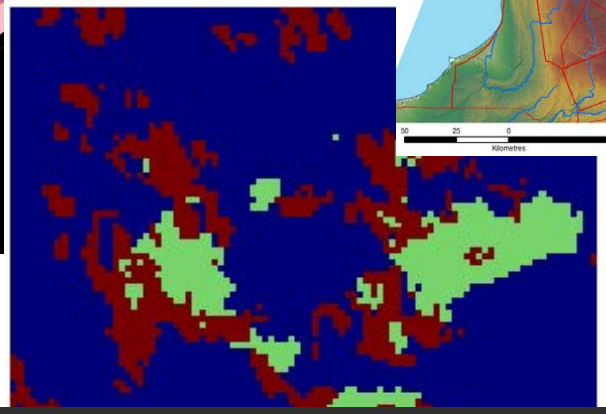

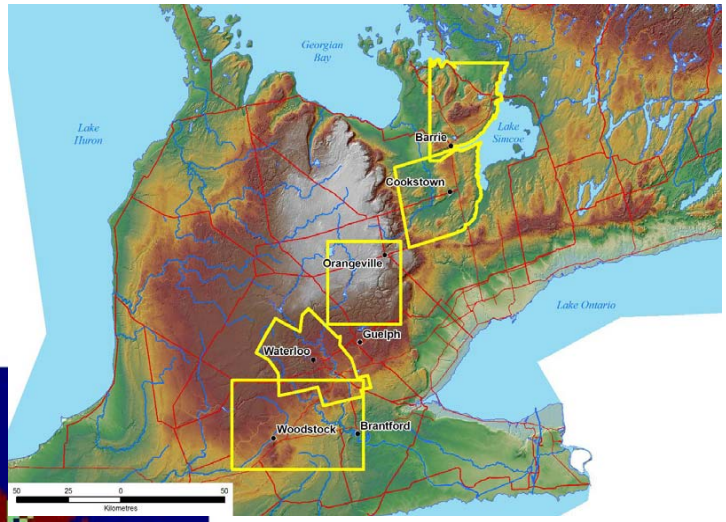

Thirteen Years of Progress in 3-D Geologic Mapping: A View from North America

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North American Workshop Co-conspirators

- Dr. Richard C. Berg, Illinois State Geological Survey
- Dr. Harvey Thorliefson, Minnesota Geological Survey/formerly Geological Survey of Canada
- Dr. Hazen Russell, Geological Survey of Canada - Ottawa

Outline

- Purpose of workshops
- Overview of meeting topics, participants, venues…
- Evolution of expertise, objectives, strategies
- Importance of software
- Importance of institutional strategies
- Current strategies
- The future…

Purpose

- The workshops have been offered to provide opportunities for geologists to share information on methods for construction of 3-D geological maps intended for groundwater and other applications.
  - Advance the state-of-the-art in shallow 3-D geologic mapping
  - Promote the use of 3-D geologic map information in groundwater management and environmental protection
  - Create a community of 3-D geologic mapping expertise, with focus on Geological Surveys

Overview of meetings

- 2001: NC-GSA, Normal, Illinois. 22 presentations. 20 organizations. 7 States, 4 Provinces.
- 2002: GSA, Denver, Colorado. 26 presentations. 26 organizations. 12 States, 7 Provinces, Finland representatives, 2 corporate representatives
- 2004: GAC-MAC, St. Catherines, Ontario. 26 presentations. 21 organizations. 6 States, 3 Provinces, Finland, UK, 2 companies.
- 2005: GSA, Salt Lake City, Utah. 28 presentations. 28 organizations. 9 States, 4 Provinces, Finland, Germany, Netherlands, Poland, UK, 5 companies
- 2007: GSA, Denver, Colorado. 20 presentations. 24 organizations. 12 States, 2 Provinces, Netherlands, UK.
- 2009: GSA, Portland, Oregon. 24 organizations. 8 States, 2 Provinces, Australia, France, Germany, Netherlands, UK, 3 companies.
- 2011: GSA, Minneapolis, Minnesota. 16 presentations, 20 organizations. 6 States, 3 Provinces, Denmark, Finland, France, Germany, Netherlands, UK.
- 2013: GSA, Denver, Colorado. 15 presentations,.16 organizations. 6 States, 3 Provinces, Denmark, Germany, Netherlands, New Zealand, UK

Evolving Expertise, Objectives, Strategies

- Expertise:
  - Data processing and standardization
  - Selected workflow: surface interpolation, cross section
  - Product definition and integration with flow models
  - Retrospective and compilation of studies
- Objectives
  - Aquifer delineation
  - Litho/allo stratigraphic approach
  - Sequence stratigraphic approach
  - Simulation of variations within mapping units
  - Integration of multiple studies, intra-institute standardization
- Strategies
  - Regional stratigraphic mapping
  - Development of standard software and workflows
  - Improving insight
  - Continued growth

Importance of Software

- Data types and structures allowed
- How data are visualized, analyzed, and interpreted
  - Borehole data
  - Map data
  - Profile data
  - Interpreted profiles
- How mapping units are defined
  - Tops vs Bottoms vs Both
  - Tins vs grids

