Kane County Water Resources Investigations: Final Report on Geologic Investigations

William S. Dey, Alec M. Davis, B. Brandon Curry, Donald A. Keefer, and Curt C. Abert

Illinois State Geological Survey
615 E. Peabody Drive
Champaign, Illinois 61820-6964

Submitted under Contract No. 02-279 to
Kane County, Illinois
Water Resources Department
Paul Schuch, Project Manager
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EXECUTIVE SUMMARY

This report summarizes the final results of a multiphase investigation on the water resources of Kane County. The objective of this report is to describe geologic and hydrogeologic mapping of Kane County as part of an assessment of its water resources (Meyer et al. 2002). The emphasis of this geologic mapping effort is on the Quaternary deposits and underlying shallow bedrock formations.

The population of Kane County was 317,471 in 1990 and 404,119 in 2000, an increase of about 27%. The Kane County population is projected to grow to 710,000 by 2030 (Kane County 2004). In anticipation of the need for reliable information on available water resources, the County has contracted with the Illinois State Water Survey (ISWS) and Illinois State Geological Survey (ISGS) to assess these resources (Meyer et al. 2002). The overall goal of this assessment is to provide Kane County with the scientific basis for developing policies and management strategies for its water resources.

This document builds on the work reported in *Kane County Water Resources Investigations: Interim Report on Geologic Investigations* (Dey et al. 2004) and *Kane County Water Resources Investigations: Interim Report on Geologic Modeling* (Dey et al. 2005a). The conceptual model, project database, geologic mapping, and compilation of a three-dimensional geologic model described in those reports provided the framework for the results presented herein. During this final phase of the investigation, additional data from water-well records have been added to the project database. The lithostratigraphic assignments made from well records have been refined and augmented. More effort has been placed into mapping the shallow bedrock units. Some previously mapped major Quaternary aquifers have been redefined and renamed due to an increased understanding of the geology and hydrogeology of the area through geologic mapping associated with this report.

This report is accompanied by the following products: *Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2007b), *Bedrock Geology, Kane County, Illinois* (Dey et al. 2007c), *Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al. 2007d), *Geologic Cross Sections, Kane County, Illinois* (Dey et al. 2007a) and *Three-dimensional Geologic Model , Kane County, Illinois* (Abert et al. 2007). The first four of the five maps were produced at a scale of 1:100,000 (1 inch on the map represents 1.58 miles on the ground). The last map is a depiction of the three-dimensional model, and, because it is shown in perspective, the scale varies across the images. This report describes the methods used to produce these maps and their significance and application. The three-dimensional model described in this report was used by the ISWS for groundwater flow modeling. Results from that modeling are due out later this year (Meyer et al. 2002).

INTRODUCTION

The population of Kane County was 317,471 in 1990, and 404,119 in 2000, an increase of about 27%. The Kane County population is projected to grow to 710,000 by 2030 (Kane County 2004). In anticipation of the need for reliable information on available water resources, the County contracted the Illinois State Water Survey (ISWS) and Illinois State Geological Survey (ISGS) to assess these resources (Meyer et al. 2002). The overall goal of this assessment is to provide Kane County with the scientific basis for developing policies and management strategies for its water resources.

This final report presents the results continuing beyond those documented in *Kane County Water Resources Investigations: Interim Report on Geologic Investigations* (Dey et al. 2004) and *Kane County Water Resources Investigations: Interim Report on Geologic Modeling* (Dey et al. 2005a). The first report summarized the literature review, the development of a conceptual model, and the geologic mapping methods used in this study. Preliminary mapping results and maps were presented also. The second report described in more detail the mapping methods employed to produce a detailed three-dimensional geologic model of Kane County and presented results from that modeling effort. For this final report, the geologic model has been further refined. The new geologic model depicts the Quaternary deposits and shallow bedrock geology. The main purpose of the model is to provide a reliable representation of the geology and hydrogeology of Kane County that can be used for county-scale planning. The geologic model data have been used to produce maps of the county and as input for a groundwater flow model.

Reliable geologic input data are fundamental for generating accurate predictions from a groundwater flow model (Alley et al. 2002). The more accurately the geologic model depicts the actual field conditions, the more accurate the groundwater flow model will be (Anderson and Woessner 1992). The results from the incorporation of the geologic model into a groundwater flow models by the ISWS will be reported in the *Computer Flow Models of Aquifer Systems Used in Kane County and Supporting Hydrologic Database* (in progress).

The focus of the work covered by this report was to develop an up-to-date, accurate model of Kane County's geology with particular emphasis on groundwater resources in the unlithified deposits that overlie the bedrock. To aid in the accurate interpretation of the geology, the study area was defined to extend one township (approximately 6 miles) beyond all the edges of Kane County (fig. 1). The extended area provided for the inclusion of additional data for geologic and hydrogeologic interpretations. As a result, the accuracy of map unit boundaries near the county line was improved. The additional data from outside the county also aided in assessment of hydrogeologic influences from outside the county. Although the conceptual model and geologic interpretations extended into the adjacent counties, the main effort was concentrated inside Kane County, and only map products of Kane County have been produced at this time.

Four terms should be clarified as to their usage in this report: lithology, stratigraphy, lithostratigraphy, and hydrostratigraphy. *Lithology* refers to the descriptions of basic properties of earth materials such as texture, porosity, and color. *Stratigraphy* refers to descriptions of the age and origin of earth materials. *Lithostratigraphy* refers to a combination of the two previous terms and describes geologic units that share common origins, age, and certain physical properties. A term similar to lithostratigraphy is *hydrostratigraphy*, a term applied when combining geologic units on the basis of similar hydraulic properties, including hydraulic conductivity. Several geologic units may be grouped into a single aquifer. Conversely, a single geologic formation may be divided into both aquifers and aquitards. Because this report is focused on describing the geology of the shallow groundwater resources of Kane County, the lithologic properties of main concern are those that define a recognizable geologic unit as being composed of aquifer or non-aquifer materials.

This report summarizes the methods used in mapping the geology of Kane County and presents the mapping results, a geostatistical assessment of the reliability of the results, and a summary of the geologic maps that accompany this report

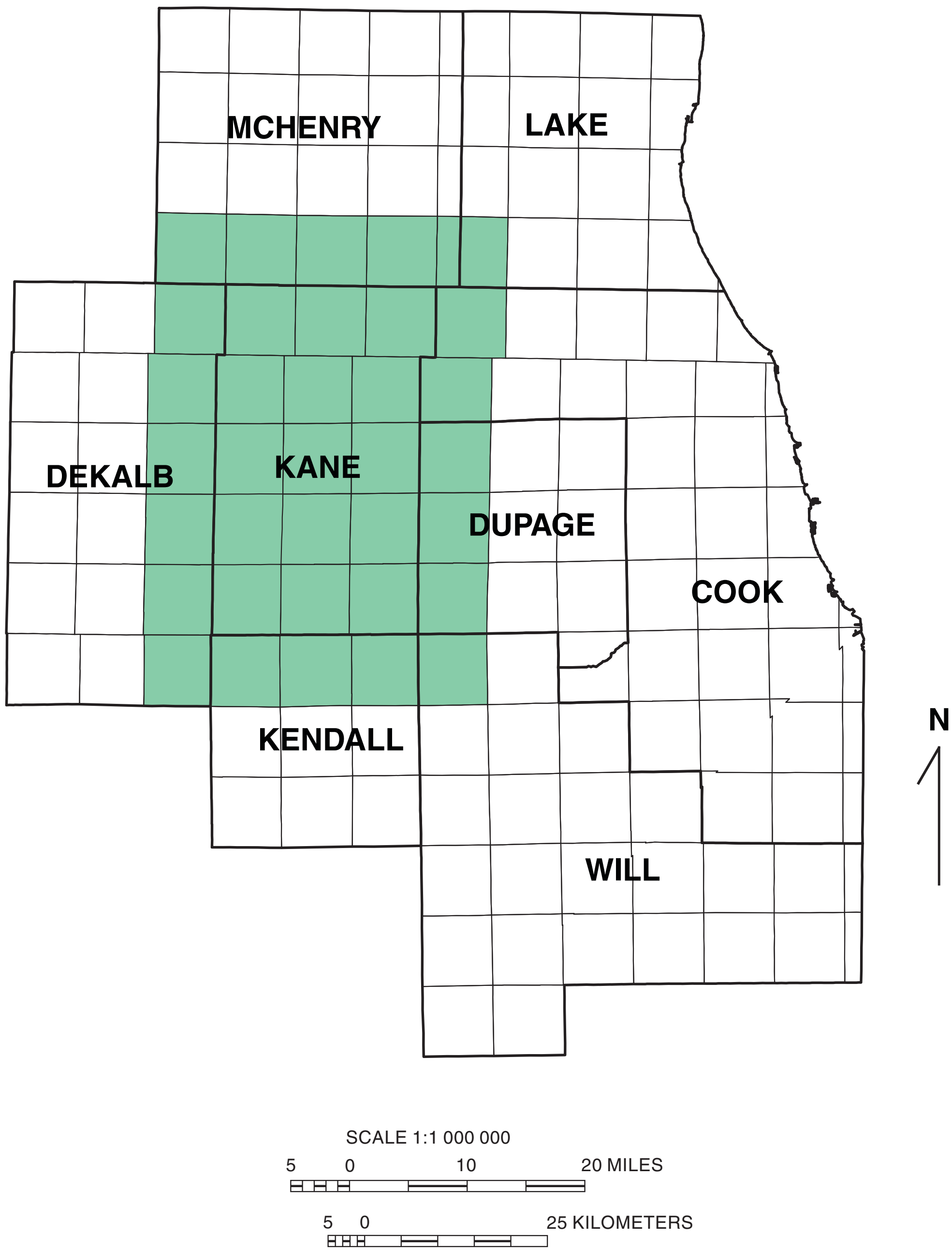

Figure 1 *Location of the study area (in green).*

METHODS

The methods used in geologic mapping and in developing the three-dimensional geologic model are described in detail in *Kane County Water Resource Investigations: Interim Report on Geologic Investigations, Kane County, Illinois* (Dey et al. 2004) and *Kane County Water Resources Investigations: Interim Report on Geologic Modeling, Kane County, Illinois* (Dey et al. 2005a). A brief summary of these methods follows.

Conceptual Model

A conceptual model of the geology of Kane County and the adjacent buffer was developed.

The conceptual model is a compilation of the current understanding of the County's geology and the processes by which it formed. This model reflects current interpretations of information from previously published materials, knowledge gained by ISGS staff and colleagues from other studies in Kane County and northeastern Illinois, and the efforts undertaken for this mapping project. The basic components of the conceptual model are the lithostratigraphic units, which are the layers of sediment that occur in a particular position in the succession of materials. Lithostratigraphic units have characteristic physical properties (such as particle-size distribution, color, and consistency) that are readily observed in the field. The units are extensive enough to justify showing them on maps and cross sections at a scale of 1:100,000. The conceptual model reflects our current understanding of how the properties and geometries of the lithostratigraphic units influence the hydrogeology of the area.

The glacial geology of northeastern Illinois was first described by Leverett (1899). From the late 1920s to the 1970s, ISGS scientists and graduate students periodically have mapped the geology of Kane County at scales of 1:62,500 to 1:100,000 (Leighton 1925, Leighton et al. 1928–1930, Gross 1969, Gilkeson and Westerman 1976, Kempton et al. 1977, Masters 1978, Kemmis 1978, Wickham 1979, Wickham et al. 1988). The physical attributes of several glacially deposited units were characterized by particle-size distribution, clay mineralogy, clast lithology, and geophysical logging (Hackett and Hughes 1965; Lund, 1965; Landon and Kempton 1971; Reed 1972, 1975; Kemmis 1981; Wickham et al. 1988). The geology of Kane County was thoroughly investigated during the effort to site the U.S. Department of Energy's Superconducting Super Collider in northeastern Illinois (Kempton et al. 1985, 1987a, 1987b; Curry et al. 1988; Graese et al. 1988; Vaiden et al. 1988). The focus of the Superconducting Super Collider investigation was the suitability of the bedrock under the region for construction of a tunnel to contain a particle accelerator. As an outgrowth of that study, digitized maps at a scale of 1:62,500 were published for bedrock topography (Vaiden and Curry 1990), drift thickness (Erdmann et al. 1990), stack units to a depth of 15 m (Curry 1990a), Tiskilwa Formation isopach (Curry 1990b), and other features. Recent hydrogeological investigations in Kane County have used seismic refraction, electrical earth resistivity surveys, test borings, and pumping tests to further characterize the glacial sediment and to locate groundwater resources (Gilkeson et al. 1987; Heigold 1990; Larson and Orozco 1991, 1992; Larson et al. 1991, 1992; Morse and Larson 1991; Curry et al. 2001b).

The glacial history of Kane County has been summarized by Curry et al. (1999), working from a stratigraphic framework developed by Willman and Frye (1970) and Hansel and Johnson (1996). Drawing heavily from these sources, Dey et al. (2004) described the conceptual model and the vertical and lateral distribution and some material properties of the lithostratigraphic units in Kane County. The lithostratigraphic units in the county are shown in figure 2. Figure 3 is a schematic diagram of the lateral and vertical relationships between units of the Mason and Wedron Groups and other geologic units. Figure 4 is a geologic map of Kane County showing the areal distribution of the lithostratigraphic units that are present at the ground surface.

A key component in developing and refining the conceptual model has been the ISGS program to map surficial deposits at a scale of 1:24,000 with funding from county agencies, the U.S. Geological Survey (USGS)-funded STATEMAP and EDMAP programs, and internal sources (fig. 5 and table 1). STATEMAP and EDMAP are both components of the National Cooperative Geologic Mapping Program. For EDMAP, the USGS partially funds graduate students to map a quadrangle under the guidance of the student's advisor and with the cooperation of the ISGS. Maps that are completed under the STATEMAP or EDMAP program may be available as downloadable files on the ISGS Web page http://www.isgs.uiuc.edu/maps-data-pub/maps.shtml. With some additional work and editing, completed STATEMAP quadrangle maps may be published by the ISGS as part of the Illinois Geologic Quadrangle Series (IGQ series). Some completed STATEMAP quadrangles are published as part of the Illinois Preliminary Geological Map Series (IPGM series); these maps receive light editing to speed their availability.

Material Description	Unit	Interpretation
	HUDSON EPISODE (~ 12,500 years B.P. to present)	
Sand and gravel; well-sorted sand and lenses of peat, grading laterally to silt and clay	Cahokia Formation c	Floodplain alluvium along rivers and streams
Peat and muck (black and brown); interbedded sand, silty clay (gray), and marl (white to light gray)	Grayslake Peat gr	Decomposed wetland vegetation and sediment in depressions and on toe slopes
	HUDSON AND WISCONSIN EPISODES (~ 55,000 years B.P. to present)	
Silt, clay, and fine sand; layered to massive; gray to brown	Equality Formation e	Lake deposits in kettles and some valleys tributary to the Fox River
	WISCONSIN EPISODE (~12,500 - 75,000 years B.P.)	
Silt and clay at ground surface; upper foot or so organic-rich in most places; contains abundant soil structures, burrows, roots, etc.	Peoria Silt p	Windblown fines (loess) modified by modern soil processes
Sand and gravel, or sand; contains lenses of silt and clay, or diamicton	Henry Formation h	Proglacial outwash deposited in channels, deltas, and alluvial fans as outwash plains downslope of glacial margins or also in kames
Diamicton; sandy loam to loam; dolomite-rich; yellowish brown; includes lenses and layers of sand and gravel	Haeger Member, Lemont Formation lh	Till and debris flow deposits associated with the Woodstock Moraine
Diamicton; silty clay, silty clay loam, and clay; gray, oxidizing to yellowish brown; includes layers of sand and gravel, silt, and silty clay	Yorkville Member, Lemont Formation ly	Till and debris flow deposits associated with the St. Charles and Minooka Moraines
Diamicton; sandy loam, loam, and silt loam; gray to grayish brown, oxidizing to yellowish brown to brown; includes common layers of sand and gravel or silt and sorted sediment	Batestown Member, Lemont Formation lb	Till and debris flow deposits associated with the Elburn Complex, Farm Ridge, and Arlington Moraines
Diamicton; clay loam to loam with lenses of sand and gravel, or sand; reddish brown, oxidizing to brown	Tiskilwa Formation t	Till and debris flow deposits forming the Marengo Moraine and Bloomington Morainic System
	ALTON SUBEPISODE, WISCONSIN EPISODE (~ 55,000 to 24,500 years B.P.)	
Silt and clay; organic-rich, black to brown; leached of carbonate minerals; contains wood fragments	Robein Member, Roxana Silt rr	Deposits accreted in low-lying areas; patchy distribution
	ILLINOIS EPISODE (~ 200,000 to 130,000 years B.P.)	
Diamicton; sandy loam to loam, reddish brown, pinkish brown, and brown; bouldery in places, with abundant lenses and layers of sand and gravel	Glasford Formation g	Till, debris flow deposits, outwash, lake sediment
	PALEOZOIC ERA (~570 to 225 million years ago)	
Dolomite; microcrystalline; cherty in places (Kankakee and Joliet), shaly, fossiliferous dolomite, shale, and thin beds of vuggy dolomite (Maquoketa Group)	Kankakee and Joliet Formations; Maquoketa Group Pz	Bedrock

Figure 2 *Stratigraphic framework of the glacial drift and shallow bedrock in Kane County.*

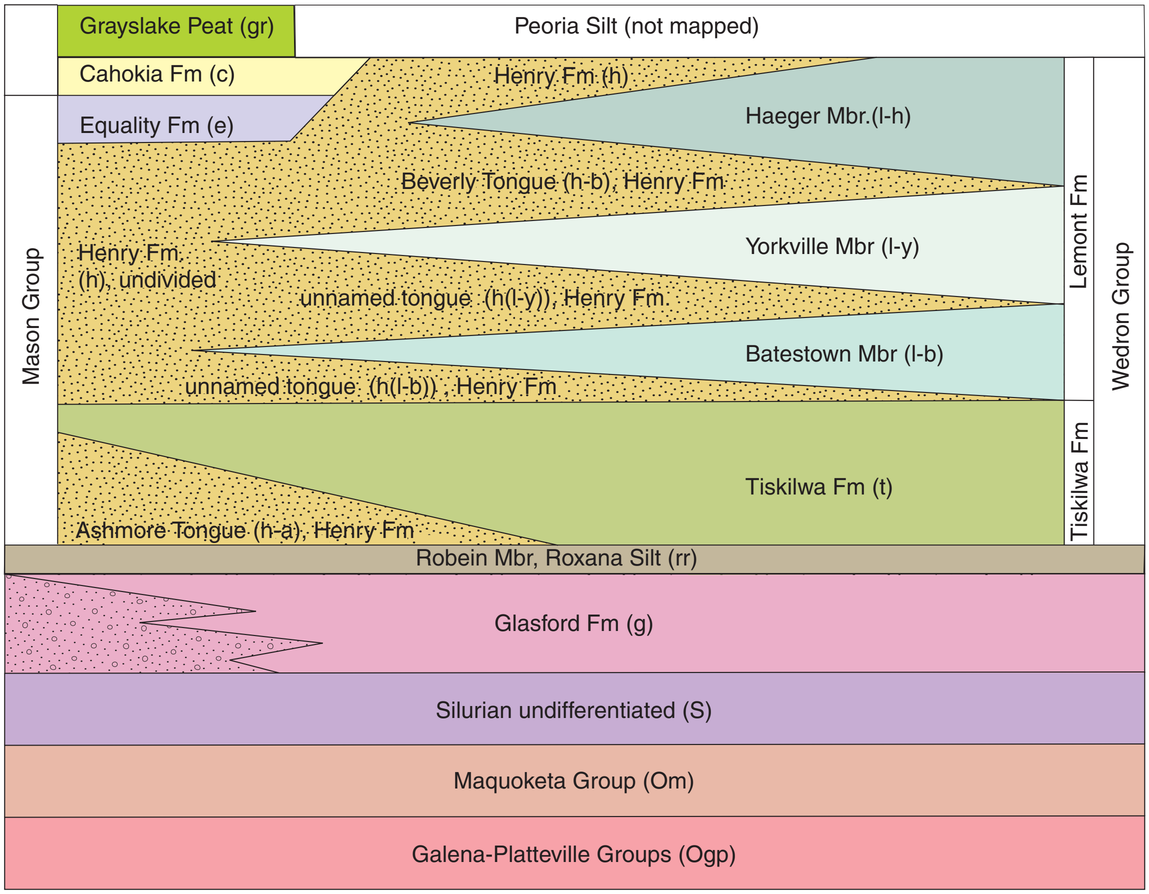

Figure 3 *Schematic diagram showing lateral and vertical relationships between Mason Group units and diamictons of the Wedron Group and the vertical sequence of shallow bedrock units below the Glasford Formation (modified from Curry et al. 1999).*

STATEMAP surficial geology quadrangle maps that have been published in the IGQ or IGPM format include Hampshire (Curry 2007b) and Maple Park (Grimley 2004). Published geologic quadrangle maps funded by ED-MAP include Barrington (Stravers et al. 2002), Big Rock (Stravers et al. 2001), Genoa (Konen 2006a), and Sycamore (Konen 2006b). For Kane County, additional IGQ maps of the surficial geology have been completed for the following 7.5-minute quadrangles: Aurora North (Curry 2001), Crystal Lake (Curry 2005), Elburn (Grimley and Curry 2001a), Elgin (Curry 2007a), Geneva (Grimley and Curry 2001b), Pingree Grove (Grimley 2006), and Sugar Grove (Curry et al. 2001b).

Data Acquisition and Management

Records of water wells and other borings on file at the ISGS were the main source of data for geologic mapping. A project database was constructed to facilitate the use of these records (Dey et al. 2004). For simplicity, the term *wells* is used to refer to the data from water wells or other types of borings. Currently, the project database contains 30,825 wells and 9,313 other forms of point data, such as seismic data, outcrop descriptions, and other observations made at the land surface.

A primary data set was created as a subset of all well records and point data in the project database. Wells were selected for the primary data set based on the quality of both the descriptions of the geologic material and location information. Wells included in the primary data set are referred to in this report as primary wells. A goal was to have a somewhat evenly distributed set of primary wells across the study area, with one well per each quarter section. This goal was not achieved in some areas and was exceeded in others. Wells have continually been added

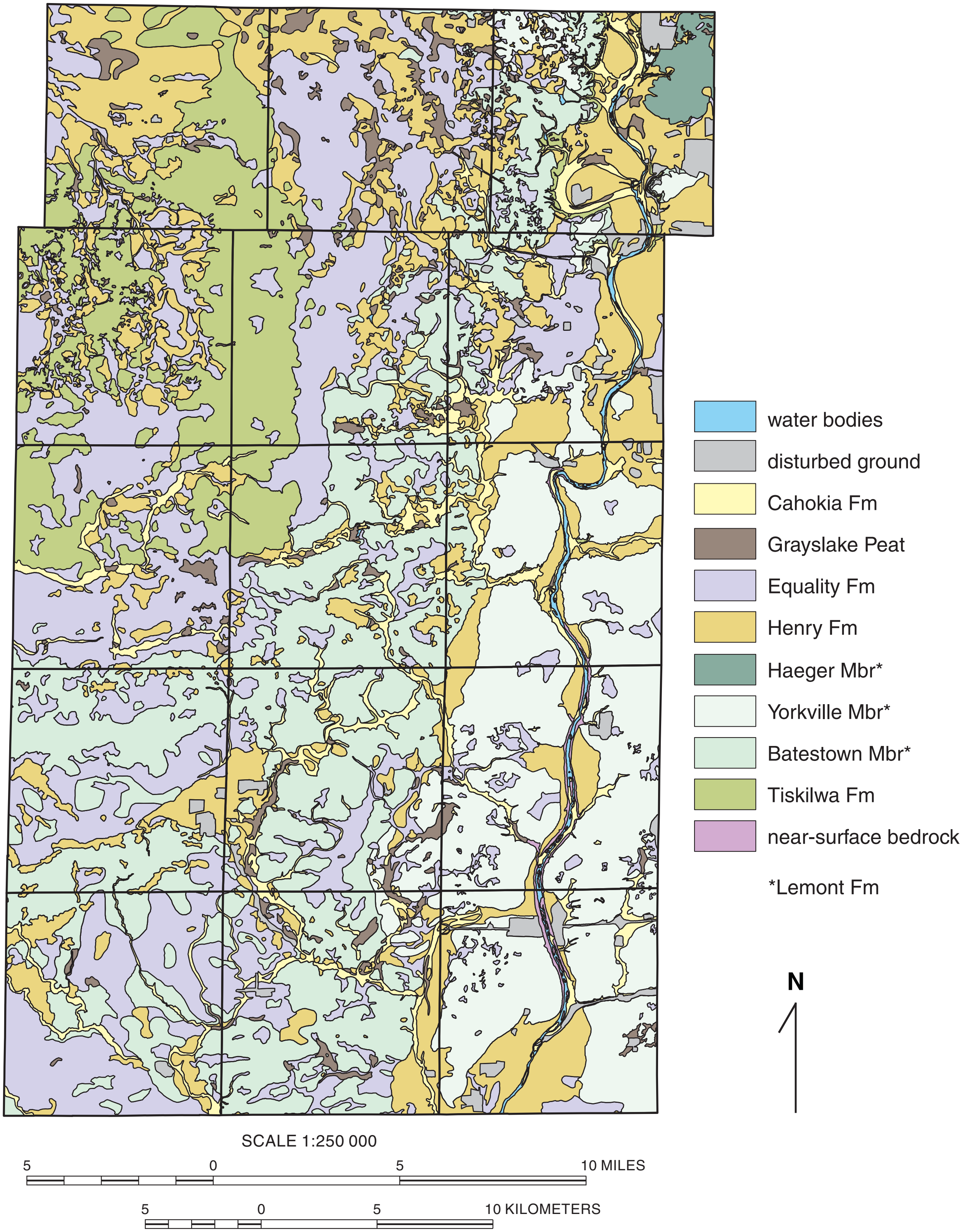

Figure 4 *Lithostratigraphic units that are present at the ground surface.*

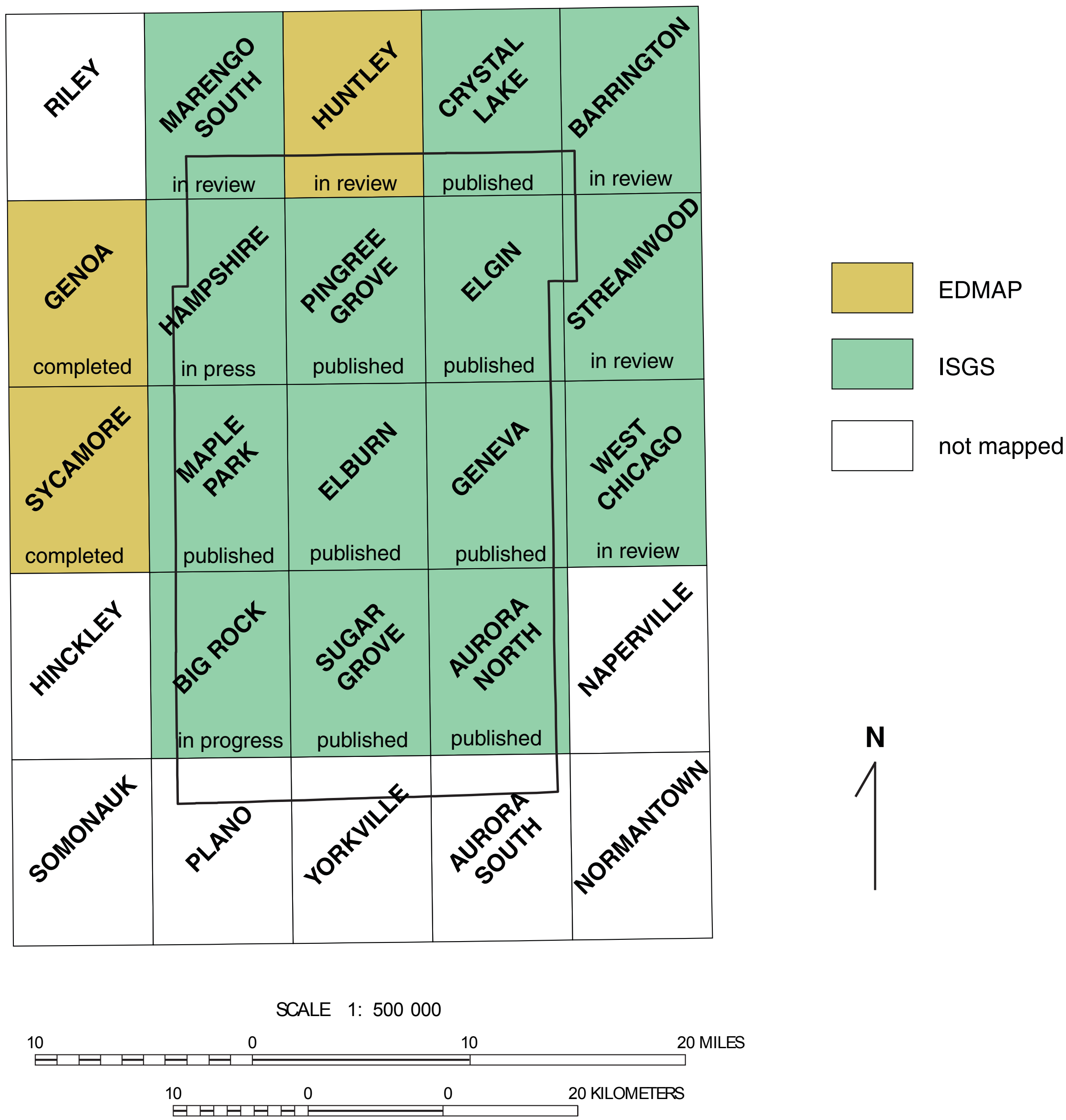

Figure 5 *U.S. Geological Survey 7.5-minute quadrangles in Kane County and adjoining areas and the status of associated geologic maps.*

to the primary data set as additional wells useful to mapping the geology of the area have been identified. For example, most of the wells from the ISWS piezometric monitoring network (Locke and Meyer 2005) were correlated to wells in the project database and were added to the primary data set. A total of 4,830 wells have been designated as primary wells.

To ensure the quality of the data used in the geologic investigation, a simple ranking system was used to characterize the usefulness of each boring record with regard to geologic content (correctness and completeness of the data, with emphasis on Quaternary materials) and location. Outcrops and the lithologic logs from stratigraphic, structural, and bridge borings described by geologists or engineers provide the most accurate, precise, and complete geologic records. Reliability of the description may be enhanced by the existence of cores, sample sets, or geophysical logs from the drill holes. Sample sets are the split samples of the washed cuttings (drilling residue brought up with the drilling fluid, usually a thick drilling mud) collected during drilling by the drillers and saved for more detailed description or analysis. The ISGS keeps a repository of sample sets collected from across the state in the ISGS Geological Samples Library. Written logs from water-well records vary greatly in their usefulness to geologic mapping. Some drillers provide high-quality, thorough descriptions of the materials encountered during drilling. Other descriptions on well logs are vague or contain colloquial terms. For example, the reddish brown loam diamicton of the Tiskilwa Formation may be described in a high-quality description as "hard red sandy clay with boulders" or may be generalized as "clay" or "drift." Some records may be useful for identifying only the top of the bedrock surface. As with stratigraphic borings, the reliability of a water-well log is greatly enhanced when a geophysical log has been made of the hole, or when a sample set is available.

The data quality of each boring or well record was ranked on a scale from 1 to 5. Stratigraphic borings accompanied by geophysical logs or sample sets were rated the highest at 5. Stratigraphic borings alone were ranked 4, as

Table 1 Status of 1:24,000 quadrangle geologic mapping in Kane County and adjacent areas.

Quadrangle	Map type	Series[1]	Authors	Year published
Aurora North	surficial geology	IGQ	Curry	2001
	bedrock topography	IGQ	Curry	2001
Aurora South	not mapped			
Barrington	surficial geology		Thomason	in review
Big Rock	surficial geology		Curry	in progress
Crystal Lake	surficial geology	IGQ	Curry	2005
	bedrock topography	IGQ	Curry	2005
	drift thickness	IGQ	Curry	2005
	data point locations	IGQ	Curry	2005
Elburn	surficial geology	IGQ	Grimley, Curry	2001
Elgin	surficial geology	IGQ	Curry	2007
	bedrock topography	IGQ	Curry	2007
	drift thickness	IGQ	Curry	2007
	data point locations	IGQ	Curry	2007
Geneva	surficial geology	IGQ	Grimley, Curry	2001
Genoa	surficial geology	EDMAP	Konen	2006
Hampshire	surficial geology	IGQ	Curry	In review
Hinckley	not mapped			
Huntley	surficial geology	EDMAP	Stravers	in review
Maple Park	surficial geology	IPGM	Grimley	2004
	bedrock topography	IPGM	Grimley, McTighe	2004
Marengo South	surficial geology		Curry	in review
Naperville	not mapped			
Normantown	not mapped			
Pingree Grove	surficial geology	IGQ	Grimley	2005
Plano	not mapped			
Riley	not mapped			
Somonauk	not mapped			
Streamwood	surficial geology		Stumpf	in review
Sugar Grove	surficial geology	IGQ	Curry et al.	2001
	bedrock topography	IGQ	Curry	2002
Sycamore	surficial geology	EDMAP	Konen	2006
West Chicago	surficial geology		Curry	in review
Yorkville	not mapped			

[1]Illinois Geologic Quadrangle (IGQ) and Illinois Preliminary Geological Map series (IPGM) are produced by and available from ISGS. EDMAPS are student-produced mapping available through the U.S. Geological Survey or on the ISGS Web site.

were detailed water-well records accompanied by geophysical logs or sample sets. Structural or bridge borings were ranked 4, even though they generally are less than 50 feet deep. Detailed water-well records alone were ranked 3. Water well records with limited material descriptions were ranked 2. Boring records that contained illogical or unintelligible information were ranked 1.

Verification of Well Locations

Efforts were made to establish the physical location of all wells in the primary data set, both by inspection in the field and cross-referencing the well location information to other records in the office. Verification of a well location in some instances resulted in revised location information being added to the project database. All wells were ranked for the quality or accuracy of the information describing their location. With the location of each well accurately defined, a digital elevation model was used to define the land-surface elevation of the location of each well in the project database (Dey et al. 2004).

For this study, wells were ranked according to the reliability of their location. Well locations field-verified by a reliable individual were ranked 5. A rank of 4 was assigned to well locations verified by matching the well owner's name as recorded on the well record with a given house or street address. A well location verified by matching a well owner's name from the record with a given parcel of land was ranked 3. Wells with unverified locations were ranked 2. Wells having unintelligible or questionable location information were ranked 1.

Table 2 Lithostratigraphic units and their mandatory vertical sequence.

Lithostratigraphic unit
1. Disturbed land
2. Peoria Silt
3. Cahokia Formation
4. Grayslake Peat
5. Equality Formation
6. Henry Formation, surficial
7. Wadsworth Formation (d)[1]
8. Sub-Wadswoth tongue, Henry Formation
10. Haeger Member, Lemont Formation (d)[1]
11. Beverly Tongue, Henry Formation
12. Yorkville Member, Lemont Formation (d)[1]
14. Sub-Yorkville tongue, Henry Formation
15. Batestown Member, Lemont Formation (d)[1]
16. Sub-Batestown, Henry Formation
17. Tiskilwa Formation (d)[1]
18. Ashmore Tongue, Henry Formation
19. Peddicord Tongue, Equality Formation
20. Robein Member, Roxanna Silt
21. Glasford Formation, uppermost fine-textured unit
22. Glasford Formation, uppermost coarse-textured unit
23. Glasford Formation, middle fine-textured unit
24. Glasford Formation, lower coarse-textured unit
25. Glasford Formation, lower fine-textured unit
26. Bedrock, undifferentiated
27. Silurian undifferentiated
28. Maquoketa Group
29. Galena-Platteville Groups
30. Ancel Group
31. Prairie du Chien
32. Undifferentiated Cambrian formations

[1]d, diamicton lithology of the stratigraphic unit listed.

Lithostratigraphic Assignments

Lithostratigraphic assignments to recognized Quaternary or bedrock stratigraphic units were made based on the geologic information in the descriptive logs of the primary wells and by using the conceptual model, published stratigraphic interpretations, and the professional judgment of geologists working on the project. Table 2 lists the lithostratigraphic units used in making assignments and their positions in the vertical sequence. Imposition of this mandatory vertical succession kept the three-dimensional model from becoming overly complex.

The vertical sequence of lithostratigraphic units resulted in some simplification of the interpretations of the geology observed in a few well records. For example, the Equality Formation typically consists of fine-textured sediment deposited in lakes. For this report, the Equality was not differentiated in the subsurface except where directly below the Cahokia Formation or Grayslake Peat but was combined with other fine-textured units. The Cahokia Formation and Grayslake Peat were restricted such that if the Cahokia Formation was observed below the Grayslake, its observed thickness was combined with the next lower unit. Occurrences of the Wasco facies of the Henry Formation were assigned either to the surficial Henry Formation or to the sub-Batestown tongue of the Henry Formation. In the few cases where any of these substitutions were made, notes were appended to the record in the project database for future reference. Additionally, lithostratigraphic assignments used for the Glasford Formation were limited to three fine-textured facies and two coarse-textured facies within the Glasford. Very rarely were more than five distinct lithologic units observed in the Glasford Formation.

Four simplifications were made to the assigned lithostratigraphic units before any lithostratigraphic surfaces were created. First, assigned occurrences of disturbed land and Peoria Silt were combined with the underlying unit. Assigned thicknesses to both of these units were too thin to justify modeling them as independent units. The presence or absence of these units at any location was considered of very little hydrogeologic significance in a county-scale model. Second, assigned occurrences of the Robein Member of the Roxanna Silt and the Peddicord Tongue of the Equality Formation were used only to define the upper surface of the Glasford Formation and were not modeled as independent units. Although the Robein has stratigraphic significance as a marker bed, its relative thinness and discontinuous occurrence made representing it in the three-dimensional model impractical. The documented occurrences of the Peddicord were too few to justify modeling it as a separate unit. When the Peddicord occurred below the Ashmore Tongue of the Henry Formation, it was combined with underlying fine-textured units of the Glasford Formation. Occurrences of the Peddicord above the Ashmore Tongue were combined with the overlying Tiskilwa Formation. The third simplification was to model the fine-textured facies of the Cahokia Formation, the Grayslake Peat, and surficial and near-surface deposits of the Equality Formation as a single near-surface unit, hereafter referred to as the surficial fine-textured layer. All three units tend to occupy low-lying areas on the landscape and occur commonly in association throughout the study area. Coarser-textured facies of the Cahokia Formation were assigned to the Henry Formation for this modeling effort. Fourth, initially only an upper surface of the Glasford was created; its lower surface was defined by the bedrock surface. The lithology of the Glasford was modeled as five discrete layers. Table 3 lists the succession of lithostratigraphic units modeled as independent layers.

As described by Dey et al. (2004), a digital map was compiled to depict the areal distribution of the uppermost lithostratigraphic units for the Kane County study area. The main input was an unpublished preliminary surficial geology map of Kane County at 1:100,000 scale compiled by Curry and Grimley (fig. 4). A grid of nodes with a spacing of ⅛ mile was superimposed on the surficial geology map of the study area. The uppermost lithologic unit was identified at each grid node, and this lithostratigraphic assignment was added to the project database.

Geologists often know more about the distribution of geologic units than is portrayed by well records or other subsurface information. For the geologic modeling process, synthetic data force computer software applications to match modeled surfaces with mapped surficial boundaries more accurately or to guide the software to map subsurface boundaries. Synthetic data were generated to define the presence or absence of units in areas of sparse data or where the existing data did not allow for adequate depiction of the geometry of the lithostratigraphic units. In some instances, synthetic data were used to give more importance to high-quality data in the modeling process. Synthetic data points were used mainly to delineate surficial or near-surface units. Synthetic data are created or defined at a location chosen by the mapper. Geologic inferences made at synthetic data points are based on the conceptual model and the judgment of the mapper. Lithostratigraphic assignments made to synthetic data points were based on conditions observed or reported at the land surface or by extrapolating between lithostratigraphic assignments made at primary wells. These synthetic data points were added to the project database.

Table 3 Lithostratigraphic units represented in the three-dimensional geologic model and their vertical sequence.

Lithostratigraphic unit
1. Surficial fine-textured unit (Cahokia, Grayslake Peat, and Equality Formations.)
2. Henry Formation, surficial
3. Wadswoth Formation (d)[1]
4. Sub-Wadsworth tongue, Henry Formation
5. Haeger Member, Lemont Formation (d)[1]
6. Beverly Tongue, Henry Formation.
7. Yorkville Member, Lemont Formation (d)[1]
8. Sub-Yorkville tongue, Henry Formation
9. Batestown Member, Lemont Formation (d)[1]
10. Sub-Batestown tongue, Henry Formation
11. Tiskilwa Formation (d)[1]
12. Ashmore Tongue, Henry Formation.
13. Glasford Formation, uppermost fine-textured unit
14. Glasford Formation, upper coarse-textured unit
15. Glasford Formation, middle fine-textured unit
16. Glasford Formation, lower coarse-textured unit
17. Glasford Formation, lower fine-textured unit
18. Top of Silurian undifferentiated
19. Top of Maquoketa Group
20. Top of Galena-Platteville Groups
21. Top of Ancell Group
22. Top of Prairie du Chien
23. Top of Cambrian (undifferentiated)

[1]d, diamicton lithology of the stratigraphic unit listed.

Lithostratigraphic Surfaces and Isopach Maps

A three-dimensional geologic model of the major lithostratigraphic units was constructed using a grid with a ⅛-mile node spacing. The modeling process defines the elevation of the top and bottom of each lithostratigraphic unit at each of these grid nodes. Where a unit is absent, the upper surface and lower surface have the same elevation value. Although we modeled lithostratigraphic surfaces with ⅛-mile spacing, we used input data on approximately ¼-mile spacing.. The finer spacing of the modeled surface allowed for flexibility in extrapolation between data from the more widely spaced wells.

The data used to create the digital three-dimensional geologic model came from the lithostratigraphic assignments made to the primary wells throughout the study area, synthetic primary wells, and the digital map of the surficial geology. The lithostratigraphic assignments define a series of points where each unit is in contact with its underlying or overlying units or the land surface.

The methods used to construct the upper and lower surfaces of the lithostratigraphic units and to compile them into a model are described in detail in *Kane County Water Resources Investigations: Interim Report on Geologic Modeling, Kane County, Illinois* (Dey et al. 2005a). In addition to the other lithostratigraphic units, a lithologic model was created for the Maquoketa Group. This unit is composed of shale and thinly bedded dolostone. This model differentiated between shales and dolostone layers. Sample set descriptions by Kolata and Graese (1983) and Graese (1991) provided a large portion of the input for the model. Additional interpretations were made from primary wells in the project database. Where sample set descriptions or drillers' logs identified the lithology as shale, those layers were assigned a numerical code of 1. Where the unit was described as dolostone, those layers were assigned a numerical code of 0. Where an interval was described as a mixture of shale and dolostone, it was assigned a value of 0.5. This numeric code is referred to as the *property value*. A file was created for every well that had lithologic assignments within the Maquoketa Group. Each file contained the x,y location coordinates, the elevation of the top, the thickness, and a property value for each lithologic unit. Additionally, units that were greater than 5 feet thick were divided into 5-foot intervals until the bottom of the unit was reached. Elevations and property values were defined for each interval. A single data set was then compiled containing the data for all the wells describing the lithology of the Maquoketa Group. The resulting data set contained the location coordinates (x, y) and the top and bottom elevations (z) for a set of units defined by a property value of 1 or 0. These data were contoured using the EarthVision® 3-D minimum tension algorithm (Dynamic Graphics Inc. 1997). This algorithm builds three-dimensional contour shells around similarly coded units. The Vertical Influence option was set during the contouring process so that the contour shells were shaped more laterally (like a hamburger) than uniformly (like a meatball). This process resulted in a three-dimensional grid with a value between 1 and 0 at each grid node. For this model, the horizontal node spacing was ⅛ mile, and the vertical node spacing was 5 feet. The 0.5-value contour was chosen to define the boundary between shale and limestone layers. The three-dimensional lithologic model was queried to produce a percent thickness as limestone of the Maquoketa Group of Kane County

The lithostratigraphic surfaces were compiled into a three-dimensional geologic model and used to create isopach maps of each modeled lithostratigraphic unit. Isopach maps are contour maps of unit thicknesses, which can be easily obtained by subtracting the elevation grid for the bottom of a unit from the elevation grid for the top of that unit. Derivative maps were created from the geologic model, such as the map of major Quaternary aquifers (described in the section beginning on p. 64).

The lithostratigraphic surfaces and isopach maps are the basic geologic maps of the Kane County study area. The lithostratigraphic surfaces and isopach maps were used to generate five maps: *Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2007b), *Bedrock Geology, Kane County, Illinois* (Dey et al. 2007c), *Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al. 2007d), *Geologic Cross Sections, Kane County, Illinois* (Dey et al. 2007a) and *Three-dimensional Geologic Model, Kane County, Illinois* (Abert et al. 2007). Although the basic geologic maps encompass the entire study area, the derivative maps cover only Kane County. Details of how the individual surfaces and isopach maps were used to construct each derivative map are included in the following section.

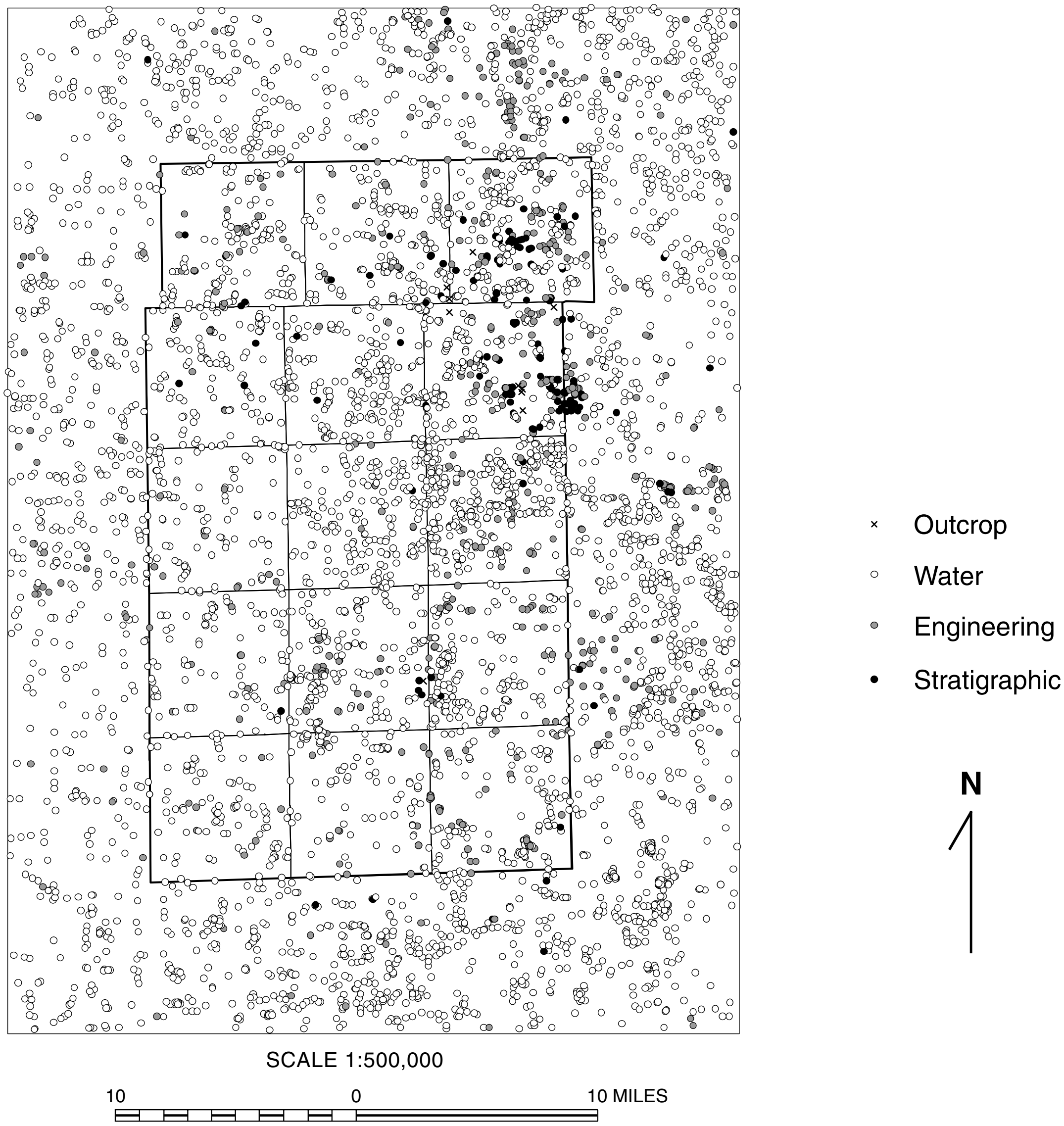

Figure 6 *Distribution of primary wells in the study area used to generate lithostratigraphic surfaces.*

RESULTS

Data Distribution and Quality

Using the methods described in the previous section to assign data quality and location quality to wells in our data set resulted in 4,830 wells being designated primary wells. Figure 6 shows the distribution of primary wells throughout the study area. Table 4 shows the number of primary wells per section in Kane County and the study area. Table 5 shows the data quality ranking of the primary wells for Kane County and the study area. Table 6 shows the location quality ranking of the primary wells for Kane County and the study area. In the process of verifying the locations of primary wells, the location of a well was adjusted when the physical location of the well did not match the location in our database. These horizontal adjustments varied from a few feet to several miles. Table 7 and figure 7 summarize the extent of the horizontal adjustments and the resulting changes in well elevation.

Table 4 Primary well distribution per section in Kane County and in the study area.[1]

Primary wells per section	Sections in County	Sections in study area
0	38	220
1	61	192
2	81	217
3	54	173
4	77	166
5	54	140
6	51	89
7	27	63
8	20	46
9	12	25
10	14	27
>10	51	76
Total		1,214

[1]1,434 total sections in study area (includes partial sections); 540 total sections in Kane County.

Table 5 Quality ranking of geologic data for primary wells in Kane County and in the study area.

Data quality	Kane County	Study area
5	112	149
4.5	9	14
4	303	513
3	1,875	4,199
2	300	581
1	0	0

Table 6 Quality ranking of location of primary wells in Kane County and in the study area.

Location quality	Kane County	Study area
5	1,591	2,644
4.5	33	34
4	366	1,041
3.5	184	431
3	212	863
2.5	189	386
2	24	57
1	0	0

Table 7 Horizontal and vertical adjustment (in feet) to wells relocated via field verification.

	GPS	Other verified	Combined
Wells relocated, no.	1,062	102	1,164
Min. location change	9.148	15	9
Max. location change	34,590	100,107	100,107
Mean location change	847	4782	1,191
Standard deviation	1,830	11,903	4,074
Median location change	393	1,656	428
More than 1 mile, no.	14	16	30
Min. elevation change	0	0	0
Max. elevation change	104	129	129
Mean elevation change	7	20	8
Standard deviation	11	26	14
Median elevation change	3	11	4
Verified, not moved	14	1,631	1,645

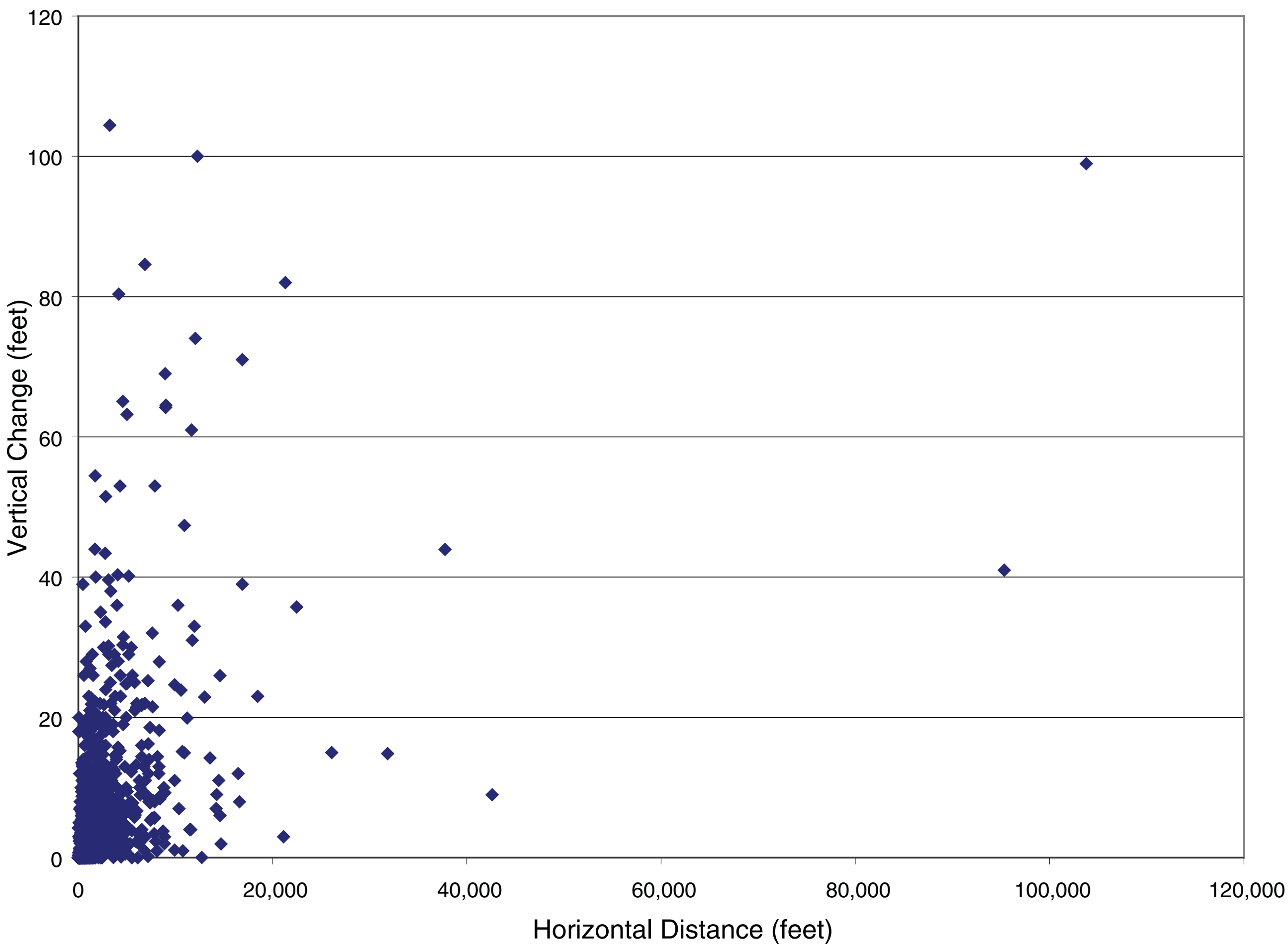

Figure 7 *Horizontal and vertical adjustments to wells assigned new location coordinates through field verification.*

Table 8 summarizes the number of assignments made to major lithostratigraphic units using data from primary wells in Kane County and in the study area. Table 9 summarizes the number of assignments made to each lithostratigraphic unit for synthetic data points in Kane County and in the study area.

Three-dimensional Geologic Model

Quaternary Geology

The methods previously described were used to produce the surfaces of the lithostratigraphic units developed from the conceptual model, where the units have lateral and vertical mapped dimensions. For example, figures 8 and 9 depict the elevation of the upper and lower surfaces of the Batestown Member of the Lemont Formation. Figure 10 is the isopach map of the same unit showing the distribution of primary wells used in mapping the unit. In this section, isopachs are shown for each of the modeled layers, resulting from the mapped defined upper and lower surface of each geologic unit. Although all of the geologic units may have varying texture across their mapped area or contain lenses of finer or coarser material, they are modeled here as homogenous units. For example, we know the Batestown member commonly contains interbeds of sand or sand and gravel of limited thickness and areal extent, but such local-scale variations are not accounted for in the model. Although we are displaying only the extent, thickness, and data distribution for each in unit in Kane County, additional data define each unit outside of the county (fig. 6 and table 8)

Surficial Fine-textured Layer

Figures 11 and 12 depict the isopach map of the surficial fine-textured layer, which is the combined thickness of Grayslake Peat, fine-textured facies of the Cahokia Formation, and surficial deposits of the Equality Formation. The Equality Formation consists of silt, clay, and fine sand deposited in quiet water under both glacial and postglacial conditions. Grayslake Peat is composed of peat in varying stage of decomposition, marl, and well-sorted sand. The fine facies of the Cahokia Formation consists of silt and clay deposited by rivers and streams. All three units commonly occupy low-lying areas on the landscape. In general, the unit is less than 10 feet thick across Kane County. The unit is 50 feet thick below Nelson Lake (Curry et al. 2001a) and greater than 20 feet thick west of Pingree Grove where Glacial Lake Pingree once existed (Grimley 2006). Figure 11 includes the distribution of the primary wells used to map the unit. Figure 12 includes the distribution of synthetic primary wells generated to help define the extent of the unit. The occurrence of this unit is more commonly identified at the land surface from soils maps or direct observation than from descriptions in well records. Synthetic data were used to assist in generating an isopach map for this unit in areas where it was observed at the land surface, and primary well data were insufficient for mapping its extent. The isopach map is the same as a depth map because the upper surface of this unit is at the land surface.

Table 8 Number of primary wells and lithostratigraphic assignments representing the surfaces of mapped units.

Lithostratigraphic unit	Kane County	Study area
Top of Equality Formation	878	1,449
Bottom of Equality Formation	875	1,433
Top of Henry Formation, surficial	810	1,481
Bottom of Henry Formation, surficial	806	1,471
Top of Wadsworth Formation (d)[1]	0	488
Bottom of Wadsworth Formation (d)[1]	0	453
Top of sub-Wadsworth tongue	0	170
Bottom of sub-Wadsworth sand and gravel	0	169
Top of Haeger Member (d)[1]	9	555
Bottom of Haeger Member (d)[1]	10	540
Top of Beverly Tongue, Henry Formation	12	602
Bottom of Beverly Tongue, Henry Formation	12	591
Top of Yorkville Member (d)[1]	531	1,527
Bottom of Yorkville Member (d)[1]	554	1,472
Top of sub-Yorkville tongue	223	742
Bottom of sub-Yorkville sand and gravel	221	733
Top of Batestown Member (d)[1]	1,329	2,005
Bottom of Batestown Member (d)[1]	1,281	1,931
Top of sub-Batestown tongue	884	1,253
Bottom of sub-Batestown sand and gravel	877	1,245
Top of Tiskilwa Formation (d)[1]	1,664	2,745
Bottom of Tiskilwa Formation (d)[1]	1,560	2,524
Top of Ashmore Tongue, Henry Formation	657	1,145
Bottom of Ashmore Tongue, Henry Formation	637	1,120
Top of Glasford Formation	1,487	2,925
Top of upper fine interval of Glasford	703	1,253
Bottom of upper fine interval of Glasford	702	1,251
Top of upper coarse interval of Glasford	734	1,238
Bottom of upper coarse interval of Glasford	733	1,237
Top of middle fine interval of Glasford	723	1,520
Bottom of middle fine interval of Glasford	711	1,493
Top of lower coarse interval of Glasford	633	1,299
Bottom of lower coarse interval of Glasford	630	1,295
Top of lower fine interval of Glasford	106	215
Bottom of lower fine interval of Glasford	102	207
Top of Bedrock, undifferentiated		
Top of Silurian undifferentiated	389	709
Bottom of Silurian undifferentiated	350	583
Top of Maquoketa Group	565	1,054
Bottom of Maquoketa Group	558	1,031
Top of Galena-Platteville Groups	289	654
Bottom of Galena-Platteville Groups	172	330
Top of Ancell Group	182	358
Bottom of Ancell Group	24	55
Top of Cambrian formations, undifferentiated	8	54

[1]d, diamicton lithology of the stratigraphic unit listed.

Surficial Henry Formation

The surficial Henry Formation consists of sand and gravel that was deposited as alluvial fans, glacial outwash channels, and kames. As mapped, this unit may contain portions of the Wasco facies of the Henry Formation and some coarse-textured facies of the Cahokia Formation. The surficial Henry Formation has a maximum thickness in Kane County of 90 feet. An isopach map of the unit is depicted in Figure 13 and includes the distribution of primary wells used in mapping the unit. Figure 14 includes the synthetic primary wells used in mapping the unit. Like the previous unit, the occurrence of the surficial Henry Formation is commonly identified from soils maps and observations at the land surface. Synthetic data were generated to help map the unit in these areas where it has been identified at or near the land surface, and primary well data were insufficient for mapping its extent.

Wadsworth Formation

This unit forms the West Chicago Moraine to the north and east of Kane County (fig. 15). The Wadsworth Formation is composed of gray, silty clay to silt loam diamicton. The thickness of the Wadsworth maybe greater than 100 feet in the study area, but the unit is not present in Kane County. The sub-Wadsworth tongue of the Henry Formation is generally less than 10 feet thick where it occurs in the study area.

Haeger Member of the Lemont Formation

This unit forms the Woodstock Moraine, which occupies a small portion of the northeast corner of Kane County (fig. 15). The Haeger Member is sandy loam diamicton with abundant, discontinuous lenses of sand and gravel and thin beds of silt and clay (Curry et al. 1997). The isopach map of the Haeger Member of the Lemont Formation is shown with primary wells (fig. 16) and synthetic data points (fig. 17). The Haeger is up to 80 feet thick in Kane County. Thick sand and gravel deposits are associated with the Haeger Member. Where buried by Haeger diamicton, these deposits are conventionally known as the Beverly Tongue of the Henry Formation. As mapped here, small portions of the Beverly Tongue lack a covering of Haeger diamicton. An isopach map of the Beverly Tongue is shown in figures 18 and 19 with the distribution of primary well and the synthetic data used in mapping the unit in Kane County. The Beverly is up to 60 feet thick in Kane County. The Haeger Member and Beverly Tongue have a limited presence in Kane County, although they constitute much of the surficial material of McHenry County to the north.

Table 9 Number of synthetic data points and lithostratigraphic assignments representing surfaces of select units.

Lithostratigraphic unit	Kane County	Study area
Top of Equality Formation	1,421	2,050
Bottom of Equality Formation	1,421	2,050
Top of Henry Formation, surficial	1,218	1,701
Bottom of Henry Formation, surficial	806	1,702
Top of Wadsworth Formation (d)[1]	0	70
Bottom of Wadsworth Formation (d)[1]	0	213
Top of sub-Wadsworth tongue	0	7
Bottom of sub-Wadsworth tongue	0	4
Top of Haeger Member (d)[1]	4	142
Bottom of Haeger Member (d)[1]	8	33
Top of Beverly Tongue, Henry Formation	1	34
Bottom of Beverly Tongue, Henry Formation	0	13
Top of Yorkville Member (d)[1]	152	354
Bottom of Yorkville Member (d)[1]	323	759
Top of sub-Yorkville tongue	1	5
Bottom of sub-Yorkville tongue	1	1
Top of Batestown Member (d)[1]	1,125	1,766
Bottom of Batestown Member (d)[1]	167	368
Top of sub-Batestown tongue	106	117
Bottom of sub-Batestown tongue	95	102
Top of Tiskilwa Formation (d)[1]	1,211	1,806
Bottom of Tiskilwa Formation (d)[1]	4	19
Top of Ashmore Tongue, Henry Formation	0	1
Bottom of Ashmore Tongue, Henry Formation	0	1
Top of Glasford Formation	18	85
Top of Bedrock, undifferentiated	53	54

[1]d, diamicton lithology of the stratigraphic unit listed.

Yorkville Member of the Lemont Formation

The Yorkville Member forms the St. Charles and Minooka Moraines (fig. 15) where it is as much as 125 feet thick. Unweathered Yorkville diamicton is gray; its matrix texture varies from clay to loam diamicton. Typically, the upper part of the Yorkville Member in Kane County is weathered and oxidizes yellow-brown in the upper 10 to 15 feet. Three textural facies of the Yorkville Member are recognized at Fermi Accelerator Laboratory including lower clay, middle loam, and upper silty clay units (Landon and Kempton 1971, Kemmis 1978, Curry 1991). The St. Charles Moraine tends to be formed of the clay facies; the Minooka Moraine is typically formed of the silty clay and loam facies. The loam facies has been associated with abundant channels of sand and gravel. Both the clay and silty clay facies typically contain fewer boulder to cobble-sized clasts than do other diamictons mapped in Kane County. Figure 20 depicts the isopach map of the Yorkville Member and the distribution of primary wells used to map the unit.

Sub-Yorkville Tongue of the Henry Formation

Figure 21 depicts the distribution of synthetic data used in mapping the diamicton. The isopach map of the sub-Yorkville tongue of the Henry Formation is shown in figures 22 and 23. The distribution of primary wells (fig. 22) and synthetic primary wells (fig. 23) used in mapping the unit are shown. This basal sand and gravel unit is up to 65 feet thick in Kane County.

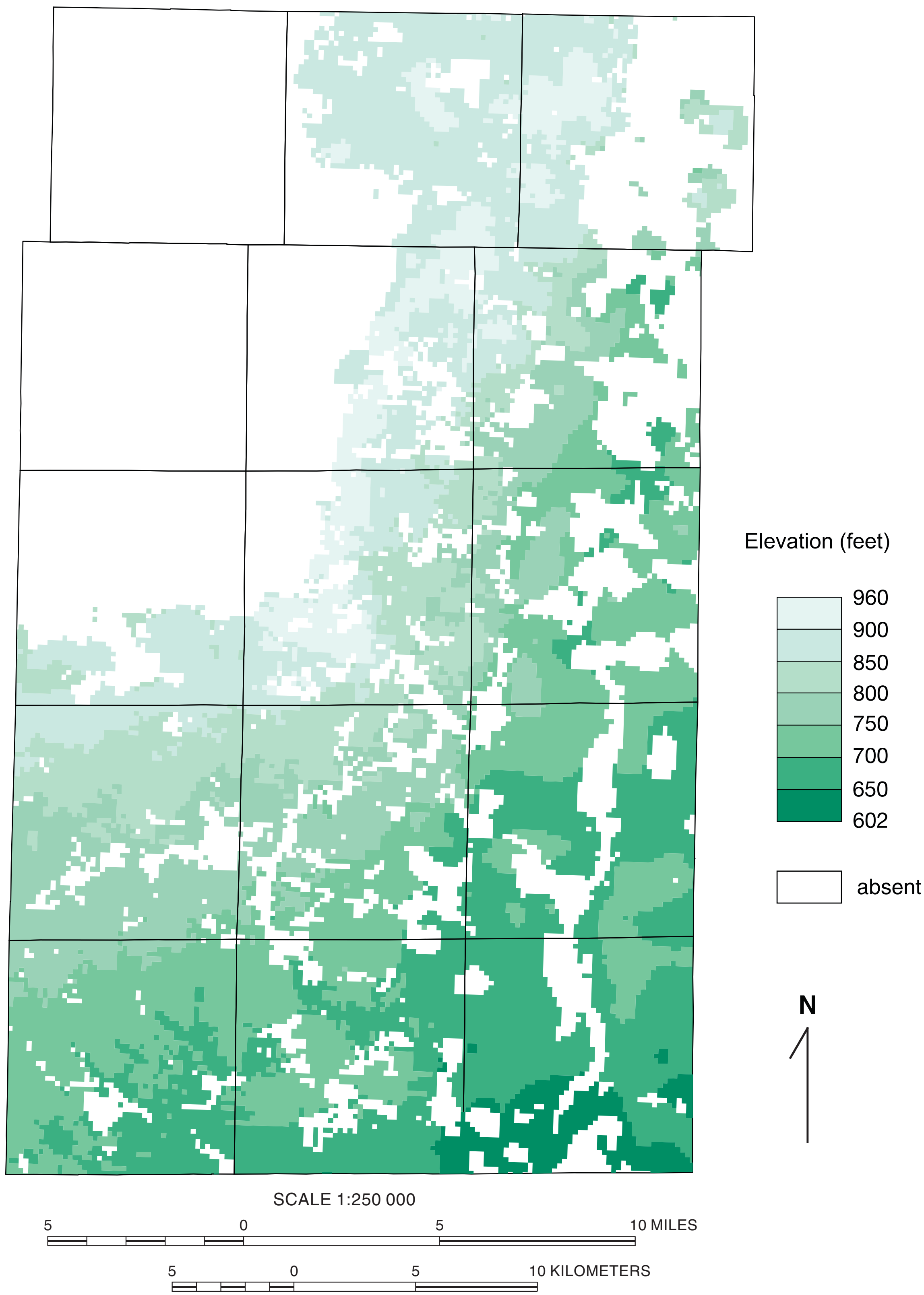

__Figure 8__ Elevation grid of the upper surface of the Batestown Member, Lemont Formation, in Kane County.

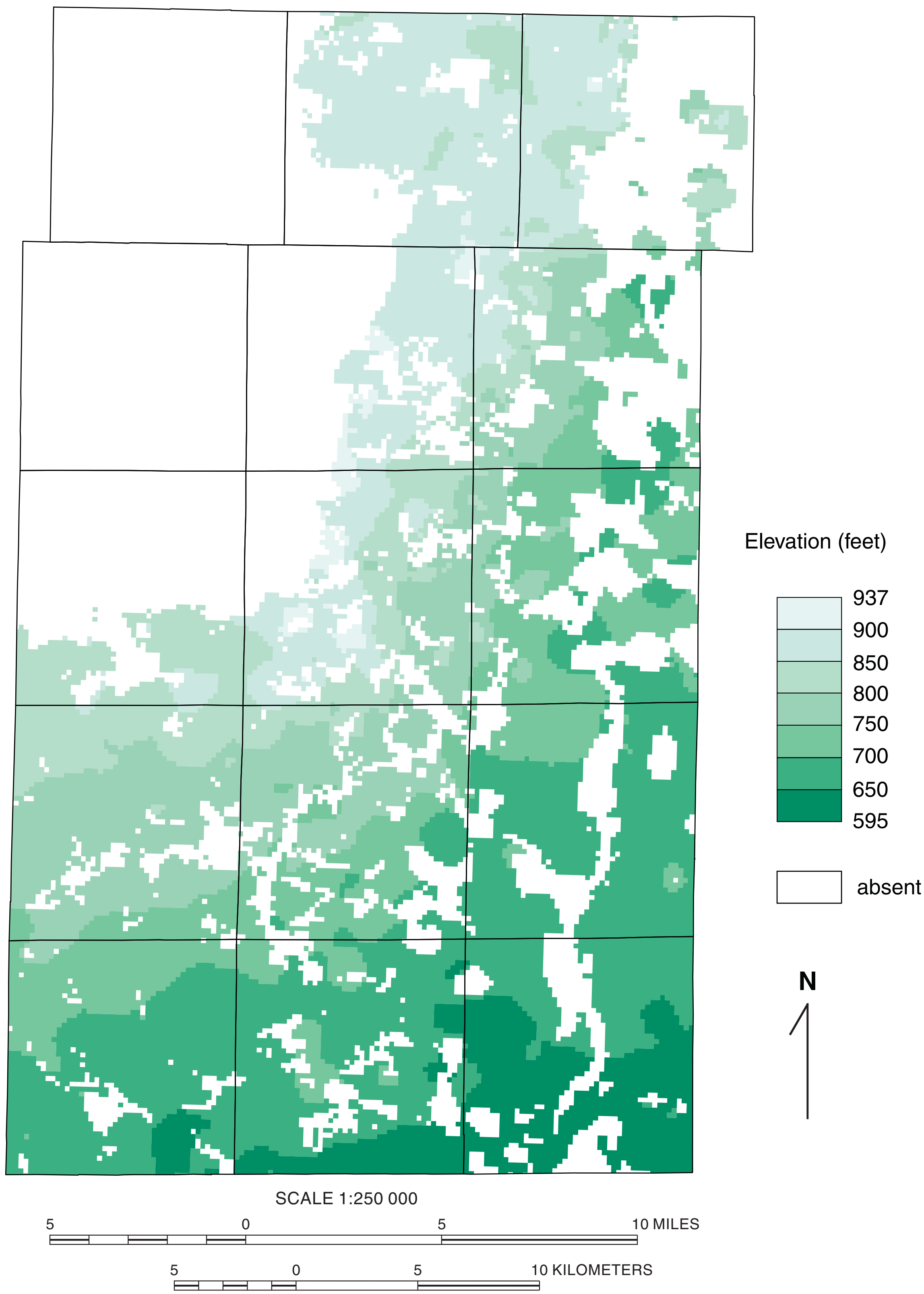

Figure 9 *Elevation grid of the lower surface of the Batestown Member, Lemont Formation, in Kane County.*

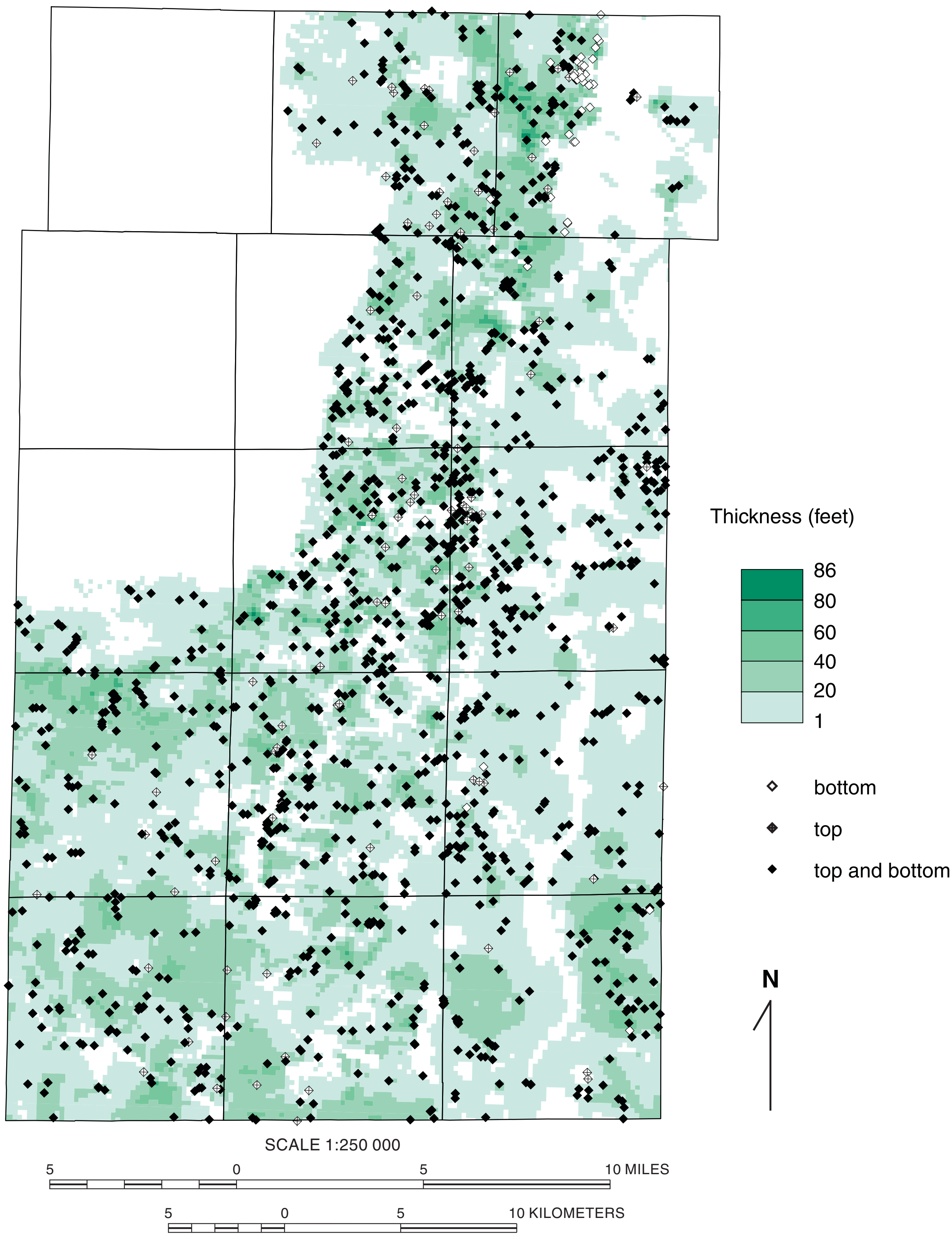

Figure 10 *Isopach map of the Batestown Member, Lemont Formation, in Kane County and the distribution of primary wells used in mapping the unit.*

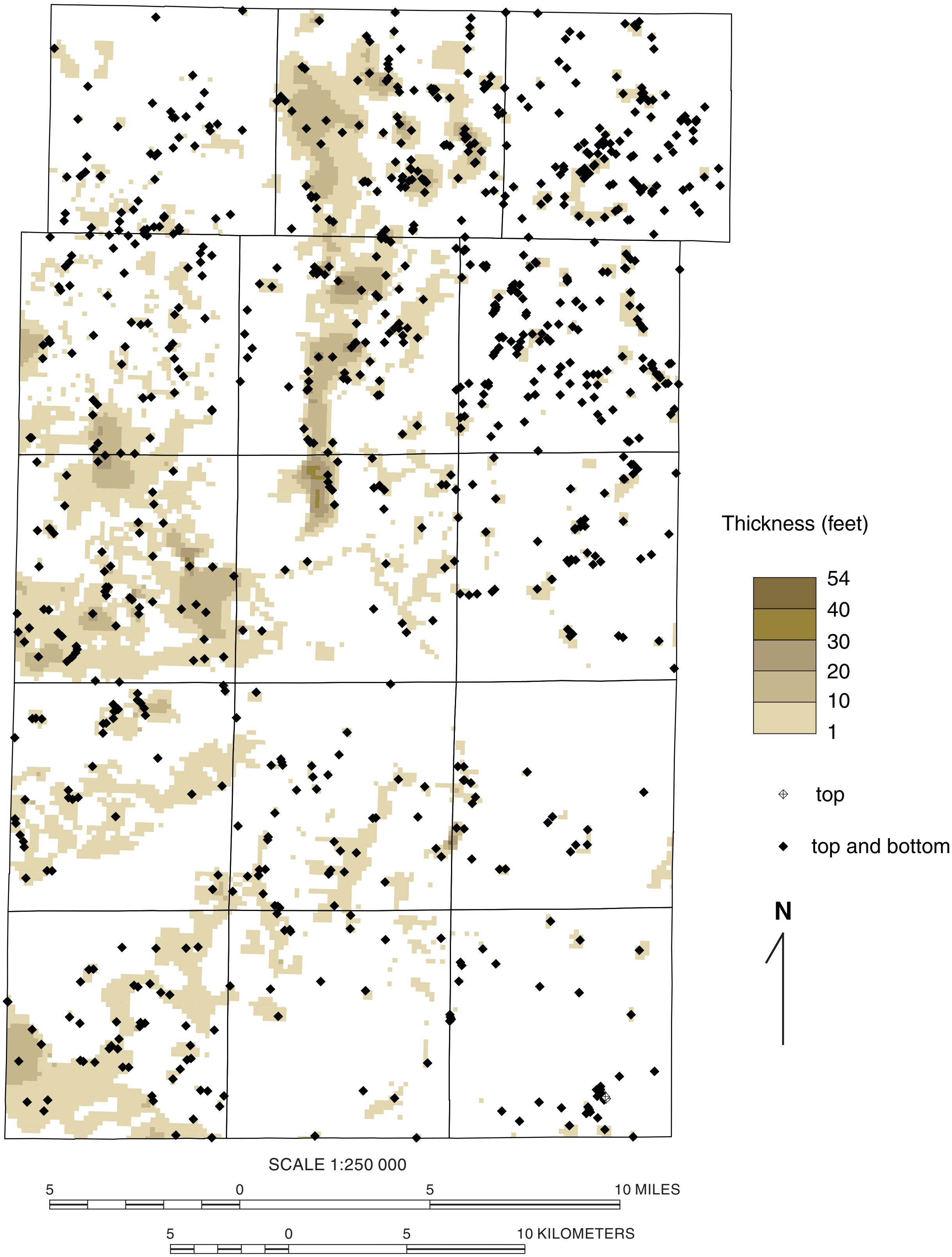

Figure 11 Isopach map of the surficial fine-textured layer (i.e., the combined thickness of the Grayslake Peat, fine-textured facies of the Cahokia Formation, and surficial deposits of the Equality Formation) in Kane County and the distribution of primary wells used in mapping the unit.

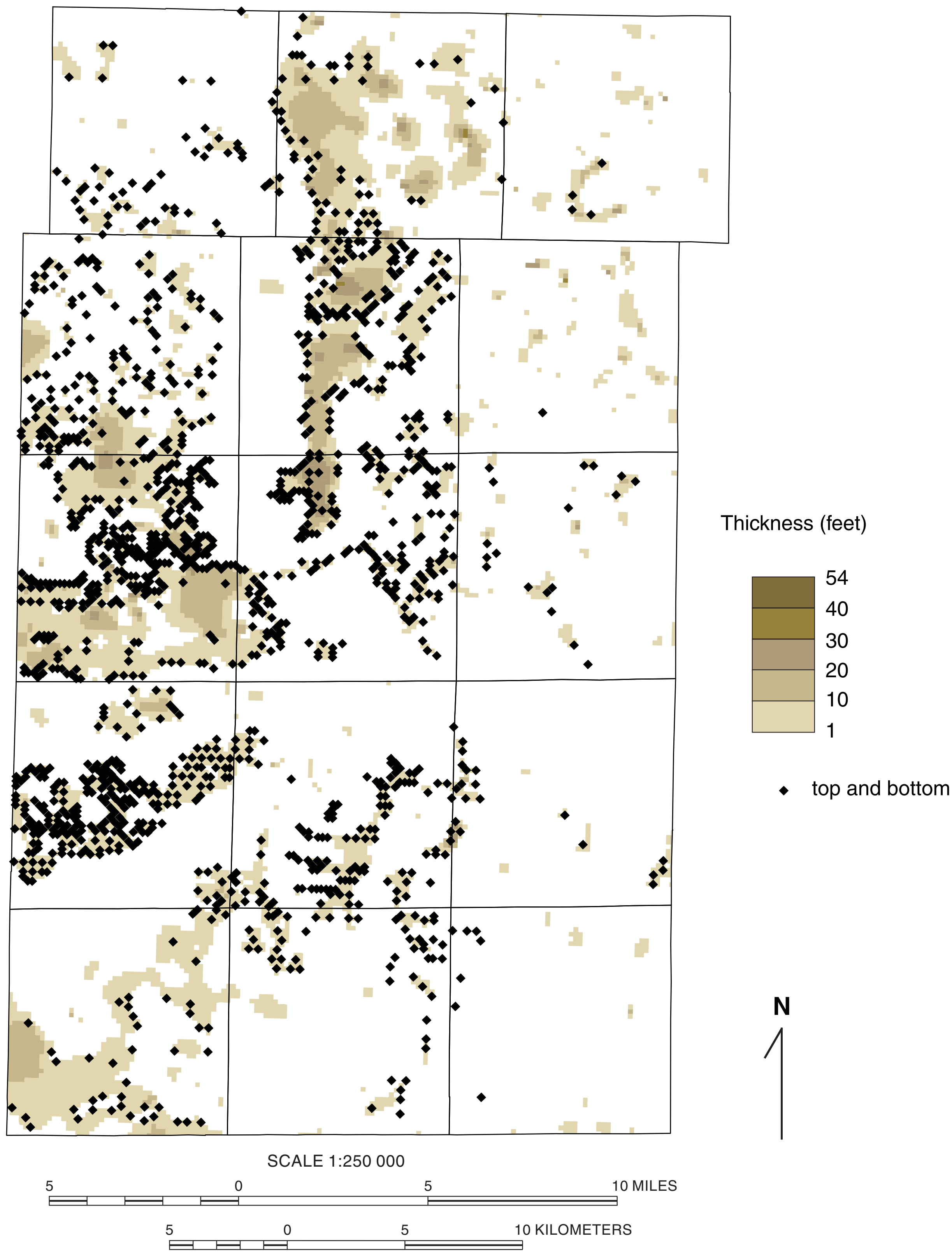

Figure 12 *Isopach map of the surficial fine-textured layer (i.e., the combined thickness of Grayslake Peat, fine-textured facies of the Cahokia Formation, and surficial deposits of the Equality Formation) in Kane County and the distribution of synthetic data points used in mapping the unit.*

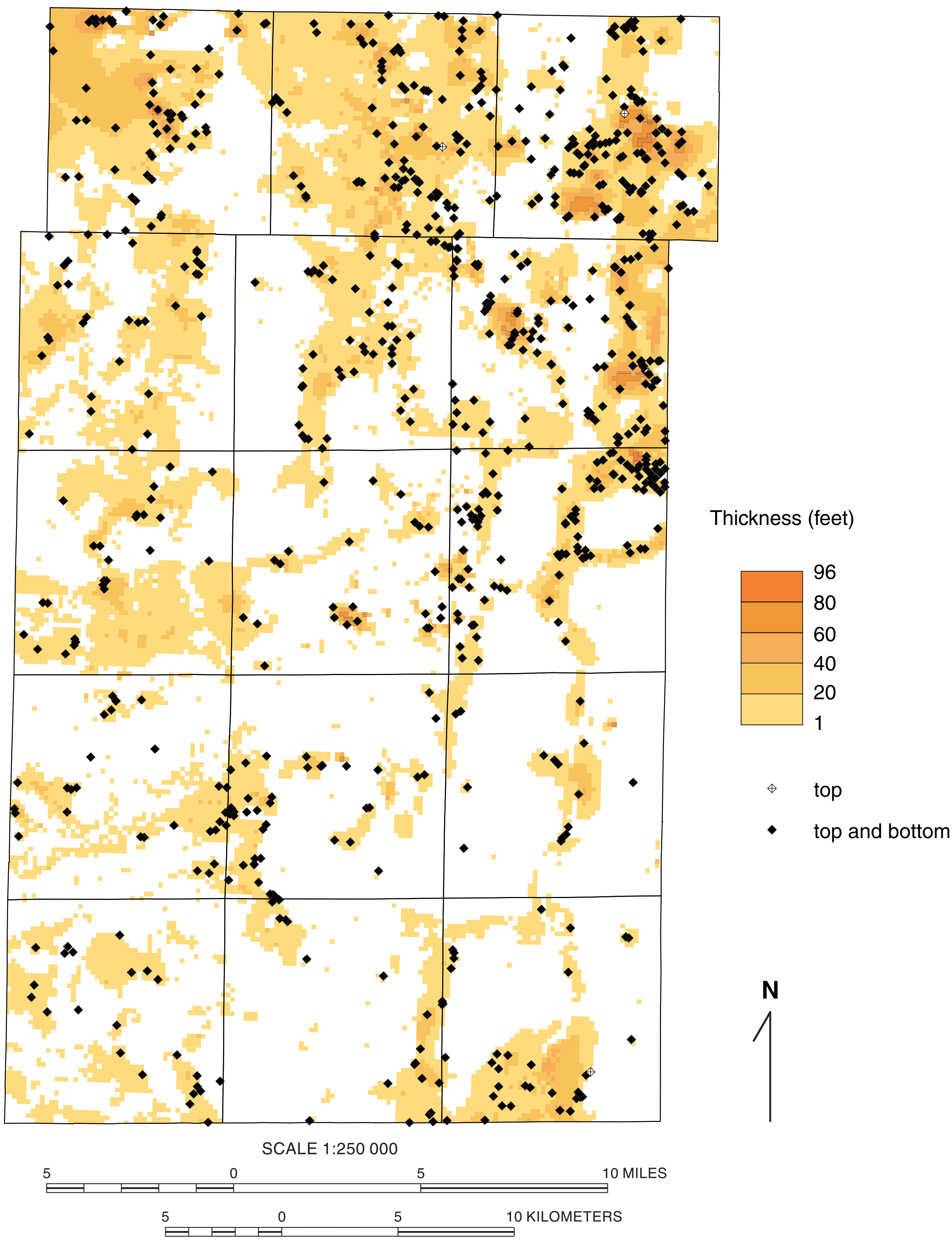

Figure 13 *Isopach map of the surficial Henry Formation in Kane County and the distribution of primary wells used in mapping the unit.*

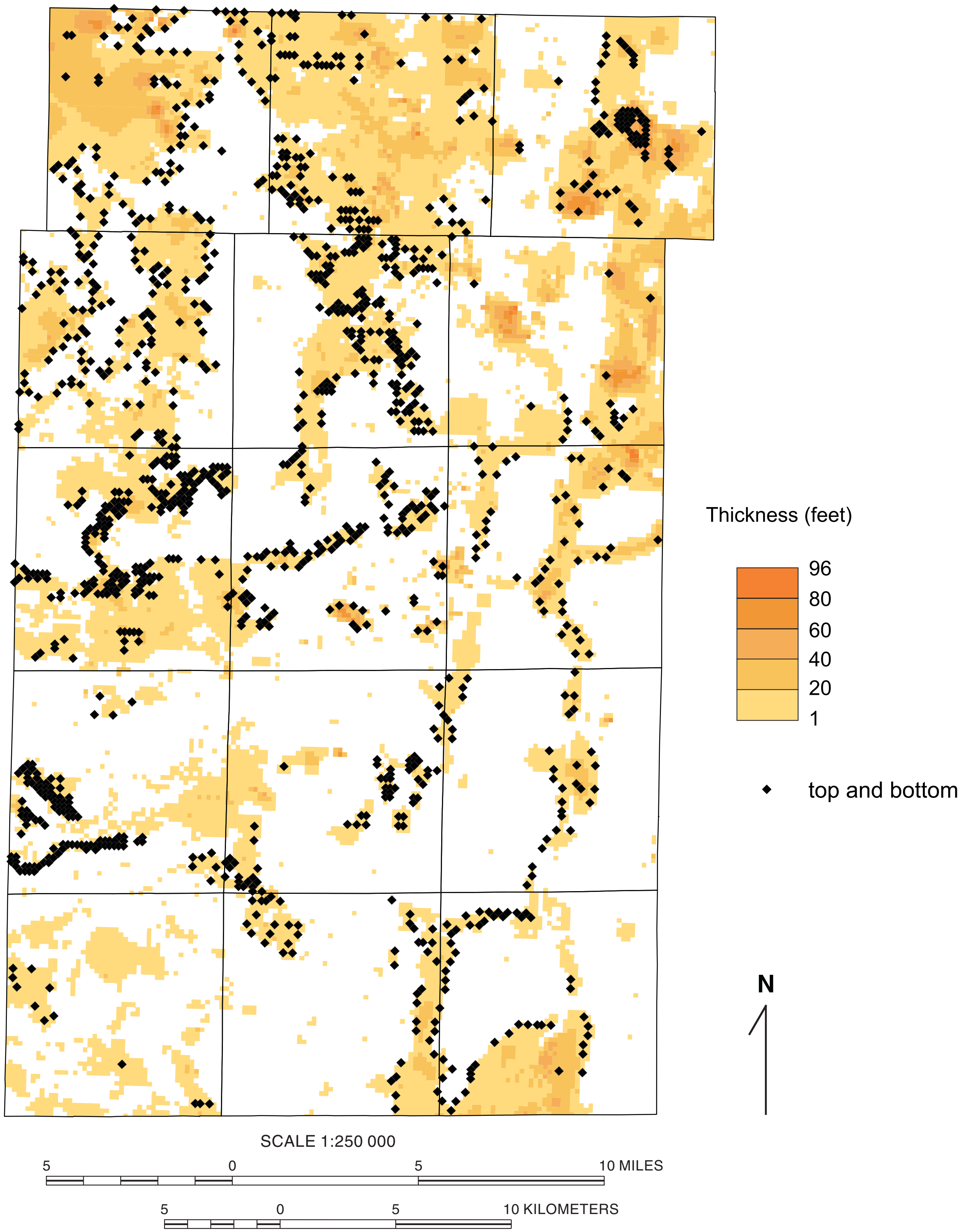

Figure 14 *Isopach map of the surficial Henry Formation in Kane County and the distribution of synthetic data points used in mapping the unit.*

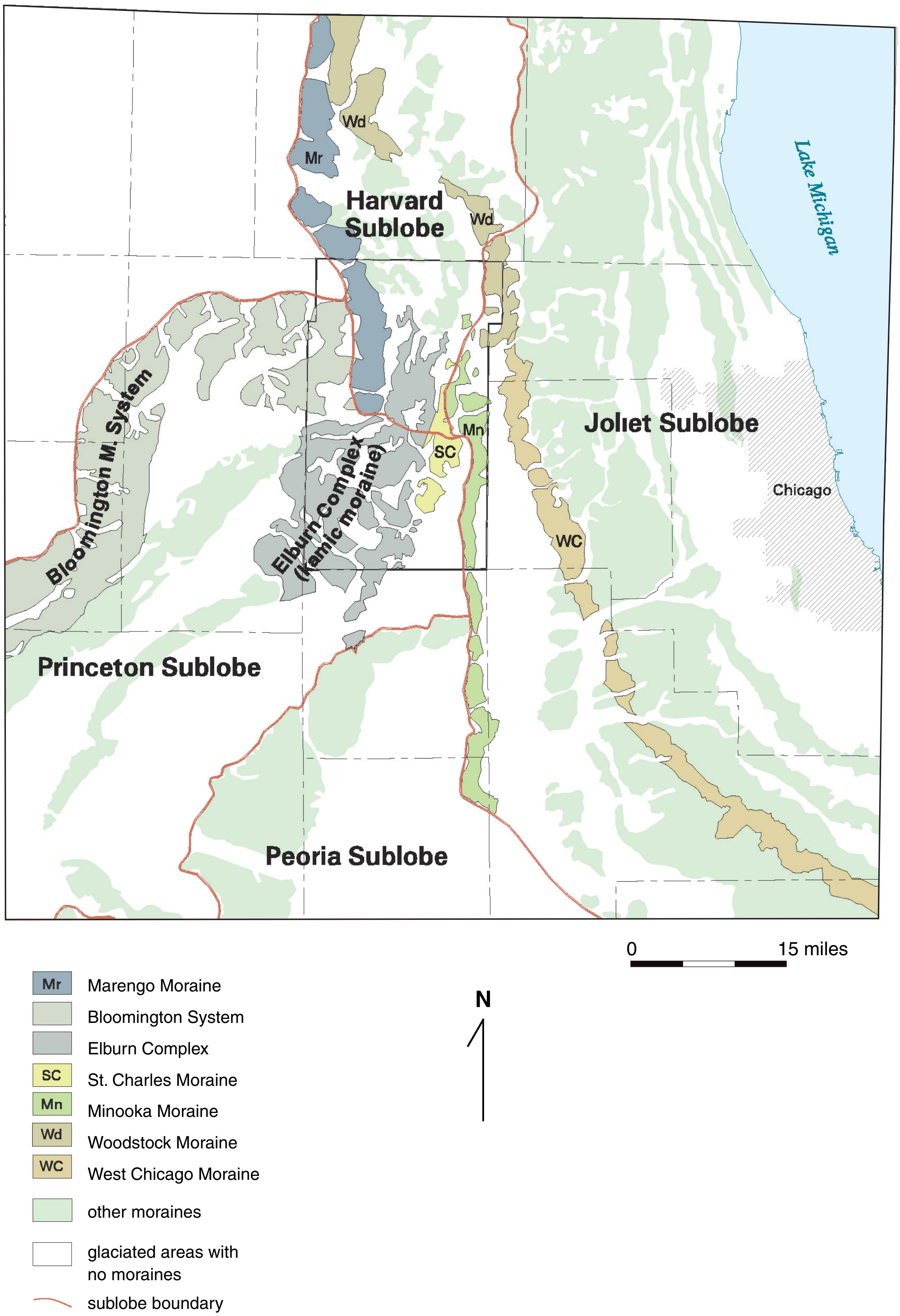

Figure 15 *Wisconsin Episode moraines in northeastern Illinois.*

__Figure 16__ Isopach map of the Haeger Member, Lemont Formation, in Kane County and the distribution of primary wells used in mapping the unit.