Software…

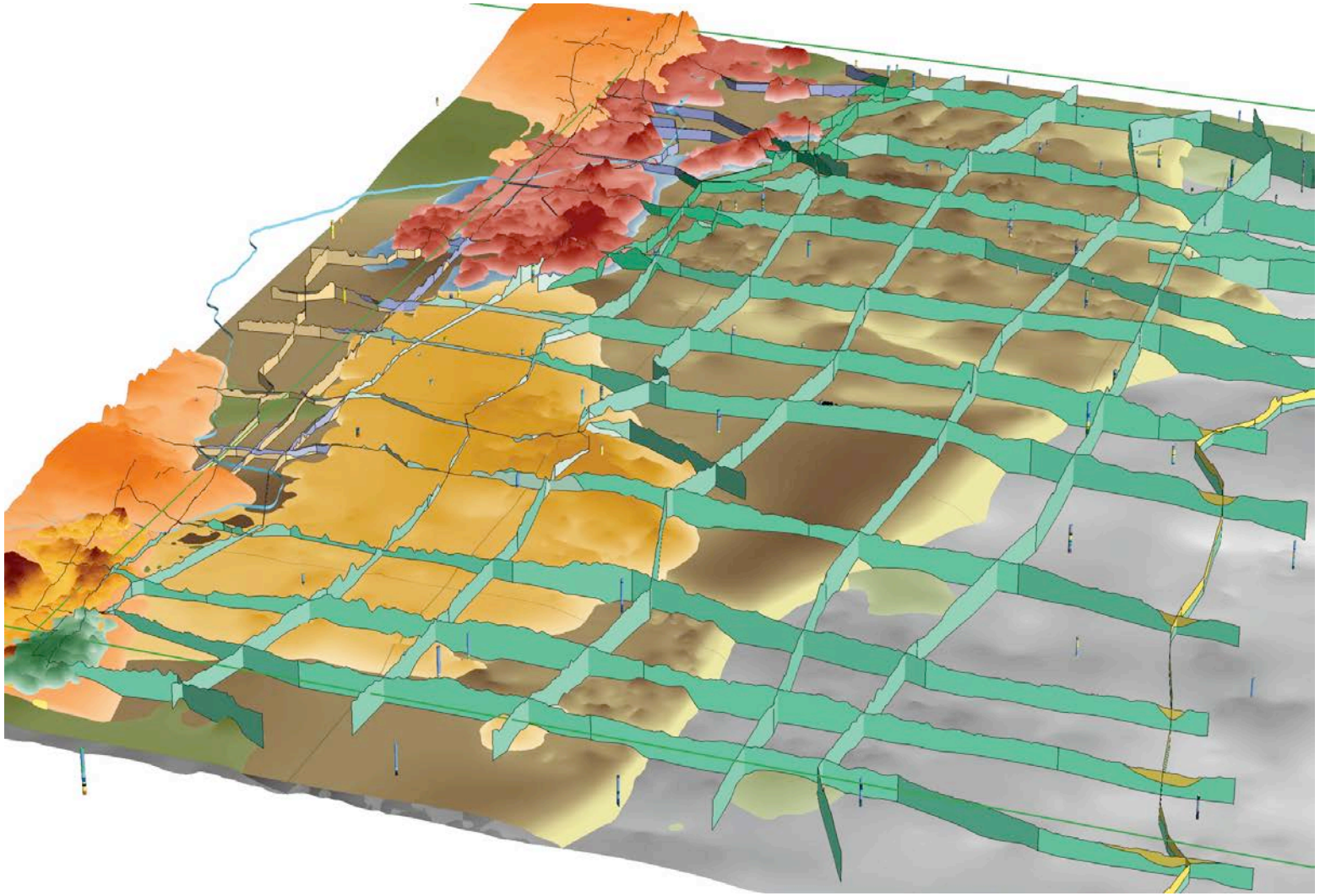
- Degree of geomorphic constraints put on data
  - User-defined points (TINS)
  - Algorithm- and user-defined curvature
  - Sections vs surfaces
  - Level and type of user interaction/constraint
- Complexities honored
  - Discontinuities
  - Tectonic/glacio-tectonic features
- Size of data allowed
  - Borehole data
  - Lidar DEMS, profiles
  - Ground-based geophysical profiles
  - Aerial geophysical profiles

Institutional Strategies - Canada

- National reaction to Walkerton groundwater contamination incident
- Competition for glacial aquifer water supplies.
- Bottom-up pressures
- Move to map in support of groundwater
- Active GSC mapping program in glacial seds
- Provincial programs developed