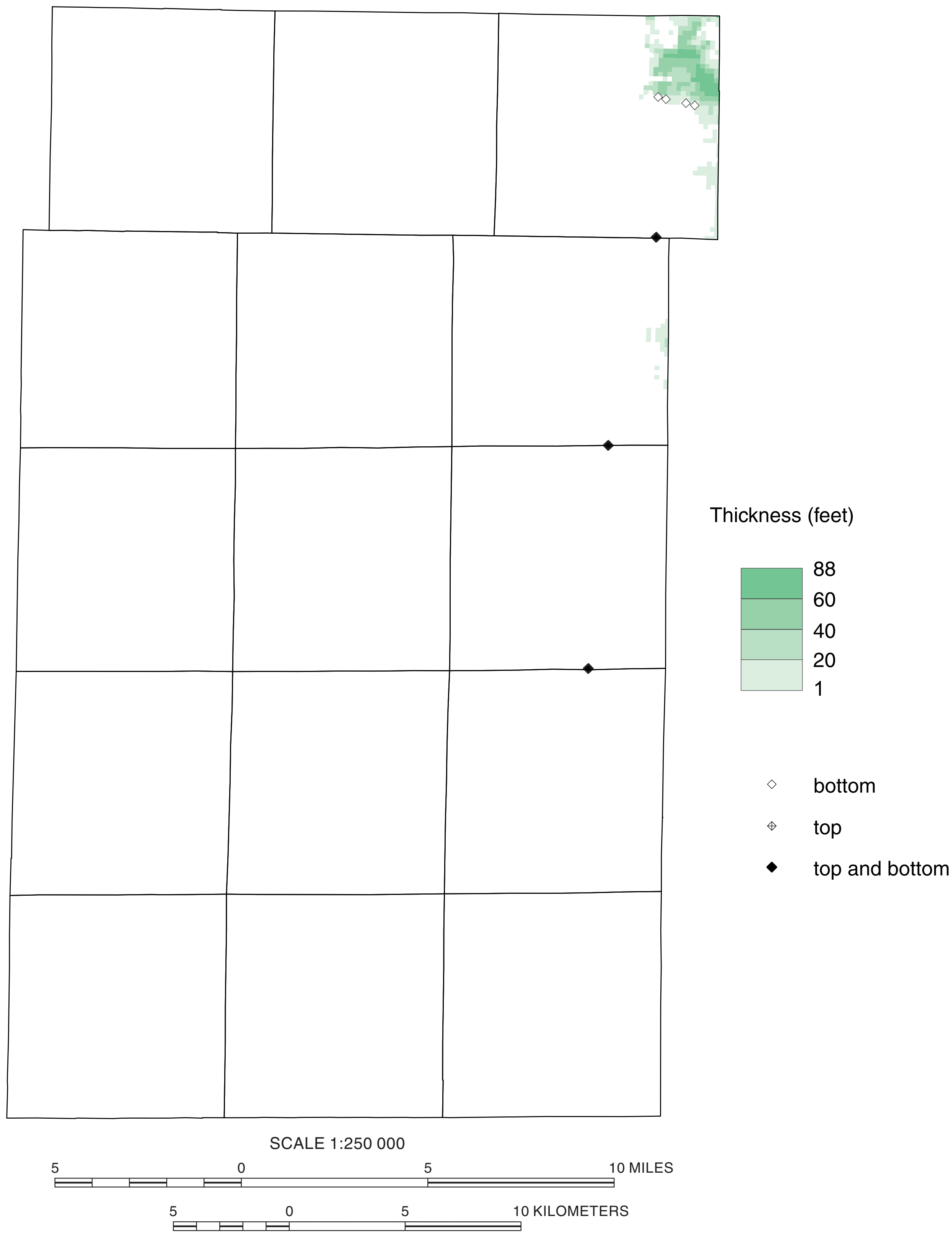

Figure 17 *Isopach map of the Haeger Member, Lemont Formation, in Kane County and the distribution of synthetic data points used in mapping the unit.*

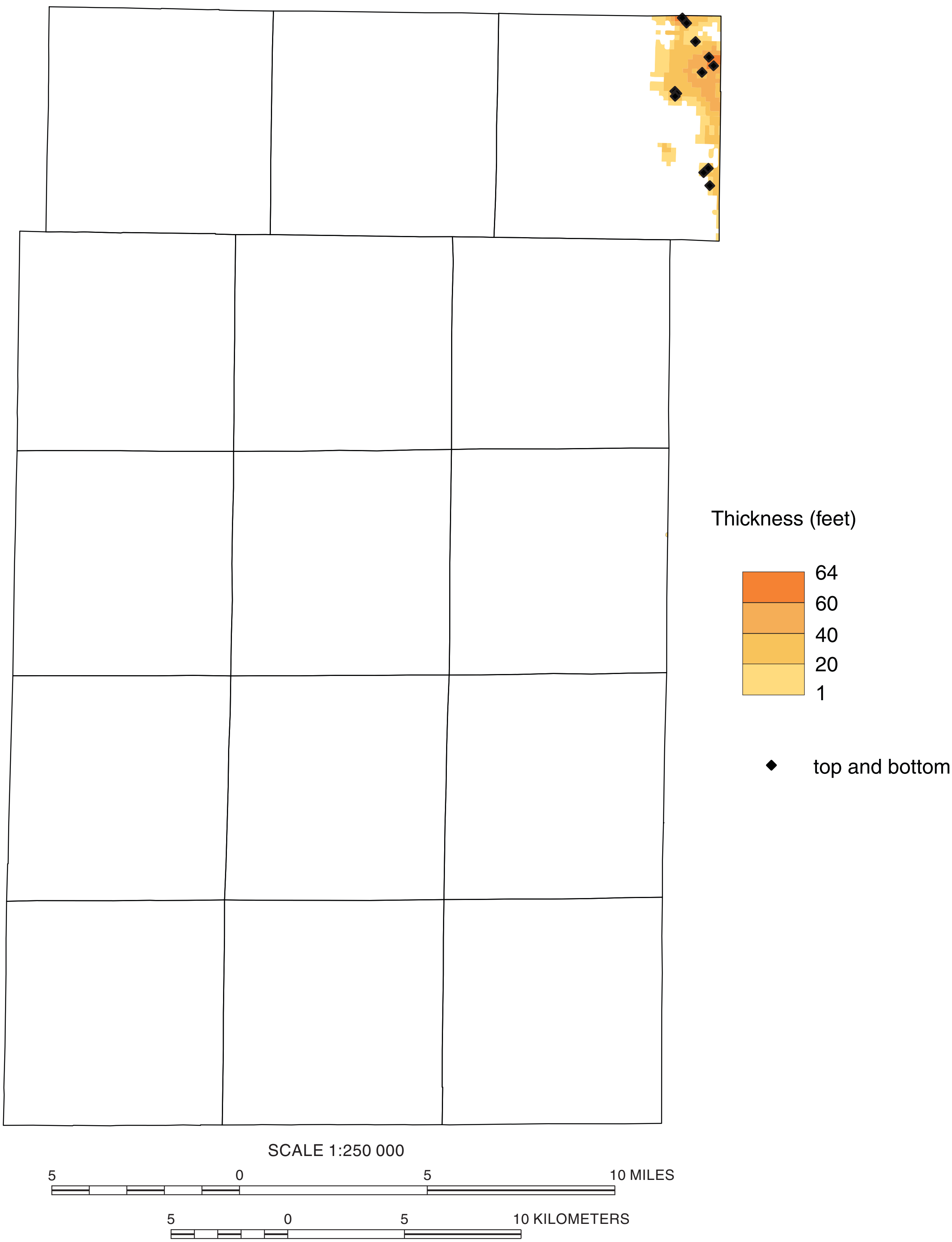

Figure 18 *Isopach map of the Beverly Tongue of the Henry Formation and the distribution of primary wells used in mapping the unit.*

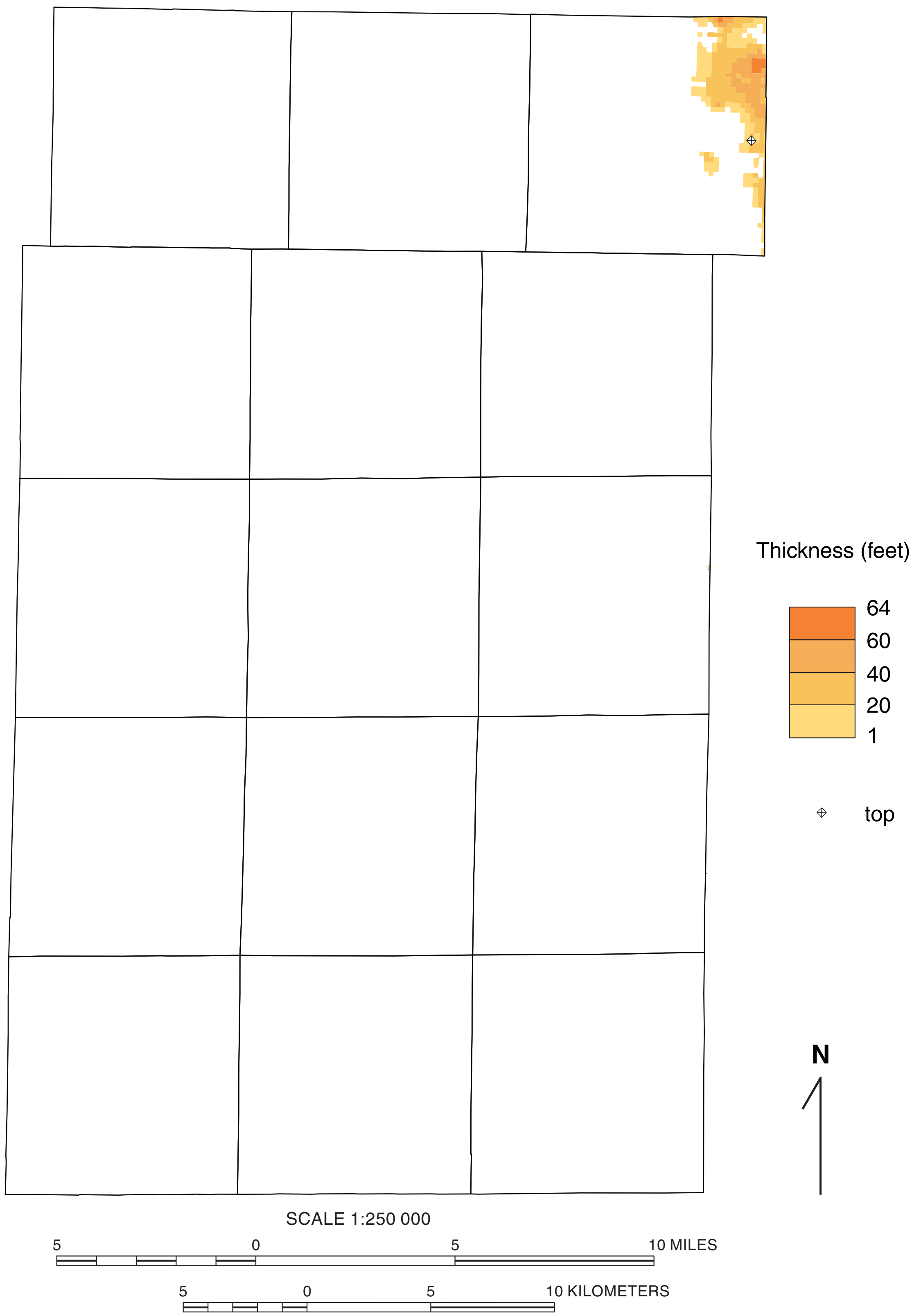

Figure 19 *Isopach map of the Beverly Tongue of the Henry Formation and the distribution of synthetic data points used in mapping the unit.*

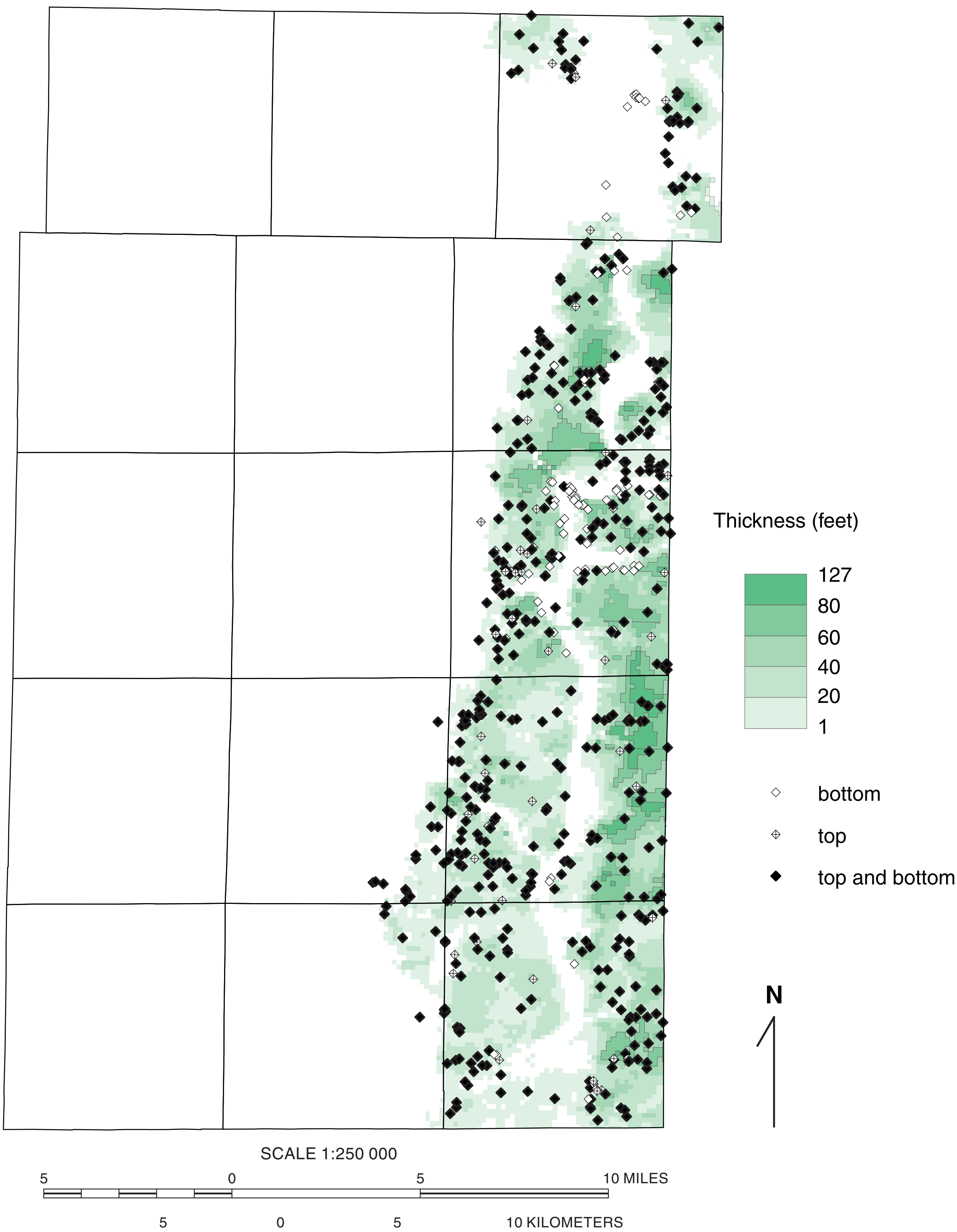

Figure 20 *Isopach map of the Yorkville Member, Lemont Formation, in Kane County and the distribution of primary wells used in mapping the unit.*

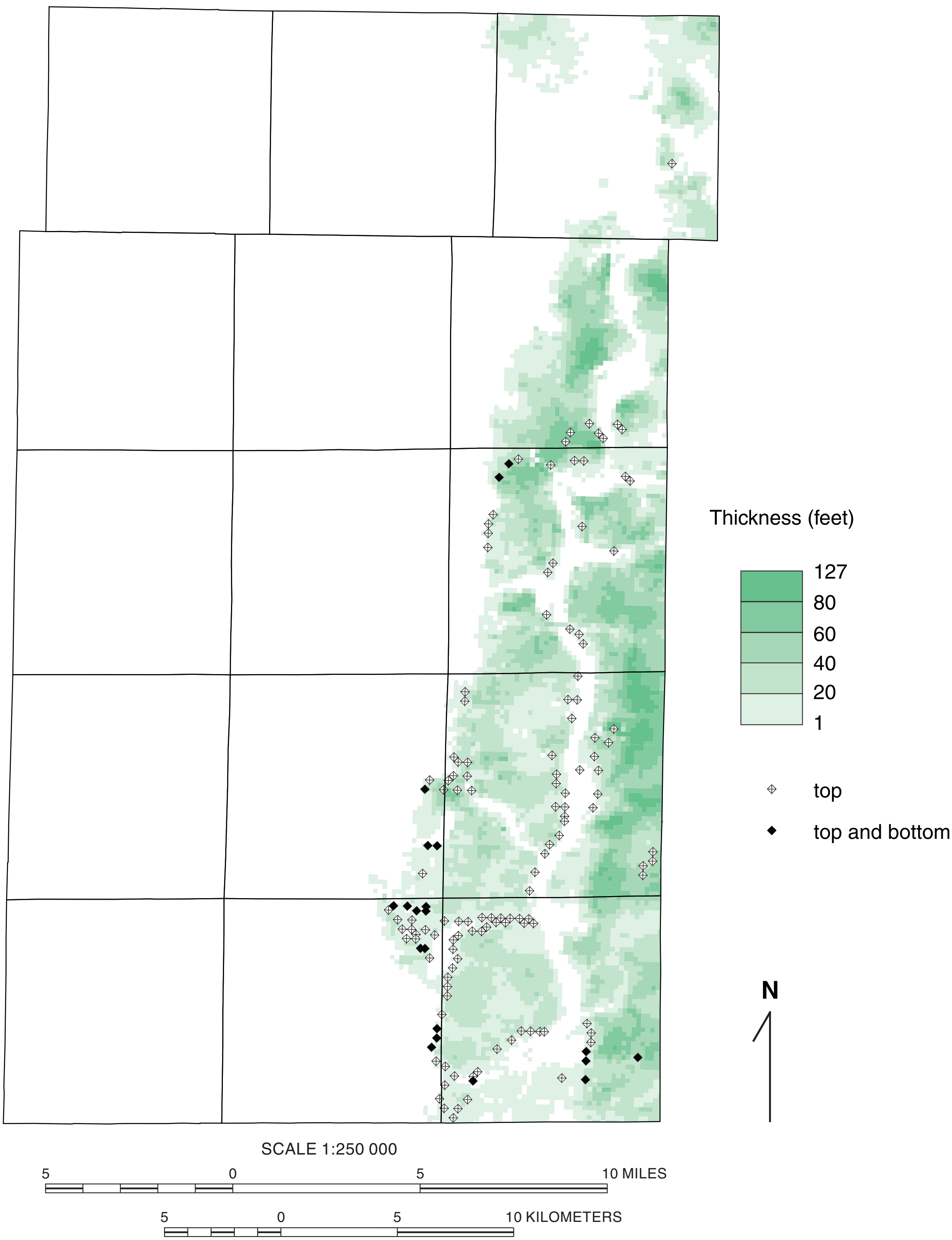

Figure 21 *Isopach map of the Yorkville Member, Lemont Formation, in Kane County and the distribution of synthetic data points used in mapping the unit.*

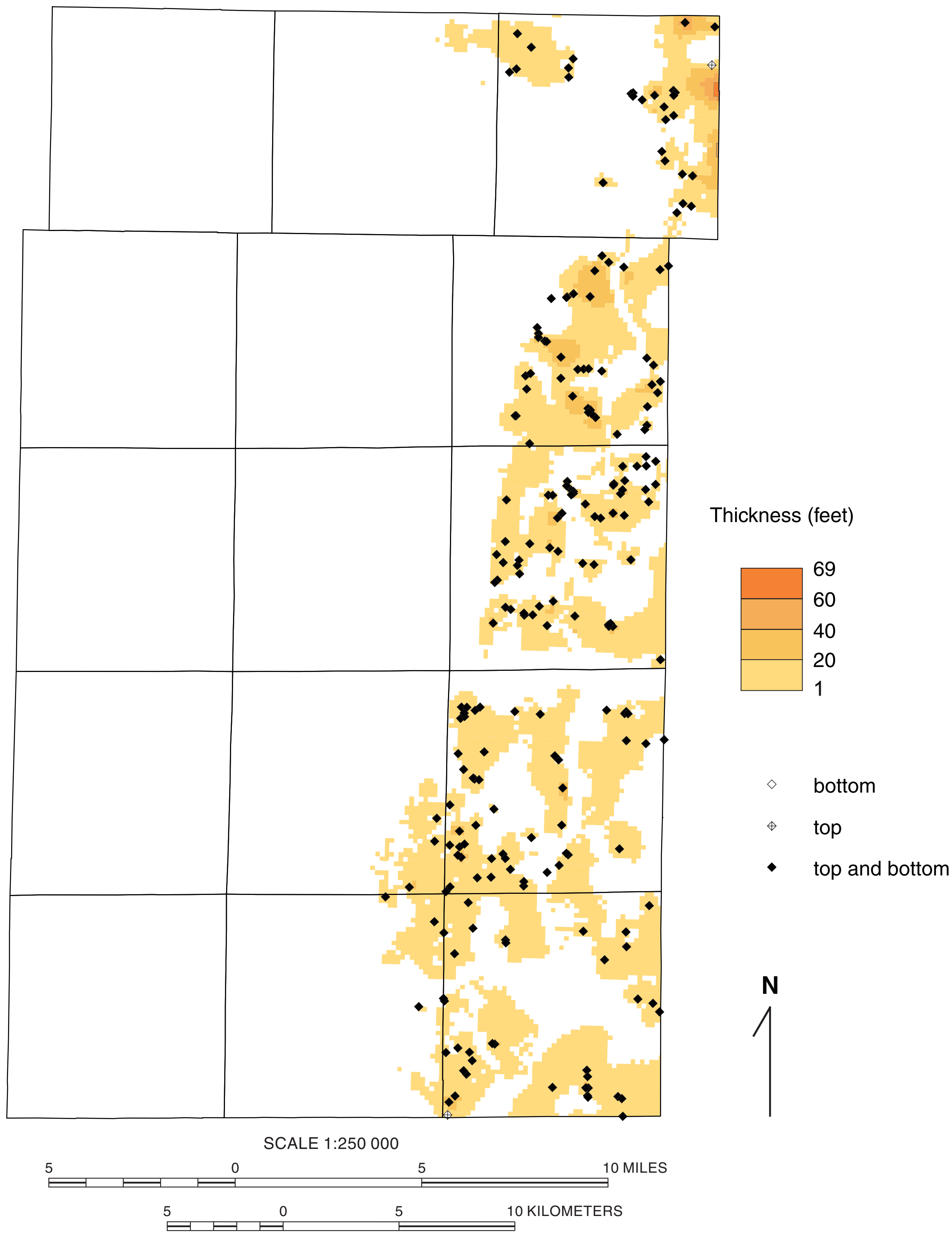

Figure 22 *Isopach map of the sub-Yorkville tongue of the Henry Formation in Kane County and the distribution of primary wells used in mapping the unit.*

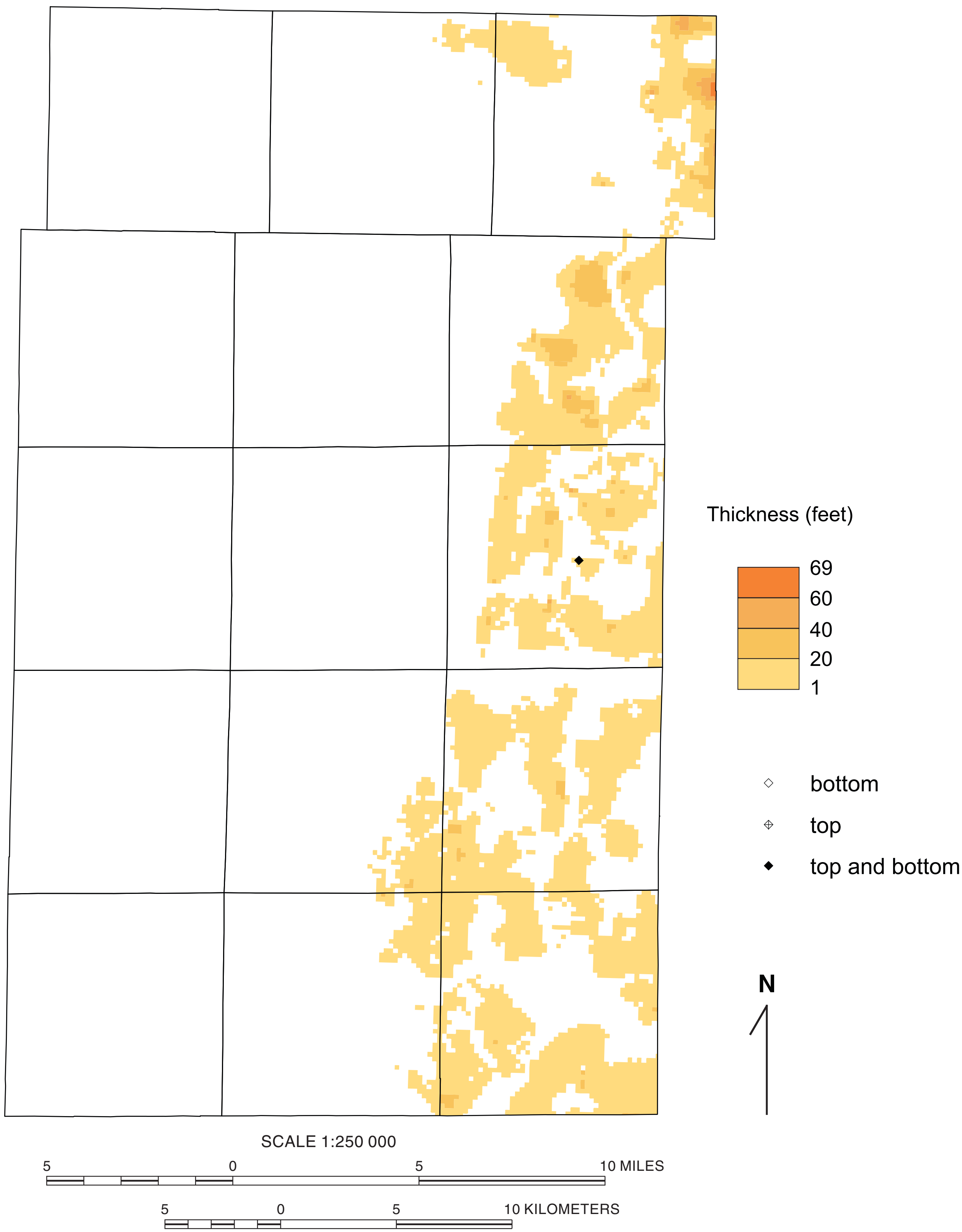

Figure 23 *Isopach map of the sub-Yorkville tongue of the Henry Formation in Kane County and the distribution of synthetic data points used in mapping the unit.*

Batestown Member of the Lemont Formation

The Batestown Member forms the upper diamicton of the Elburn Complex (fig. 15), Arlington Moraine, and Gilbert's Drift. The Batestown is a uniform to stratified (layered) loam to silt loam diamicton containing abundant interbeds of sand and gravel or sand. The loam diamicton facies tends to be brown and uniform; this facies occurs primarily southwest of the Marengo Moraine. The silt loam diamicton facies tends to be somewhat browner than the loam facies and occurs primarily in south and central Kane County. The thickness of Batestown diamicton is highly variable and reaches a maximum thickness of 85 feet in Kane County. Figure 10 depicts the isopach of the Batestown Member and the distribution of primary wells used in mapping it. Figure 24 depicts the distribution of synthetic data points used in mapping the unit. The majority of these synthetic data points were generated to define the top of the Batestown where it is overlain by surficial sand and gravel of the Henry Formation or the surficial fine-textured layer. Other large landforms formed of Batestown-associated sand and gravel include Johnson's Mound (a kame) and Bald Mound (Curry et al. 1999). Kamic sand and gravel deposits were mapped as the Wasco facies of the Henry Formation by Grimley and Curry (2001a), but in most cases are mapped in this report as surficial Henry Formation.

Sub-Batesville Tongue of the Henry Formation

The isopach map of the sub-Batestown tongue of the Henry Formation is shown figures 25 and 26; the distribution of primary wells and synthetic primary wells used in mapping the unit are shown. This sub-Batestown tongue is up to 70 feet thick in Kane County.

Tiskilwa Formation

The Tiskilwa Formation forms the Bloomington Morainic System and the Marengo Moraine (fig. 15). The diamicton of the Tiskilwa Formation is as much as 270 feet thick (figs. 27 and 28). Elsewhere in Kane County, the unit comprises a significant proportion of the glacial drift, especially in north-central and central Kane County. It is largely absent in the southeast. The Tiskilwa overlies the Robein Member of the Roxana Silt and sorted units of the Mason Group, including silt and clay of the Peddicord Tongue (Equality Formation) and sand and gravel of the Ashmore Tongue (Henry Formation). The Tiskilwa Formation is composed primarily of reddish brown clay loam to loam diamicton with channel-shaped bodies and lenses of sand and gravel, sand, and silt and clay. Locally, a basal stratified facies occurs that is composed of mostly thinly bedded, sorted sediment interbedded with layers of very hard diamicton. In the stratified facies, occasional deformed and truncated channel-shaped deposits of sand and gravel, in addition to inclusions of organic silt with sheared, polished, and striated surfaces, attest to deposition in an active ice environment (Curry et al. 1999). At the Fox River Stone Quarry, prolate pebbles have strongly preferred orientations in both facies of diamicton, suggesting deposition as subglacial till deposited beneath active ice (Curry et al. 1999). The diagnostic characteristics of Tiskilwa diamicton are that (1) it is harder, redder, and thicker than the other diamictons mapped in Kane County and (2) its stratigraphic position. Figure 27 depicts the isopach map of the Tiskilwa Formation and the distribution of primary wells used in mapping it. Figure 28 shows the isopach map of the Tiskilwa Formation and the distribution of synthetic data points generated to map the unit. As with the Batestown Member, the majority of these synthetic data points were generated to define the top of the Tiskilwa Formation, where it is overlain by surficial sand and gravel of the Henry Formation or the surficial fine-textured layer.

Ashmore Tongue of the Henry Formation

This Ashmore Tongue, which is up to 90 feet thick in Kane County, consists of the proglacial sand and gravel underlying the Tiskilwa Formation diamicton. Figure 29 depicts an isopach map and the distribution of primary wells used in mapping the unit. No synthetic data were used to map the Ashmore Tongue in Kane County.

Robein Member of the Roxana Silt

A distinct unit composed of black to very dark brown, leached silt loam with wood fragments, the Robein Member, occurs throughout the county above the Glasford Formation. Generally less than 3 feet thick, this layer has been traced throughout northeastern Illinois, where it may be compact peat, soupy muck, or organic-rich silt as much as 28 feet thick (Kempton et al. 1987a). Interpreted to be a buried soil formed in loess, this unit ranges in age from about 55,000 to about 23,500 yr B.P. (Curry 1989, Curry et al. 1999, Curry and Pavich 1996). Although not modeled as a separate unit for this report, the Robein was identified where possible from well records (fig. 30).

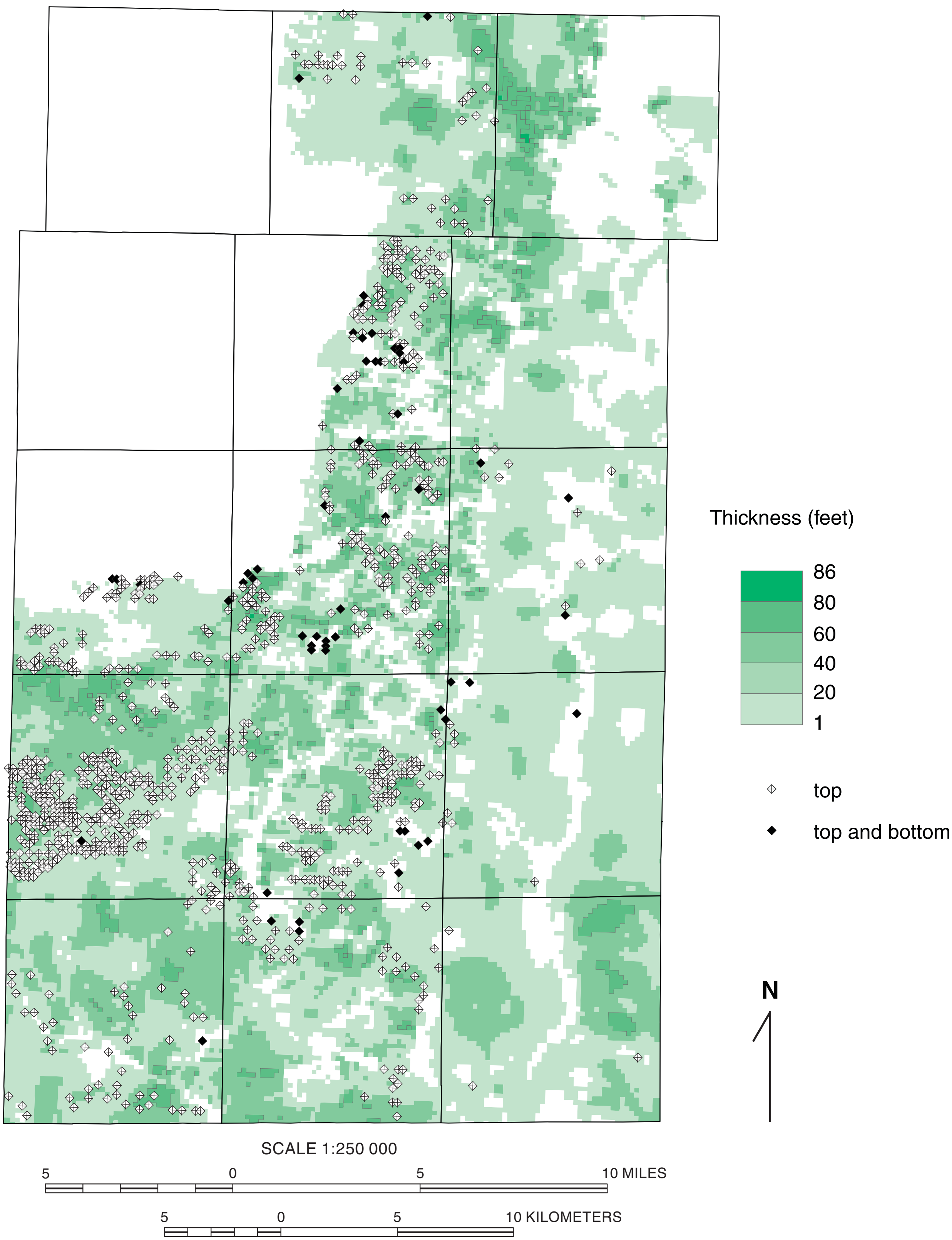

Figure 24 *Isopach map of the Batestown Member, Lemont Formation, in Kane County and the distribution of synthetic data points used in mapping the unit.*

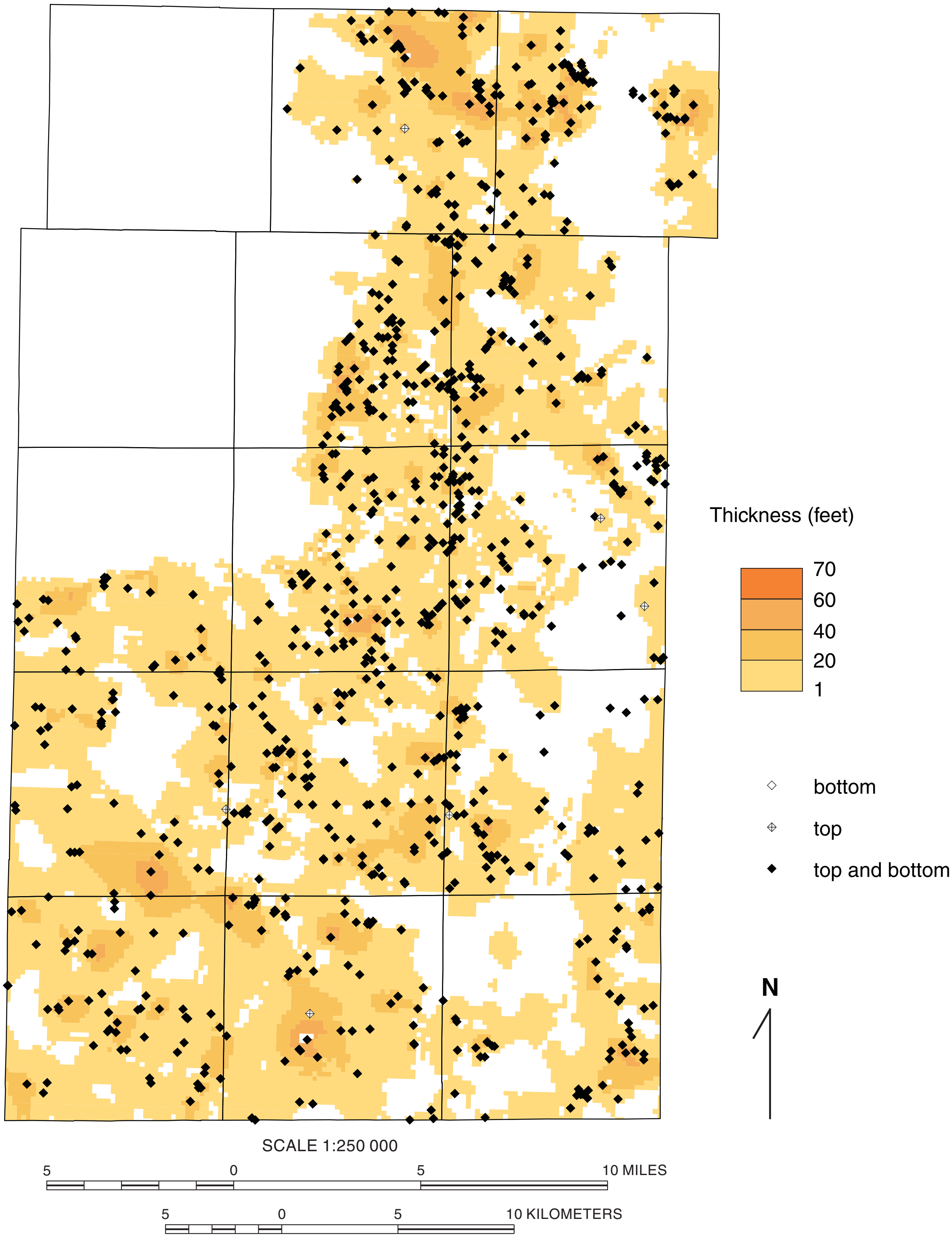

Figure 25 *Isopach map of the sub-Batestown tongue of the Henry Formation in Kane County and the distribution of primary wells used in mapping the unit.*

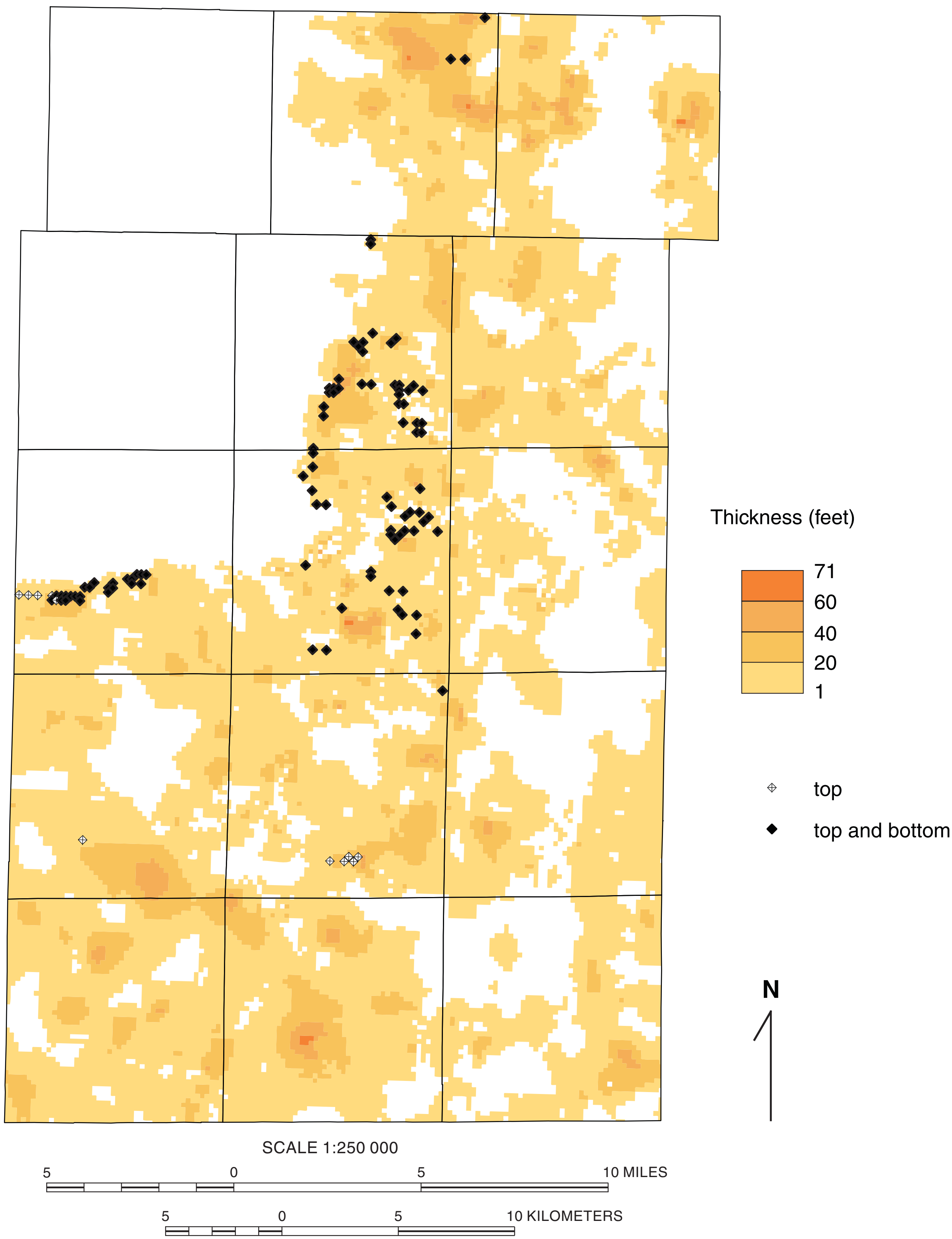

__Figure 26__ Isopach map of the sub-Batestown tongue of the Henry Formation in Kane County and the distribution of synthetic data points used in mapping the unit.

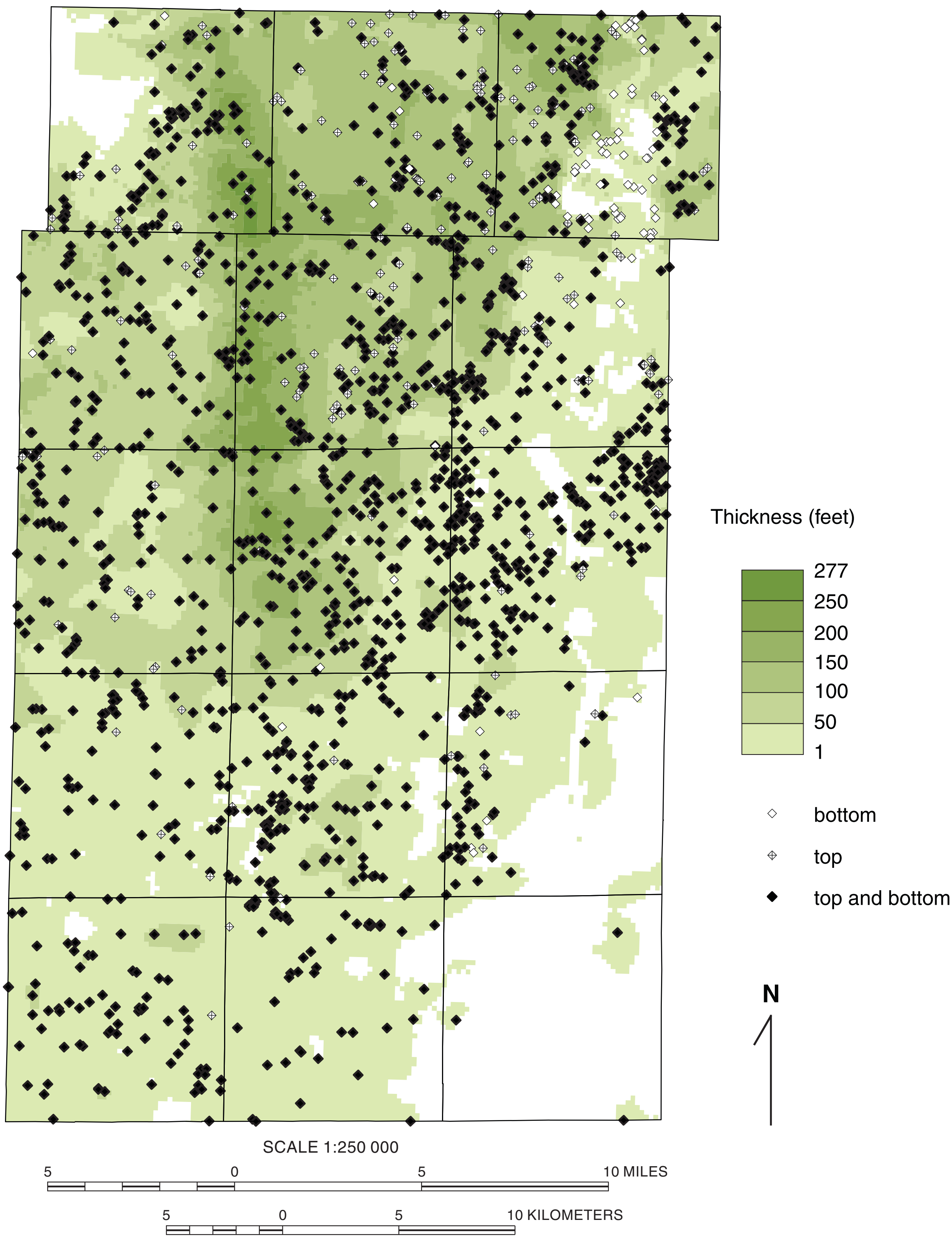

Figure 27 *Isopach map of the Tiskilwa Formation in Kane County and the distribution of primary wells used in mapping the unit.*

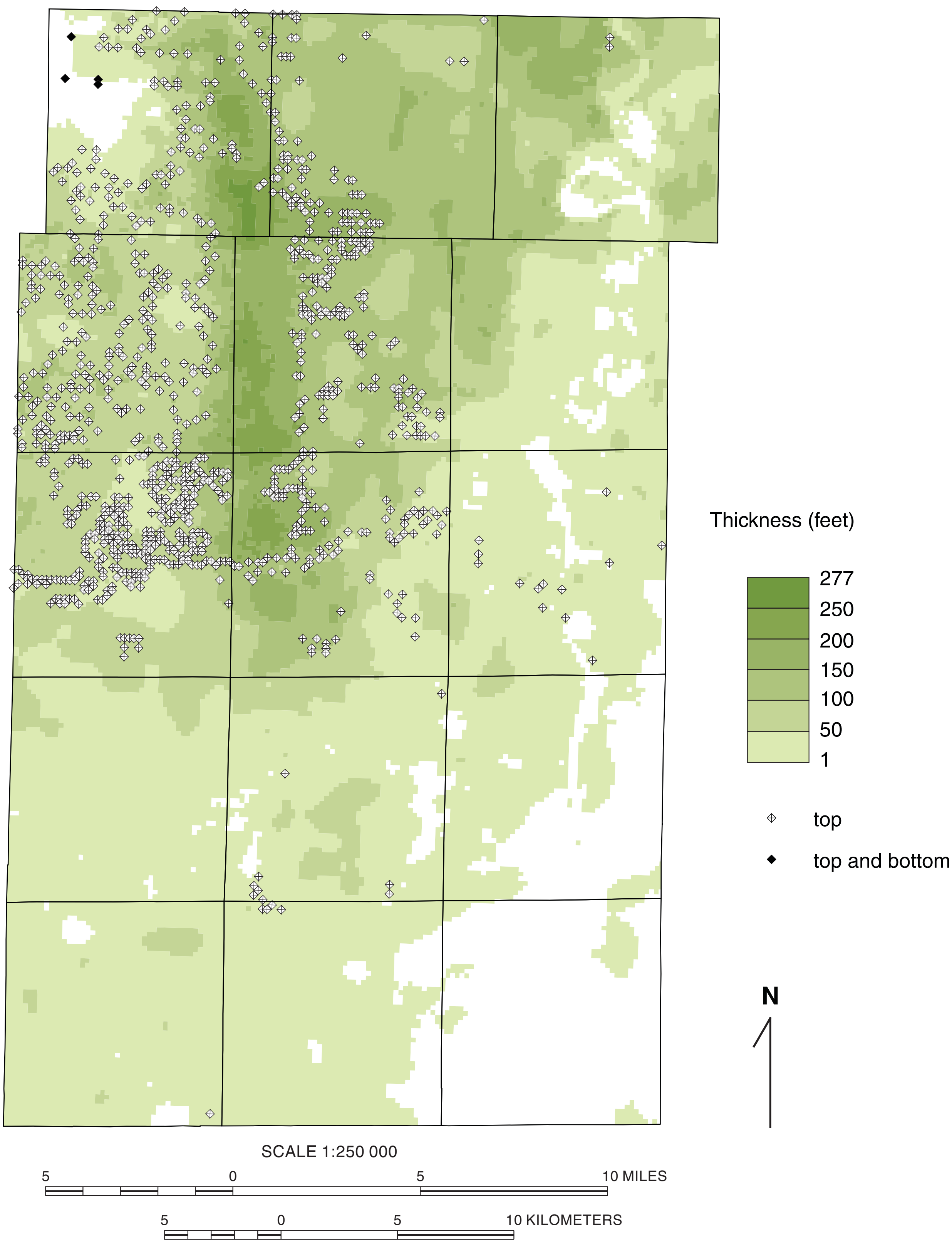

Figure 28 *Isopach map of the Tiskilwa Formation in Kane County and the distribution of synthetic data points used in mapping the unit.*

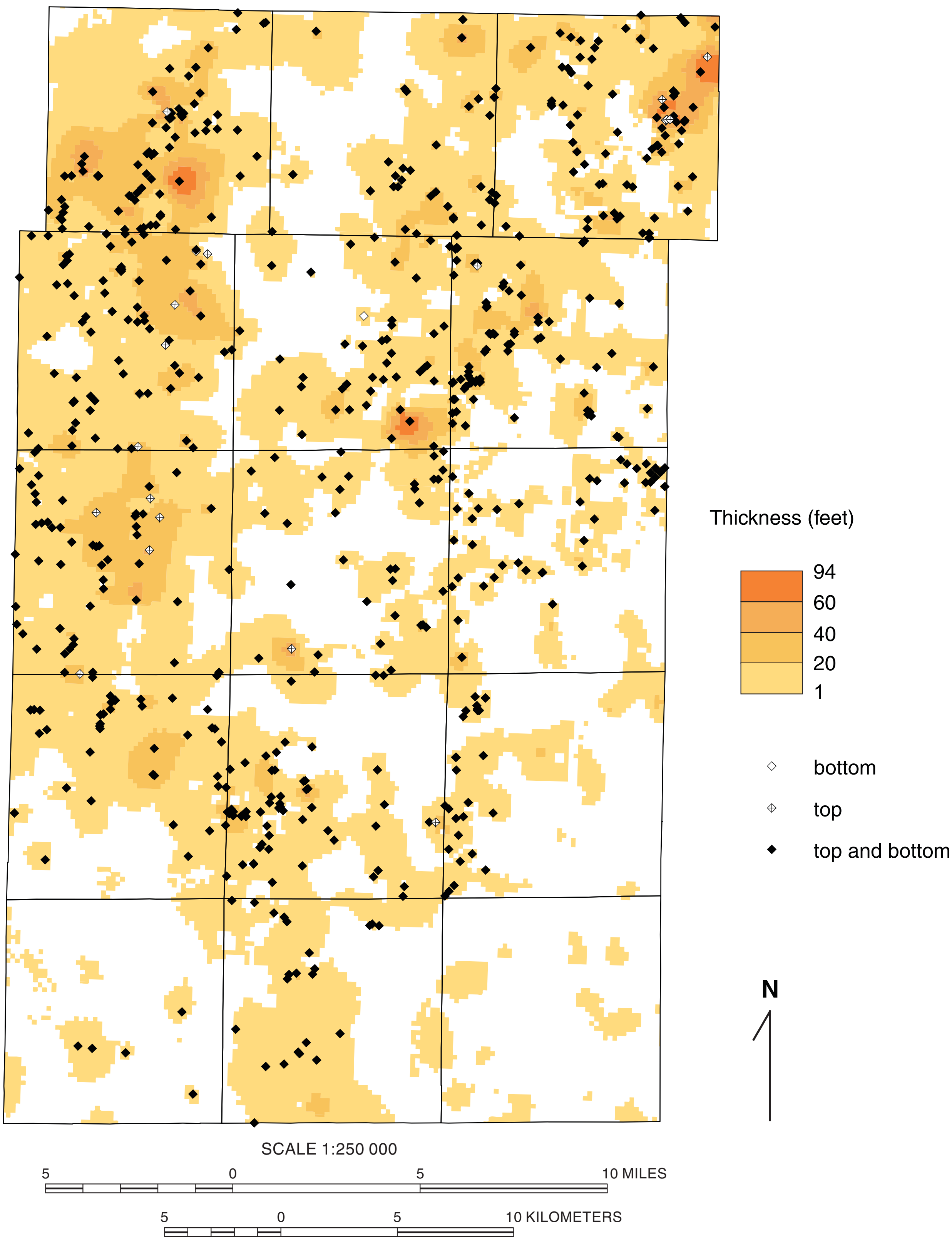

Figure 29 *Isopach map of the Ashmore Tongue of the Henry Formation in Kane County and the distribution of primary wells used in mapping the unit.*

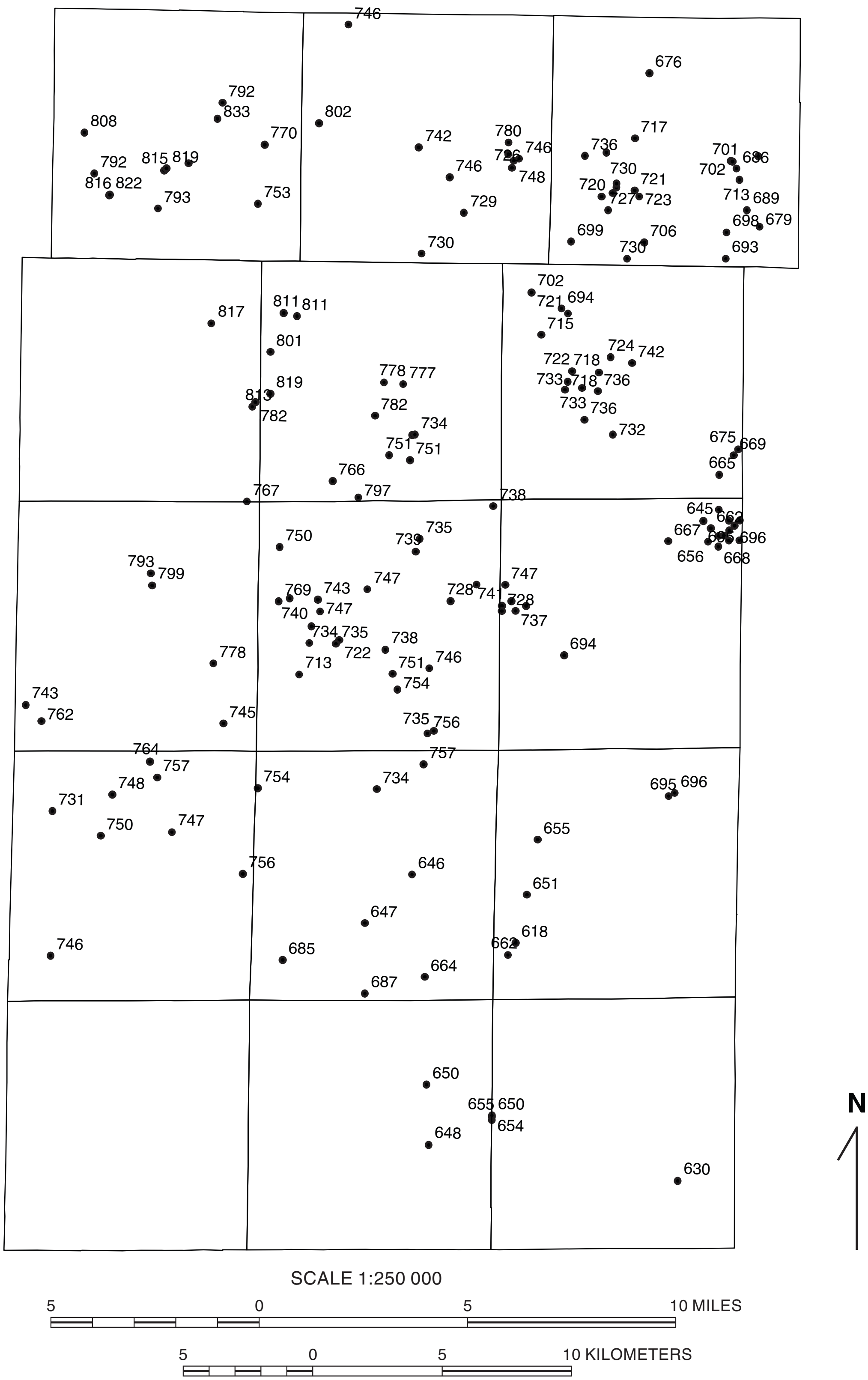

Figure 30 *Distribution and upper elevation (feet) of observation of the Robein Member, Roxana Silt, in Kane County.*

The Robein Member is an important marker bed, separating the overlying younger units of the Wisconsin Episode from underlying older units of the Illinois Episode. Occurrences of the Robein were modeled as a part of the upper surface of the Glasford Formation.