Institutional Strategies: US

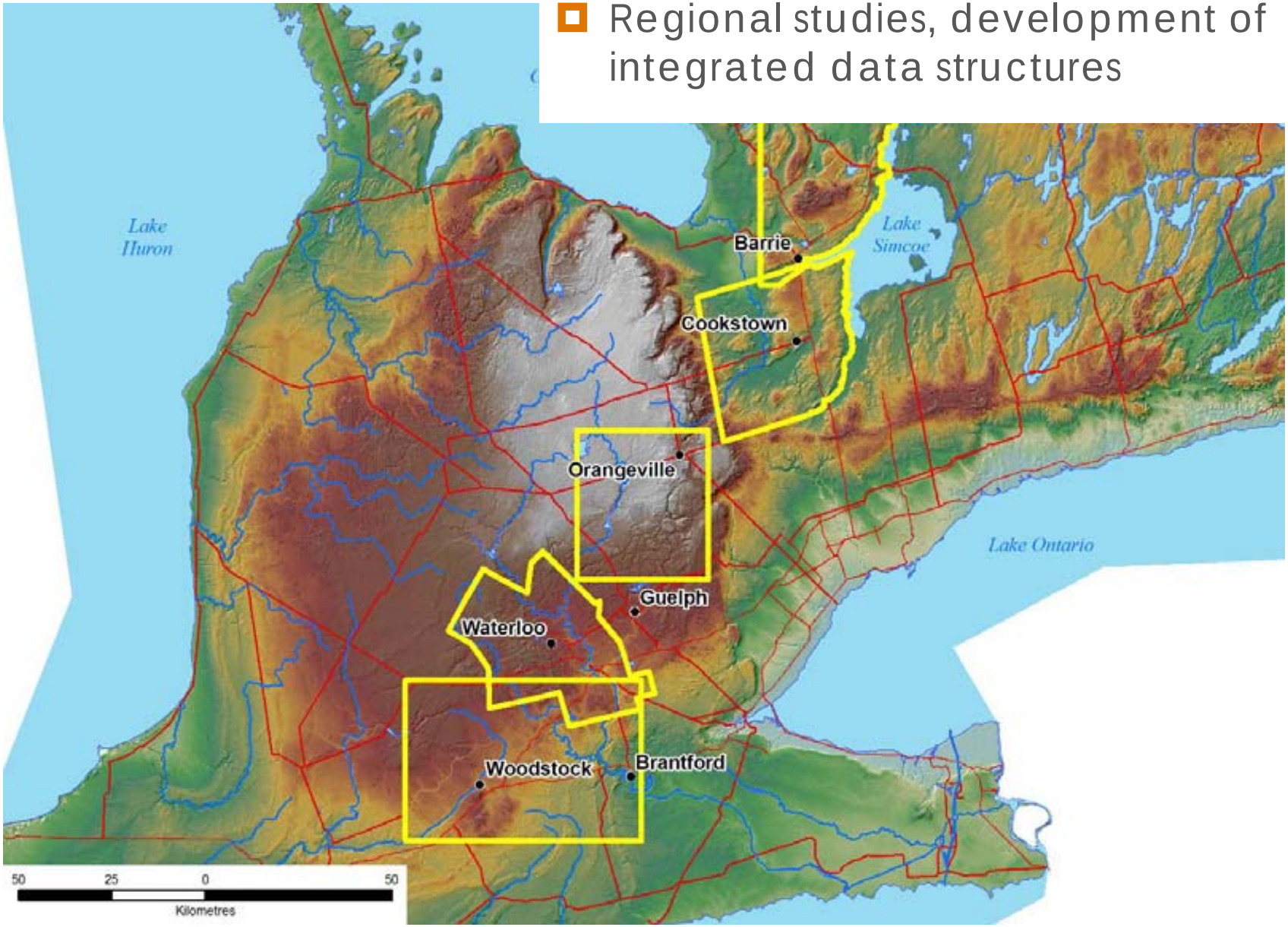
- No national pressures
- States slowly coming to terms with groundwater shortages
- State-Survey-led discussions, Top-down, not as successful
- No USGS mapping program in glacial seds, good mapping for mineral resources, hazards
- State-led fragmented approach
- Great Lakes Geological Mapping Coalition
- Initial move to flow models ahead of geologic mapping
- Later call for geology to aid parameterization…reduce uncertainties

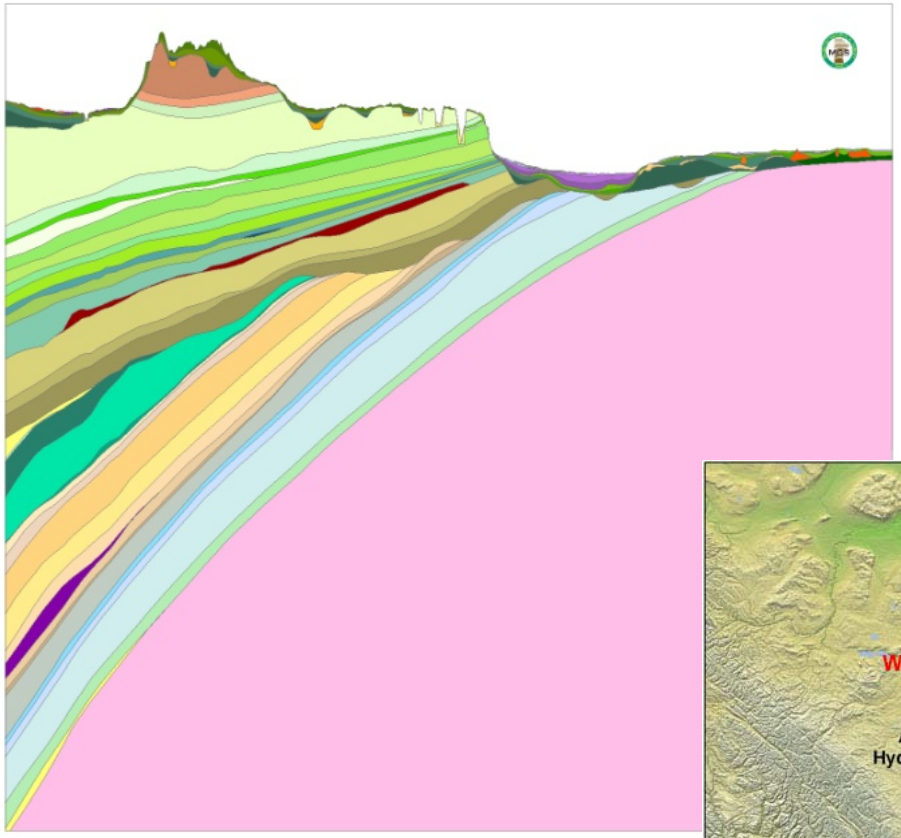


Current Strategies

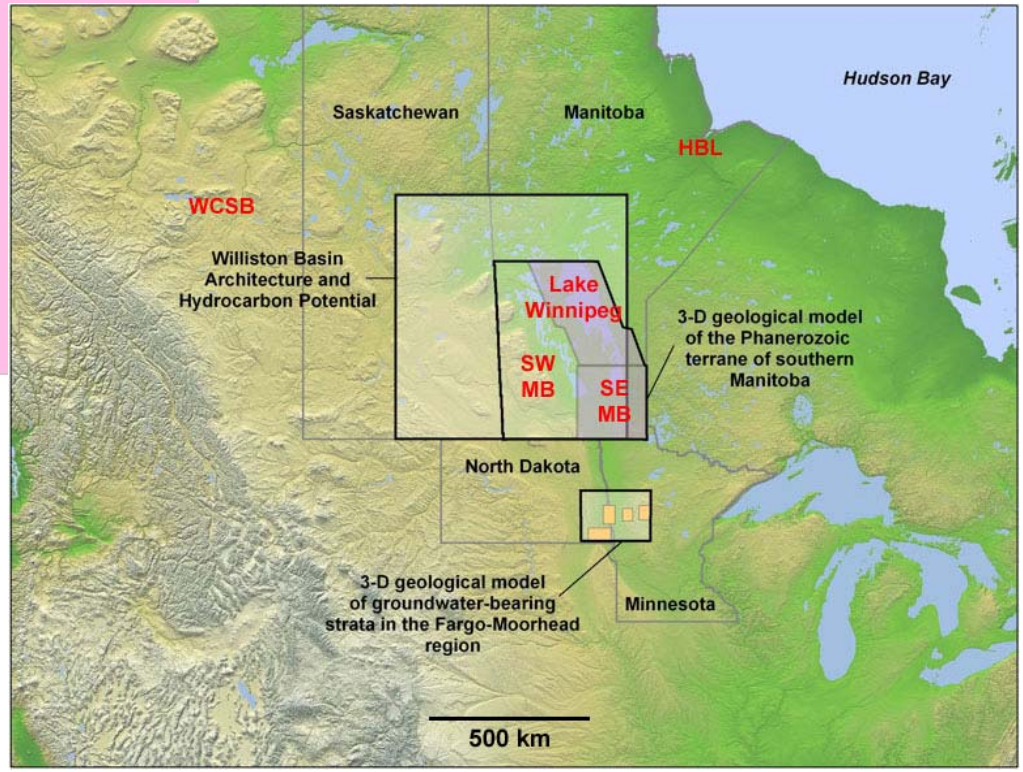
- Data format and metadata standardization
  - Institutional
  - International…may be nearing maturity
- Institutional product-focused, map-integration, strategies
- Geostatistical methods for describing within mapping-unit variabilities…simulation of multiple possible interpretations
- Increased use of geophysics…particularly HTEM
- Integration and management of large data
  - Lidar
  - HTEM
  - Simulation results (Monte Carlo)

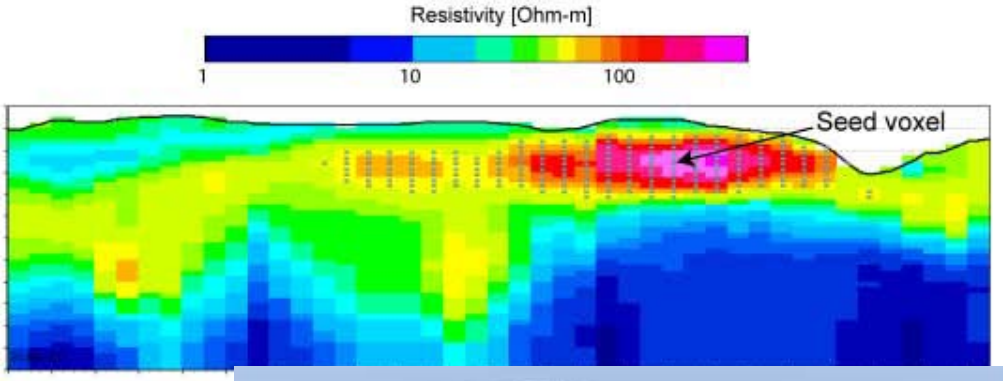
- Regional studies, development of integrated data structures