Glasford Formation

This Glasford Formation includes the oldest Quaternary deposits in Kane County. The Glasford is the surficial unit (below a mantle of loess) in the northwestern corner of project study area. The Glasford Formation is found in the subsurface throughout most of north, west, and central Kane County and is thickest where it fills buried bedrock valleys. The most important criteria for identifying the unit are that it occurs below the Robein Member of the Roxana Silt or that the unit shows evidence of soil weathering (usually ascribed to development of the Sangamon Geosol) buried by younger glacial deposits. The Glasford Formation is observed in many quarries in the county, including the Feltes Sand and Gravel Pit (Curry et al. 1999). The Glasford is composed of diamicton (till and debris flow deposits, mostly the former), sand and gravel, and uniform silt and clay.

Although not differentiated into recognized stratigraphic units, the Glasford Formation constitutes several lithologic units with varying physical attributes. For example, at the Feltes Sand and Gravel Pit, the Glasford Formation is yellow-brown, coarse-textured diamicton and associated with thick, bouldery sand and gravel (Curry et al. 1999). In other areas of the county, the Glasford Formation is a finer-grained diamicton or silty lake sediment.

For this report, the Glasford Formation has been modeled as five lithologic layers: an upper fine-textured layer, an upper coarse-textured layer, a middle fine-textured layer, a lower coarse-textured layer, and a lower fine-textured layer (table 3). Figure 31 shows the distribution of primary wells used to map the upper surface of the Glasford Formation. This surface and the synthetic data points used in mapping it are shown in figure 32. Figure 33 shows the isopach map for the total thickness of the Glasford Formation. The distribution of primary wells used to map the upper fine-textured layer is shown in figure 34, superimposed on an isopach map of the unit. The isopach map of the upper coarse-textured layer and the distribution of primary wells used to map the unit are shown in figure 35. This layer forms the uppermost portion of the Glasford Formation in areas where the upper fine-textured layer is absent. The isopach map of the middle fine-textured layer and the primary wells used to map it are shown in figure 36. Figure 37 shows an isopach map of the lower coarse-textured layer and the primary wells used to map it. The isopach of the lower fine-textured layer is depicted in figure 38.

Bedrock Geology

Bedrock Topography

The bedrock topography depicts the landscape of the bedrock surface and the location of the major bedrock valleys. These bedrock valleys commonly contain sand and gravel aquifers and are locations where groundwater in the bedrock may recharge groundwater in the drift (Gilkeson et al. 1987). The bedrock surface topography was compiled using data from 4,045 primary wells. Portions of the bedrock surface elevation and the location of the deepest parts of the buried bedrock valleys were estimated in places using seismic refraction methods (Heigold 1990). Bedrock surface elevation estimates generated from seismic refraction data are generally within 20 feet of the actual bedrock surface elevation as determined by subsequent test drilling (Gilkeson et al. 1987, Curry and Seaber 1990). Because of this uncertainty, not all available seismic reflection data were used to construct this map, but 1,672 seismic data points were used to fill in areas of sparse data. In addition, 28 data points were used to define where bedrock crops out at the land surface. Figure 39 shows the bedrock topography of Kane County and the distribution of primary wells, seismic data points, and outcrops used to map the surface. Figure 40 shows the bedrock surface and the distribution of synthetic data points used to map it. The synthetic data points were mainly used to connect locations where primary wells and seismic data indicated deep portions of bedrock valleys. There is a possibility that some of the low points in the bedrock surface do not form a continuous valley, but maybe attributed to karstic or paleokarstic features. Where weathering and dissolution occur along joints and fractures in carbonate rock, large void spaces can be formed, causing depressions or sinkholes (Panno et al. 1997). Formation of such void spaces has been observed near the upper surface of the Galena-Platteville Groups where the Maquoketa Group is thin or absent (Booth and Ekberg 2006).

Bedrock Lithostratigraphy

Stratigraphic assignments were simplified into six units: undifferentiated Silurian formations, the Maquoketa Group, the Galena-Platteville Groups, the Ancell Group, the Prairie du Chien Group, and the upper surface of the

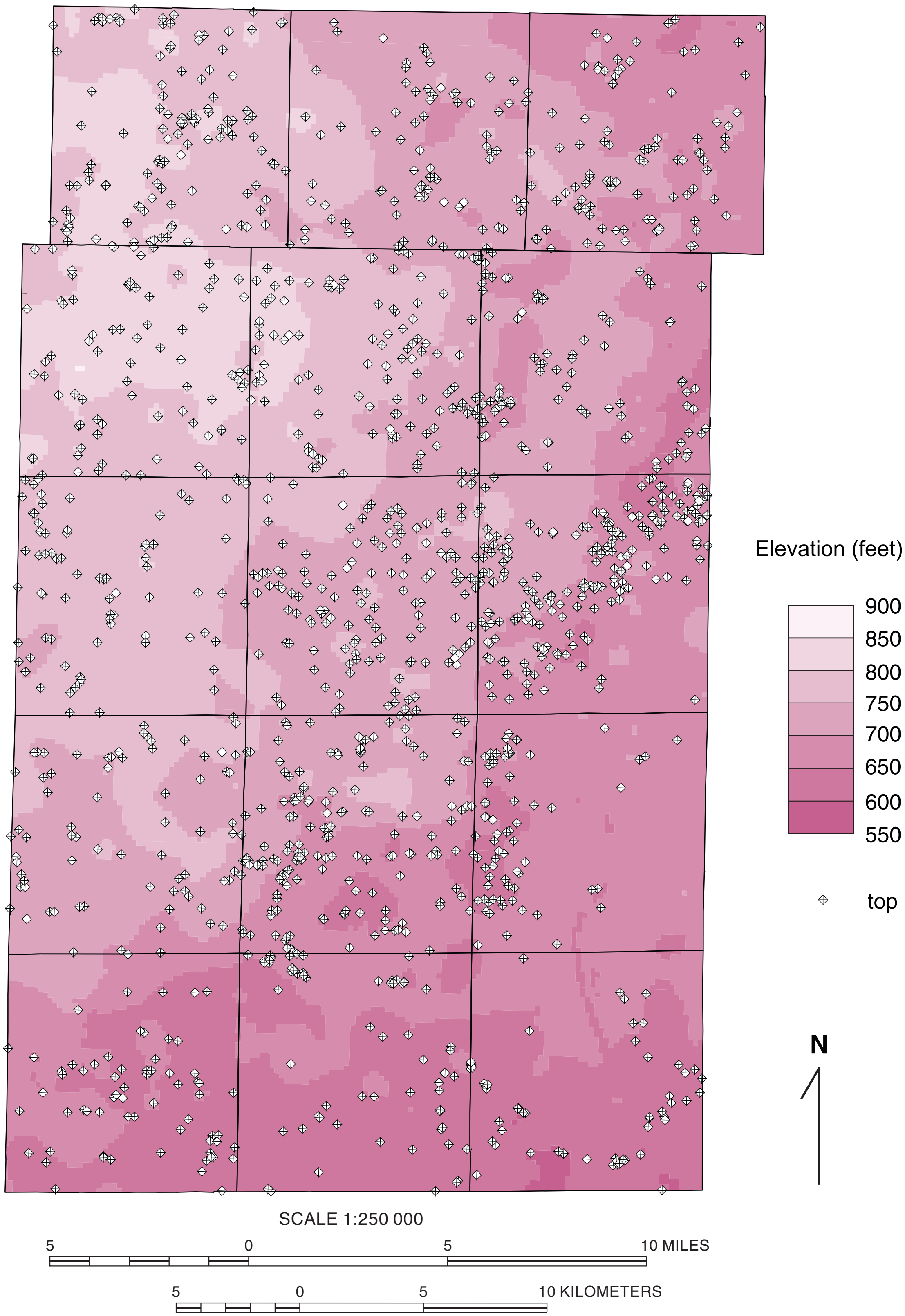

Figure 31 *Elevation grid of the upper surface of the Glasford Formation in Kane County and the distribution of primary wells used in mapping the surface.*

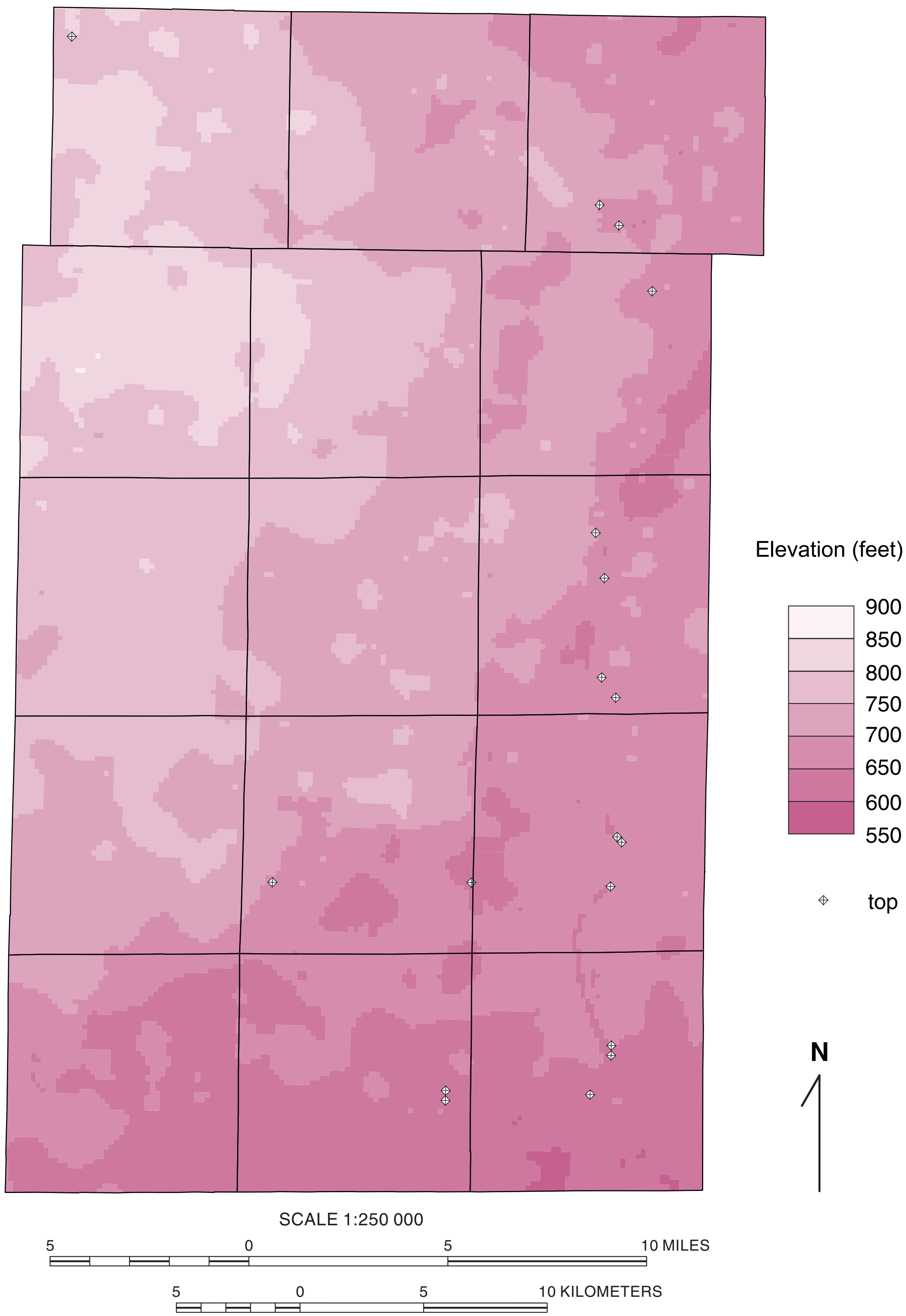

Figure 32 *Elevation grid of the upper surface of the Glasford Formation in Kane County and the distribution of synthetic data points used mapping the surface.*

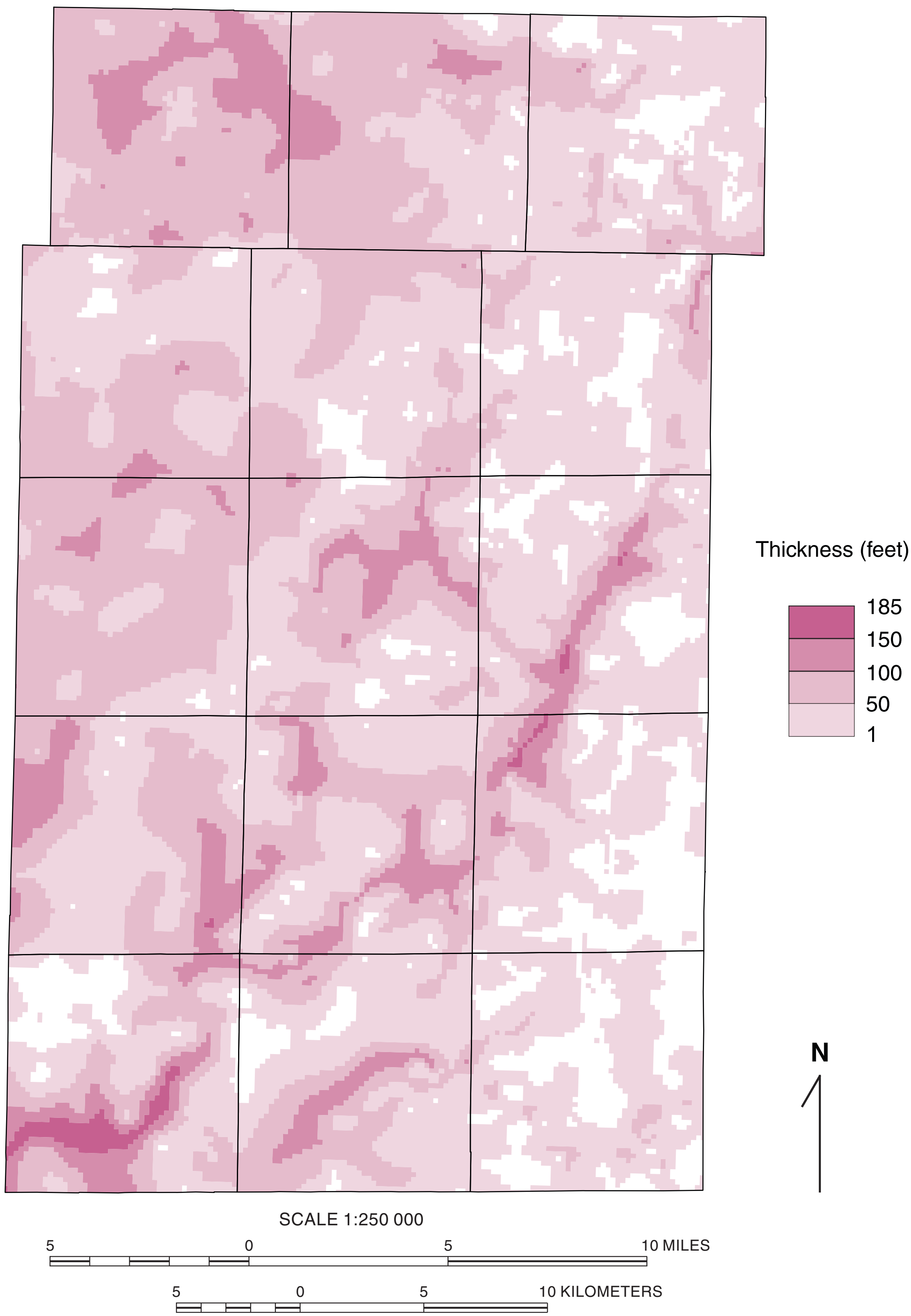

Figure 33 *Isopach map of the Glasford Formation in Kane County.*

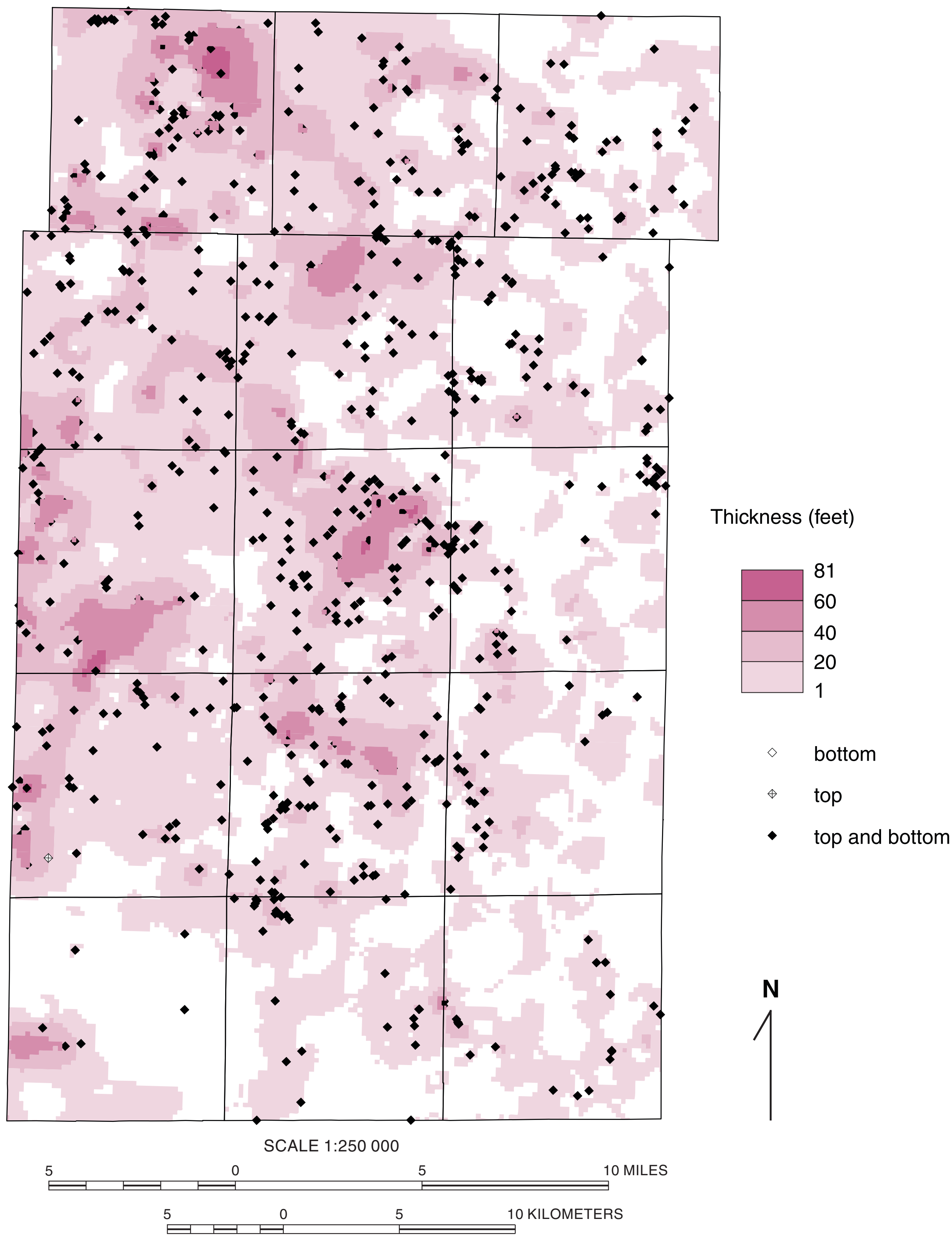

Figure 34 *Isopach map of the upper fine-textured unit of the Glasford Formation in Kane County and the distribution of primary wells used in mapping the unit.*

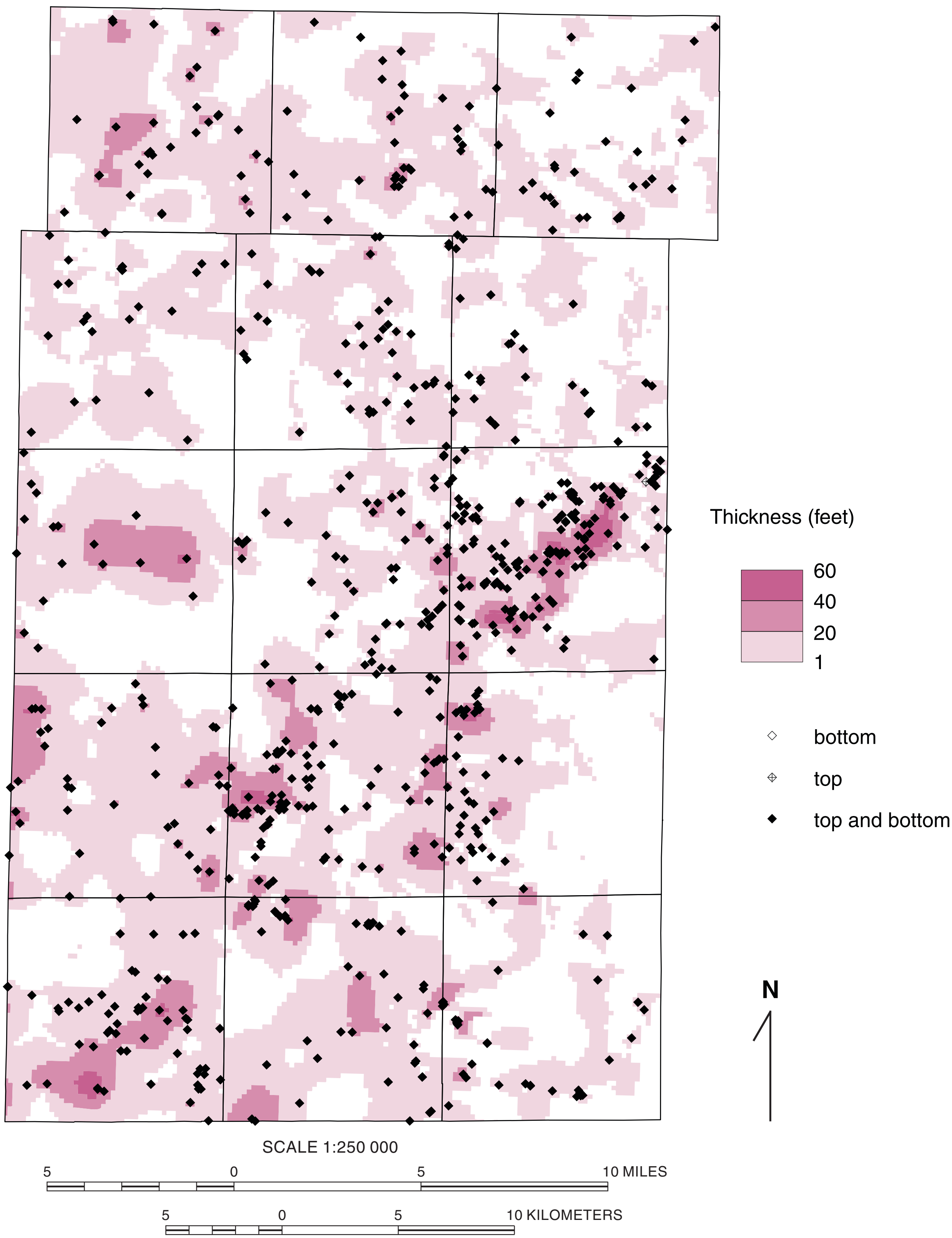

Figure 35 *Isopach map of the upper coarse-textured unit of the Glasford Formation in Kane County and the distribution of primary wells used in mapping the unit.*

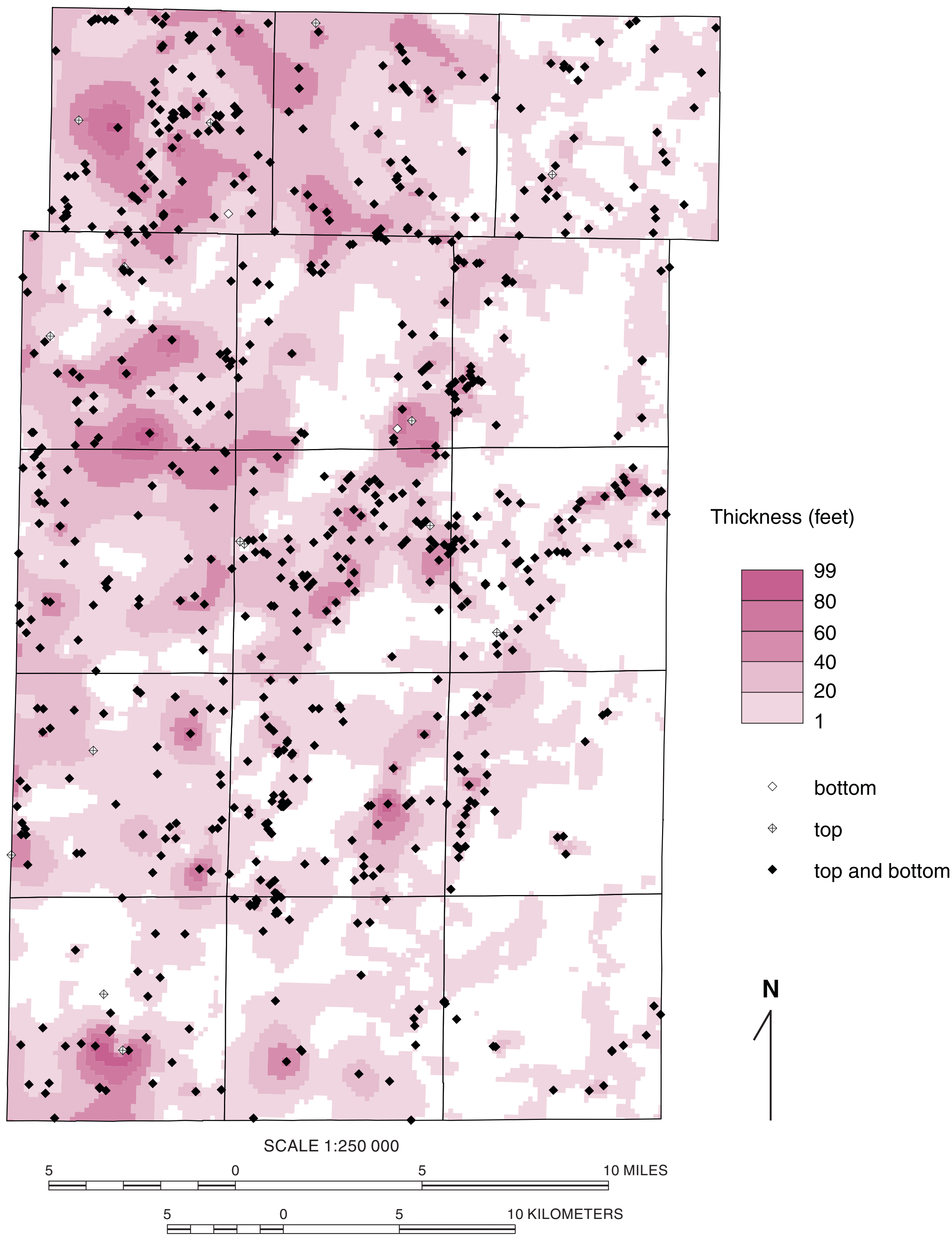

Figure 36 *Isopach map of the middle fine-textured unit of the Glasford Formation in Kane County and the distribution of primary wells used in mapping the unit.*

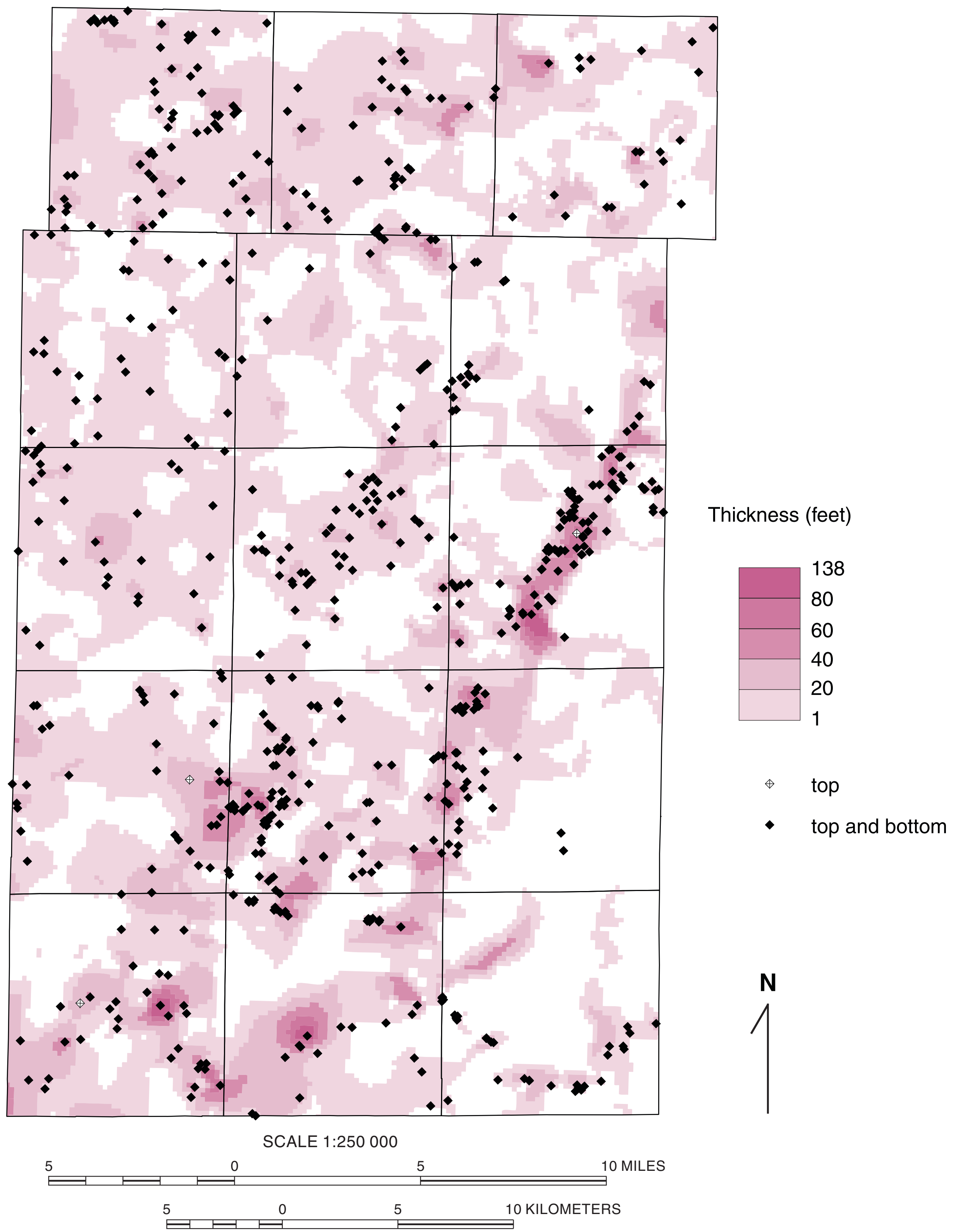

Figure 37 *Isopach map of the lower coarse-textured unit of the Glasford Formation in Kane County and the distribution of primary wells used in mapping the unit.*

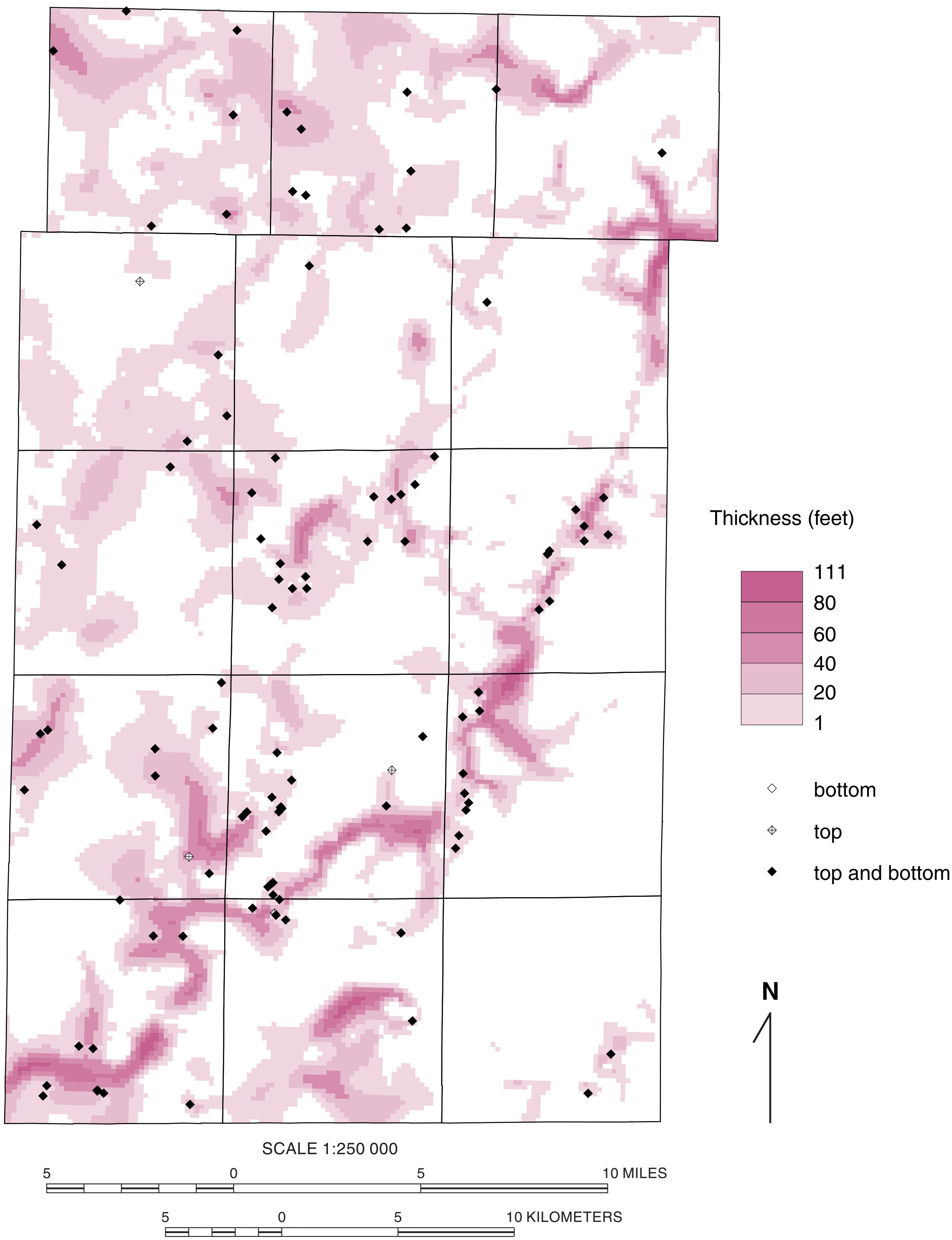

Figure 38 *Isopach map of the lower fine-textured unit of the Glasford Formation in Kane County and the distribution of primary wells used in mapping the unit.*

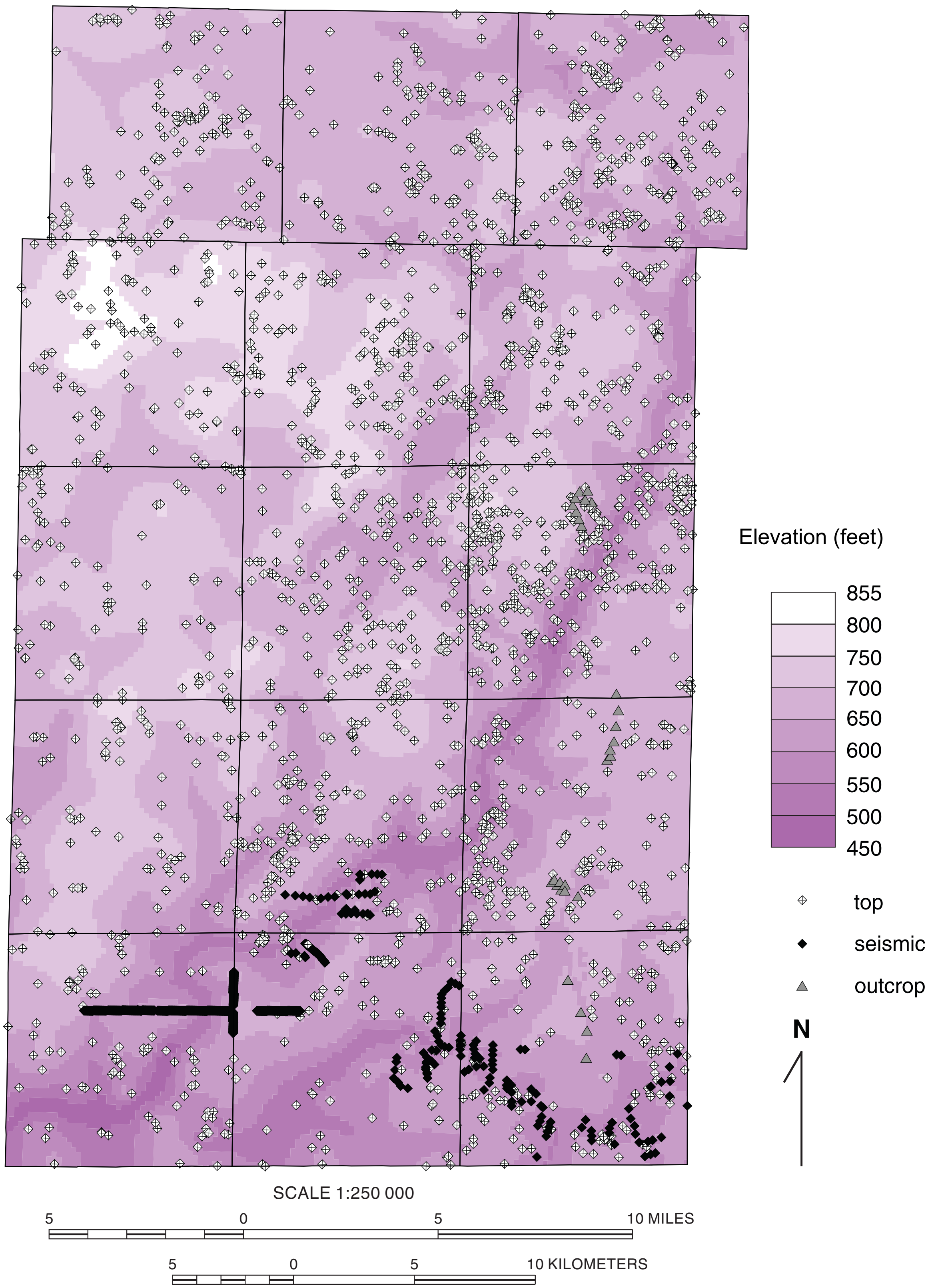

Figure 39 *Bedrock topography of Kane County and the distribution of primary wells, seismic data, and outcrops used in mapping the surface.*

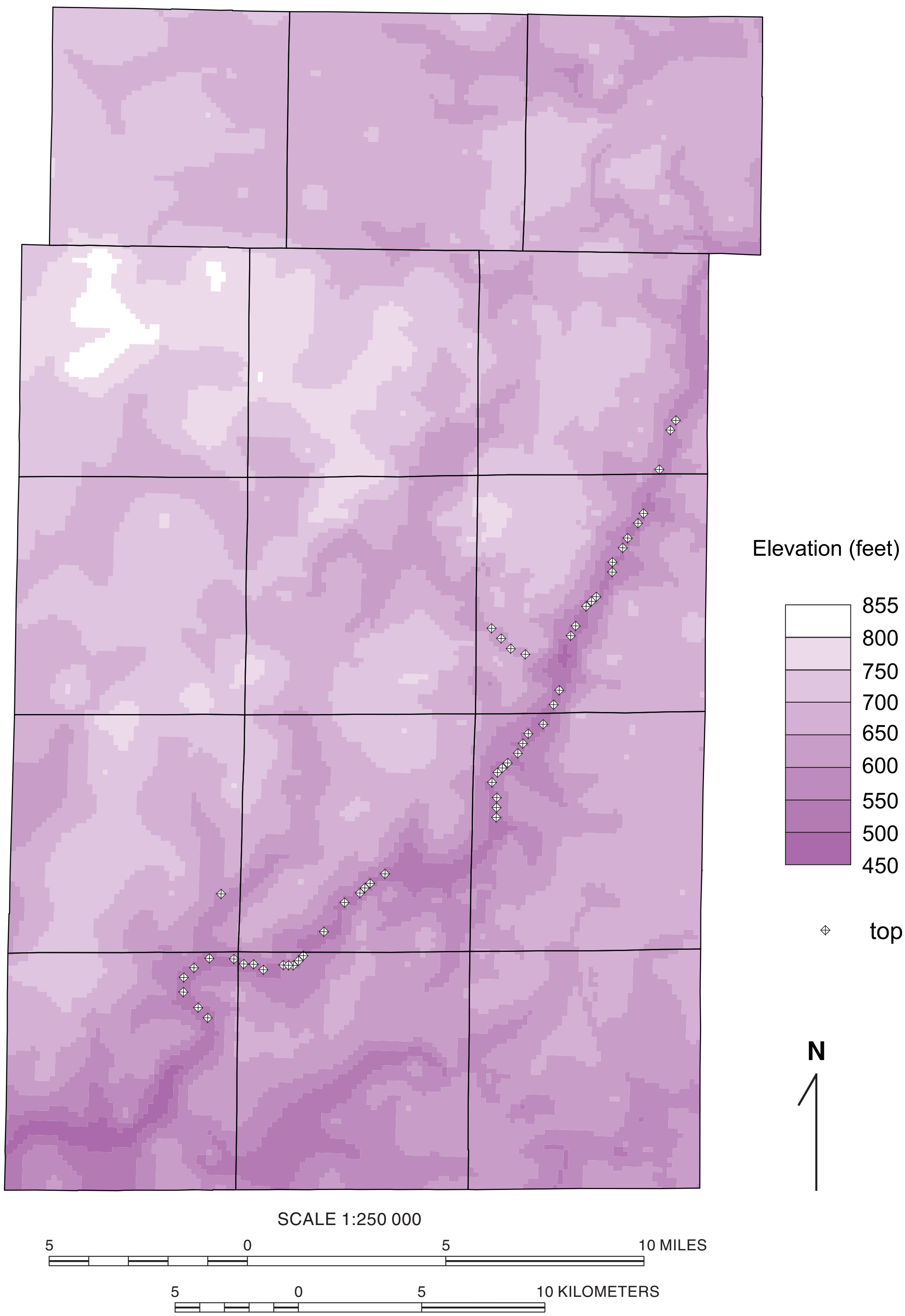

Figure 40 *Bedrock topography of Kane County and the distribution of synthetic data points used in mapping the surface.*

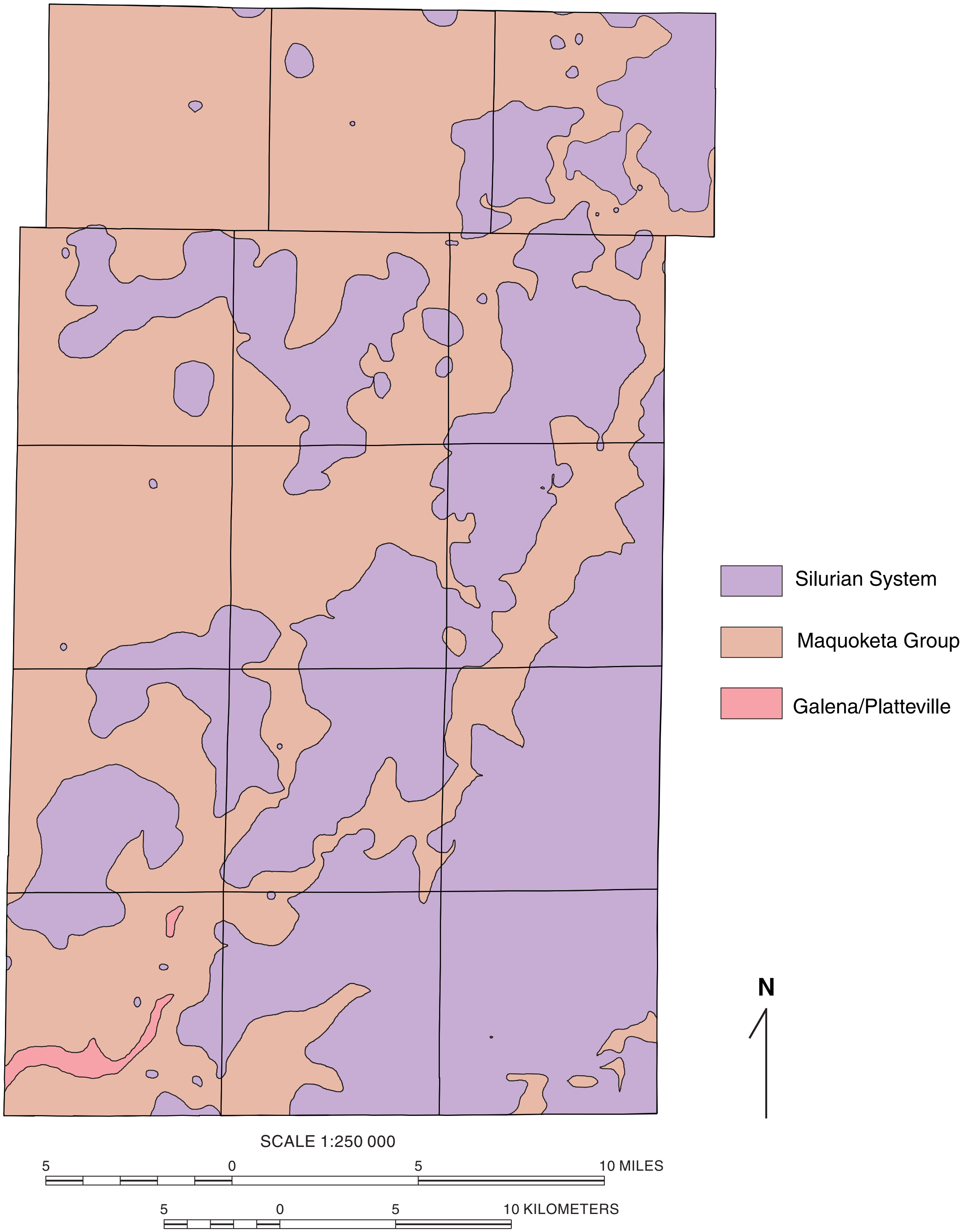

__Figure 41__ The subcrop pattern of the major stratigraphic bedrock units in Kane County.

undifferentiated Cambrian System (table 3). In general, availability of data to identify units decreases with depth. Deeper or older units are less well defined than the shallower or younger units. Because the emphasis of this report is on the shallow groundwater resources of Kane County, no effort was made to map the deeper Cambrian age aquifers. Figure 41 shows the subcrop pattern of the major bedrock units in Kane County.

The youngest bedrock unit that occurs in the county is carbonate rock of the Silurian System. This unit is composed of dolomite and limestone (Willman et al. 1973) and has a thickness less than 150 feet throughout the county (fig. 42). Where present, the Silurian bedrock is widely used for industrial and residential water supply, and groundwater yield can be large (Visocky et al. 1985). The most productive part of the unit is the upper 50 feet where weathering of joints and fractures may significantly increase secondary porosity (Graese et al. 1988).

The Maquoketa Group of the Ordovician System occurs throughout most of Kane County. This unit is composed of shale, thinly bedded shale, and carbonate rock (Graese 1991). The unit has an average thickness of 135 feet throughout the county. Where present, the unit is generally between 100 and 200 feet thick (fig. 43). Figure 44 depicts estimates of percentage of the unit thickness as carbonate rock. Regionally the unit is an aquitard or confining layer, yet locally, the Maquoketa may yield water sufficient for residential use (Visocky et al. 1985). Moderate groundwater yields can sometimes occur where the unit is present at the bedrock surface and joints are present in the unit (Graese et al. 1988).

The oldest unit that occurs at the bedrock surface is the Galena Group. For this mapping effort, the Galena and Platteville Groups were not distinguished. These Ordovician age units are composed primarily of fine-grained to medium-grained carbonate rock (Willman et al. 1973). The combined thickness of the Galena and Platteville Groups is between 250 to 380 feet throughout the county but is generally between 300 and 350 feet (fig. 45). The Galena-Platteville is not a major source of groundwater in Kane County. Where overlain by other bedrock units, hydraulic conductivity and yield to wells are both low (Visocky et al. 1985, Graese et al. 1988). In the southwestern part of the county, where the unit is at or near the bedrock surface, dissolution may have widened fractures in the upper portion of the unit (Panno et al. 1997, Booth and Ekberg 2006). Yield to wells could potentially be higher in these areas.

The next older unit mapped is the Ancell Group of the Ordovician System. The Ancell Group is predominantly a fine- to medium-grained sandstone (Willman et al. 1973). The Ancell varies in thickness from about 180 to 440 feet across the county with a mean thickness of about 330 feet (fig. 46). The sandstone of the Ancell Group yields small to moderate quantity of water used throughout the county for residential, small industrial, and small municipal supplies (Graese et al. 1988). Where larger quantities of water are needed, wells are usually drilled into deeper bedrock aquifers.

The Prairie du Chien Group underlies the Ancell Group and is discontinuous under Kane County. The unit is absent in northern portions of the county and is over 300 feet thick in south-central portions of the county (fig. 47). The unit's mean thickness across the county is 110 feet. The unit was defined using records from 50 wells, 17 of which are located in the county. The Prairie du Chien Group is generally a cherty carbonate rock with interbedded sandstone (Willman et al. 1973). Crevices in limestone and sandstone layers in the unit may yield a small to moderate quantity of water (Visocky et al. 1985).

In Kane County, the uppermost Cambrian age units and the Prairie du Chien Group form a regional confining layer that separates the deeper aquifers from shallower aquifers (Visocky et al. 1985). Cambrian aged units were identified mostly using sample set descriptions from the ISGS Geological Record Unit. Records from 36 wells were used to describe the surface of the Cambrian rock, 5 of these wells are located within Kane County. The surface has an elevation in Kane County between about 100 feet above and 407 feet below mean sea level (fig. 48). Where identified in the sample set descriptions, the uppermost unit was identified as 20 to 120 feet of rock from the Trempealeau System over rock of the Franconia Formation.

Evaluating the Accuracy of the Geologic Model

The three-dimensional geologic model predicts the occurrence of geologic lithostratigraphic units. As with any geologic map, it is inevitable that the geologic model will contain some errors. These errors will be due to (1) unidentified errors in the data, (2) areas with low data density, (3) generalizations in the texture of the lithostrati-

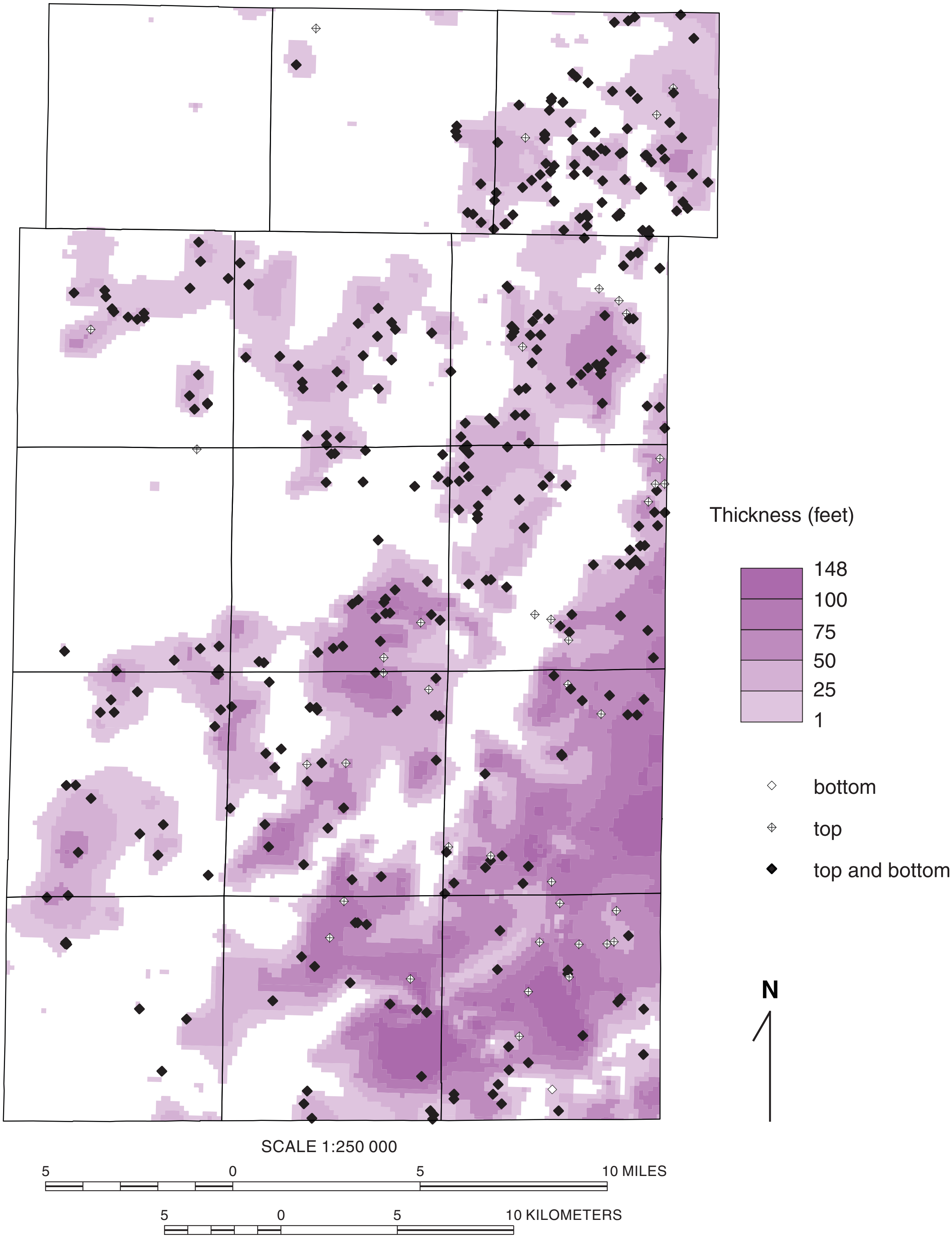

Figure 42 *Isopach map of the Silurian System in Kane County and the distribution of primary wells used in mapping the unit.*

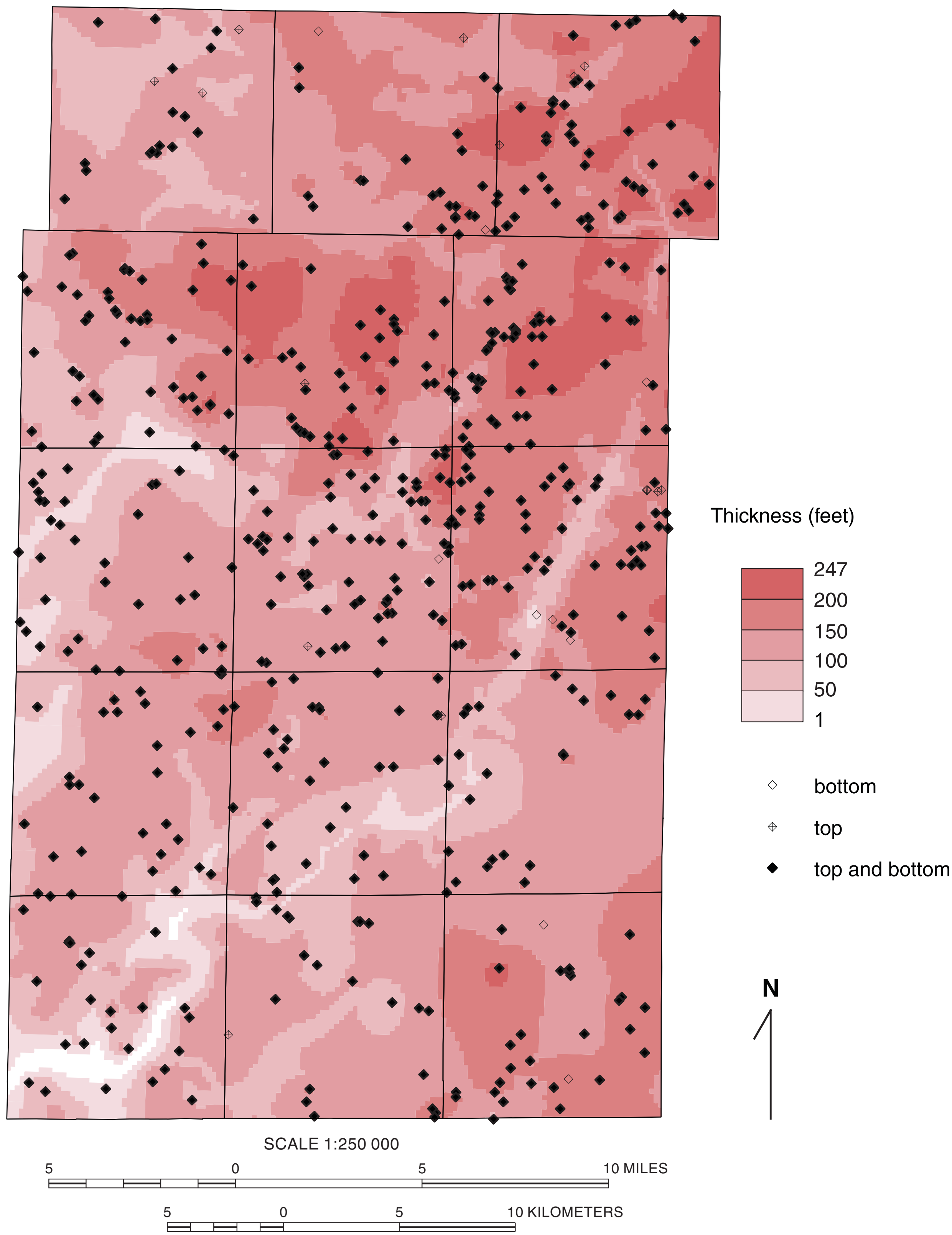

Figure 43 *Isopach map of the Maquoketa Group of the Ordovician System in Kane County and the distribution of primary wells used in mapping the unit.*

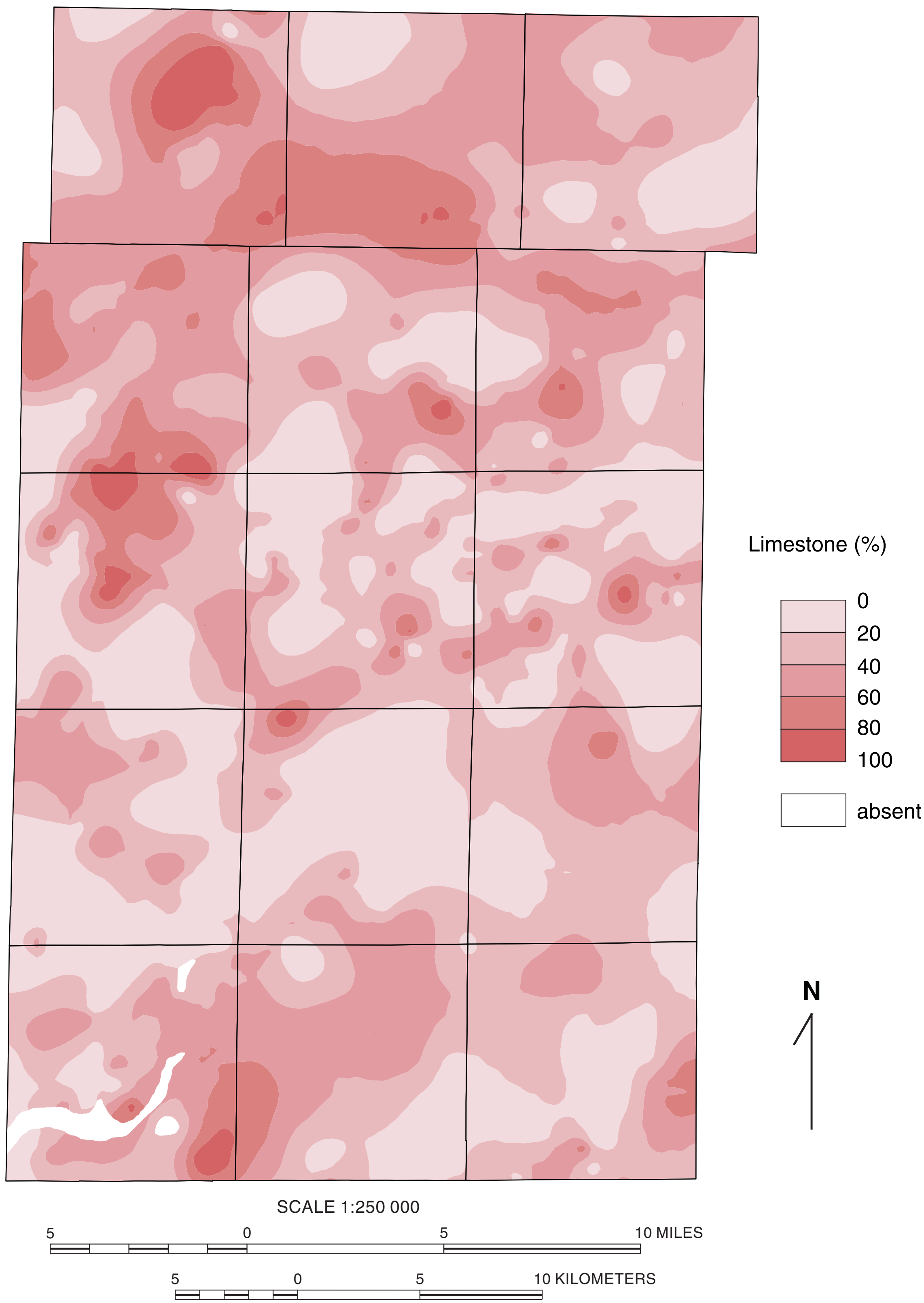

Figure 44 *Estimates of percent carbonate rock by thickness of the Maquoketa Group of the Ordovician System in Kane County.*

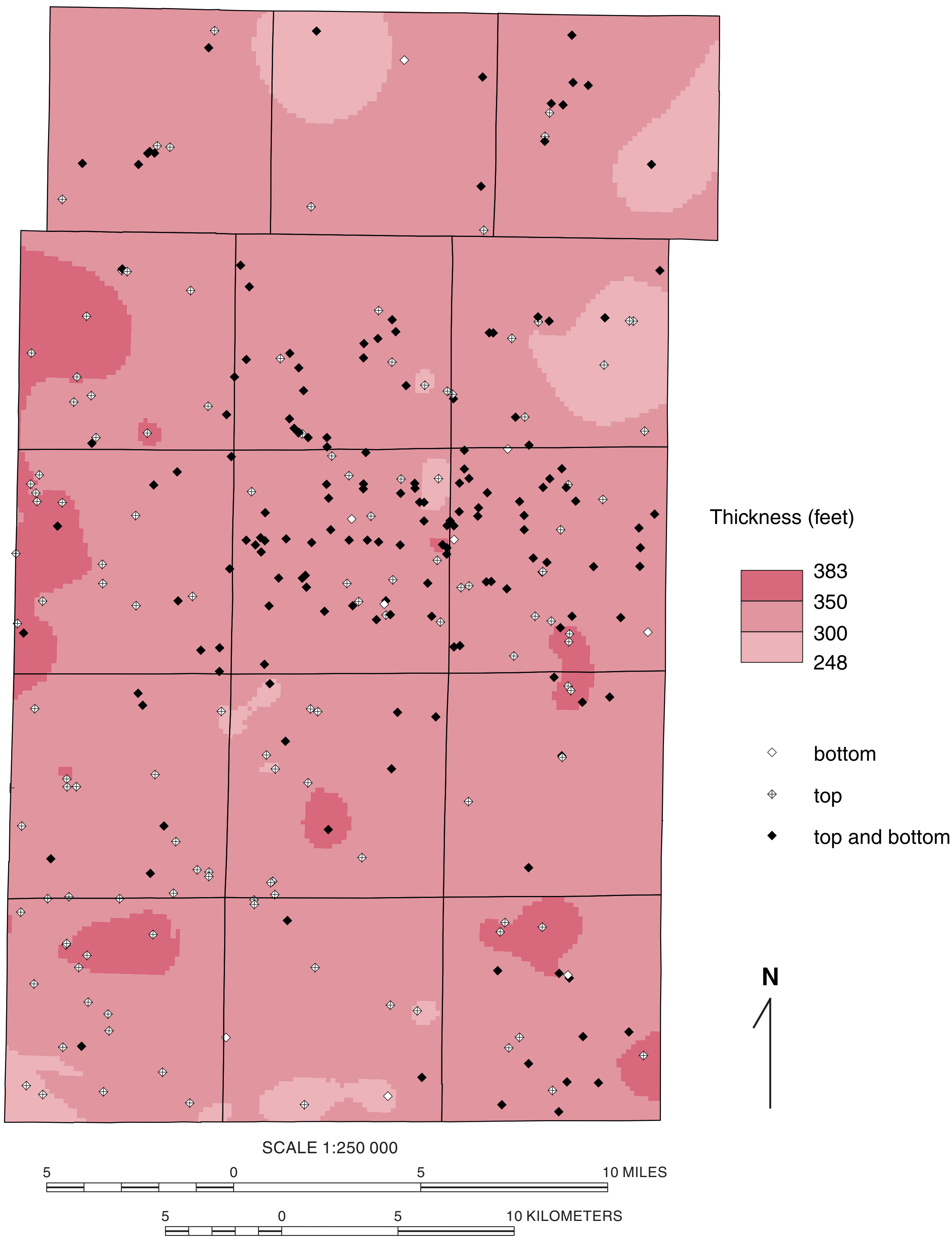

Figure 45 Isopach map of the Galena and Platteville Groups of the Ordovician System in Kane County and the distribution of primary wells used in mapping the unit.

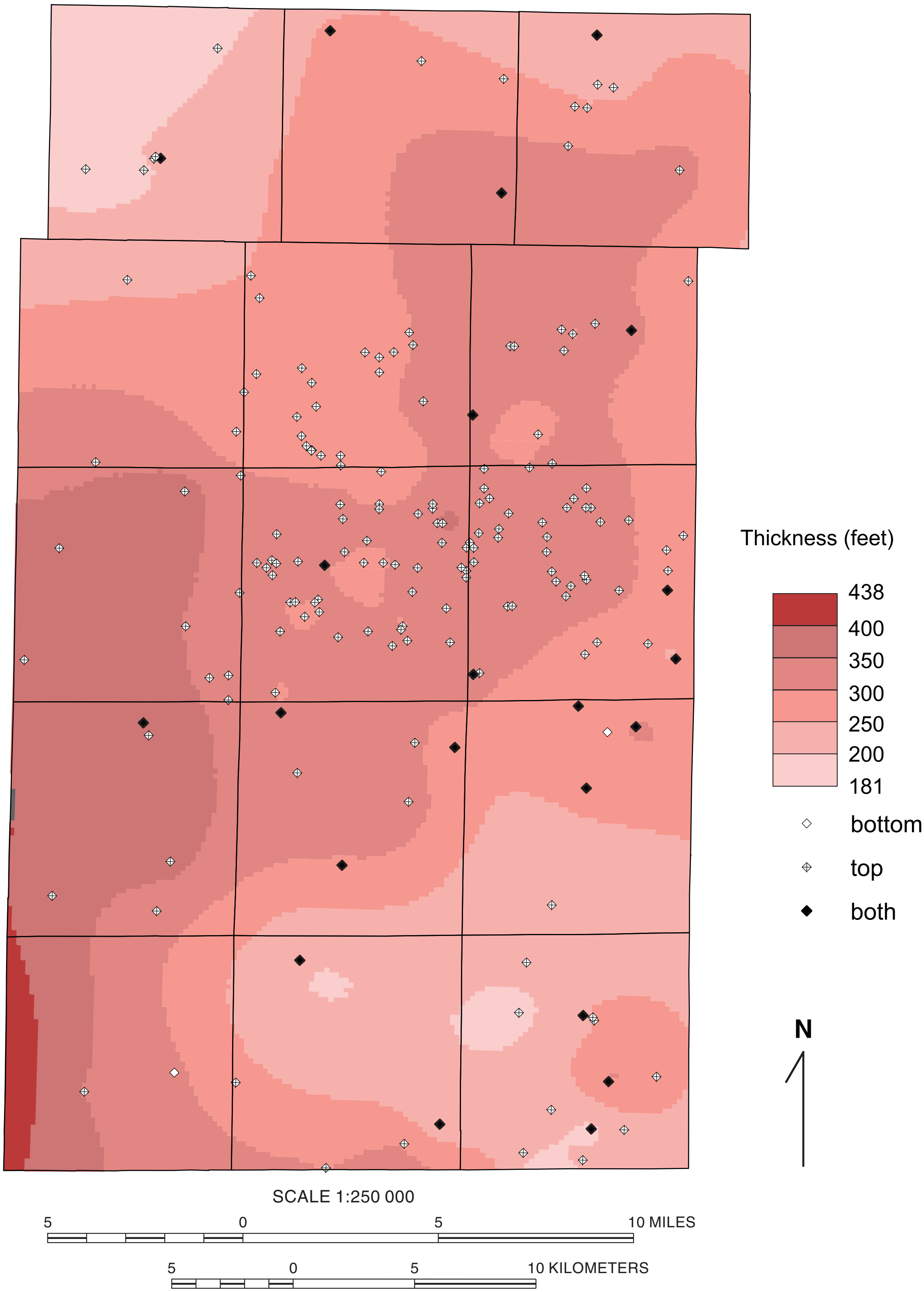

Figure 46 *Isopach map of the Ancell Group of the Ordovician System in Kane County and the distribution of primary wells used in mapping the unit.*

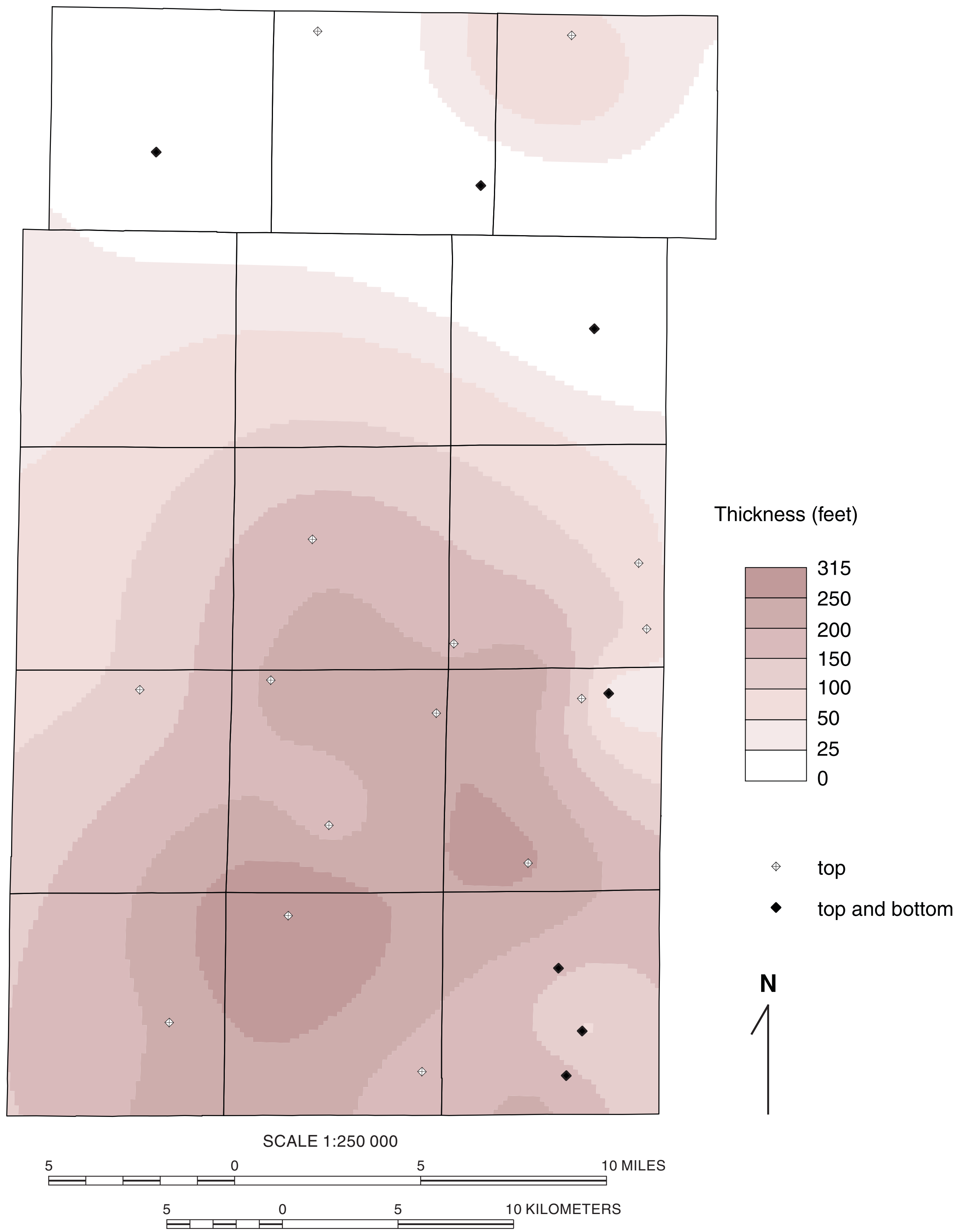

Figure 47 *Isopach map of the Prairie du Chien Group of the Ordovician System in Kane County and the distribution of primary wells used in mapping the unit.*

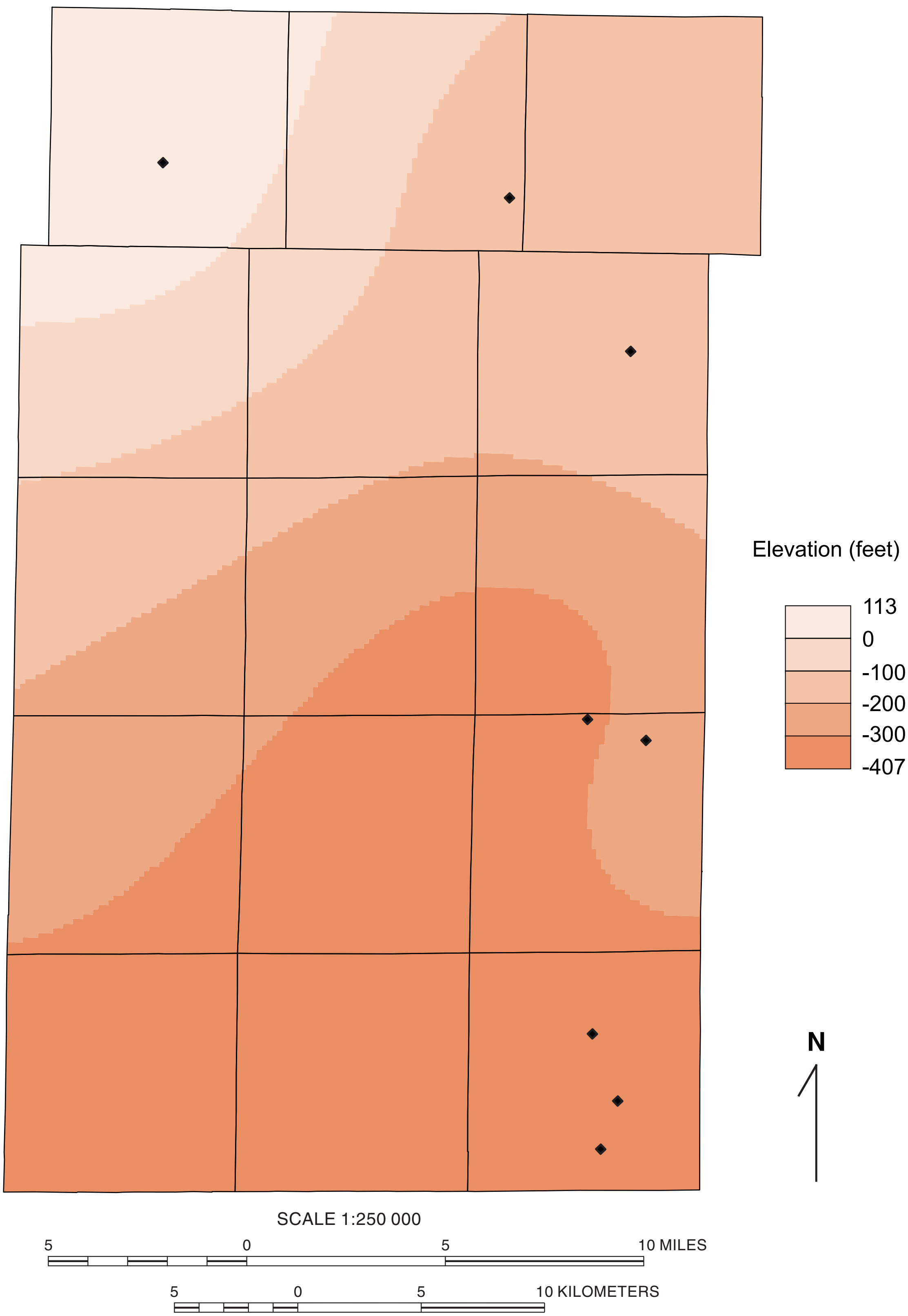

Figure 48 *Elevation of the upper surface of the Cambrian System in Kane County and the distribution of primary wells used in mapping the surface.*

graphic units, and (4) generalizations in the thickness and occurrence of each unit. Unfortunately, it is very difficult to estimate the distribution of these errors and their impact on the accuracy of the resultant geologic model. It is very difficult, therefore, to identify where the model might be more or less reliable. Most of the existing methods for evaluating the accuracy of geologic maps rely on statistical assumptions that do not use much geologic knowledge (Chiles and Delfiner 1999, Journel 1994). We feel that it is critical to integrate the geologic knowledge gained from mapping into any evaluation of geologic map accuracy. For this study, we have explicitly incorporated the geologic knowledge gained in this project in our evaluations of the accuracy of the geologic model of Kane County. Our evaluation considered limitations in the geologic model's accuracy from the four sources of error identified above. A report of the analysis is contained in Appendix A1.

Results from the analysis show the accuracy of the geologic model meets or exceeds that needed to meet the design goal for use in supporting county-scale evaluations of geologic materials for water resource management. Thin textural changes are probably underreported in the drillers' material descriptions from water wells records. Small or localized errors in the reported thickness or occurrence of geologic units is very probable, but not to a degree that should effect the utility of the geologic model. Generalizations used in assigning texture to geologic units need to be taken into consideration during the calibration process when using the geologic model as input for a groundwater flow model. Generalizations in thickness and areas of low data density are not outside the design goal for accuracy for most units. Low data density for the Ashmore Tongue of the Henry Formation, however, contributes to a higher uncertainty regarding the continuity of this unit that may have consequences for groundwater flow characteristics.

GEOLOGIC MAPS

Three-dimensional Geologic Model

We originally proposed production of a stack-unit map or other three-dimensional representation of Kane County for this report (Meyer et al. 2002). A draft stack-unit map of Kane County was produced using a simplified version of the lithostratigraphy presented in the conceptual model, but the map was too complex for land use planning applications. Instead, the *Three-dimensional Geologic Model, Kane County, Illinois* (Abert et al. 2007) was produced. The current model is a refined version of the preliminary three-dimensional model (Abert et al. 2004). The lithostratigraphic surfaces created to produce the geologic model were imported into three-dimensional modeling software (Earth Vision®, Dynamic Graphics Inc. 1997). The surfaces were combined to produce a three-dimensional model similar to those produced for other ISGS publications (Abert 2000, 2001). The software allowed the mappers to see the relationships between geologic units and make adjustments where geologic units occurred out of accordance with the conceptual model. Images from the model were created by separating each Quaternary lithostratigraphic unit from the three-dimensional model and displaying it in a consistent projection. The projection is a view from the southeast at 25 degrees above the horizontal.

Application

The *Three-dimensional Geologic Model, Kane County, Illinois* (Abert et al. 2007) provides a visual representation of the geology of the county. The images from the model allow visualization of the individual lithostratigraphic layers and their interrelationships. The model's usefulness can be described as more illustrative or educational. A page-size depiction of images of the modeled units is included in Appendix A2 and is available at http://www.isgs.uiuc.edu/maps-data-pub/icgm/pdf-files/kane-3d.pdf.

Geologic Cross Sections

Geologic cross sections are two-dimensional representations of the geologic material present in a vertical plane passing through a portion of the Earth's surface. The cross sections offer an image of the distribution and thickness of the geologic units present, usually along a straight line in the geographic area of interest or on a line drawn through a series of points across that area. Traditionally, the points are borings or outcrops where the mappers are highly confident of their geologic interpretation.

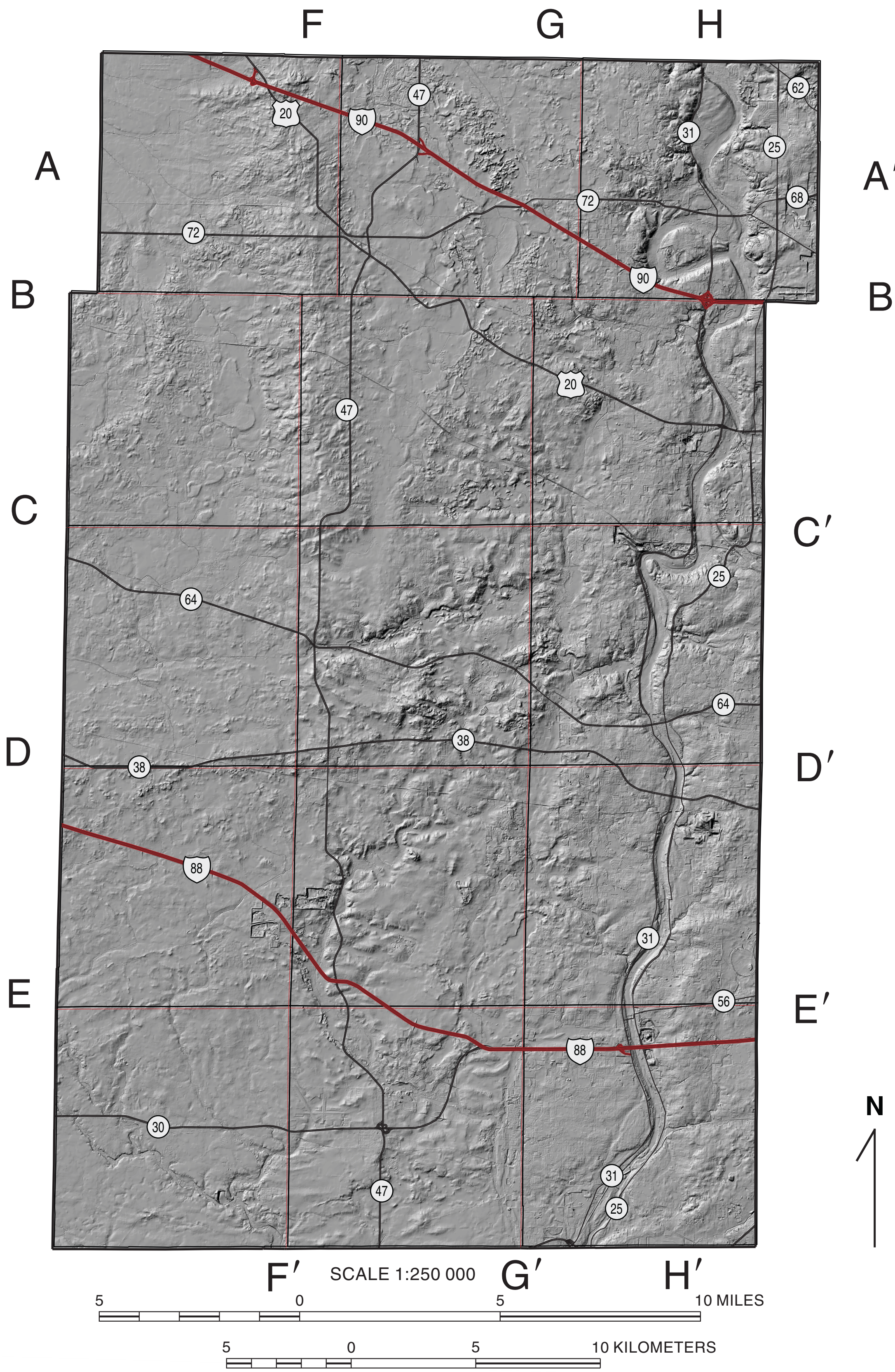

Figure 49 *Location of geologic cross section lines in Kane County. Cross sections are shown on pp. 110–111.*

The cross sections accompanying this report (Dey et al. 2007a) were created by taking slices through the three-dimensional geologic model at a scale of 1:100:000. Three slices are north to south, and five are east to west. Figure 49 shows where the cross sections pass through the county.

Application

The cross sections complement the three-dimensional geologic model (Abert et al. 2007). The cross sections provide a visual representation of the geology of the county along parallel lines through the county and allow visualization of the individual stratigraphic layers and how they relate to one another. Like the geologic model images, the primary applications of the cross sections are for illustration and education rather than regulatory. The cross sections can be viewed at http://www.isgs.uiuc.edu/maps-data-pub/icgm/pdf-files/kane-cs.pdf and http://www.isgs.uiuc.edu/maps-data-pub/icgm/pdf-files/kane-cs.pdf

A page-size depiction of the cross sections is included in Appendix A3.

Major Quaternary Aquifers

Elements of the three-dimensional model were used to produce *Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2007b), replacing the *Interim Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2005b). On the new map, four aquifers are renamed to coincide with local geographic features. The definition of one renamed aquifer is adjusted to include additional lithostratigraphic units based on the current geologic model.

In Illinois, major aquifers are defined as geologic units (sand and gravel or fractured and/or permeable bedrock) capable of yielding at least 70 gallons per minute (gpm) of water to wells completed in them (Miller et al. 1985). Quaternary aquifers in Kane County are saturated thick sand and gravel deposits. These deposits are considered aquifer materials because their porosity and hydraulic conductivity are high and allow for the free flow of water. Aquifer materials are aquifers only when they are saturated. We have mapped the distribution of Quaternary aquifer materials in the county and have used results from potentiometric surface mapping by the ISWS to determine where the aquifer materials are and where they may be saturated (Locke and Meyer 2007). Our map depicts the location of deposits of Quaternary aquifer materials that have the potential to meet the definition of major aquifer. The thickness for each aquifer map unit represents an aggregate thickness of sand and gravel deposits within the mapped unit and not necessarily the thickness of any one lithostratigraphic unit. Boundaries are shown where the aquifer material thickness is 20 feet or greater. The mapped units are greater than 50 feet thick at some points within their distribution and are several square miles in areal extent. Any properly constructed well that is sited where one of the mapped combinations of aquifers materials have a saturated thickness of greater than 20 feet should have a high probability of producing greater than 70 gpm of water, assuming minimal influence from other pumping wells or aquifer boundaries.

Following the descriptions of Curry and Seaber (1990), Vaiden and Curry (1990) mapped four Quaternary aquifers that had the potential for development as public water supplies in Kane County. Working from these definitions and employing results from the current mapping effort, we have identified five named major Quaternary aquifers and a group of unnamed major Quaternary aquifers.

1. The St. Charles aquifer, named for the St. Charles Bedrock Valley, is located in the valley and its tributaries in eastern and southern Kane County. The St. Charles aquifer is composed of the Ashmore Tongue of the Henry Formation and sand and gravel deposits of the Glasford Formation (fig. 50). These units are in hydraulic contact in a large portion of the mapped area of the aquifer. In the northern half of the county, away from the Fox River, the aquifer is commonly more than 50 feet below the land surface. In the Fox River valley, the aquifer is commonly less than 20 feet below the land surface. The aquifer has some hydraulic connection to the Fox River in the vicinity of St. Charles where the aquifer is probably under unconfined or leaky confined conditions. Throughout the rest of aquifer's extent, the geometry of units within the geologic model suggest that the St. Charles aquifer is probably under confined conditions. The maximum thickness of the aquifer is 170 feet.

2. The Hampshire aquifer, named for the village of Hampshire, is located west of the Marengo Moraine (fig. 15) in northwestern Kane County. The Hampshire aquifer is composed of the Ashmore Tongue of the Henry Formation and the sand and gravel deposits of the Glasford Formation (fig. 51). Surficial sand and gravel of the Henry Formation are included in areas where the Tiskilwa Formation is absent north and west of Hampshire. These

coarse-textured units are all in hydraulic contact northwest of Hampshire where the aquifer is unconfined. Where the Tiskilwa Formation is present (south and east of Hampshire), the aquifer is probably under confined conditions. The Ashmore Tongue and Glasford sand and gravel deposits are in hydraulic contact in the area around Burlington. Elsewhere the aquifer is separated into distinct layers by intervening Glasford diamicton. The maximum thickness of the aquifer is 120 feet. This aquifer is the equivalent of the previously mapped Bloomington aquifer (Curry and Seaber 1990).

3. The Virgil aquifer, named for the town of Virgil, is located in west-central Kane County. The Virgil aquifer is composed of the Ashmore Tongue of the Henry Formation and sand and gravel deposits of the Glasford Formation (fig. 50). These coarse-textured units are in hydraulic contact near the center and eastern portion of the aquifer. In other parts of the aquifer, the Glasford diamicton separates the coarse-textured units. The aquifer is overlain by greater than 20 feet of Tiskilwa Formation, lies 50 to 200 feet below the land surface, and has a maximum thickness of 125 feet. Because of the position of the Virgil aquifer within the sediment sequence, the aquifer is probably under confined conditions with a maximum thickness of 125 feet.

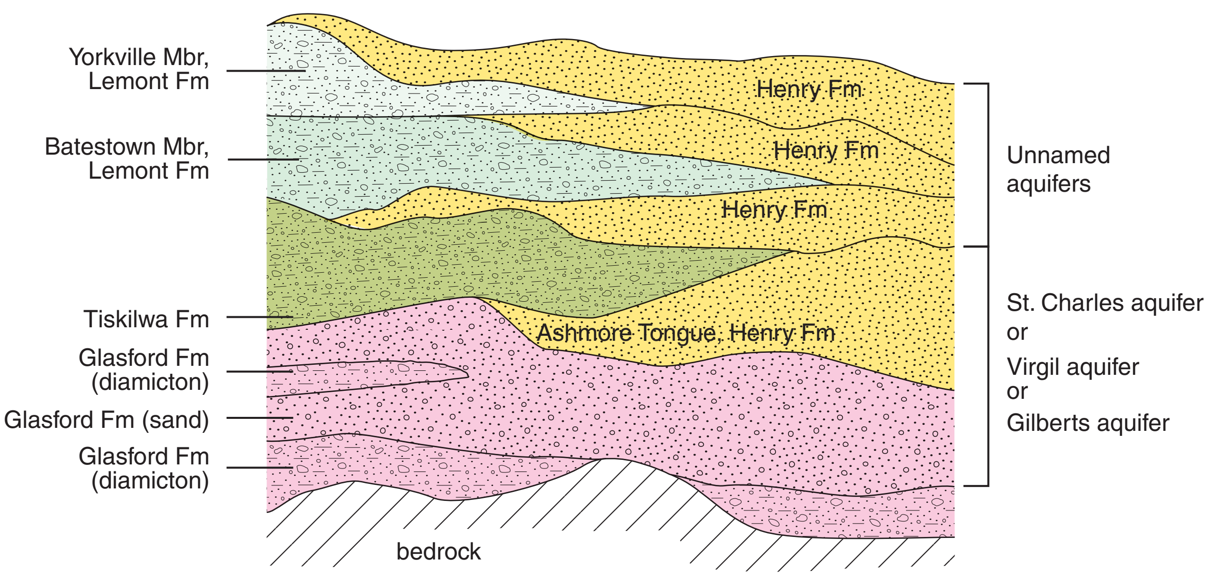

Figure 50 *Schematic diagram of the St. Charles, Virgil, Gilberts, and unnamed aquifers.*

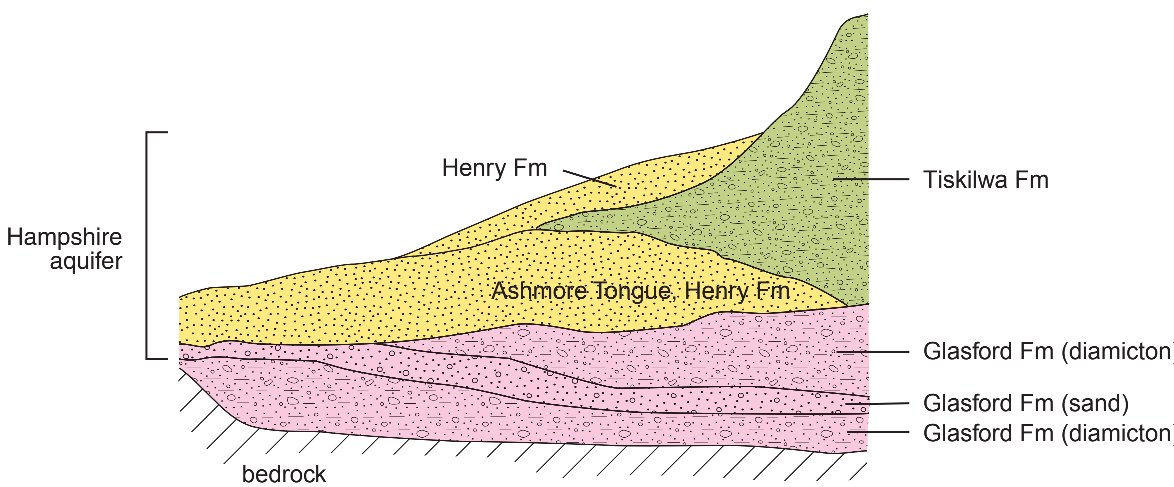

Figure 51 *Schematic diagram of the Hampshire aquifer.*

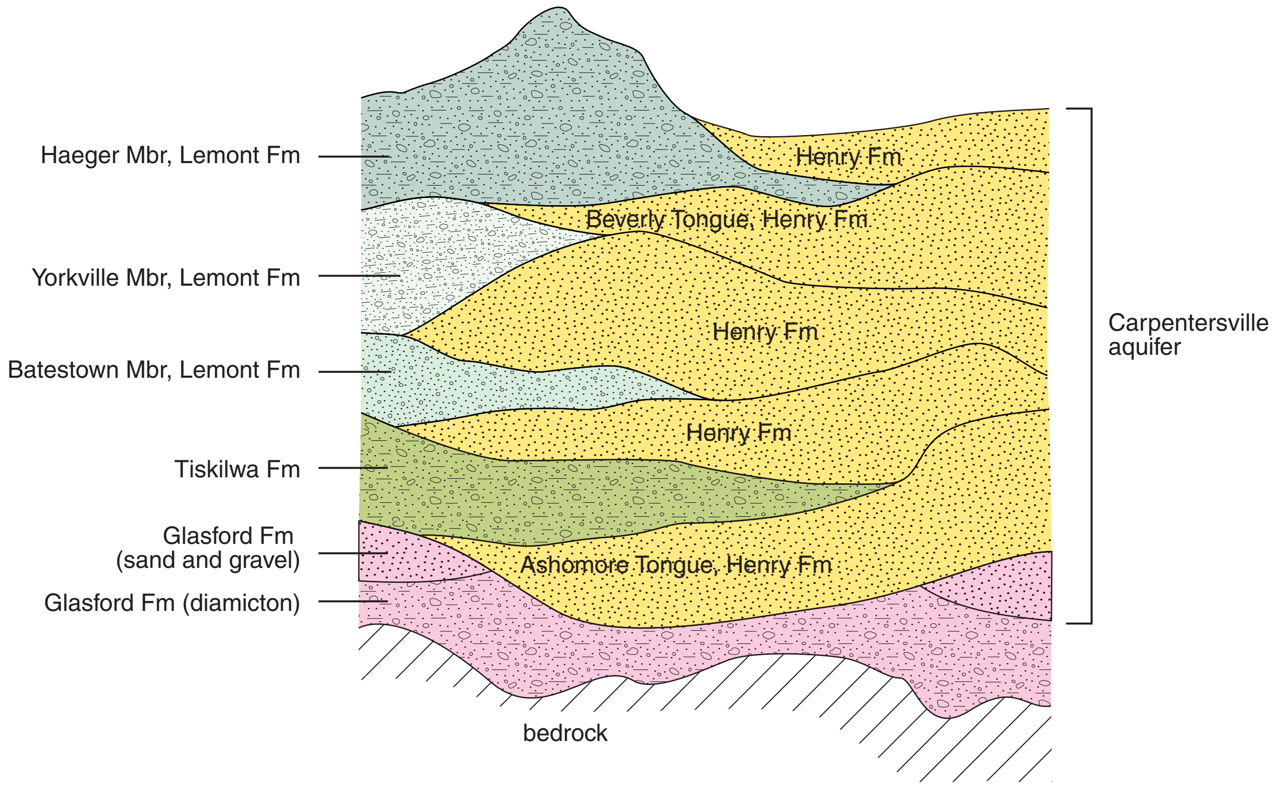

Figure 52 *Schematic diagram of the Carpentersville aquifer.*

4. The Gilberts aquifer, named for the town of Gilberts, is located in north-central Kane County. It is composed of the Ashmore Tongue of the Henry Formation and sand and gravel deposits of the Glasford Formation (fig. 50). The Gilberts aquifer is overlain by 50 to greater than 100 feet of Tiskilwa Formation and is 125 to 250 feet below the land surface. The aquifer is probably under confined conditions and is up to 100 feet thick. The St. Charles, Hampshire, Virgil, and Gilberts aquifers share most of the same hydrostratigraphic units, but there is enough geographic separation between them to consider them as separate aquifers, even though there may be limited hydraulic connection between the aquifers.