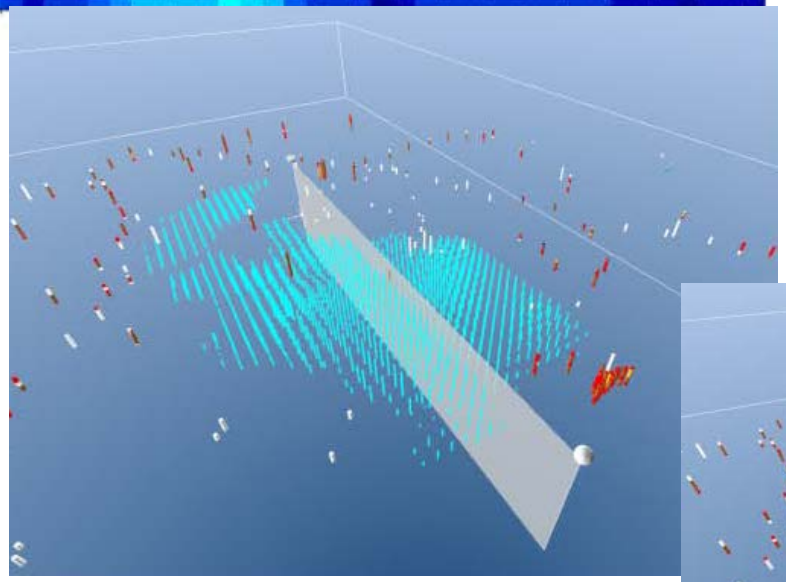


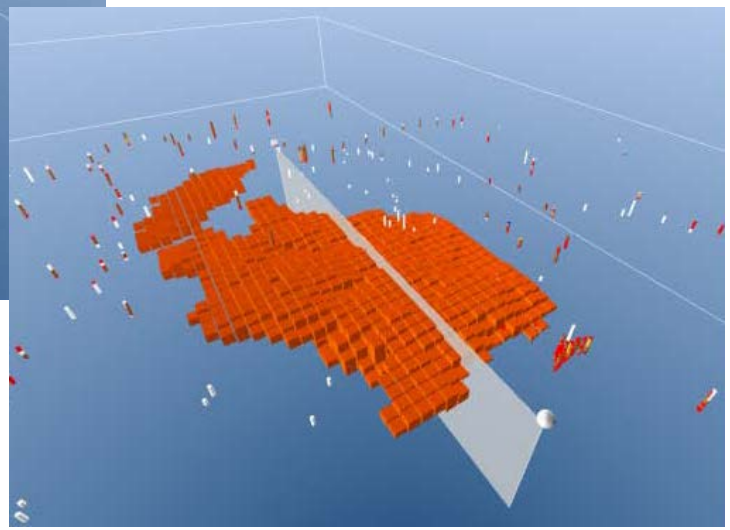


- Alternative map products
- Regional compilations and merging of separate mapping projects