5. The Carpentersville aquifer, named for the town of Carpentersville, is located in northeastern Kane County immediately below the ground surface and east of the Fox River. The Carpentersville aquifer is composed of the surficial sand and gravel deposits of the Henry Formation, the Beverly Tongue of the Henry Formation, the sub-Batestown and sub-Yorkville tongues of the Henry Formation, the Ashmore Tongue of the Henry Formation, and the sands and gravel deposits of the Glasford Formation (fig. 52). All of these coarse-textured units have some hydraulic connection in the mapped extent of the aquifer in Kane County or to the east in Cook County. The upper sand and gravel units in the aquifer may not be fully saturated; therefore, the mapped thickness may be overestimated. The maximum thickness of the aquifer material is 180 feet. This aquifer is equivalent to the previously mapped Valparaiso aquifer (Curry and Seaber 1990).

6. The unnamed aquifers are composed of the surficial sand and gravel of the Henry Formation and/or the sub-Batestown and sub-Yorkville tongues of the Henry Formation (fig. 50). Curry and Seaber (1990) had previously identified assemblages of these hydrostratigraphic units as the Kaneville aquifer (a member of the Elburn aquiformation). These units lack the horizontal continuity of a single aquifer but locally may meet the definition of major aquifer. Water-level data in the units constituting these aquifers are sparse, making generalized assessment of their saturated thickness and hydraulic condition imprudent. The maximum thickness of these aquifer materials is 120 feet.

The Quaternary aquifer map was constructed by compiling appropriate individual isopach (thickness) maps for each of the major sand and gravel units in the county where the units have some amount of inferred hydraulic continuity. Hydraulic continuity was inferredd by generating maps where intervening fine-textured units were absent. The map depicts only those regions where the combined thickness of sand and gravel units is greater than 20 feet. For example, the St. Charles aquifer was delineated by combining isopach maps of the sand and gravel deposits of the Ashmore Tongue (fig. 29) and the sand and gravel deposits of the Glasford Formation, the upper and lower coarse-textured units (figs. 35 and 37). The isopach maps of the sand and gravel deposits were compared with isopach maps of the upper and middle fine-textured units of the Glasford Formation (figs. 34 and 36) to identify areas where these intervening units were absent. The absence of these fine-textured units in portions of the mapped area were taken as evidence that hydraulic continuity exists between the coarse-textured units. The combined thicknesses were then superimposed on the bedrock topography map. The St. Charles aquifer was identified as the thick sand and gravel deposits in the vicinity of the St. Charles Bedrock Valley and its tributary bedrock valleys (fig. 53).

The Hampshire aquifer was delineated by combining isopachs of the Ashmore Tongue and the sand and gravel deposits of the Glasford Formation in the region west of Marengo Moraine. The combined thickness shown on these two isopach maps was compared to the isopach map of the Tiskilwa Formation. Where the Tiskilwa Formation is absent, the isopach map of the surficial sand and gravel deposits of the Henry Formation was added to the assemblage of aquifer materials. The map depicts areas where these units have a contiguous thickness of greater than 20 feet (fig. 54).

The Gilberts and Virgil aquifers were delineated by combining isopach maps of the Ashmore Tongue and sand and gravel deposits of the Glasford Formation. The map depicts areas where these units have a contiguous thickness of greater than 20 feet (figs. 55 and 56).

The Carpentersville aquifer was delineated using isopachs for all of the coarse-textured Quaternary units east of the Fox River. The map depicts areas where these units have a contiguous thickness of greater than 20 feet (fig. 57).

The unnamed aquifers were delineated by combining isopachs of surficial sand and gravel of the Henry Formation and/or sand and gravel deposits associated with the Batestown and Yorkville members of the Lemont Formation. The map depicts areas where these units have a contiguous thickness of greater than 20 feet (fig. 58).

Application

Major Quaternary Aquifers, Kane County, Illinois (Dey et al. 2007b) shows areas where there is a high probability of obtaining greater than 70 gpm from a properly constructed well finished in one of the mapped aquifers. Areas where the aquifers are close to or greater than 100 feet thick are recommended as locations to begin searching for shallow high-capacity wells. *Major Quaternary Aquifers, Kane County, Illinois* (Dey et al. 2007b) is intended to be used for county-scale planning and as guide to exploration for developing shallow groundwater resources. As noted, this map does not identify areas where aquifer materials are present but less than 20 feet thick.This map should not be used as a substitute for site-specific work. The map is available at http://www.isgs.uiuc.edu/maps-data-pub/icgm/pdf-files/kane-qa.pdf. A page-size version of the map is included in Appendix A4.

Bedrock Geology

Information on the topography of the bedrock surface and the composition of the uppermost bedrock unit was combined to produce *Bedrock Geology, Kane County, Illinois* (Dey et al. 2007c). The map replaces the *Interim Map of Bedrock Geology, Kane County, Illinois* (Dey et al. 2005c). Additional data were used in creating the bedrock topographic surface and delineating the surfaces of the bedrock units.

The bedrock map was constructed by compiling from the geologic model all the bedrock units that are present at the bedrock surface, including Silurian age carbonate rock and Ordovician age Maquoketa Group and Galena-Platteville Groups. Topographic or bedrock contour lines were superimposed on the bedrock units. These lines show the shape of the bedrock surface and features such as bedrock valleys. The larger bedrock valleys are named on the map. The isopach of the Silurian age rock was included as an inset map.

Application

This map can be used to identify the uppermost bedrock unit and the location of major bedrock valleys. Some important Quaternary aquifers, such as the St. Charles aquifer, are associated with bedrock valleys. As with all maps at a scale of 1:100,000, the map should not be used as a substitute for site-specific work. A page-size version of the

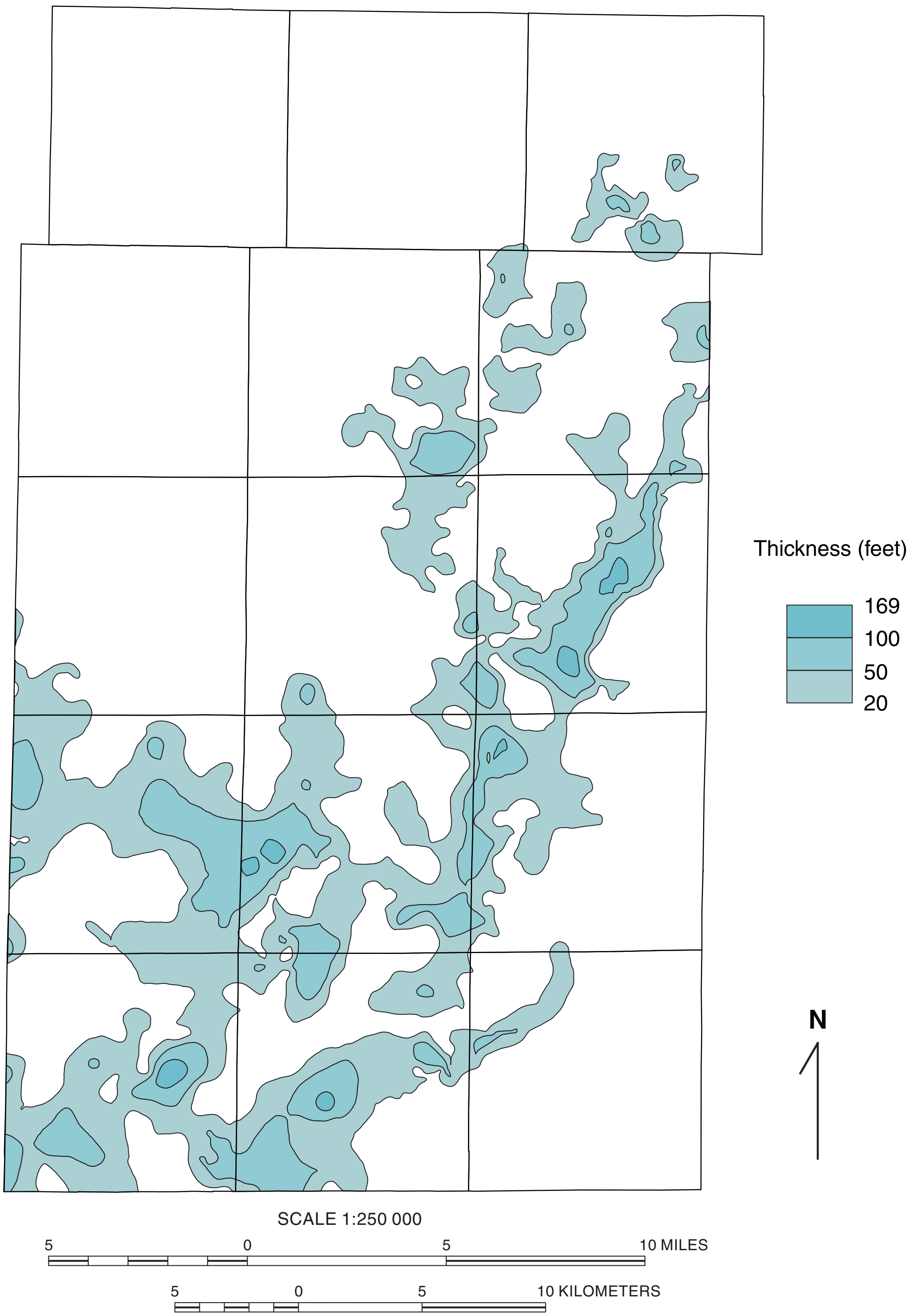

Figure 53 *Distribution and thickness of the St. Charles aquifer in Kane County.*

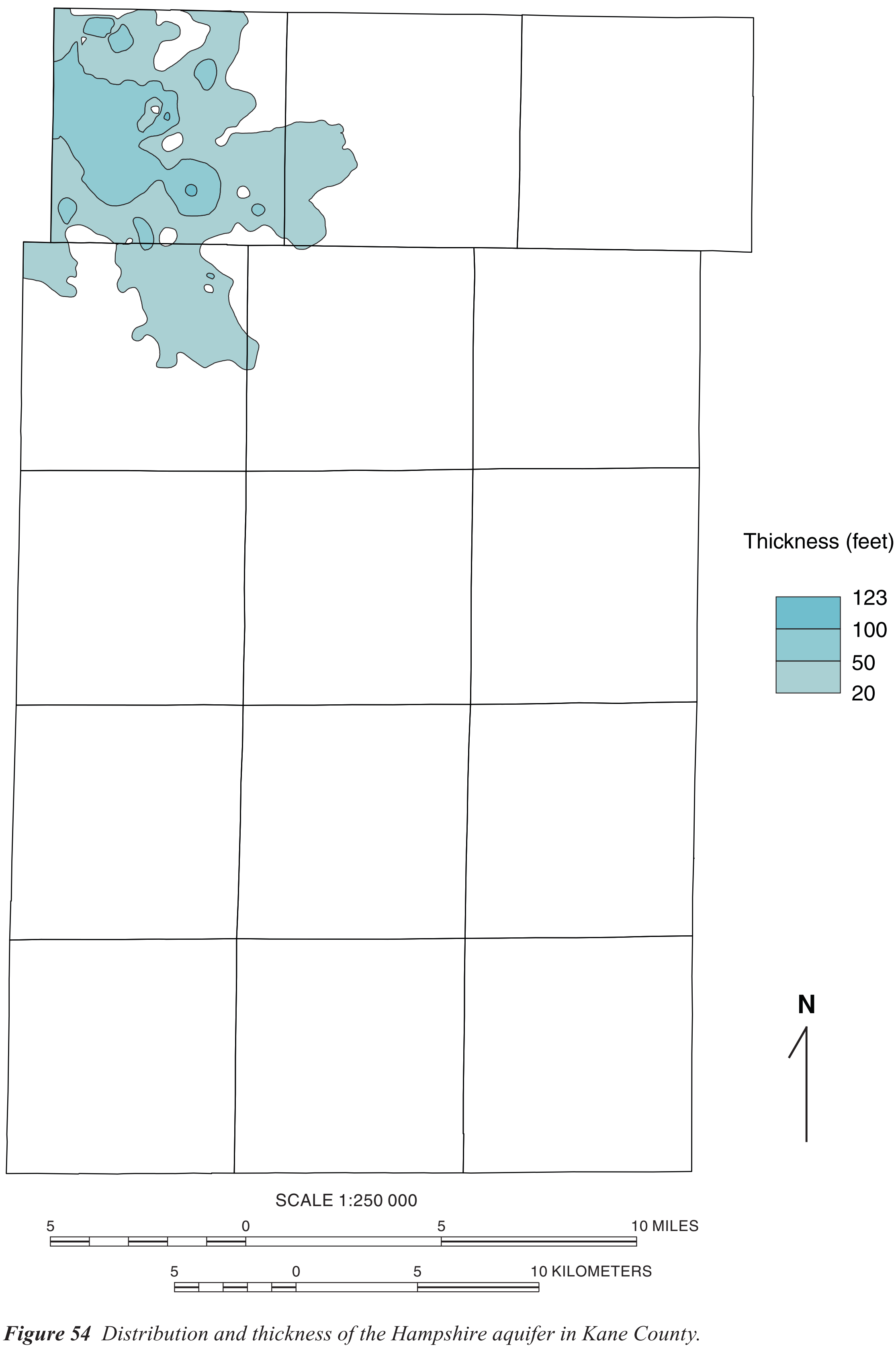

Figure 54 *Distribution and thickness of the Hampshire aquifer in Kane County.*

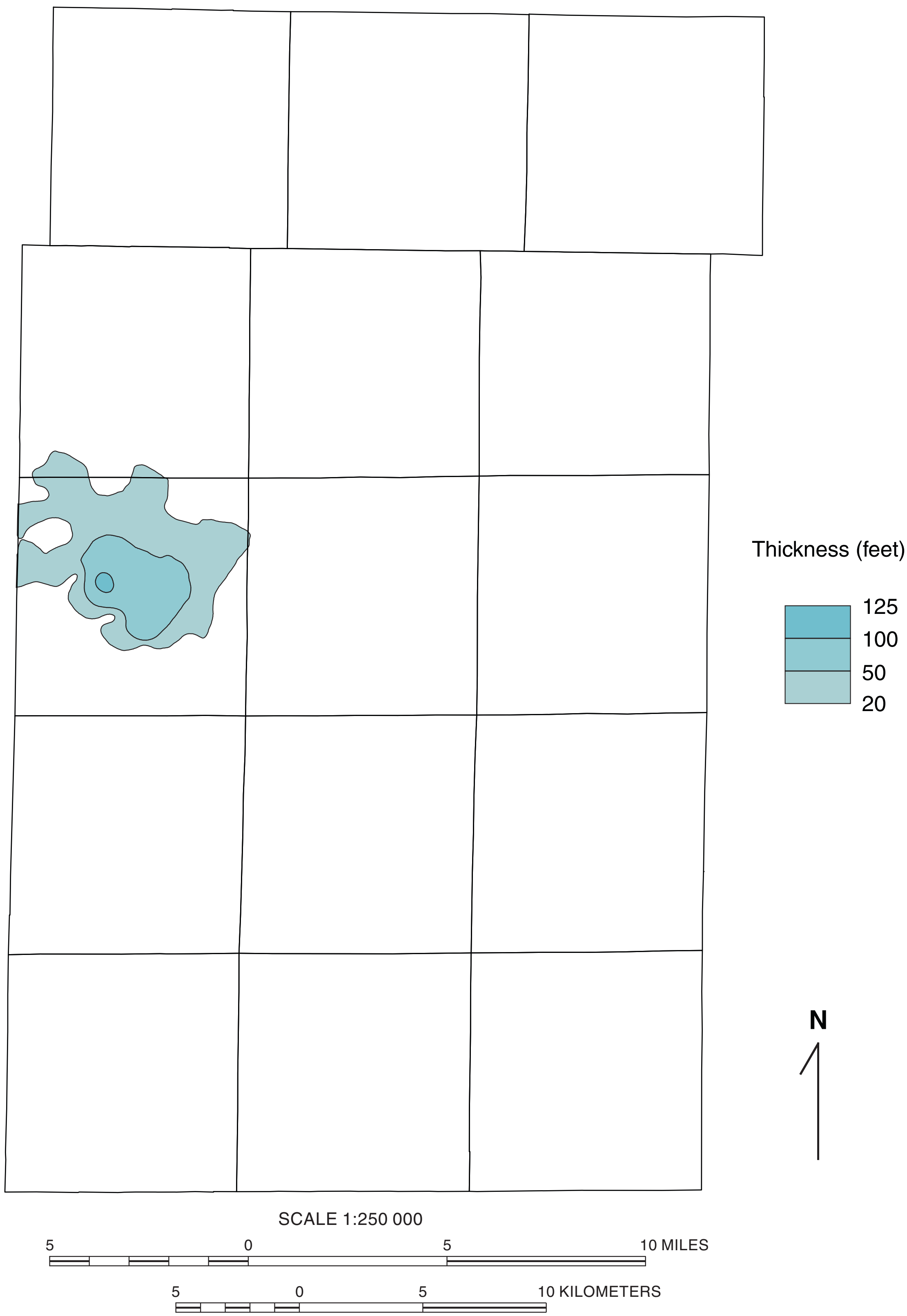

Figure 55 Distribution and thickness of the Virgil aquifer in Kane County.

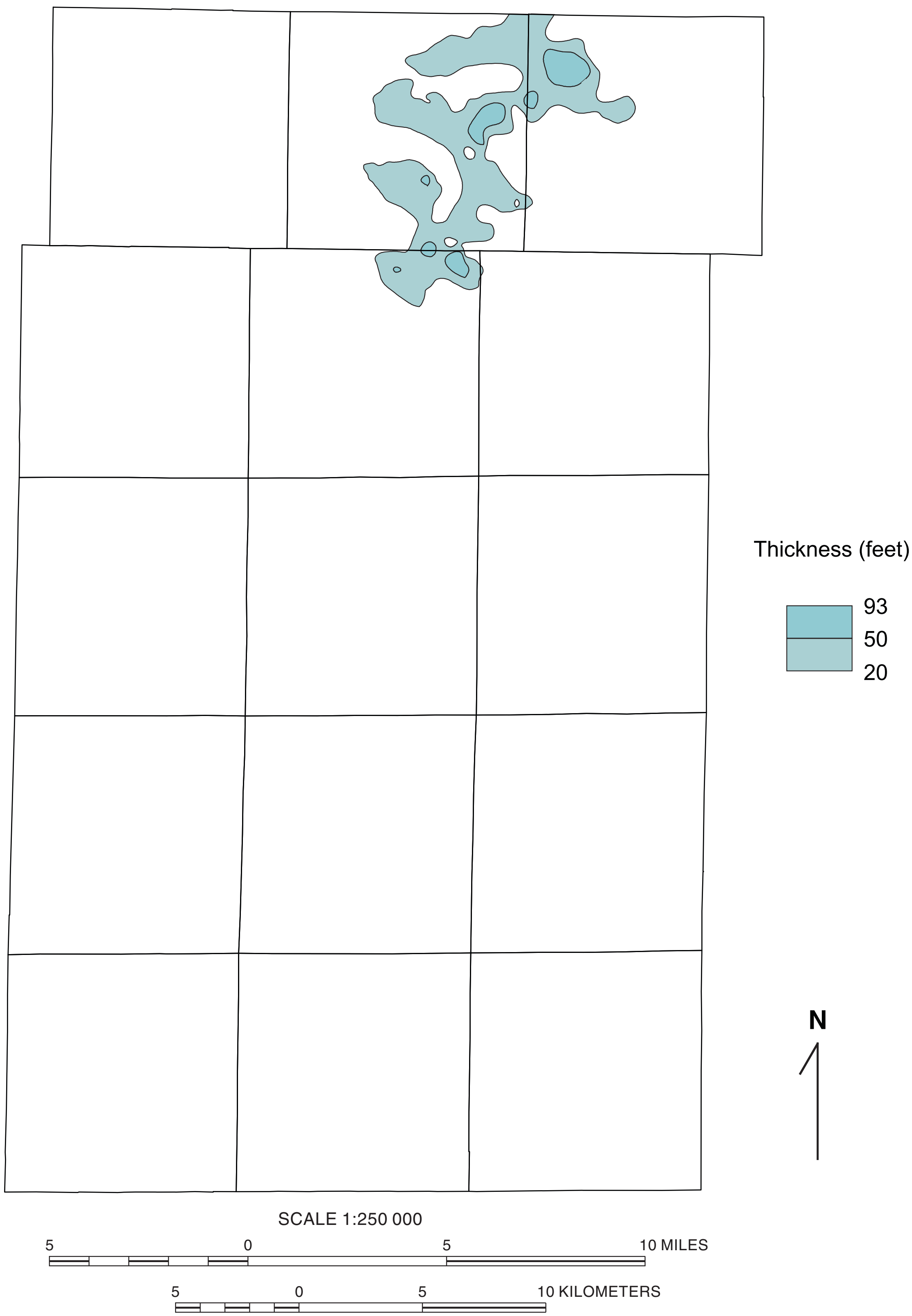

Figure 56 *Distribution and thickness of the Gilberts aquifer in Kane County.*

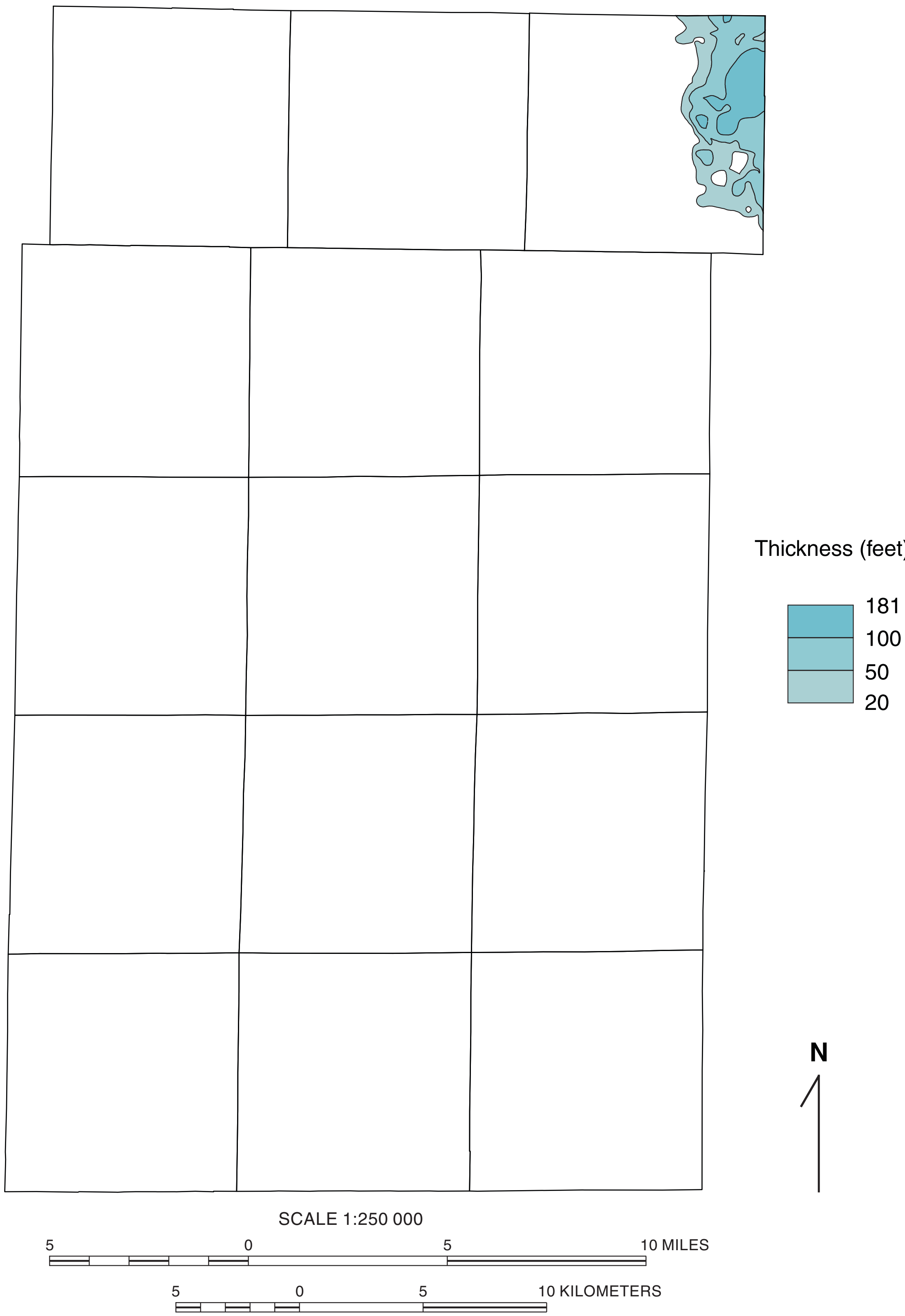

Figure 57 *Distribution and thickness of the Carpentersville aquifer in Kane County.*

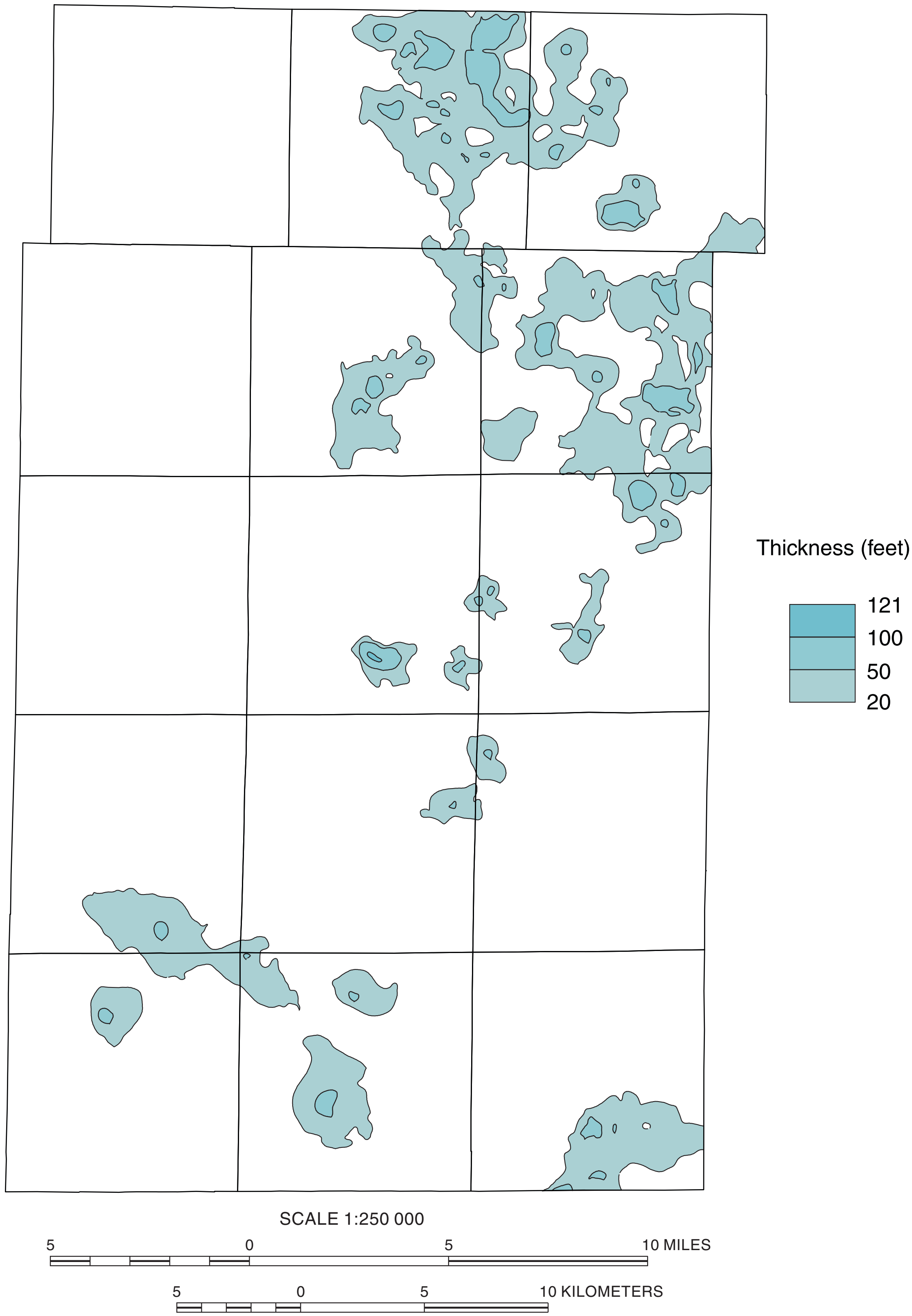

Figure 58 *Distribution and thickness of the unnamed aquifers in Kane County.*

bedrock geology map is included in Appendix A5. The map is available at http://www.isgs.uiuc.edu/maps-data-pub/icgm/pdf-files/kane-bg.pdf.

Aquifer Sensitivity

The map *Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al 2007d), is a representation of the potential vulnerability of aquifers in an area to contamination from sources at or near the surface. The U.S. Environmental Protection Agency (1993) defines aquifer sensitivity/contamination potential as “a measure of the ease with which a contaminant applied on or near the land surface can migrate to an aquifer. It is a function of the intrinsic characteristics of both the geologic materials comprising the aquifer as well as the overlying saturated and unsaturated material. It is independent of land use and the types of contaminant introduced.”

The method for classifying aquifer sensitivity used to produce the aquifer sensitivity map of Kane County (Dey et al., 2007d) was based on the mapping system developed by Berg (2001). The system uses depth to and thickness of the uppermost aquifer or aquifer material and relative permeability of overlying material to assign a classification rating. Aquifers are defined as geologic materials that are saturated and sufficiently permeable to yield economic quantities of water to wells or springs (Fetter 1994). In Kane County, shallow aquifers are generally composed of unlithified sand and gravel deposits or of bedrock units of fractured carbonates. For this map, sand and gravel deposits were defined as aquifers in areas where the units were greater than 5 feet thick (35 Illinois Administrative Code 620.210) and extended over at least a square mile of area. Carbonate bedrock of Silurian age was defined as an aquifer where it was the uppermost bedrock unit and greater than 15 feet thick (35 Illinois Administrative Code 620.210). The Silurian rock is commonly fractured at its upper surface (Graese et al. 1988). Geologic materials that would be classified as aquifers but are above the water table and therefore not saturated were grouped with aquifers in the interpretation for this map because they still provide a conduit for the vertical flow of water and potential contaminants. Glacial diamicton (an unsorted mixture of gravel, sand, silt, and clay commonly called “till”), wind-blown silt (loess), peat, silty and clayey river and lake sediment, shale, and unfractured carbonate bedrock are not considered aquifers because they are generally fine-grained and have limited potential to yield water to a well.

Aquifer sensitivity to contamination is assumed to decrease with depth. Studies in Minnesota (Klaseus et al. 1989) and Iowa (Libra et al. 1993) found a decrease in agricultural chemicals in water samples collected at a depth of greater than 100 feet. Schock et al. (1992) found that depth to uppermost aquifer was useful for predicting the occurrence of agricultural chemicals in drilled wells in rural Illinois, using depth intervals of less than 50 feet and greater than 50 feet. In a subsequent study, Mehnert et al. (2003) found that the depth to the uppermost aquifer was useful for predicting the occurrence of agricultural chemicals in monitoring wells in rural Illinois, using intervals of less than 20 feet, 20 to 50 feet, and greater than 50 feet.

Thicker aquifers provide a greater groundwater resource than do thinner aquifers, potentially yielding more water and utilization by more people. The importance of protection from contamination theoretically increases with aquifer thickness. Thus, sensitivity to contamination classifications increased with aquifer thickness. Following Berg’s (2001) recommendation, aquifer thickness intervals used were 5 to 20 feet (or 15 to 20 feet for fractured carbonate), 20 to5 0 feet, and greater than 50 feet.

The isopach maps of each coarse-textured lithostratigraphic unit mapped in Kane County (figs. 13, 18, 22, 25, 29, 35, and 37) and the Silurian formations (fig. 42) were delineated using the thickness intervals given in the preceding paragraph. Maps depicting depth to the upper surface of each aquifer were made by subtracting the elevation of the surface of the unit from the land surface. These maps were delineated using Berg’s (2001) depth-to-aquifer categories. The depth-to-aquifer map of each unit was combined with the aquifer thickness map of that unit, and individual aquifer sensitivity maps were created for each unit, again in accordance with the methods of Berg (2001). The final aquifer sensitivity map was generated by combining the individual sensitivity maps of each unit such that the stratigraphically uppermost unit is shown on the map. The resulting map had an aquifer sensitivity value for every node in the geologic model. Aquifer sensitivity values were reassigned to some nodes to simplify the map. For example, where one node of a given aquifer sensitivity value was completely surrounded by nodes sharing a different value, the interior node was reassigned to the value of the surrounding nodes. This reassignment was done on a case-by-case basis across the map. Edges of the map units were then smoothed using topography and uppermost geologic unit as a guide.

The Haeger Member is a sandy loam diamicton with abundant, discontinuous lenses of sand and gravel and thin beds of silt and clay (Curry et al. 1997). It is not uniformly coarse enough to be considered aquifer material. However, the Haeger Member is coarse enough that its presence over an aquifer does not offer the same protection from contamination as an equal thickness of a finer-grained diamicton. Although the Haeger Member is treated as non-aquifer material for this aquifer sensitivity map, its presence at the land surface is uniquely noted due to the lower potential protection it offers underlying aquifers. The isopach map of the Haeger Member (fig. 26) was used to delineate the area where aquifer sensitivity may be affected. The aquifer sensitivity classification rates sequences from Map Unit A to Map Unit E in order of decreasing sensitivity to aquifers becoming contaminated.

Map Unit A: High Potential for Aquifer Contamination

Map Unit A is defined as areas where the upper surface of the aquifer is within 20 feet of the land surface and with sand and gravel or high-permeability bedrock aquifers greater than 20 feet thick. Map Unit A is classified as an area of high aquifer sensitivity. It is most prevalent in southern and northwestern Kane County and along the Fox River where the glacial drift is thin. In these areas, contaminants from any source can move rapidly through the sand and gravel deposits to wells or nearby streams. Land use practices should be very conservative in all areas mapped as Unit A.

Map Unit A1

Aquifers are greater than 50 feet thick and are within 5 feet of the land surface. Small patches of Unit A1 occur throughout the county. Notable occurrences are found northwest of Hampshire (as part of a large alluvial fan extending west of the Marengo Moraine and north of the Bloomington Morainic System (fig. 15)) and along reaches of the Fox River (where glacial drift is thin and fractured dolomite or thick sand deposits are at or very near ground surface).

Map Unit A2

Aquifers are more than 50 feet thick and between 5 and 20 feet below ground surface. This map unit is not very common in Kane County.

Map Unit A3

Aquifers between 20 to 50 feet thick occur within 5 feet of the land surface. Because of their similar definitions, the distribution of Unit A3 is in areas where Unit A1 is also mapped. It also is common in northern Kane County.

Map Unit A4

Aquifers are between 20 and 50 feet thick between 5 and 20 feet below the land surface. Unit A4 is much more common than similarly defined Unit A2. Large areas of Unit A4 also occur in southern Kane County associated with the Elburn Complex (fig. 15).

Map Unit B: Moderately High Potential for Aquifer Contamination

Unit B is defined as areas where aquifers are within 20 feet of the land surface, and sand and gravel aquifers are between 5 and 20 feet thick or high-permeability bedrock aquifers are between 15 and 20 feet thick. Groundwater is sensitive to contamination due to the minimal barrier of diamicton or silt and clay.

Map Unit B1

Sand and gravel aquifers are between 5 and 20 feet thick, and high permeability bedrock aquifers are between 15 and 20 feet thick; either type is within 5 feet of the land surface. This unit is common throughout the county. Notable occurrences include areas in the Elburn Complex (fig. 15) along Route 47 north of Sugar Grove and in outwash terraces along the Fox River.

Map Unit B2

Sand and gravel aquifers are between 5 and 20 feet thick, and high permeability bedrock aquifers are between 15 and 20 feet thick; either type is between 5 and 20 feet of the land surface This unit is found in patches throughout the county in association with Unit B1. Unit B2 is most common in the Elburn Complex (fig. 15) and in north-central Kane County.

Map Unit C: Moderate Potential for Aquifer Contamination

In Unit C areas, aquifers are buried by 20- to 50-foot-thick, fine-grained deposits, including all diamicton units and silt and clay of the Equality Formation. The mantle of fine-grained material offers moderate protection for underlying aquifers from waste spreading or from septic systems. Schock et al. (1992) reported that pesticide and nitrate detections in Illinois were significantly fewer where aquifers were buried by 20 to 50 feet than where aquifers were shallower.

Map Unit C1
Aquifers are greater than 50 feet thick and buried by 20 to 50 feet of fine-grained material. Unit C1 occurs in isolated patches throughout the county. It is most common in southeastern Kane County near the Fox River.

Map Unit C2
Aquifers are between 20 to 50 feet thick and are buried by 20 to 50 feet of fine-grained material. This unit is widespread in the Elburn Complex (fig. 15)

Map Unit C3
Sand and gravel aquifers are between 5 and 20 feet thick, and high-permeability bedrock aquifers are between 15 and 20 feet thick, and either type is buried by 20 to 50 feet of fine-grained material. Again, these units are widespread in the Elburn Complex (fig. 15).

Map Unit D: Moderately Low Potential for Aquifer Contamination
The probability that groundwater will become contaminated is moderately low in places where sand and gravel aquifers are buried by fine-grained deposits 50 to 100 feet thick. In Kane County, such areas occur below moraines.

Map Unit D1
Aquifers are more than 50 feet thick and are buried by 50 to 100 feet of fine-grained material. The largest mapped areas of Unit D1 occur in southeastern Kane County.

Map Units D2
Aquifers are between 20 to 50 feet thick and are buried by 20 to 50 feet of fine-grained material. These units are widespread in the Bloomington Morainic System, Elburn Complex, and the Minooka and St. Charles Moraines (fig. 15).

Map Unit D3
Sand and gravel aquifers are between 5 and 20 feet thick, and bedrock aquifers are between 15 and 20 feet thick and buried by 20 to 50 feet of fine-grained material. These units have a distribution similar to Unit D2.

Map Unit E: Low Potential for Aquifer Contamination
Map Unit E occurs in places where diamicton, lacustrine silt and clay, or shale is more than 100 feet thick. Discontinuous lenses of sand and gravel may occur in the diamicton, but they typically are not aquifers. The large area mapped as Unit E is associated with the Marengo Moraine and, to a lesser degree, the Bloomington Morainic System. Isolated patches of this unit occur throughout the rest of the county.

Overprint Pattern: Sandy Diamicton (Haeger Member) at Land Surface
A stippled overprint pattern shows where the Haeger Member is at the land surface. Overprinted map units have a higher potential of sensitivity to contamination than the same map unit in areas without the stipple overprint pattern. The Haeger Member occurs only in northeastern Kane County east of the Fox River.

Application
Kane County's *2030 Land Resource Management Plan* (Kane County 2004) recognized the vulnerability of the county's water resources to contamination. Nine objectives for water resources management are articulated in the Plan (p. 104). The second objective addresses protecting the county's groundwater resources. *Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey 2007d) is a useful tool for county-wide planning. The map should be used as a guide for decisions that have a potential to negatively impact groundwater. The map is based on generalized textural properties and assumptions about hydraulic characteristics of geologic materials and hydraulic gradients, but not results from water quality or groundwater flow analysis. Because of the generalizations used in preparing the map, any mapped unit may contain small areas of greater or lesser aquifer sensitivity to contamina-

tion. This map should not be used as a substitute for evaluation of individual sites. It should not be enlarged. A page-size version of the map is included in Appendix A6. Also, the map is available at http://www.isgs.uiuc.edu/maps-data-pub/icgm/pdf-files/kane-as.pdf.

SUMMARY

An improved three-dimensional geologic model was generated for Kane County and vicinity. The project database has been continually updated and now contains 40,138 water-well and boring records and other point data. Primary wells used in the mapping effort have been increased to 4,830. Lithostratigraphic assignments increased 10 to 50% for most units in Kane County, and the average increase was about 20% for all units compared to the interim maps. Percent increases for lithostratigraphic assignments to units outside Kane County but throughout the study area were similar. The result is an integrated model of the shallow geology of Kane County that is a great improvement over previous mapping efforts and specifically constructed to meet the needs of county-scale groundwater planning and management. The geometry of the major Quaternary and shallow bedrock units has been mapped using a large quantity of reliable data. Previous mapping efforts have provided a solid conceptual framework to build upon but resulted in a suite of independent surficial geologic maps and no integrated delineation of the subsurface geology. The model and maps described in this report provide Kane County and other users robust and reliable tools to guide decisions that involve water-related issues and other environmental concerns.

Findings from this report have been shared with ISWS staff for their use in completing the *Computer Flow Models of Aquifer Systems Used in Kane County and Supporting Hydrologic Database*, which is currently in progress

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REFERENCES

Abert, C.C., 2000, Three-dimensional Geological Mapping of the Villa Grove Quadrangle, Douglas County, Illinois, Proceedings, Digital Mapping Techniques '00 Workshop, May 17–20, 2000, Lexington Ky: Reston, Virginia, U.S. Geological Survey, Open-File Report 00-325, p.125–129.

Abert, C.C., 2001, Geographic Information System and Computer Modeling: Support, Methodology and Application to Geologic Mapping, *in* Z. Lasemi and R.C. Berg, eds., Three-dimensional Geological Mapping: A Pilot Program for Resource and Environmental Assessment in the Villa Grove Quadrangle, Douglas County, Illinois: Illinois State Geological Survey, Bulletin 106 p.12–15.

Abert, C.C., W.S. Dey, A.M. Davis, and B.B. Curry, 2007, Three-dimensional Geologic Model, Kane County: Illinois State Geological Survey, Illinois County Geologic Map, ICGM Kane-3D, scale is variable.

Abert, C.C., W.S. Dey, A.M. Davis, B.B. Curry, and J.C. Sieving, 2004, Preliminary Three-dimensional Geologic Model, Kane County: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Kane-3D, scale is variable.

Alley, M.A., R.W. Healey, J.W. LaBaugh, and T.E. Reilly, 2002, Flow and storage in groundwater systems: Science, v. 296, p.1985–1990.

Anderson, M.P., and W.M. Woessner, 1992, Applied Groundwater Modeling, Simulation of Flow and Advective Transport: San Diego, California, Academic Press, 381 p.

Berg, R.C., 2001, Aquifer Sensitivity Classification for Illinois Using Depth to Uppermost Aquifer and Aquifer Thickness: Illinois State Geological Survey, Circular 560, 14 p.

Booth, C.J., and D.W. Ekberg, 2006, Hydrogeological Characterization of the Galena-Platteville Dolomite in Northern Illinois: Report to Fermi Lab on Year-1 Study: De Kalb, Illinois, Northern Illinois University, 71 p.

Chiles, J.-P., and P. Delfiner, 1999. Geostatistics: Modeling Spatial Uncertainty: Wiley Series in Probability and Statistics: New York, Wiley-Interscience, 695 p.

Curry, B.B., 1989, Absence of Altonian glaciation in Illinois: Quaternary Research, v. 31, p.1–13

Curry, B.B., 1990a, Distribution and thickness of the Tiskilwa Till in Kane County: Illinois State Geological Survey, Open File Series 1990-2g, 1:62,500.

Curry, B.B., 1990b, Stack Unit Map (to 50 ft) of Kane County: Illinois State Geological Survey, Open File Series 1990-2i, 1:62,500.

Curry, B.B., 1991, Statistical Evaluation of Common Geotechnical Parameters of Glacial Drift Units at Fermi National Accelerator Laboratory, Batavia, Illinois: Proceedings, 34th Annual Meeting, Association of Engineering Geologists, Sept. 29–Oct. 4, 1991, Chicago, IL, p. 258.

Curry, B.B.,1998, Quaternary Geology, Elgin Quadrangle, Kane and Cook Counties, Illinois, 1:24,000. Submitted to the U.S. Geological Survey STATEMAP Program

Curry, B.B., 1999, Quaternary Geology of Hampshire Quadrangle, Kane and De Kalb Counties, Illinois, 1:24,000. Submitted to the U.S. Geological Survey STATEMAP Program.

Curry, B.B., 2001, Surficial Geology, Aurora North Quadrangle, Kane and DuPage Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map:IGQ-Aurora North-SG, 1:24,000.

Curry B.B., 2005, Surficial Geology Map, Crystal Lake Quadrangle, Kane and McHenry Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map:IGQ-Crystal Lake -SG, 1:24,000

Curry, B.B., 2007a, Surficial Geology Map, Elgin Quadrangle, Kane and Cook Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map: IGQ-Elgin-SG, 1:24,000.

Curry, B.B., 2007b, Surficial Geology Map, Hampshire Quadrangle, Kane and De Kalb Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map: IGQ-Hampshire-SG, 1:24,000 (in progress).

Curry, B.B., and R.G. Baker, 2000, Paleohydrology, vegetation, and climate during the last interglaciation (Sangamon Episode) in south-central Illinois: Palaeogeography, Palaeoclimatology, and Palaeoecology 155(1–2): 59–81.

Curry, B.B., R.C. Berg, and R.C. Vaiden, 1997, Geologic Mapping for Environmental Planning, McHenry County, Illinois: Illinois State Geological Survey, Circular 559, 79 p. plus four plates.

Curry, B.B., W.S. Dey, E.C. Grimm, S.L. Sargent, and S.A. Kuzin, 2001a, Investigation of the Geology, Hydrology, Water Balance, Paleovegetation, and Paleohydrology of Nelson Lake Marsh: unpublished contract report to the Kane County Forester Preserve, Geneva, Illlinois.

Curry, B.B., A.M. Graese, M. Hasek, R.C. Vaiden, R.A. Bauer, J.P. Kempton, D. Schumacher, K.A. Norton, and W.G. Dixon, Jr., 1988, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Results of the 1986 Test Drilling Program: Illinois State Geological Survey, Environmental Geology Notes 122, 108 p.

Curry, B.B., D.A. Grimley, and T.H. Larson, 2001b, Surficial Geology, Sugar Grove Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map IGQ-SG, 1:24,000.

Curry, B.B., D.A. Grimley, and J.A. Stravers, 1999, Quaternary Geology, Geomorphology, and Climatic History of Kane County, Illinois: Illinois State Geological Survey, Guidebook 28, 40 p.

Curry, B.B., and P.R. Seaber, 1990, Hydrogeology of Shallow Groundwater Resources, Kane County, Illinois: Illinois State Geological Survey, Contract/Grant Report 1990-1, 37 p.

Curry, B.B., and M.J. Pavich, 1996, Absence of glaciation in Illinois during marine isotope stages 3 through 5: Quaternary Research 31:19–26.

Dey, W.S., C.C. Abert, A.M. Davis, and B.B. Curry, 2007a, Geologic Cross Sections, Kane County, Illinois: Illinois County Geologic Map, ICGM Kane-CS 1:100,000

Dey, W.S., B.B. Curry, J.C. Sieving, A.M. Davis, and C.C. Abert, 2004, Kane County Water Resources Investigations: Interim Report on Geologic Investigations, Kane County, Illinois: Illinois State Geological Survey, Open File Series 2004-9, 75 p.

Dey, W.S., B.B. Curry, J.C. Sieving, A.M. Davis, and C.C. Abert, 2005a, Kane County Water Resources Investigations: Interim Report on Geologic Modeling, Kane County, Illinois: Illinois State Geological Survey, Open File Series 2005-6, 50 p.

Dey, W.S., A.M. Davis, and B.B. Curry, 2007b, Major Quaternary Aquifers, Kane County, Illinois: Illinois County Geologic Map, ICGM Kane-QA, 1:100,000.

Dey, W.S., A.M. Davis, and B.B. Curry, 2007c, Bedrock Geology, Kane County, Illinois: Illinois County Geologic Map, ICGM Kane-BG, 1:100,000.

Dey, W.S., A.M. Davis, and B.B. Curry, 2007d, Aquifer Sensitivity to Contamination, Kane County, Illinois: Illinois State Geological Survey, Illinois County Geologic Map, ICGM Kane-AS, 1:100,000.

Dey, W.S., A.M. Davis, B.B. Curry, J.C. Sieving, and C.C. Abert, 2005b, Interim Map of Major Quaternary Aquifers, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Kane-QA, 1:100,000.

Dey, W.S., A.M. Davis, B.B. Curry, J.C. Sieving and C.C. Abert, 2005c, Interim Map of Bedrock Geology, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Kane-BG, 1:100,000.

Erdmann, A., R.C. Vaiden, and B.B. Curry, 1990, Drift thickness of Kane County, Illinois: Illinois State Geological Survey, Open File Series 1990c (map), 1:62,500.

Fetter C W., 1994, Applied Hydrogeology: Upper Saddle River, New Jersey, Prentice Hall, 691 p.

Gilkeson, R. H., S.S. McFadden, D.E. Laymon, and A.P. Visocky, 1987, Hydrogeologic Evaluation of Groundwater Resources in Buried Bedrock Valleys, Northeastern Illinois: Proceedings of the Focus Conference on Midwestern Ground Water Issues, National Water Well Association, p. 145–167.

Gilkeson, R.H., and A.A. Westerman, 1976, Geology for Planning in Northeastern Illinois, II, Geology for Planning in Kane County: Illinois State Geological Survey, Open File Series 1976-2, 41 p. plus unpublished maps (prepared for the Northeastern Illinois Planning Commission).

Graese, A.M., 1991, Facies Analysis of the Ordovician Maquoketa Group and Adjacent Strata in Kane County, Northeastern Illinois: Illinois State Geological Survey, Circular 547, 36 p.

Graese, A.M., R.A. Bauer, B.B. Curry, R.C. Vaiden, W.G. Dixon, Jr., and J.P. Kempton, 1988, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Regional Summary: Illinois State Geological Survey, Environmental Geology Notes 123, 100 p.

Grimley, D.A., 2004, Quaternary Geology Map of Maple Park Quadrangle, Kane and De Kalb Counties, Illinois, Illinois State Geological Survey, Illinois Preliminary Geological Map, IGPM-Maple Park-SG, 1:24,000.

Grimley, D.A., 2006, Quaternary Geology Map, Pingree Grove Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map, IGQ-Pingree Grove-SG, 1:24,000.

Grimley, D.A., and B.B. Curry, 2001a, Surficial Geology Map, Elburn Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map, IGQ-Elburn-SG, 1:24,000.

Grimley, D.A., and B.B. Curry, 2001b, Surficial Geology Map, Geneva Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Geneva-SG, 1:24,000.

Gross, D.L. 1969. Glacial Geology of Kane County, Illinois: Ph.D. dissertation, University of Illinois at Urbana-Champaign, 211 p.

Hackett, J.E., and G.M. Hughes, 1965, Controlled Drilling Program in Northeastern Illinois: Illinois State Geological Survey, Environmental Geology Notes 1, 5 p.

Hansel, A.K., and W.H. Johnson,1996, Wedron and Mason Groups: Lithostratigraphic Reclassification of Deposits of the Wisconsin Episode, Lake Michigan Lobe Area,. Illinois State Geological Survey, Bulletin 104, 116 p.

Heigold, P.C., 1990, Seismic Reflection and Seismic Refraction Surveying in Northeastern Illinois: Illinois State Geological Survey, Environmental Geology Notes 136, 52 p.

Journel, A.G., 1994. Geostatistics and Reservoir Geology, in J.M. Yarus and R.L. Chambers, ed., Stochastic Modeling and Geostatistics: Tulsa, Oklahoma, American Association of Petroleum Geologists, AAPG Computer Applications in Geology, No. 3, p. 19–20.

Kane County, 2004, 2030 Land Resource Management Plan: Geneva, Illinois, Kane County Development Department, 184 p

Kemmis, T.J., 1978, Properties and origin of the Yorkville Till Member at the National Accelerator Laboratory Site, northeast Illinois: Master's thesis, University of Illinois, Urbana-Champaign, 331 p.

Kemmis, T.J., 1981, Importance of the regulation process to certain properties of basal tills deposited by the Laurentide Ice Sheet in Iowa and Illinois, U.S.A.: Annals of Glaciology, v. 2, p. 147–152.

Kempton, J.P., R.A. Bauer, B.B. Curry, W.G. Dixon, Jr., A.M. Graese, D.R. Kolata, P.C. Reed, M.L. Sargent, and R.C. Vaiden, 1987a, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois—Results of the Fall 1984 Test Drilling Program: Illinois State Geological Survey, Environmental Geology Notes 117, 102 p.

Kempton, J.P., R.A. Bauer, B.B. Curry, W.G. Dixon, Jr., A.M. Graese, P.C. Reed, and R.C. Vaiden, 1987b, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois—Results of the Spring 1985 Test Drilling Program: Illinois State Geological Survey, Environmental Geology Notes 120, 88 p.

Kempton, J.P., J.E. Bogner, and K. Cartwright, 1977, Geology for Planning in Northeastern Illinois, VIII, Regional Summary: Illinois State Geological Survey, Open File Series 1997-2, 84 p. (prepared for the Northeastern Illinois Planning Commission).

Kempton, J.P., R.C. Vaiden, D.R. Kolata, P.B. DuMontelle, M.M. Killey, and R.A. Bauer, 1985, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois— Preliminary Geological Feasibility Report: Illinois State Geological Survey, Environmental Geology Notes 111, 63 p.

Klaseus, T.G., G.C. Buzicky, and E.C. Schneider, 1989, Pesticides and Groundwater: Surveys of Selected Minnesota Wells: Minneapolis, Minnesota, Minnesota Department of Public Health and Minnesota Department of Agriculture, 95 p.

Kolata, D.R., and A.M. Graese, 1983, Lithostratigraphy and Depositional Environments of the Maquoketa Group (Ordovician) in Northern Illinois: Illinois State Geological Survey Circular 528, 49 p.

Konen, M., 2006a, Quaternary Geology Map of the Genoa 7.5-minute Quadrangle, Northeastern Illinois, U.S. Geological Survey National Geologic Mapping Program, EdMap Series: De Kalb, Illinois, Department of Geology and Environmental Geology, Northern Illinois University.

Konen, M., 2006b, Quaternary Geology Map of the Sycamore 7.5-minute Quadrangle, Northeastern Illinois, U.S. Geological Survey National Geologic Mapping Program, EdMap Series: De Kalb, Illinois, Department of Geology and Environmental Geology, Northern Illinois University.

Landon, R.A., and J.P. Kempton, 1971, Stratigraphy of the Glacial Deposits at the National Accelerator Laboratory Site, Batavia, Illinois: Illinois State Geological Survey, Circular 456, 21 p.

Larson, T.H., S.S. McFadden, and R.H. Gilkeson, 1991, Hydrogeology of Shallow Groundwater Resources, Aurora and Vicinity, Kane County, Illinois: Illinois State Geological Survey, Open File Series 1991-12, 19 p.

Larson, T.H., S.S. McFadden, and R.H. Gilkeson, 1992, Hydrogeology of Shallow Groundwater Resources, Geneva-Batavia Township, Kane County, Illinois: Illinois State Geological Survey, Open File Series 1992-5, 15 p.

Larson, T.H., and P.G. Orozco, 1991, Results of a Shallow Seismic Refraction Survey near the Village of North Aurora, Illinois: Illinois State Geological Survey, Open File Series 1991-15, 17 p.

Larson, T.H., and P.G. Orozco, 1992, Results of a Shallow Seismic Refraction Survey near Gilberts in Kane County, Illinois: Illinois State Geological Survey, Open File Series 1992-11, 27 p.

Leighton, M.M., 1925, The glacial history of the Elgin region: Illinois Academy of Science, Transactions, v. 17, p. 65-71.

Leighton, M.M., P. MacClintock, L.E. Workman, and W.E. Powers, 1928-1930, Geology and Mineral Resources of the Barrington, Elgin and Geneva Quadrangles: Illinois State Geological Survey, Manuscript 252, 207 p.

Leverett, R., 1899, The Illinois Glacial Lobe: Reston, Virginia,U.S. Geological Survey, Monograph 38, 817 p.

Libra, R.D., G.R. Halberg, K.D. Bex, B.C. Kross, L.S. Siegley, M.A. Kulp, R.W. Field, D.J. Quade, M. Selim, B.K. Nation, H.H. Hall, L.A. Etre, J.K. Johnson, H.F. Nicholson, S.L. Berberich, and K.L. Cherryholmes, 1993. The Iowa State-wide Rural Well-Water Survey: June 1991, Repeat Sampling of the 10% Subset: Iowa City, Iowa, Iowa Department of Natural Resources, Technical Information Series 26, 30 p.

Locke, R.A., and S.C. Meyer, 2005, Kane County Water Resources Investigations: Interim Report on Shallow Aquifer Potentiometric Surface Mapping. Illinois State Water Survey, Contract Report 2005-04, 96 p.

Locke, R.A., II, and S.C. Meyer, 2007, Kane County Water Resources Investigations: Final Report on Shallow Aquifer Potentiometric Surface Mapping: Champaign, Illinois, Illinois State Water Survey, Contract Report 2007-06, p. 85.

Lund, C.R., 1965, Data from Controlled Drilling Program in Kane, Kendall, and De Kalb Counties, Illinois: Illinois State Geological Survey, Environmental Geology Notes 6, 56 p.

Masters, J.M., 1978, Sand and Gravel and Peat Resources in Northeastern Illinois: Illinois State Geological Survey, Circular 503, 11 p.

Mehnert, E., W.S. Dey, D.A. Keefer, H.A. Wehrmann , S.D. Wilson, and C. Ray, 2003, Pesticide Occurrence in Shallow Monitoring Wells in Illinois: Program and Abstracts, 48th Annual Midwest Ground Water Conference, Kalamazoo MI, October 1 -3, 2003, p. 46.

Meyer S.C., D.D. Walker, S.M. McConkey, W.S. Dey, B.B. Curry, C.C. Abert, and E.Mehnert, 2002, Water-Resources Investigations for Kane County, Illinois: Illinois State Water Survey and Illinois State Geological Survey, proposal to Kane County Development Department, 55 p.

Miller, J.R., R.C. Berg, T.M. Johnson, and H.A. Wehrmann, 1985, Siting a Low-Level Radioactive Waste Disposal Facility in Illinois: Statewide Criteria Description of Maps Compilation Data Base and Intended Use: Illinois State Geological Survey, Report to Illinois Department of Nuclear Safety, 27 p.

Morse, W.J., and T.H. Larson, 1991, Hydrogeology of Shallow Groundwater Resources in the Vicinity of St. Charles, Kane County, Illinois: Illinois State Geological Survey Open File Series, 1991-13, 12 p.

Panno, S.V., C.P. Weibel, and W. Li, 1997, Karst Regions of Illinois: Illinois State Geological Survey, Open File Series, 1997-2, 42 p.

Reed, P.C., 1972, Data from Controlled Drilling Program in Du Page, Kane, and Kendall Counties, Illinois: Illinois State Geological Survey, Environmental Geology Notes 53, 42 p.

Reed, P.C., 1975, Data from Controlled Drilling Program in Kane County, Illinois: Illinois State Geological Survey, Environmental Geology Notes 75, 38 p.

Schock, S.C., E. Mehnert, M.E. Caughey, G.B. Dreher, W.S. Wilson, C. Ray, S.F.J. Chou, J. Valkenburg, J.M. Gosar, J.R. Karny, and M.L. Barnhardt, 1992, Pilot Study: Agricultural Chemicals in Rural Private Wells in Illinois: Illinois State Water Survey and Illinois State Geological Survey, Cooperative Groundwater Report 14, 80 p.

Srivastava, R.M., 1994. An Overview of Stochastic Methods for Reservoir Characterization, *in* J.M. Yarus and R.L. Chambers, eds., Stochastic Modeling and Geostatistics: Tulsa, Oklahoma, American Association of Petroleum Geologists, AAPG Computer Applications in Geology, No. 3, p. 3–16.

Stravers, J.A., K.L. Hibben, M. Konen, and D.M. Kulczycki, 2001, Quaternary Geology Map of the Big Rock 7.5-minute Quadrangle, Northeastern Illinois, United States Geological Survey National Geologic Mapping Program, EdMap Series: De Kalb, Illinois, Department of Geology and Environmental Geology, Northern Illinois University.

Stravers, J.A., C. Welsh, and D.M. Kulczycki, 2002, Quaternary Geology Map of the Barrington 7.5-minute Quadrangle, United States Geological Survey National Geologic Mapping Program, EdMap Series: De Kalb, Illinois, Department of Geology and Environmental Geology, Northern Illinois University.

35 Illinois Administrative Code 620.210.

U.S. Environmental Protection Agency, 1993, Ground Water Resource Assessment: Washington, DC, Office of Ground Water and Drinking Water, EPA 813-R-93-003, 232 p.

Vaiden, R.C., and B.B. Curry, 1990, Bedrock Topography of Kane County, Illinois: Illinois State Geological Survey, Open File Series 1990-2b 1:62,500.

Vaiden, R.C., M.J. Hasek, C.R. Gendron, B.B. Curry, A.M. Graese, and R.A. Bauer, 1988, Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois—Results of Drilling Large-diameter Test Holes in 1986: Illinois State Geological Survey, Environmental Geology Notes 124, 58 p.

Visocky, A.P., M.G. Sherrill, and K. Cartwright, 1985, Geology, Hydrogeology, and Water Quality of the Cambrian and Ordovician Systems in Northern Illinois: Illinois State Geological Survey, Cooperative Goundwater Report 10, 136 p.

Wickham, S.S., 1979, The Tiskilwa Till Member, Wedron Formation—A Regional Study in Northeastern Illinois: Master's thesis, University of Illinois, Urbana-Champaign, 227 p.

Wickham, S.S., W.H. Johnson, and H.D. Glass, 1988, Regional Geology of the Tiskilwa Till Member, Wedron Formation, Northeastern Illinois: Illinois State Geological Survey, Circular 543, 35 p.

Willman, H.B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback and J.A. Simon, 1973, Handbook of Illinois Stratigraphy: Illinois State Geological Survey, Bulletin 95, 261 p.

Willman, H.B., and J.C. Frye. 1970. Pleistocene Stratigraphy of Illinois. Illinois State Geological Survey, Bulletin 94, 204 p.

APPENDIX A1: EVALUATING THE ACCURACY OF THE GEOLOGIC MODEL

The three-dimensional geologic model predicts the distribution and thickness of lithostratigraphic units. As with any geologic map, it is inevitable that the geologic model will contain some errors. These errors will be due to (1) unidentified errors in the data, (2) areas with low data density, (3) generalizations in the texture of the lithostratigraphic units, and (4) generalizations in the thickness of each unit. Unfortunately, it is very difficult to estimate the distribution of these errors and their impact on the accuracy of the resultant geologic model. It is difficult, therefore, to calculate the accuracy of the model at any location. Most of the existing methods for evaluating the accuracy of geologic maps rely on statistical assumptions that do not use much geologic knowledge (Journel 1994, Chiles and Delfiner 1999). We feel that it is critical to integrate the geologic knowledge gained from mapping into any evaluation of geologic map accuracy. For this study, we have explicitly incorporated the geologic knowledge gained from this project in our evaluation of the accuracy of the geologic model of Kane County. Our evaluation considered limitations in the geologic model's accuracy from the four identified sources of error.

Geologic Map Errors due to Errors in the Data

The main source of geologic information used for this project was drillers' logs from domestic water wells. The accuracy of these logs is impossible to quantify precisely. Review of drillers' logs for this project suggested there were likely to be reporting errors in the depth at which specific units were encountered and in the texture assigned to the units. The evaluation of large numbers of drillers' logs revealed close correspondence in the general descriptions between many of the well logs and demonstrated the usefulness of these records for estimating the location and thickness of units that occur over areas greater than several square miles. The records likely are increasingly less reliable as they are applied to smaller land areas. Because the map area covers almost 650 square miles, the water-well drillers' logs are probably reliable for identifying the major geologic units, their occurrence, and thickness.

In addition to revealing limitations in identifying small deposits, comparison of material descriptions between drillers' logs and core descriptions from ISGS staff suggest that water-well drillers tend to make more systematic errors in reporting specific textures of geologic deposits. For example, they tend to miss fine sand deposits, silt deposits, and thin sand deposits and tend to report more clay than is observed in detailed core sample descriptions.

To summarize the expected impacts of data errors on the accuracy and utility of the geologic model, these records appear very useful for identifying and correlating extensive glacial till and sand and gravel deposits greater than about 5 feet thick, sinuous geologic deposits that are more than about 0.5 miles wide and several miles long, and bedrock deposits. These records appear generally unreliable for accurately predicting the location of glacial deposits that are less than 5 feet thick, narrow and sinuous, less than about 0.5 miles wide, or composed primarily of silt or fine sand.

The consequences of these limitations to application of the geologic model to county-scale groundwater flow modeling are completely consistent with the mapping goals and are generally insignificant. The data seem sufficiently accurate to identify the major aquifer and non-aquifer deposits. It is important to note that within these accuracy bounds, however, the model is likely to miss thin, continuous sand or gravel deposits that could be several miles long. While these deposits, if present, will be insignificant to most county-scale predictions of flow, they might play an important role in larger flow paths if they connect larger aquifers that are otherwise hydraulically disconnected. In addition, if these smaller deposits are present, they would represent preferential flow channels, which could be significant to groundwater flow on the scale of a few townships.

Geologic Map Errors due to Variations in Data Density

The target data density for this project was 1 point per ¼ mile. The intent of this data density was to ensure consistent identification of map features that are generally over 1 to 2 miles square miles in extent. This strategy was, in general, very successful, and the model appears to be reliable for identifying geologic features exceeding this size. There are some mapping units and areas of the county, however, where data densities do not meet the 1 point per ¼ mile goal. In general, the deeper geologic units are less completely characterized because fewer wells penetrate to their depth. This results in a general decrease in data density with depth. This situation is mostly a problem with regard to the Glasford Formation within the glacial deposits and all of the bedrock formations. Because the bedrock formations are much more uniform, and we are not generally describing rock-type variations within any bedrock unit, the lower data densities within the bedrock formations do not impact the accuracy of the bedrock maps. The lower data densities in parts of the complex Glasford Formation, however, do reduce the accuracy of the model.

To summarize the expected impacts of variations in data density on the accuracy and utility of the geologic model, most of the glacial deposits have a data density for most of the county that meets the stated goals. These units are, therefore, expected to be very accurate in displaying thickness variations that are larger than 2 square miles. The accuracy of the model in regard to the Glasford Formation fine- and coarse-textured layers is expected to identify variations of this size fairly well, but it is expected that there will be several areas where the model identifies only variations in the range of about 5 to 10 square miles.

Part of the difficulty in assessing the impact of variations in data density on model accuracy is that, within the county, there are probably some thin, sinuous deposits, or portions of deposits, that are much less than 2 miles wide and longer than 3 miles. These features will not be accurately represented in the model unless they have been penetrated by several wells along their length, and this scenario is unlikely. Undetected sinuous features such as these are likely to be somewhat more of a problem within the Glasford Formation. It is important to note that although these thin, sinuous features will not be reliably identified in these maps, the designed data density suggests that they were never intended to be reliably identified. That is, this limitation was designed into the study and should not be interpreted as a shortcoming of the model.

The consequences of the data density accuracy on the groundwater flow modeling and water management decision making are, in general, positive and suggest that data density will not contribute to errors in the groundwater flow models. The impacts of reduced Glasford Formation accuracy are likely to be of concern and could negatively impact the reliable estimation of flow through this deposit. This impact is important, as the Glasford is typically immediately above the bedrock surface and fills all of the bedrock valleys. Inaccuracies in the distribution and character of this unit could impact estimations of flow in bedrock valleys and estimates of recharge to bedrock aquifers, both of which affect the regional flow budget and potentially regional management decisions.

It is worth noting that although this level of accuracy is very close to the designed accuracy data density goals, the inability of the geologic model to identify thin, sinuous features could pose significant problems for prediction of local groundwater flow and could result in the selection of inappropriate local management goals. These errors and their consequences could be remediated through more detailed geologic investigations in relevant areas of the County.

Geologic Map Errors due to Generalizations in Texture of Lithostratigraphic Units

The generalizations made in defining the lithostratigraphic mapping units affect the accuracy of the resultant geologic maps. In many cases, the lithostratigraphic units contain relatively thin layers of limited areal extent that have textures very different from the bulk texture of the unit. For example, fine-grained tills often have thin sand layers or lenses within them. Sand and gravel deposits often contain thin lenses of clay, silt ,or diamicton. The ISGS field mappers are aware of the potential occurrence of these lenses, which are common to Illinois glacial sediments. These variations in texture can have important consequences for groundwater flow and were considered in this evaluation of map accuracy.

Texturally, the Ashmore Tongue consists predominantly of medium to coarse sand with gravel, with locally significant occurrences of fine-textured deposits near the top of the unit. The sub-Batestown and sub-Yorkville tongues of the Henry Formation predominantly contain fine- to medium-grained sand with some gravel, with locally occurring layers of fine-textured deposits near the top of the units. The fine-textured deposits within the sub-Batestown and sub-Yorkville tongues are not as common and tend to be thinner than those in the Ashmore Tongue. This means that, locally, a significant portion of the mapped Ashmore thickness and a portion of the mapped sub- Batestown and sub-Yorkville tongues thicknesses are not composed of sand and gravel. Because the sub-Yorkville tongue is more discontinuous and generally thinner than the sub-Batestown tongue, when present, the fine-grained layers are likely to represent a larger fraction of the total thickness for the sub-Yorkville tongue than for the sub-

Batestown tongue. The actual resulting overestimation of thickness for each unit will depend on the thickness and occurrence of the fine-textured sediments. Because these fine-grained layers within the three sand and gravel units are only present locally and then infrequently recorded within the well records, we cannot reliably estimate the errors in thickness that these textural generalizations create. We can, however, estimate the likely relative impact to groundwater flow modeling. Errors in sand unit thickness because of these textural generalizations should be considered when the geologic model is used as input for groundwater flow modeling. Groundwater modelers should recognize and make accommodations for the possibility of textural variations within each unit as they assign hydraulic properties. Recognition of and accommodation for the impacts of textural generalizations on the distribution of hydraulic properties in the aquifers could significantly reduce any errors that might propagate into groundwater flow modeling results. The following evaluation summarizes the potential impacts of textural generalizations on errors in groundwater flow modeling results.

Hydraulic conductivity is a measure of the ease with which water can flow through a geologic deposit. Because the hydraulic conductivity of these glacial deposits is related to their texture, it is likely that errors due to the textural generalizations will result in an overestimation of the assigned average hydraulic conductivity for each of these three sand units. Transmissivity is a measure of the horizontal flow of water to a well and is calculated by multiplying hydraulic conductivity by the thickness. Although textural generalizations within the sand units will result in potentially significant errors within the thickness and hydraulic conductivity estimates, the errors in transmissivity will be significantly larger. This is because errors in transmissivity due to the textural errors are estimated by multiplying the errors in thickness and hydraulic conductivity.

Errors in hydraulic conductivity and transmissivity estimates are expected to follow the same trends as the errors in thicknesses. Errors for all of these properties are expected to be proportionally greater within the Ashmore Tongue than within the sub-Batestown or sub-Yorkville tongues. The errors within the sub-Yorkville are expected to be greater than those within the sub-Batestown.

The errors in hydraulic conductivity and transmissivity might be significant enough to impact the reliability of county-wide groundwater flow modeling within the Ashmore and possibly the sub-Yorkville tongue. Errors in hydraulic properties due to textural generalizations would likely pose a larger problem for the reliability of more localized groundwater flow modeling. However, because the actual occurrence of fine-grained layers within these sand and gravel deposits is unknown, it is impossible to know whether their occurrence is frequent enough to create significant errors in either the estimates of hydraulic properties or the groundwater flow modeling results. Additional field work could be conducted to target high priority areas and further evaluate the occurrence and potential importance of fine-grained layers within these coarse-textured units.

The textural generalizations within the fine-textured units have a significantly different impact than textural generalizations within the coarse-textured units. Texturally, the Tiskilwa Formation tends to have lenses of sand and gravel deposits near the base. Also, the Batestown Member can have thin sand and gravel deposits near the base of the unit, but these are much less likely than in the Tiskilwa Formation. The Yorkville Member can contain thin deposits of sand and gravel near the base, but, like the Batestown Member, these deposits are less likely than in the Tiskilwa Formation. The consequence of these textural variations on groundwater flow modeling would be an underestimation of leakance or vertical flux of water through these units. Even so, the size of the errors in leakance estimation would be expected to be small. Therefore, the net impact of these textural variations on groundwater flow modeling will be insignificant, and any significant textural variations within a single till unit will be corrected for within the calibration stage of the groundwater flow modeling.

Geologic Map Errors due to Generalizations in Thickness

Evaluating errors in the geologic model due to generalizations, or simplifications, in the thickness of each deposit is a more difficult task than evaluating the other sources of map error. Geologists routinely simplify the thickness of deposits in maps because it is impossible to have enough data to describe the thickness of any buried deposit with 100% reliability. The amount of simplification in a geologic map depends on the density and accuracy of available data and the complexity of the geologic deposit being mapped. As with the actual thickness values, the amount and location of errors in thickness predictions are impossible to know with 100% reliability. There are a few established methods, however, that can be used to estimate the amount and location of errors in thickness of individual deposits.

We chose two standard statistical methods, semivariogram modeling and stochastic simulation, and applied them in a novel way to estimate the errors in thickness for each unit. Semivariogram modeling allows us to describe the variations in thickness across the County in a way that recognizes any geologically relevant patterns of variation. Importantly, the descriptions provided by the semivariogram modeling avoid the simplifications in thickness that we are trying to characterize. Stochastic simulation is a modeling method that allows us to create a large number of different versions of thickness or isopach maps of any geologic unit. Each version, or simulated isopach map, honors the data values and contains the variability described by a semivariogram model. Stochastic simulation allows us to produce many different isopach maps, all of which avoid the simplifications in thickness that are included in isopach map from the geologic model. This characteristic allows us to use these simulated isopach maps to characterize the errors contributed by the originally mapped simplifications in thickness.

For this process, the mappers and modelers worked together to analyze how the thickness of the units changed across the County. The insights gained from this analysis were used with the semivariogram modeling and stochastic simulation to estimate the amount and locations of error in the isopach maps. The typical use of stochastic simulation in evaluating error relies solely on semivariogram models of deposit thicknesses that were calculated from the water-well data. We modified this approach by conducting a second round of simulations. This second round of simulations relied on semivariogram models that were calculated from the original isopach maps for select units. In general, the water-well data had more local variability in thickness than the original maps did; the semivariogram models from the well data reflected this greater variability, as did the resulting isopach maps from the simulations.

This modified approach to stochastic simulation provided better insight into the possible range of errors throughout the County than would have resulted from the typical simulation approach. The simulations conducted based solely on the well data values suggested larger errors in predicted thickness, at more locations, than did the simulations based on the well data and isopach maps from the geologic model. The simulation results also allowed us to identify where the units were likely to exceed various thickness thresholds (e.g., probability of exceeding 10 feet thick). Evaluated together, the complete collection of simulation results is a powerful tool for helping us understand where the thicknesses of the geologic units are most accurate.

For the semivariogram modeling and stochastic simulation, we used the Isatis software package (Geovariances, Inc., www.geovariances.com). Analysis was performed on four of the more important geologic units; the sub-Yorkville tongue of the Henry Formation, the Batestown Member of the Lemont Formation, the Tiskilwa Formation, and the Ashmore Tongue of the Henry Formation. Accuracies of thickness maps within these four units should be similar to the accuracy of thickness maps for other units, so the four can be considered representative of the other units in the geologic model.

A full discussion of this method and presentation of all results will be published in a separate report. This present report briefly summarizes the results obtained from this analysis. As a general observation, because the isopach maps from the geologic model represent simplifications of the thickness, even before running the simulations, we can predict that the errors in these maps will result in localized overestimations and underestimations of the total thickness of each unit. Overestimations of thickness of geologic units may result in overestimations of the transmissivities of the coarse-textured units and underestimations of the leakage rates through fine-textured units. Conversely, underestimations of the thickness of geologic units may result in the underestimation of transmissivities in course-textured units and overestimation of leakage through fine-textured units. The size of these errors will be dependent on the average thickness of the specific unit and the observed or predicted variability in that thickness. As noted earlier, the distribution of data points is dense enough to generally meet the goal of one point every quarter mile. This data density limits the error in thickness estimates to local variations. Although the magnitude of these local variations can be significant for some units, the spatial size of these errors is going to be small. The deeper units have the potential for some slightly larger areas where increased errors might occur, but even in the worst case, these errors would not pose significant impacts to county-wide groundwater management decisions.

The remainder of this section will describe the general range in simulated thickness predictions for each unit, including estimates of where the units will exceed specific thickness values, estimates of where the units will be less than 1 foot thick, and the likely importance of errors in transmissivity or leakance on groundwater flow modeling results. The detail provided in the remainder of this section is intended to provide insight that might be relevant to more localized groundwater flow modeling or groundwater management decisions.

In all cases, sensitivity analyses of transmissivity or leakance could be conducted on sand and gravel deposits or tills, respectively, to provide insight on the vulnerability of the groundwater flow modeling results to errors in estimated thickness. Alternatively, additional field work could be conducted at targeted locations to measure the thickness distributions for specific units in detail. This information could be used to improve the geologic maps, to revise the estimates of thickness errors based on these improved maps, and to revise the estimates of errors in transmissivity and leakage based on the improved thickness estimates.

Sub-Yorkville Tongue, Henry Formation

Figures A1 and A2 show two possible distributions of the sub-Yorkville tongue of the Henry Formation. Figure A1 is an example of a simulation map where the local variability in thickness is low, similar to the published thickness map. Figure A2 shows a map with more local variability, similar to that found in the thickness values from the well logs. Figures A3 and A4 provide estimates of where the sub-Yorkville tongue sands are thicker than 10 or 20 feet, respectively. Importantly, there are very few areas where the sand is expected to be greater than 20 feet thick, and the simulation results suggest these areas are usually less than 1 square mile. The simulation results also support the idea that much of the area underlying the Yorkville till will contain some sub-Yorkville sand and gravel deposits, although most of this deposit will be less than 10 feet thick. Figure A5 shows that much of the depositional area for this sand has a low to moderate probability of being less than 1 foot thick.

The simulation results illustrate the large amount of local variation in thickness within the sub-Yorkville tongue. Because the data density describing this unit is so high, it is unlikely that errors in transmissivity due to errors in thickness estimates will have any negative impact on the county-wide groundwater flow modeling results. This unit is thin and discontinuous and is only present in the eastern third of the county. Because of the limited thickness and distribution of this unit, it is unclear how the errors in thickness, and subsequent errors in transmissivity, might impact more localized groundwater flow modeling.

Batestown Member, Lemont Formation

Figures A6 and A7 show two possible distributions of the Batestown Member of the Lemont Formation. Figure A6 is an example of the simulation results where the local variability in thickness is low, similar to the isopach map from the geologic model. Figure A7 is an example of Batestown thickness map with large local variability. In figure A6, the thickest and thinnest parts of the formation are larger, less variable, and more contiguous than these same areas in figure A7. Figures A8 and A9 provide estimates of where the Batestown Member is likely to be thicker than 10 and 20 feet, respectively. Figure A10 shows the likelihood that the Batestown Member is less than 1 foot thick. Importantly, these figures suggest that Batestown is significantly thicker in the western two thirds of the county than in the eastern third, and a significant portion of the unit in the eastern third of the county is thinner than 1 foot.

Both figures A6 and A7 suggest that the western portion of the Batestown Member has a significant amount of local variability in thickness. The relative thinness of much of the Batestown Member suggests that these localized variations in thickness might often represent a large fraction of the deposit. The data density for defining this unit is high, suggesting that errors are typically localized and not expected to miss either a regionally significant thick zone or a complete absence of the Batestown. Given the large variations in local thickness, however, it seems likely that the leakance through the Batestown Member may be overgeneralized with respect to local estimates, which might result in this unit being seen as a larger barrier to flow than is realistic. Difficulties in characterizing flow through diamictons using groundwater flow models suggest that focused field observations of water levels and age dating of groundwater samples would be the best ways to evaluate the hydrologic importance of localized errors in thickness of the unit.

Tiskilwa Formation

Figures A11 and A12 show two possible distributions of the Tiskilwa Formation. Because the thickness in Tiskilwa is so locally uniform based on the well log data, these end members of the Tiskilwa thickness distribution are very similar. Both maps show a significant amount of local variation in and east of the Marengo Moraine. Most of the remainder of the county seems to have very little local variation in thickness. Figures A13 and A14 show the likelihood that the Tiskilwa Formation is thicker than 20 feet and 250 feet, respectively. Figure A15 shows the likelihood that the Tiskilwa Formation is thinner than 1 foot.

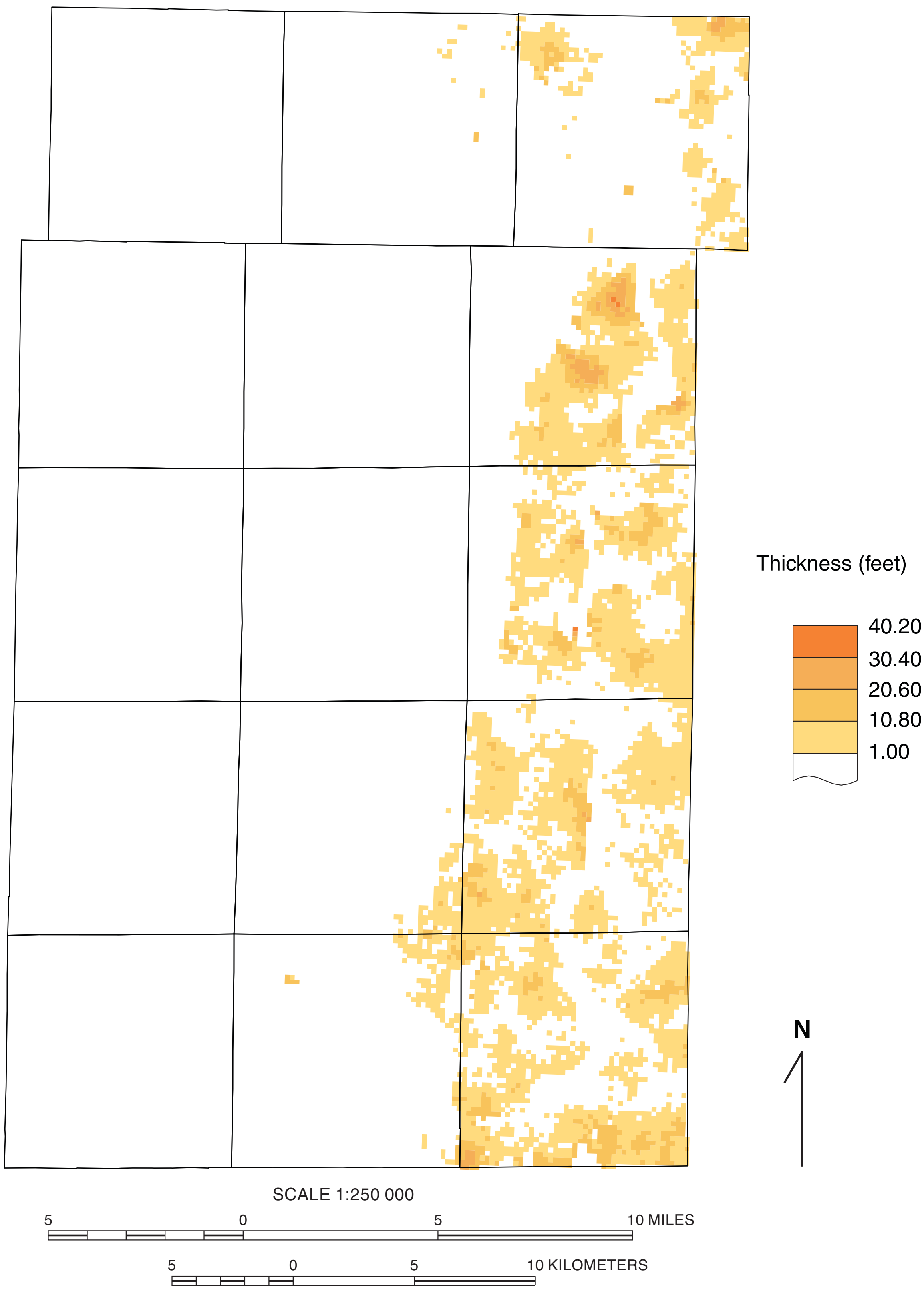


Figure A1 *Simulation map of the thickness of the sub-Yorkville tongue of the Henry Formation showing small local variability.*

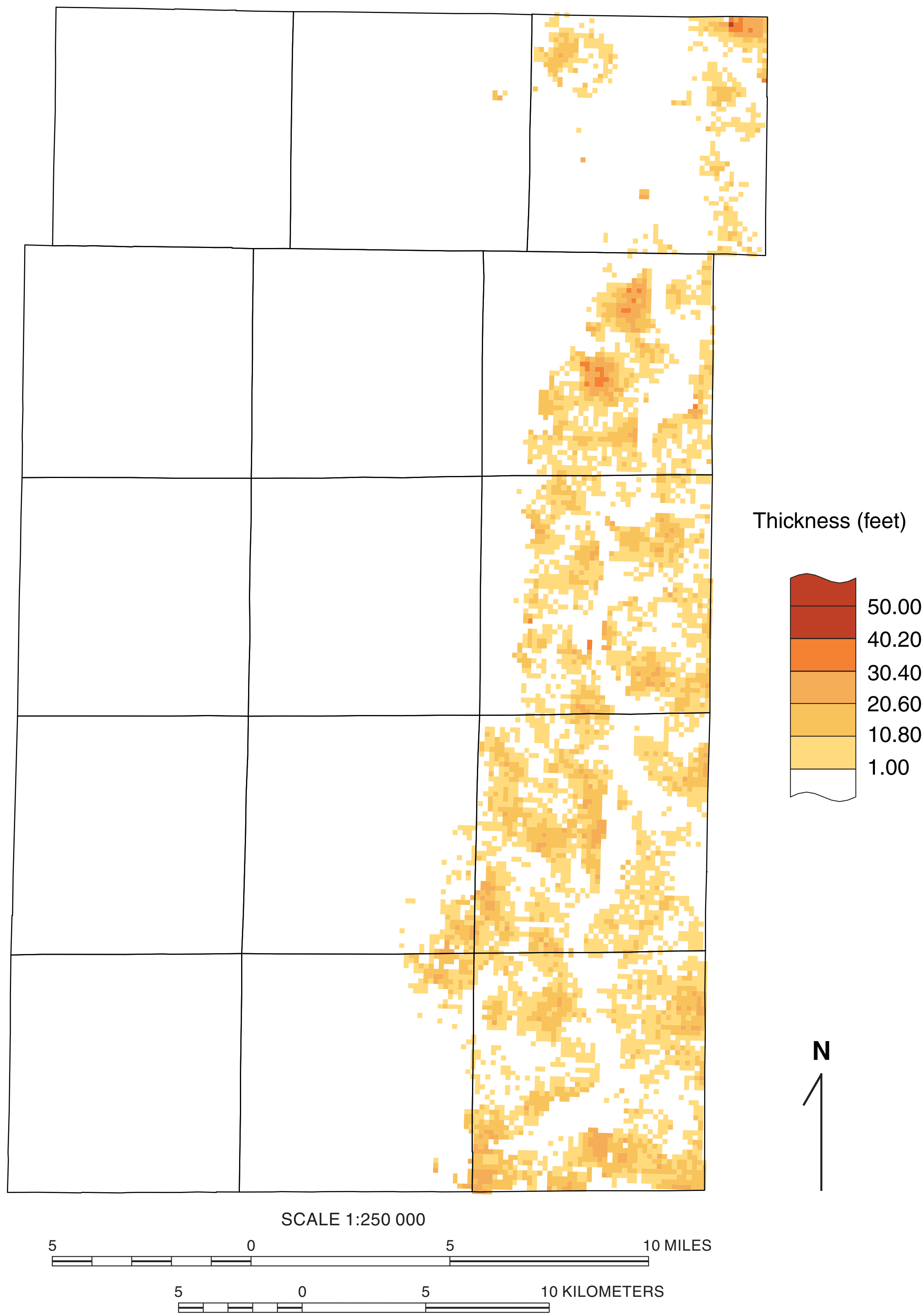


Figure A2 *Simulation map of the thickness of the sub-Yorkville tongue of the Henry Formation showing large local variability.*

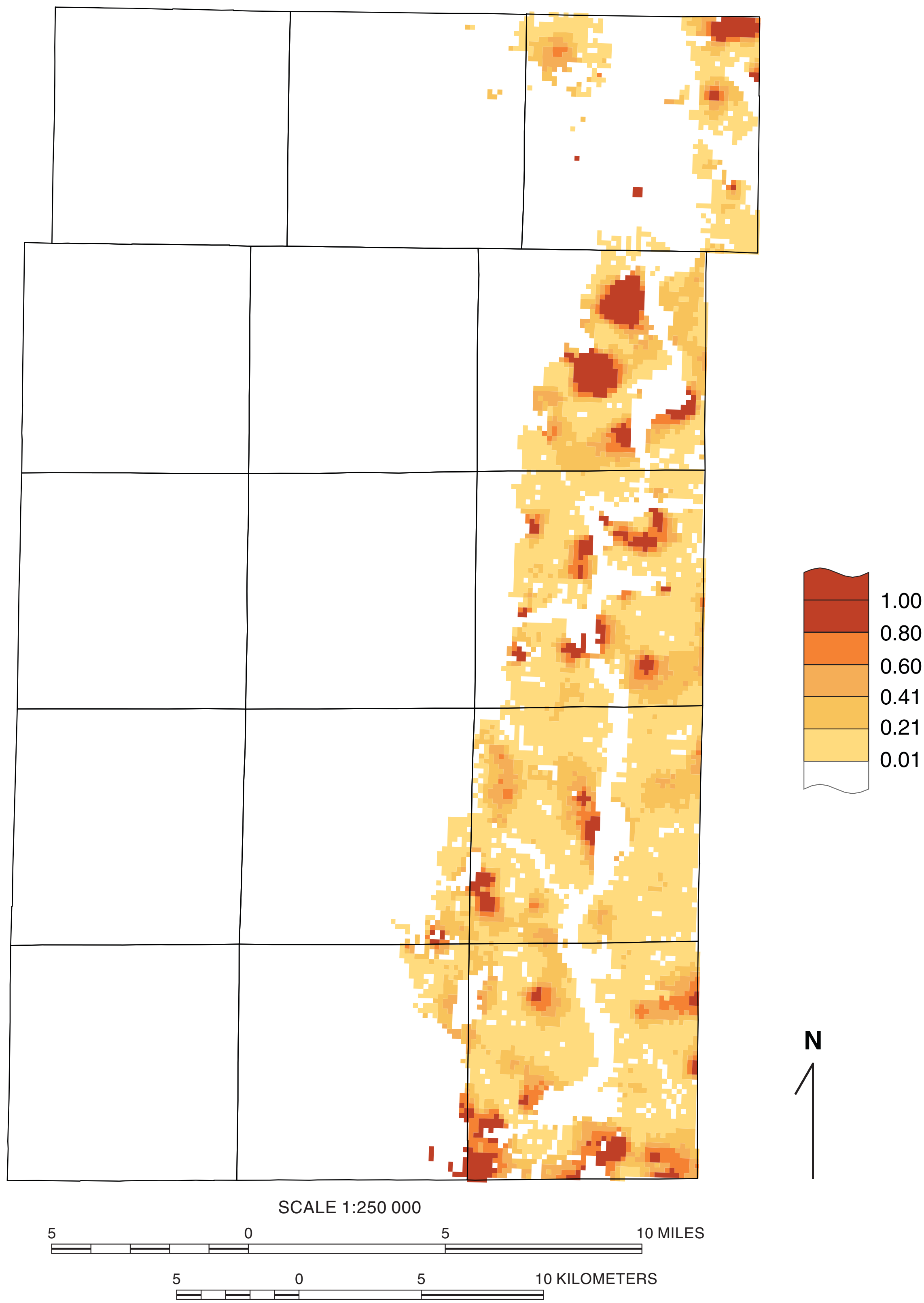


Figure A3 *Probability that the sub-Yorkville tongue is greater than 10 feet thick.*

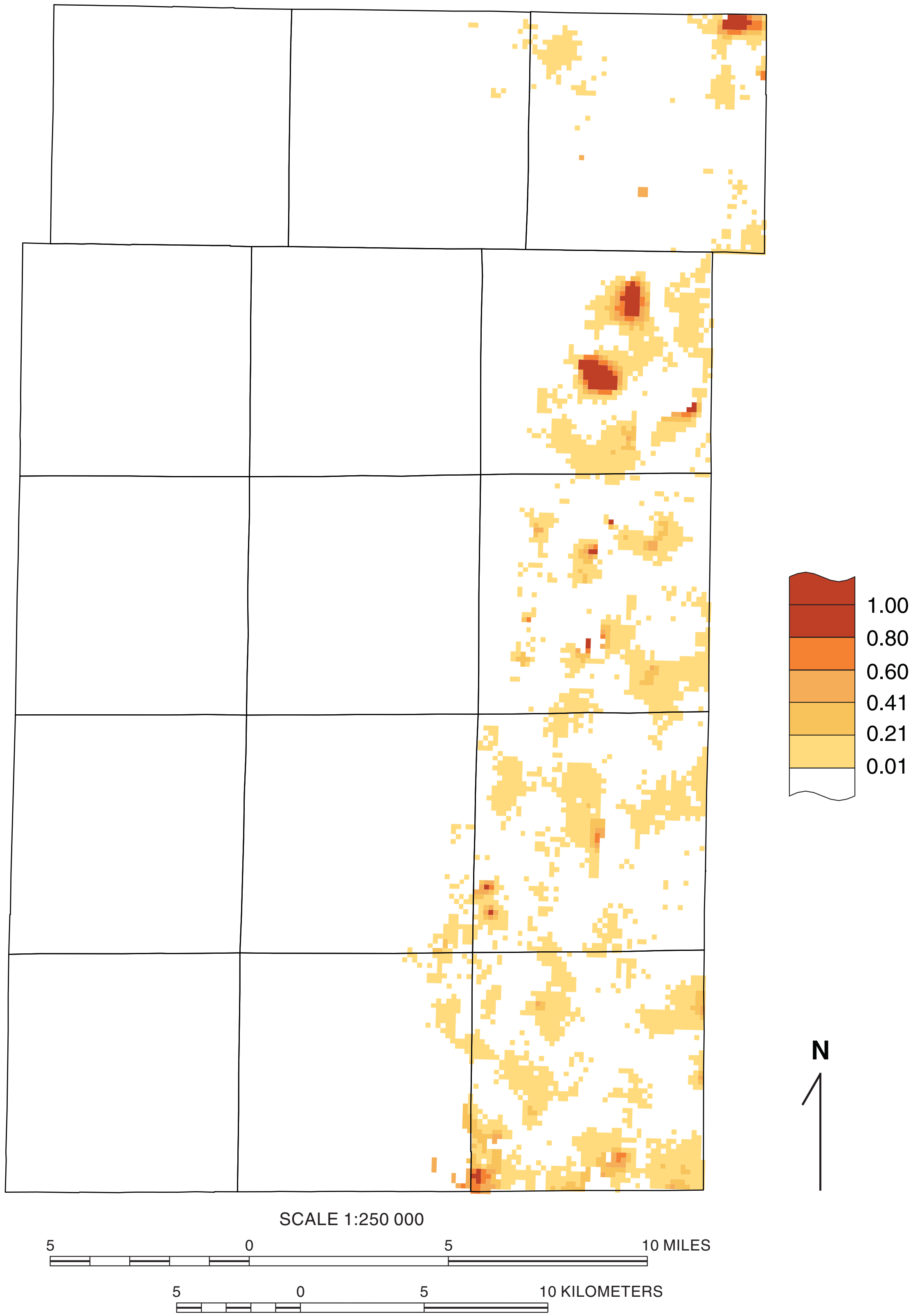


Figure A4 *Probability that the sub-Yorkville tongue is greater than 20 feet thick.*