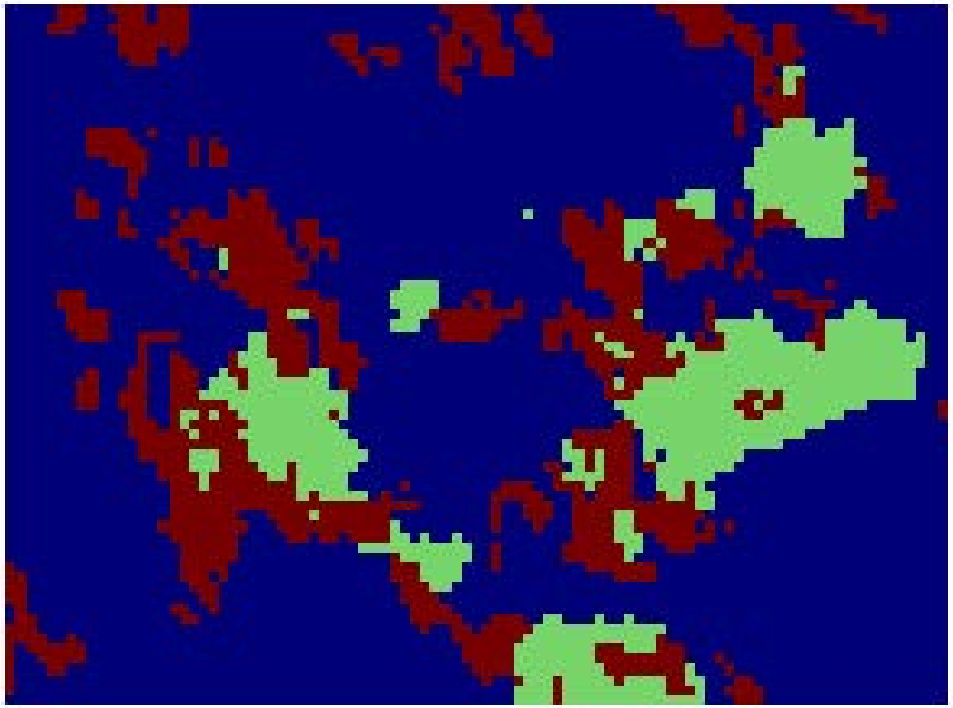




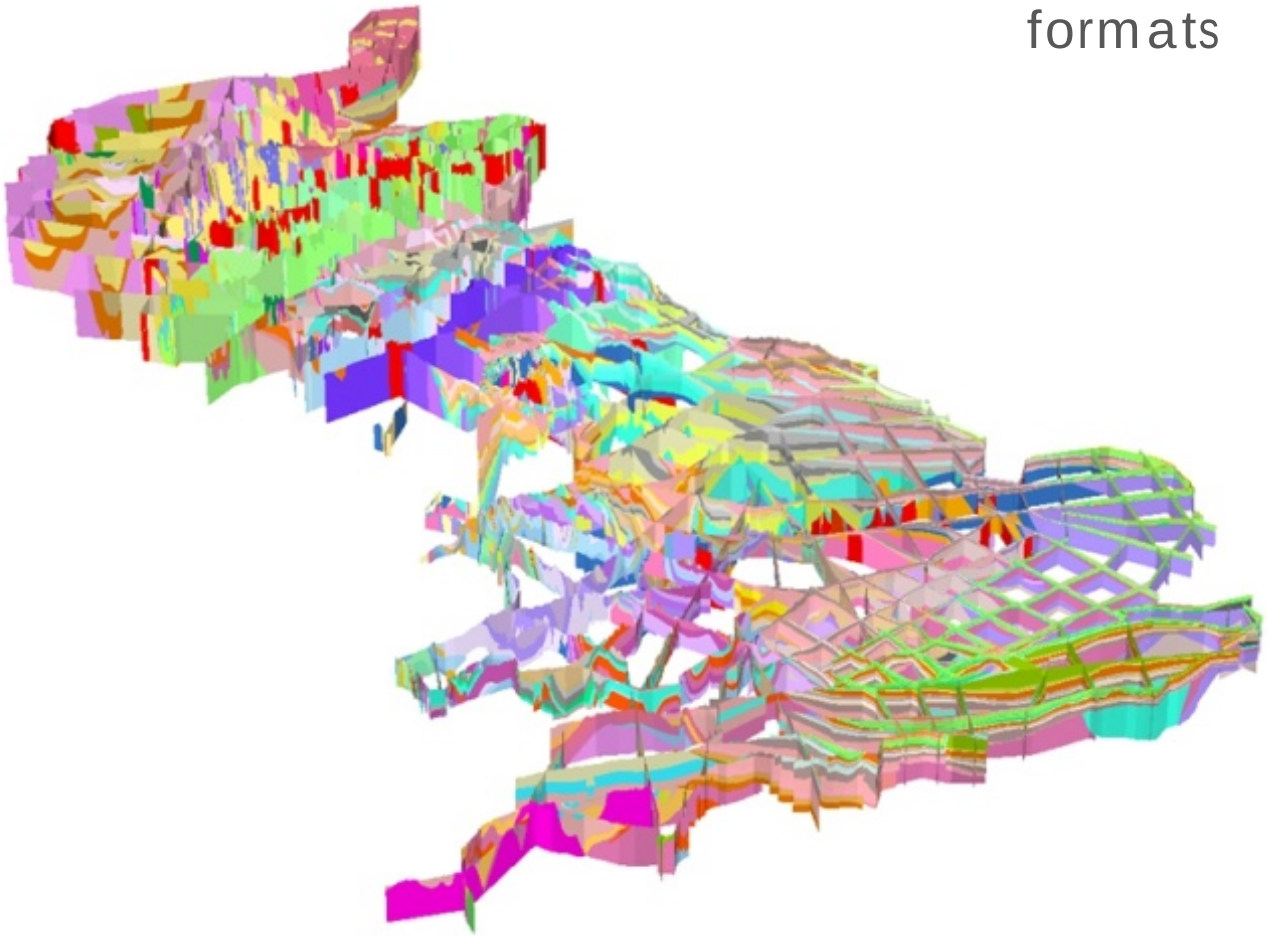


- Helicopter-borne Time-domain Electromagnetic data collection and interpretation

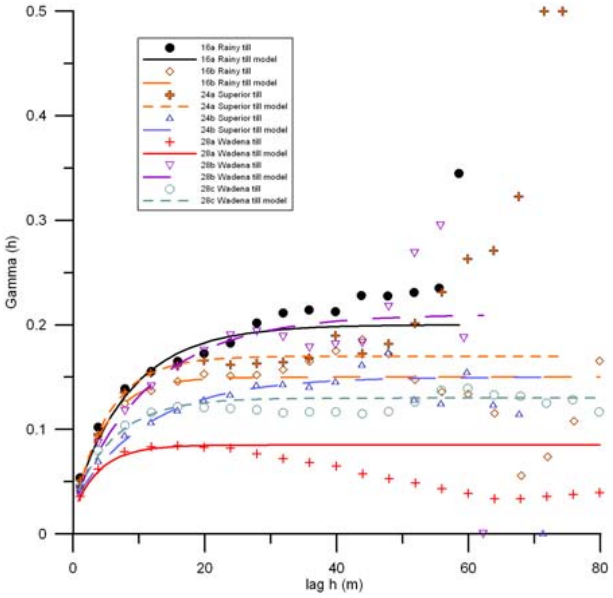
- Multiple Point Statistics rely on training images to constrain simulations

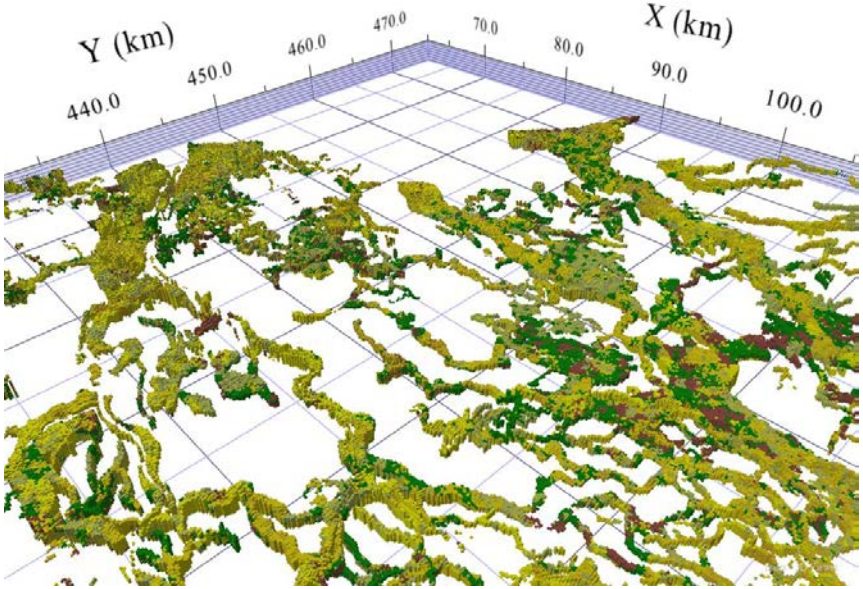


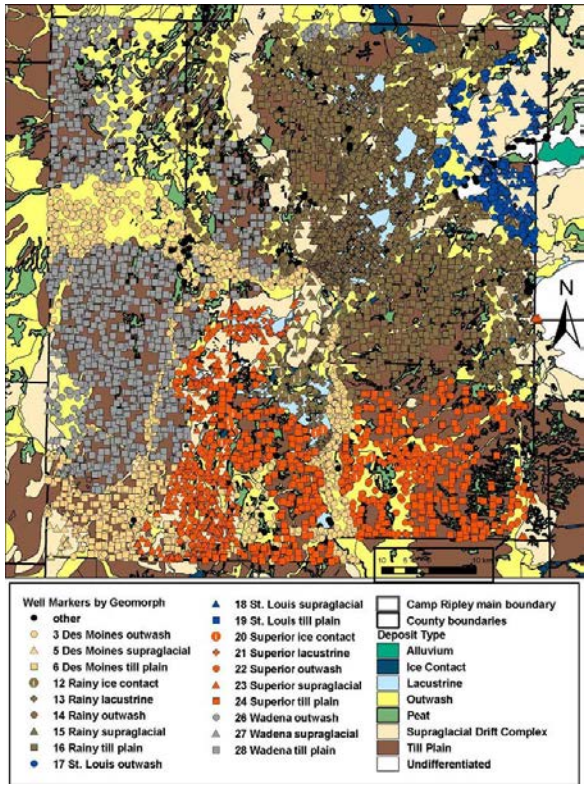
- Creation of regional models, in alternate formats



- Innovations in use of statistical and geologic knowledge



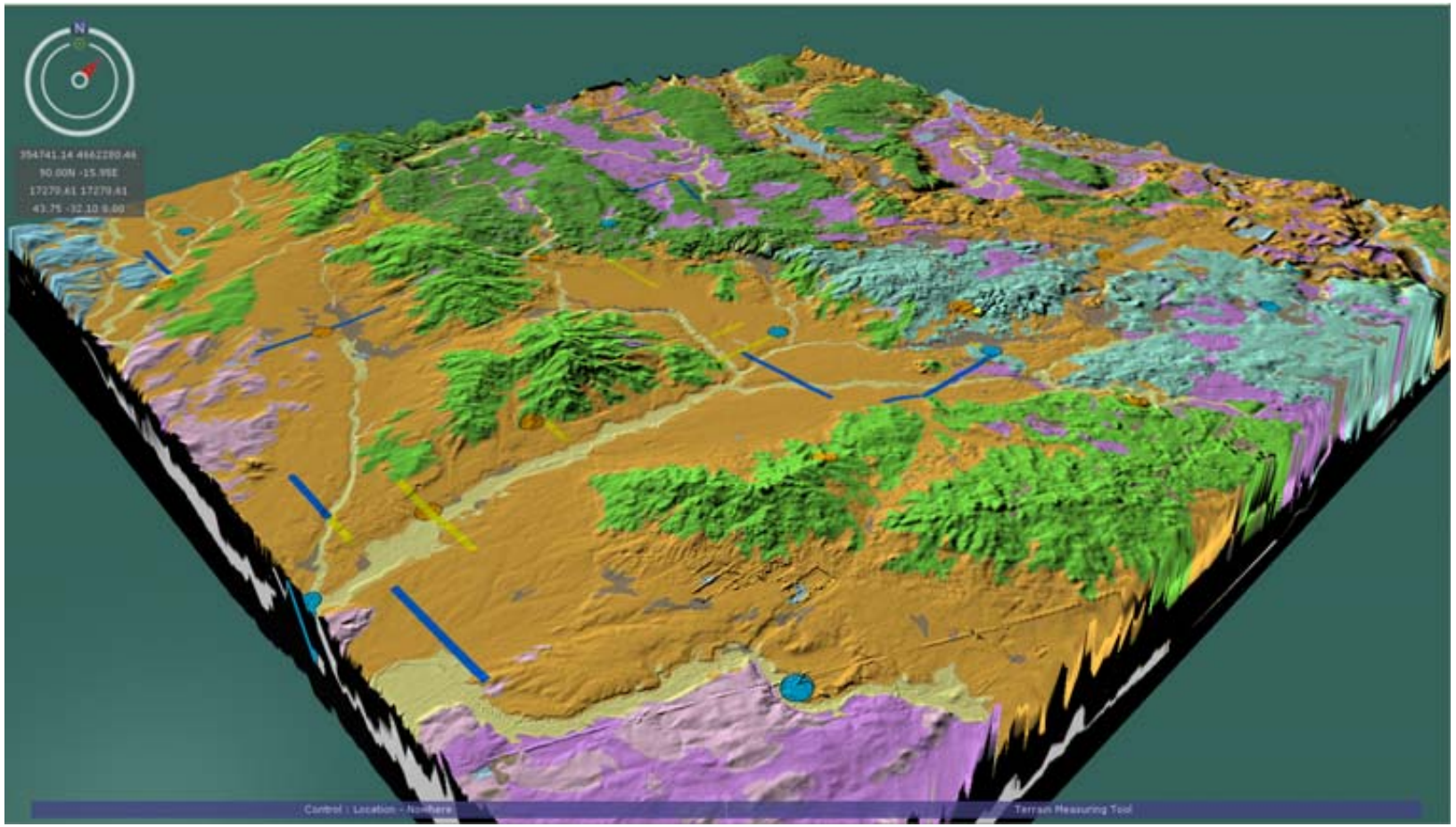




Looking to the future…

- Integrating geologic knowledge
  - Improved predictions, less worry about bias
- Further focus on simulation to understand uncertainties
  - Data
  - Interpretations
  - Geometries
  - Within-unit variabilities
- Institutional data storage and archiving
- AEM as a strategic tool
- Advances in software
  - Incorporation of more geologic constraints
  - Integration of select statistical methods
  - Advances in product delivery

- Integration of Lidar data, reliance on high-quality visualization for analyzing and interpreting the data.



http://lsgs.illinois.edu/three-dimensional-geologic-mapping

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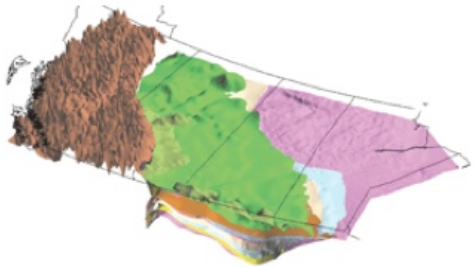
Three-Dimensional Geological Mapping



There is an increasingly pressing need for high-quality 3-D geological information about shallow deposits as attention to environmental and land-use issues grow, particularly in urban and suburban areas. Attention is also turning to the study of regional groundwater systems and to their long-term sustainable development. Although technological capability is accelerating even as these demands for information are becoming increasingly more compelling, there is a continuing lack of high-quality data. This situation is particularly true in the densely populated and industrialized parts of the United States, Canada, and Europe, which are covered by thick glacial deposits. The ongoing challenge of this complex geology produces a sustained and urgent need for developing optimal mapping and modeling methods. We must therefore ensure good communication among mappers who are (1) experimenting with new ways to deal with large data sets, (2) developing ways of integrating data of variable quality with high-quality test holes and geophysics, and (3) developing methods to construct 3-D geological models of appropriate detail that can be used for land and water applications, such as hydrogeologic modeling.

Six workshops on geological mapping for groundwater applications have addressed this need. The first workshop was held at the 2001 North-Central GSA meeting in Normal, Illinois. The second workshop was held prior to the annual 2002 GSA meeting in Denver, Colorado. The Illinois State Geological Survey and the Geological Survey of Canada chaired and sponsored both events. The third workshop was held at the annual 2004 Geological Association of Canada/Mineralogical Association of Canada meeting in St. Catharines, Ontario. The fourth

Search

- Advanced Energy Technology Initiative (AETI)
- Coal
- Engineering Geology
- Environmental Assessments
- Geochemistry
- Geophysics
- Hydrogeology
- Industrial Minerals
- Mapping
  - 3-D Mapping Workshops
    - Abstract Ordering Information
    - Workshop Contact Information
    - Workshop Extended Abstracts
  - 3-D Modeling in McHenry County
  - Kentucky Mapping Program