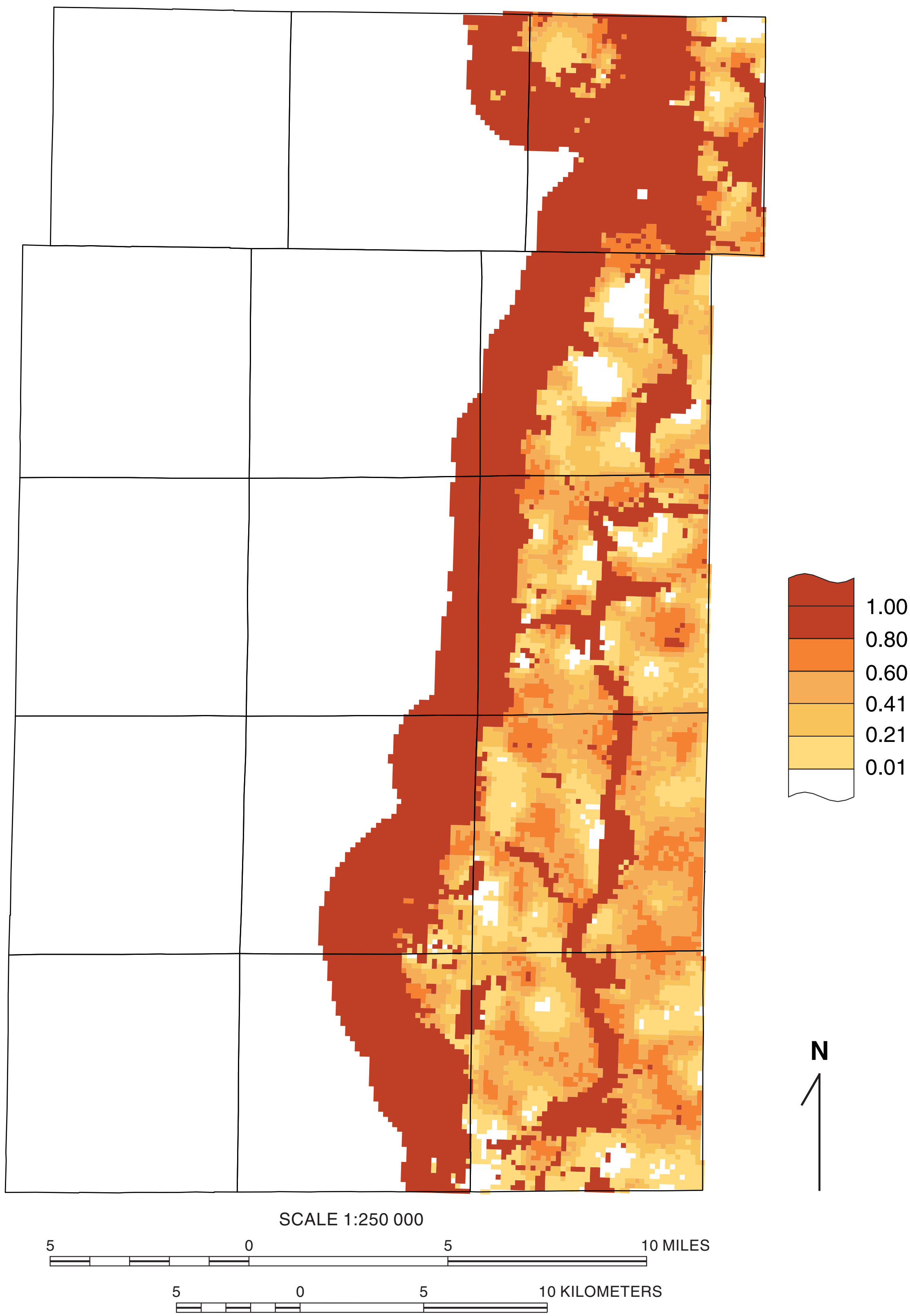


Figure A5 *Probability that the sub-Yorkville tongue is less than 1 foot thick.*

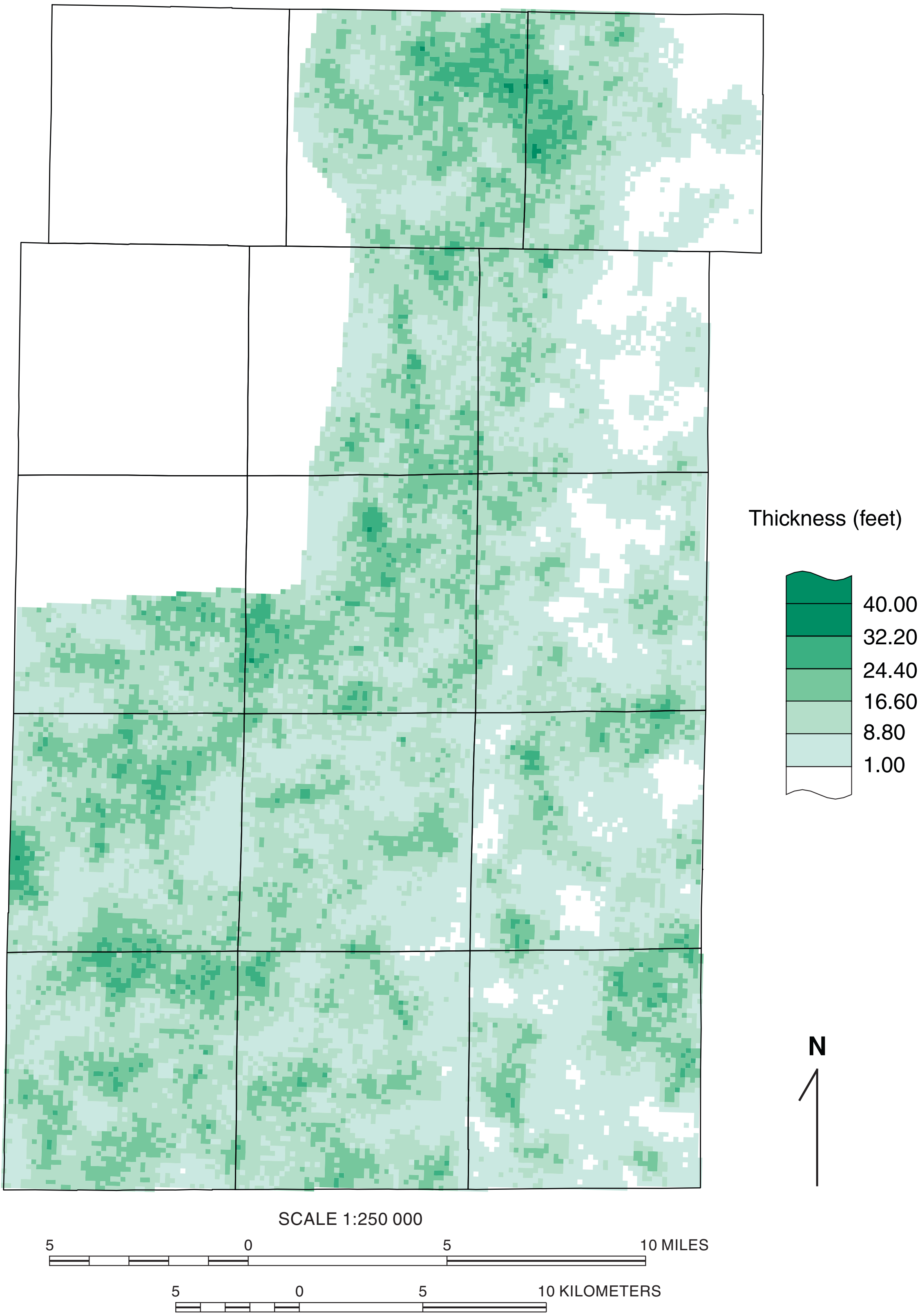


Figure A6 *Simulation map of the thickness of the Batestown Member of the Lemont Formation showing small local variability.*

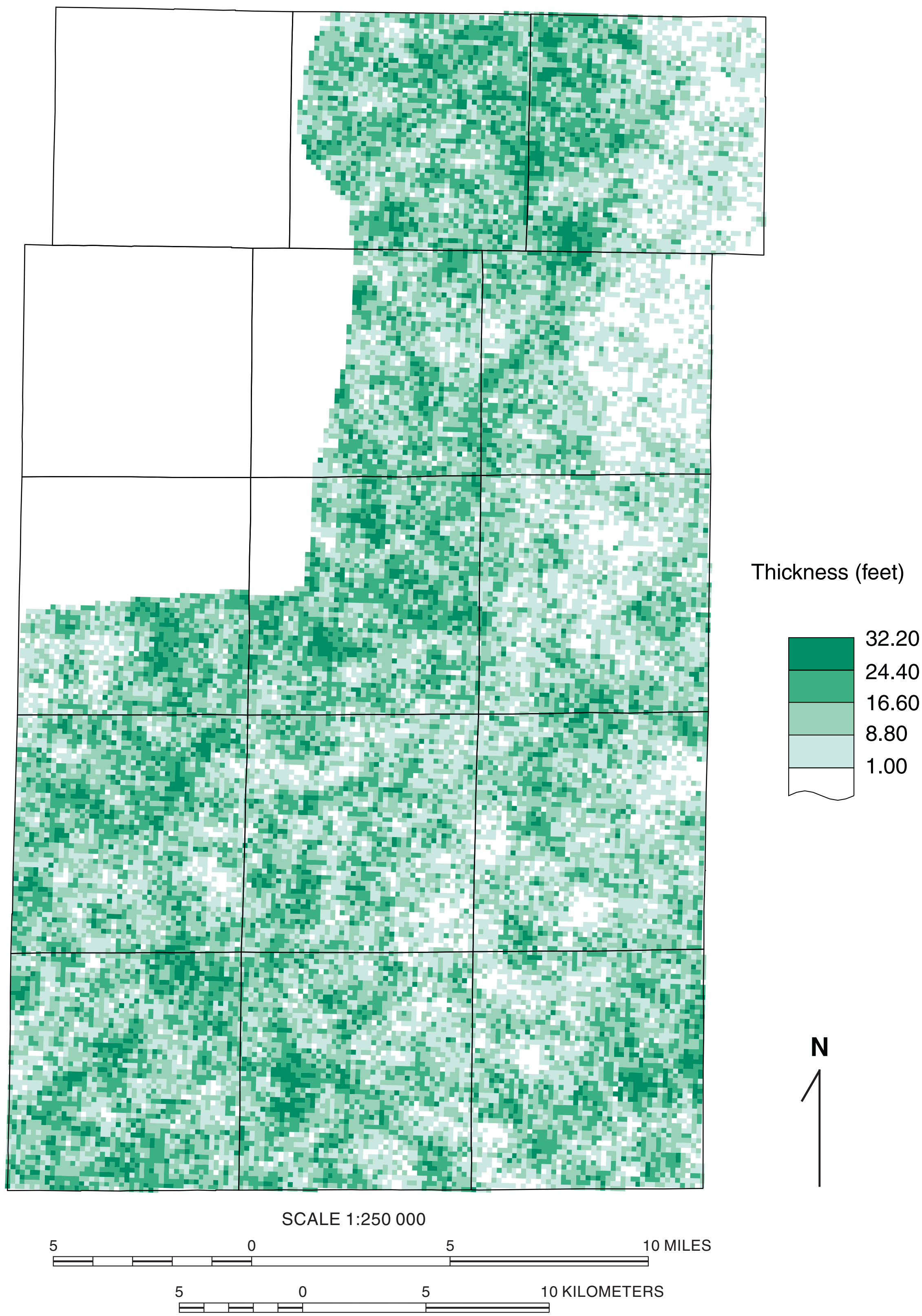


Figure A7 *Simulation map of the thickness of the Batestown Member of the Lemont Formation showing large local variability.*

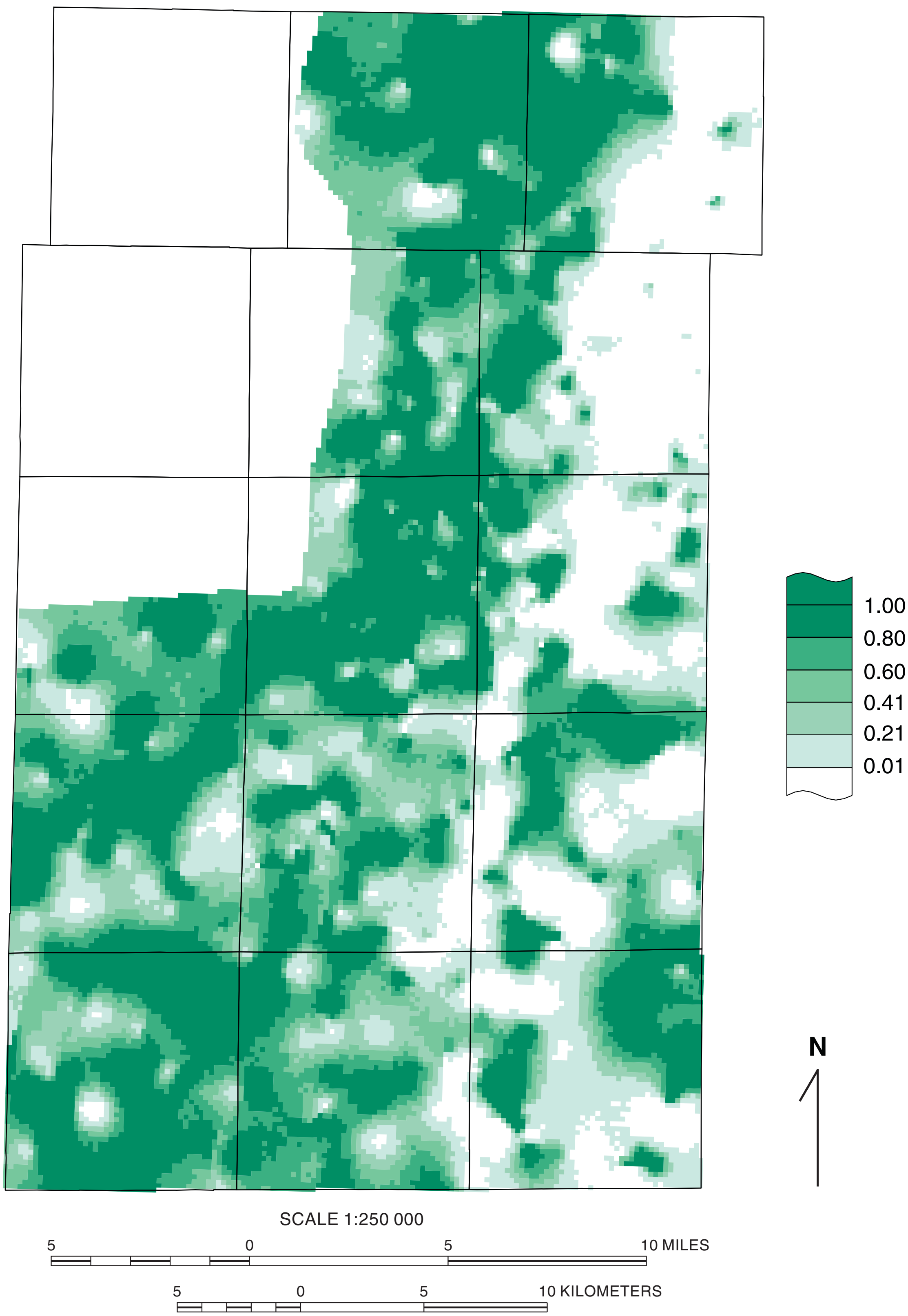


Figure A8 *Probability that the Batestown Member diamicton is greater than 10 feet thick.*

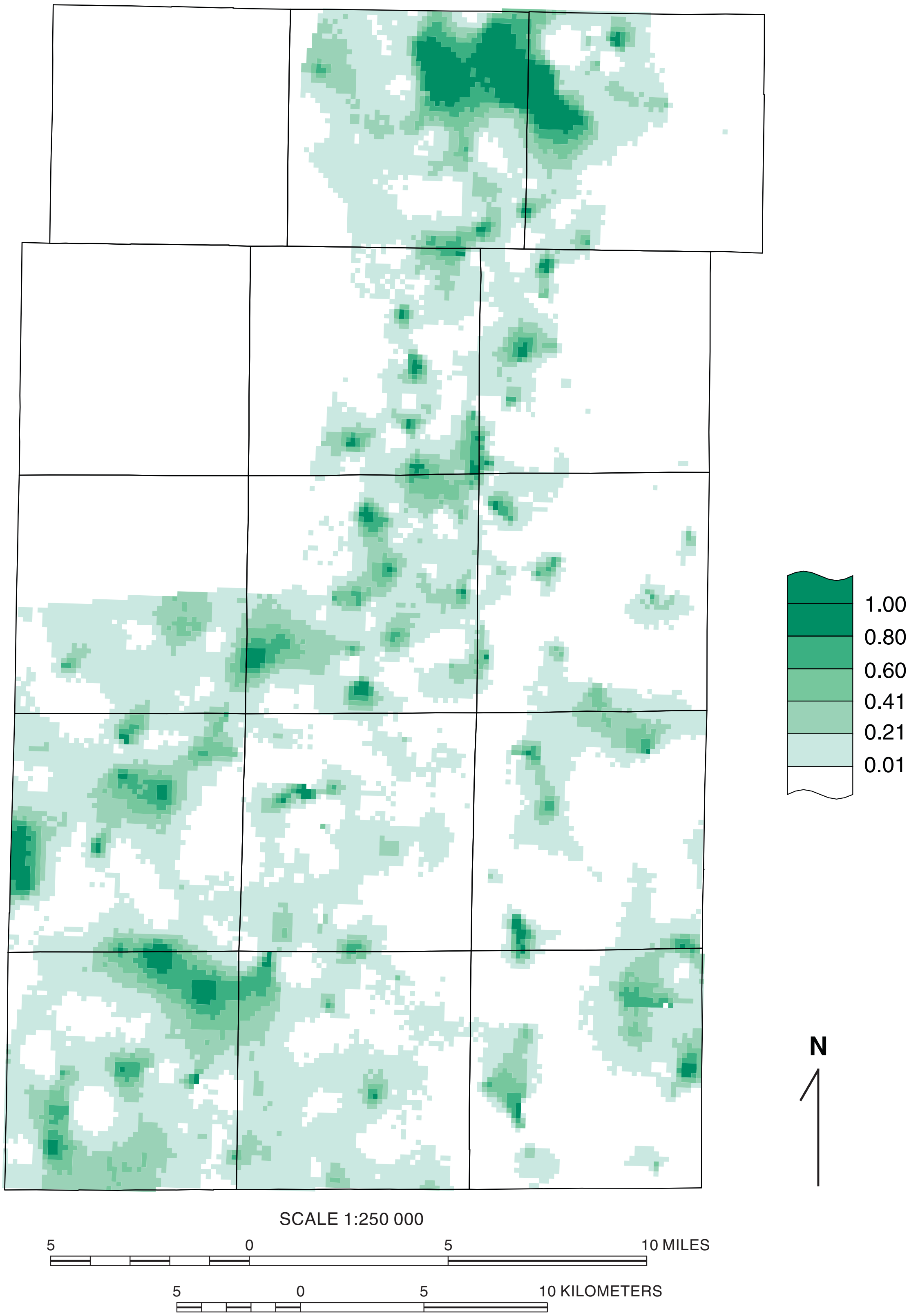


Figure A9 *Probability that the Batestown Member diamicton is greater than 20 feet thick.*

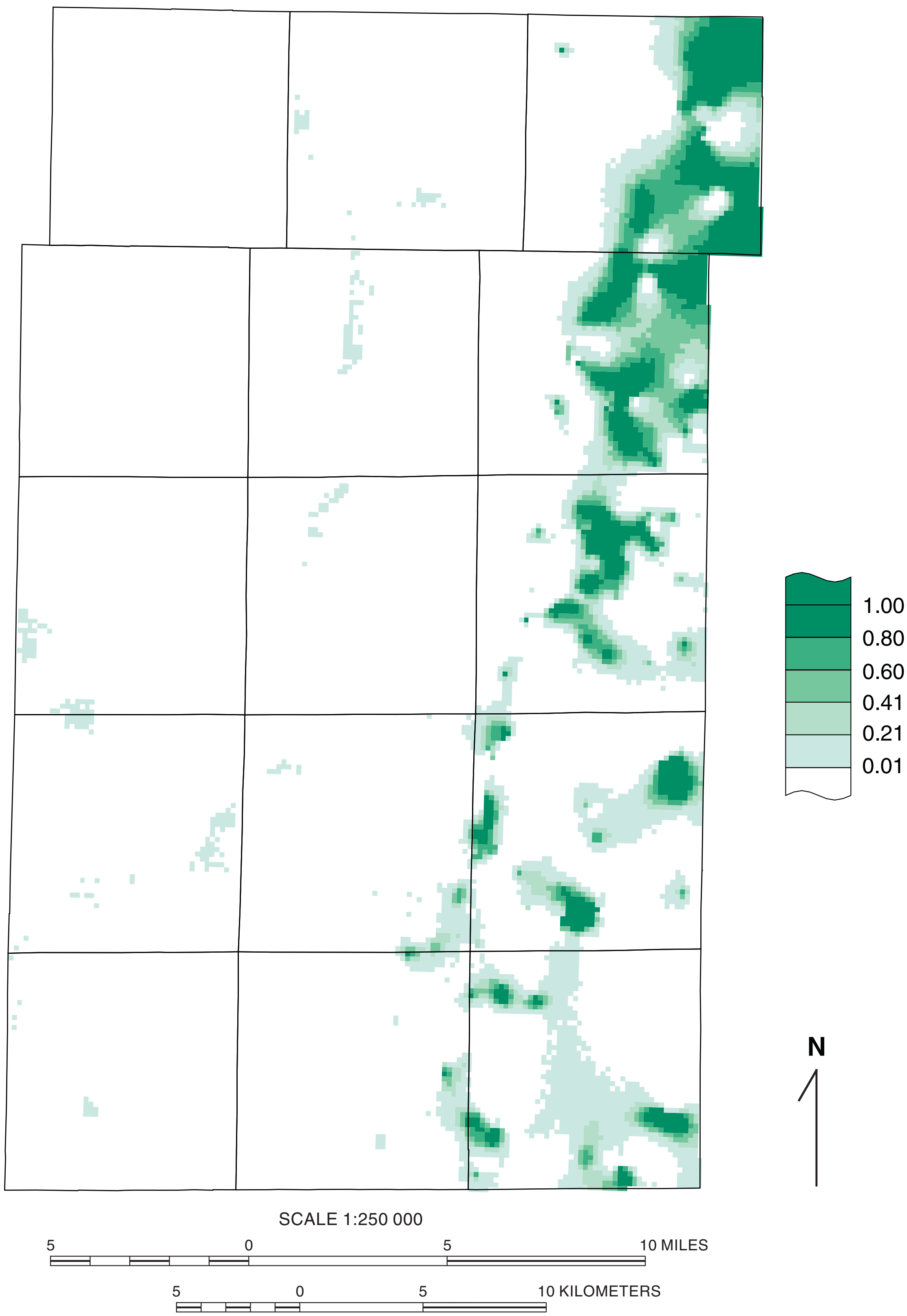


Figure A10 *Probability that the Batestown Member diamicton is less than 1 foot thick.*

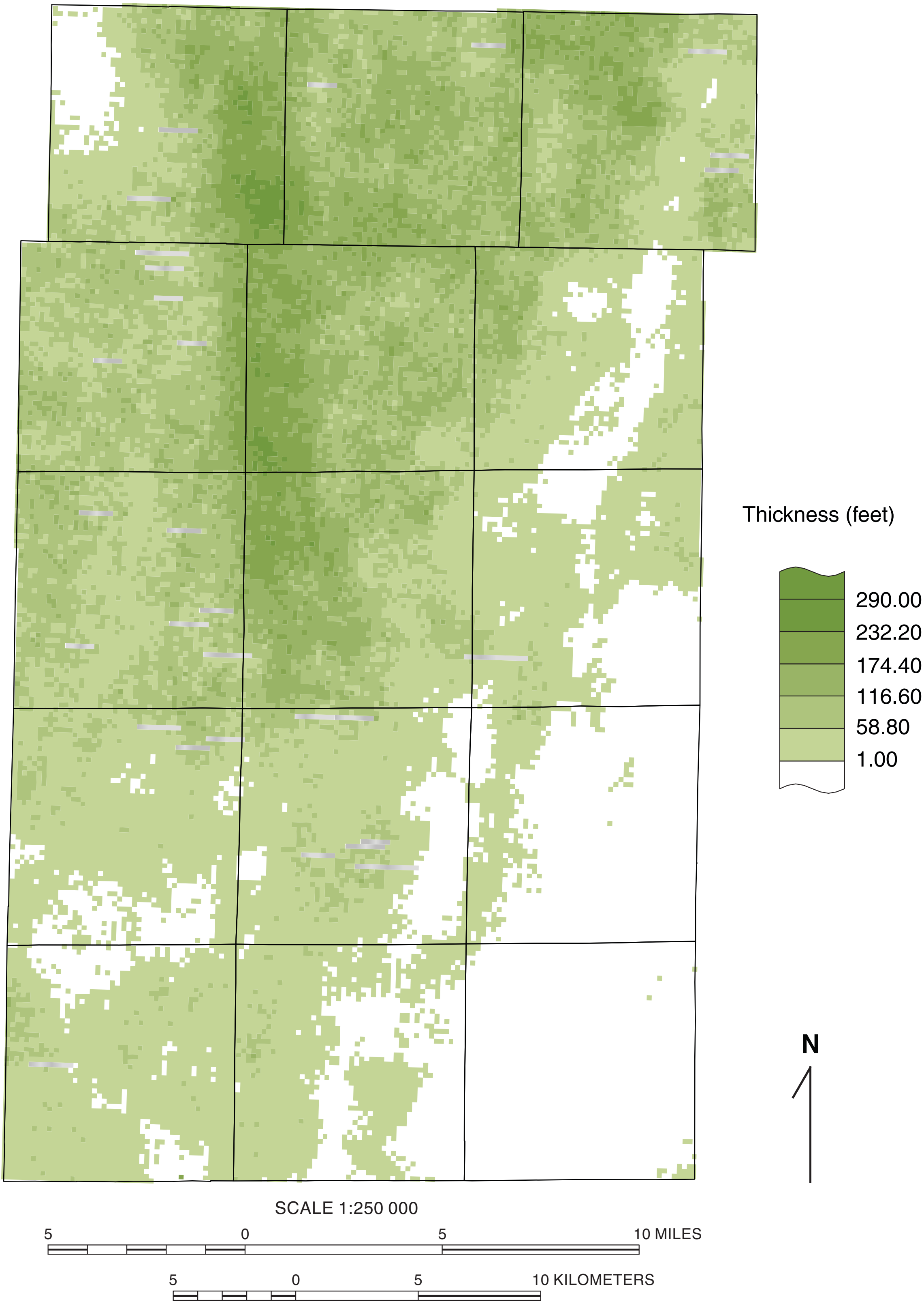


Figure A11 *Simulation map of the thickness of the Tiskilwa Formation diamicton showing small local variability.*

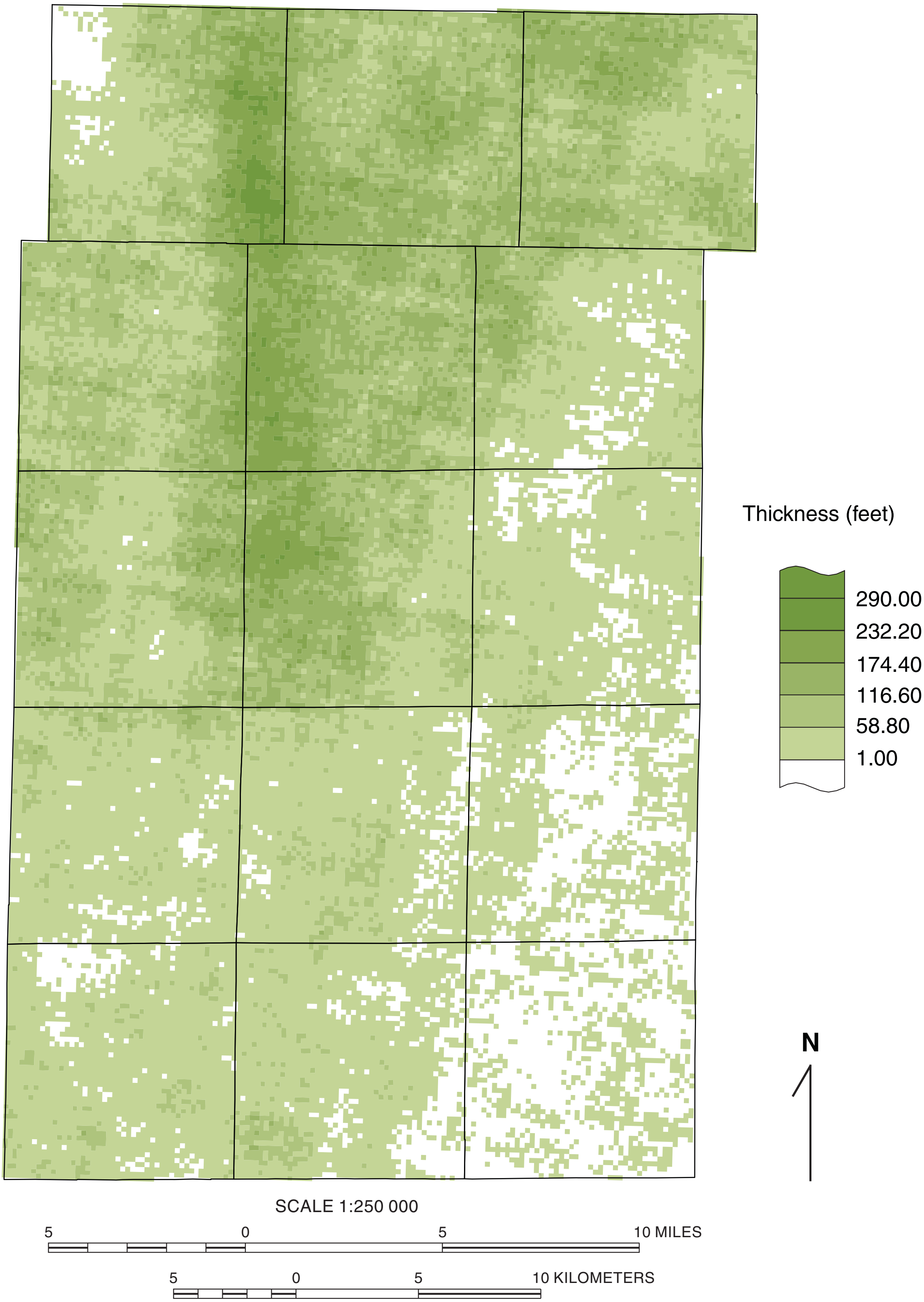


Figure A12 *Simulation map of the thickness of the Tiskilwa Formation diamicton showing large local variability.*

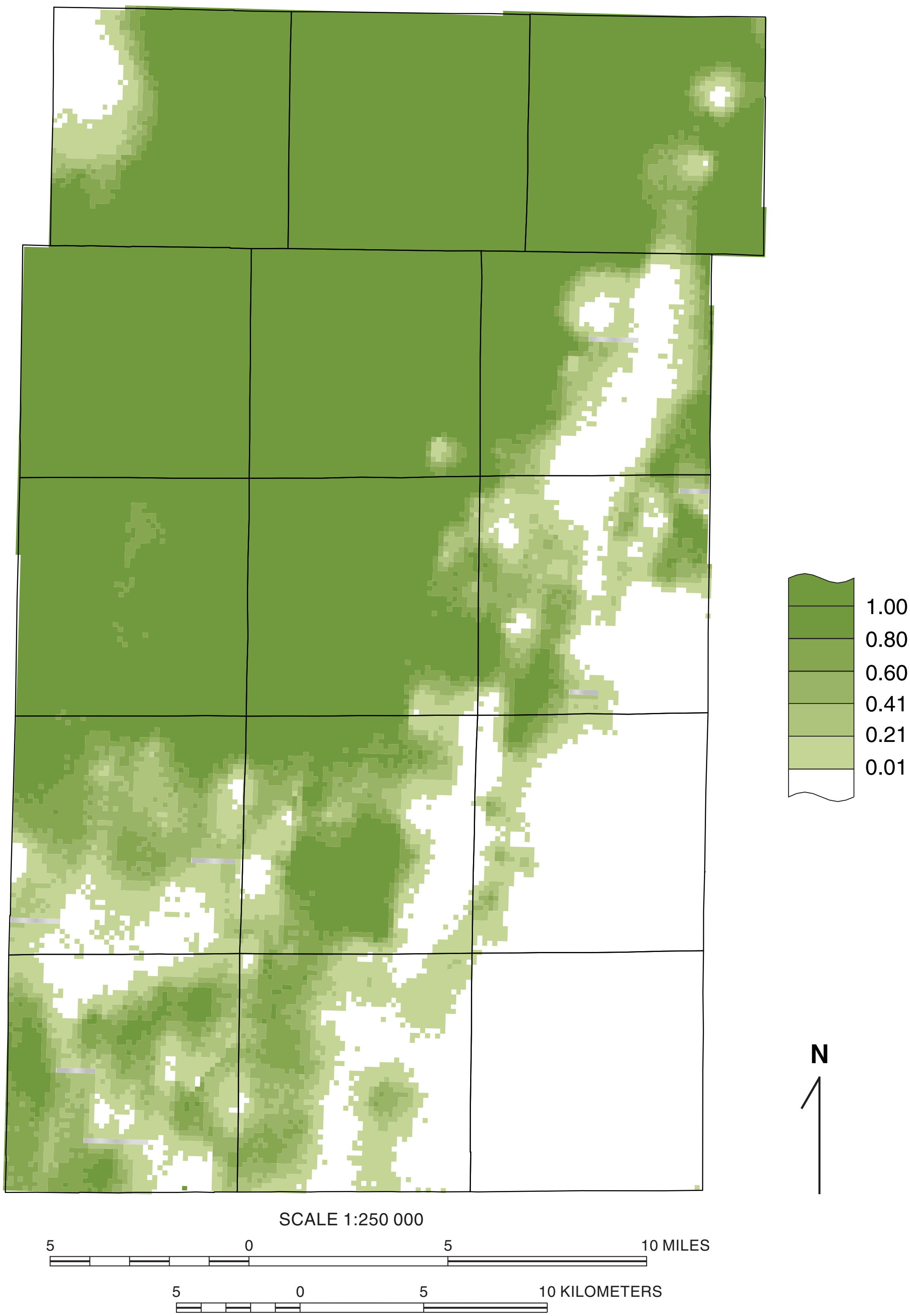


Figure A13 *Probability that the Tiskilwa Formation diamicton is greater than 20 feet thick.*

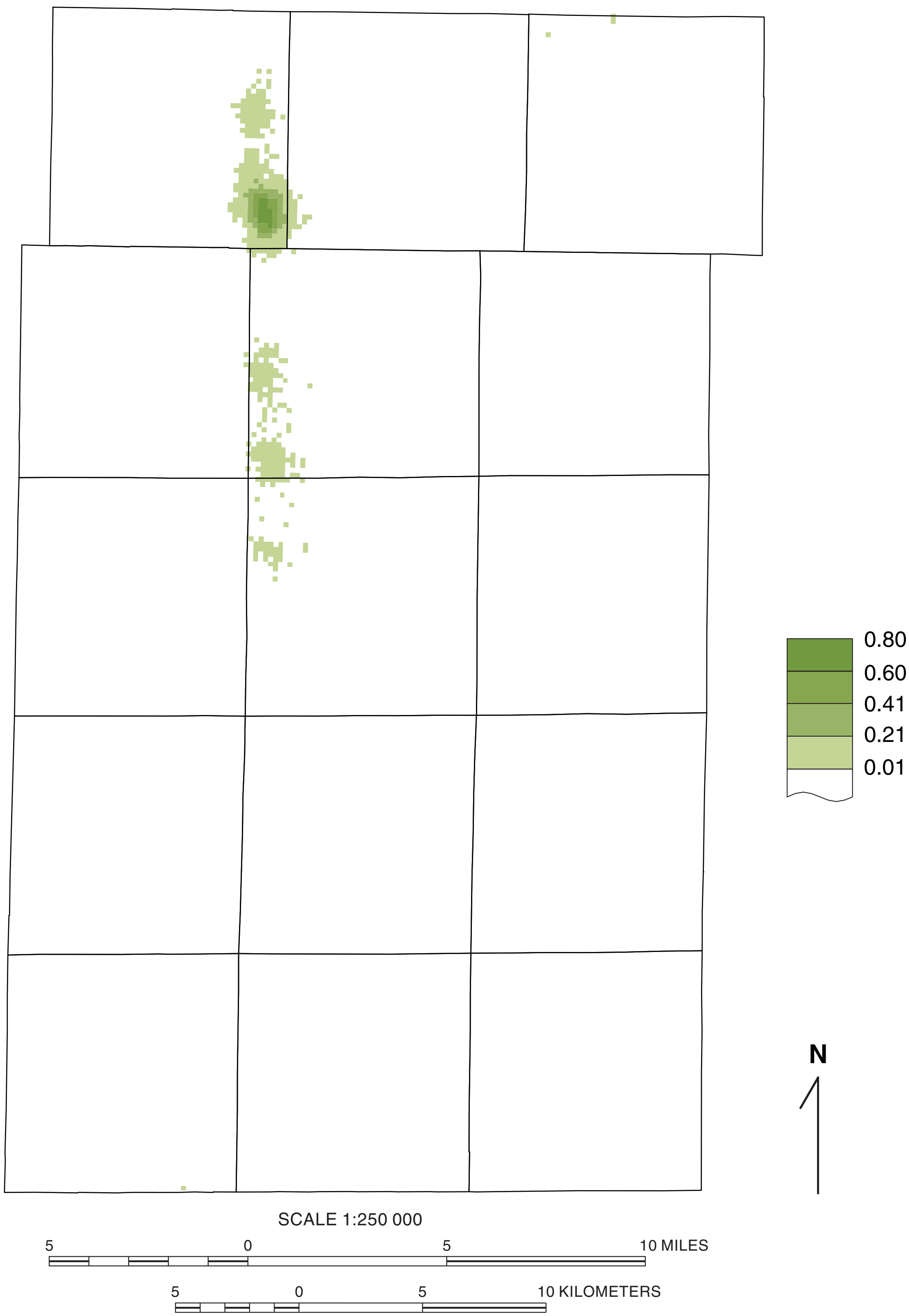


Figure A14 *Probability that the Tiskilwa Formation diamicton is greater than 250 feet thick. This map is based on step-one simulation results.*

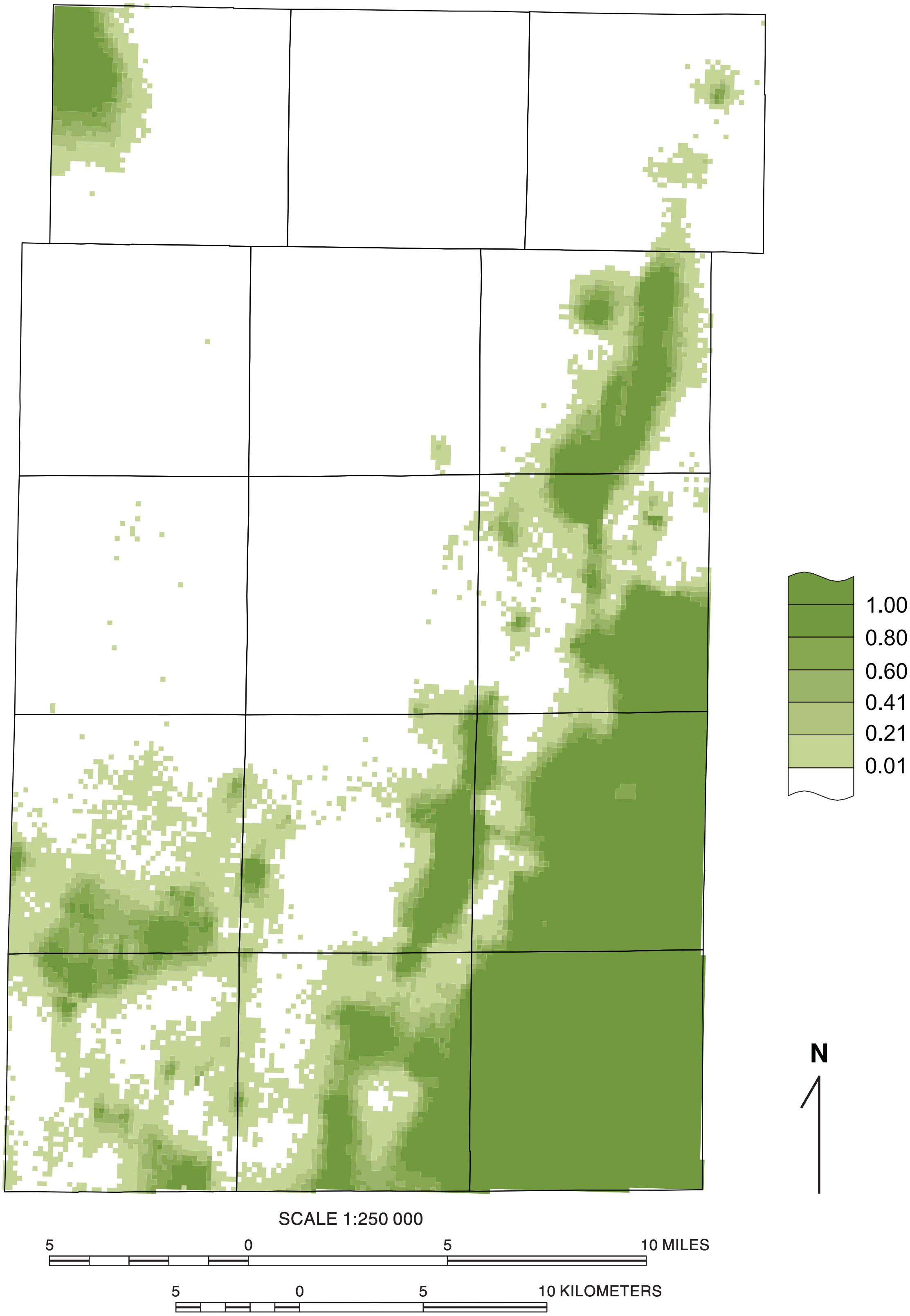


Figure A15 *Probability that the Tiskilwa Formation diamicton is less than 1 foot thick. This map is based on step-one simulation results.*

Errors associated with the thickness of the Tiskilwa Formation in the geologic model may contribute to errors in the estimated leakance characteristics of this unit. Because most of the large variations in the Tiskilwa thickness are local in extent and tend to be concentrated around the thickest parts of the deposit, the impacts of these errors in thickness on the groundwater flow are likely to be insignificant on a county-scale. The large local variations in thickness around the Marengo Moraine may contribute to levels of error in leakance estimation that are not relevant to regional water management concerns. Difficulties in characterizing flow through diamictons using groundwater flow models further suggest that focused field observations of water levels and age dating of groundwater samples would be the best ways to evaluate the importance of potential errors in texture and thickness of the Tiskilwa Formation.

Ashmore Tongue, Henry Formation

Figures A16 and A17 show two possible distributions of the Ashmore Tongue of the Henry Formation. Figure U16 is an example of a simulation map where the deposit is more continuous and the local variability in thickness is low, similar to the unit's appearance on the published thickness map. Figure U17 shows a map where the deposit is very discontinuous with much more local variability, similar to that found in the thickness values from the well logs.

Figures A18 and A19 provide estimates of where the Ashmore Tongue sands are thicker than 10 or 20 feet, respectively. Figure A20 shows an estimate of where the Ashmore is less than 1 foot thick. A large portion of the Ashmore in the western third and much of the northeastern quarter of the county is estimated as being generally greater than 10 feet thick. Based on the simulation results, only a fraction of these same areas have a greater than 60% chance of being greater than 20 feet thick. The simulations suggest that most of the southern tier of townships and much of the central and southeastern portions of the county have a significant likelihood of being less than 1 foot thick.

The large range in continuity and local variability among the simulation maps suggests a larger uncertainty within this unit than other units. This larger uncertainty is due to a much lower data density than the targeted one point per ¼ mile. The simulation map with the more continuous and less variable distribution (fig. A16) suggests that the majority of the county has no Ashmore sand. The Ashmore within this map is present in larger bodies, generally over 2 square miles in extent, and often much larger. The map showing less continuous and more variable distribution (fig. A17) suggests that a similarly large percentage of the county has no Ashmore, but, when present, the Ashmore is often found in small bodies, generally under 1 square mile in extent, and often much smaller. These two examples suggest very different possibilties for Ashmore continuity that are likely to result in distinctly different groundwater flow characteristics. In addition to the uncertainty in the continuity of the Ashomre, the overall large uncertainty of thickness within the Ashmore may translate into large errors in transmissivity estimates. The uncertainty within the Ashmore can be reduced through targeted field investigations.

Summary

The three-dimensional geologic model predicts the occurrence of geologic lithostratigraphic units. As with any geologic map, it is inevitable that the geologic model contains some errors. Identified sources of errors were (1) unidentified errors in the data, (2) areas with low data density, (3) generalizations in the texture of the lithostratigraphic units, and (4) generalizations in the thickness of each unit. Although it is very difficult to estimate the distribution of these errors and their impact on the accuracy of the resultant geologic model, we have tried to summarize the potential effect of errors from these four sources. In general, the results from the analysis show that the accuracy of the geologic model is sufficient to meet its design goals for use as a county-scale tool for water resource management. Potential errors in the geologic model should be taken into account when using the geologic model as input for a groundwater flow model. Errors related to generalizations of texture and thickness of the Ashmore and sub-Yorkville tongues of the Henry Formation, in particular, may be investigated through the groundwater flow model calibration process. Uncertainties in map units due to low data density and generalizations in thickness can be reduced through targeted field investigations.

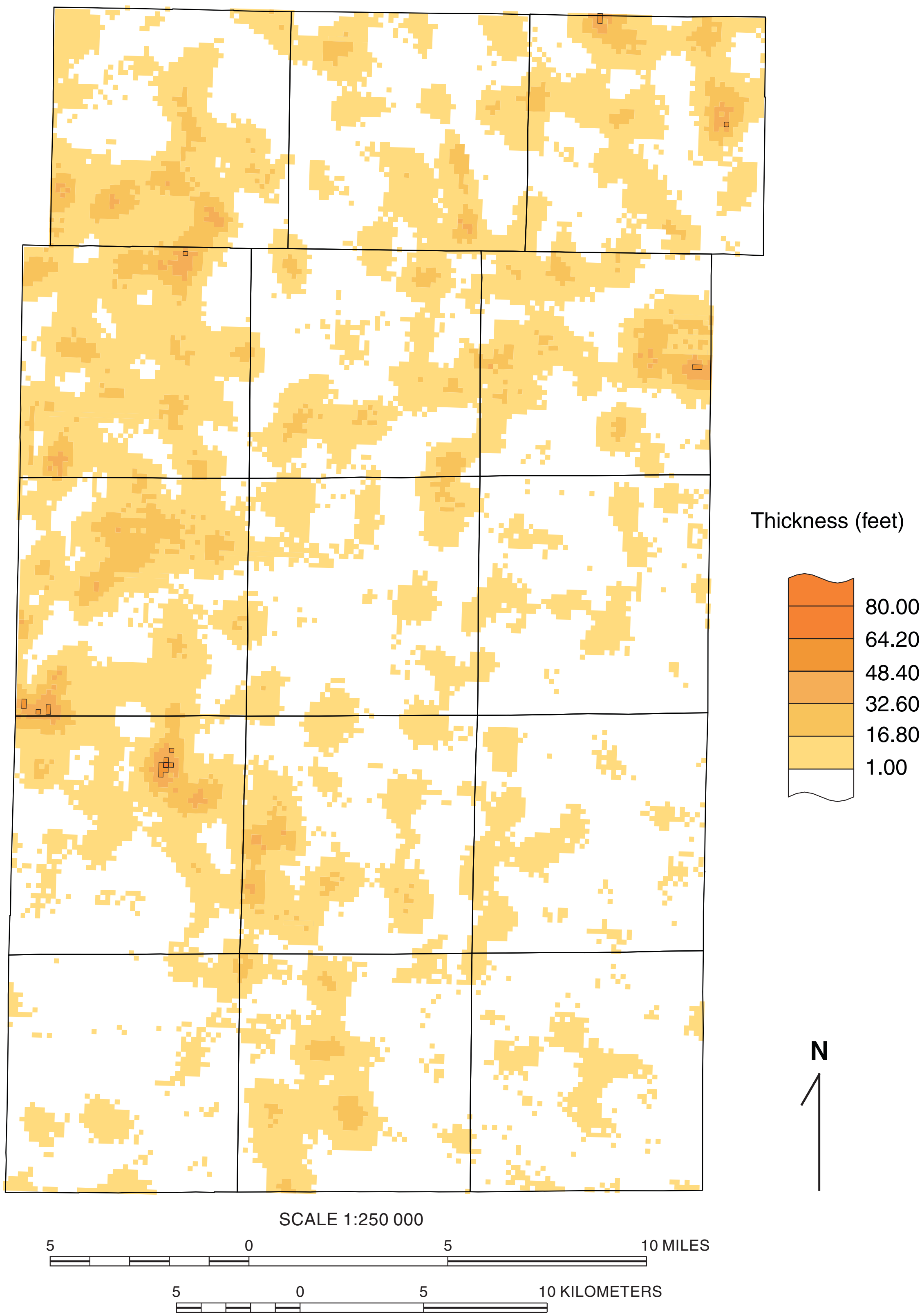


__Figure A16__ Thickness of the Ashmore Tongue of the Henry Formation showing small local variability. This map is the 50th percentile map when Step 1 results are sorted on total thickness.

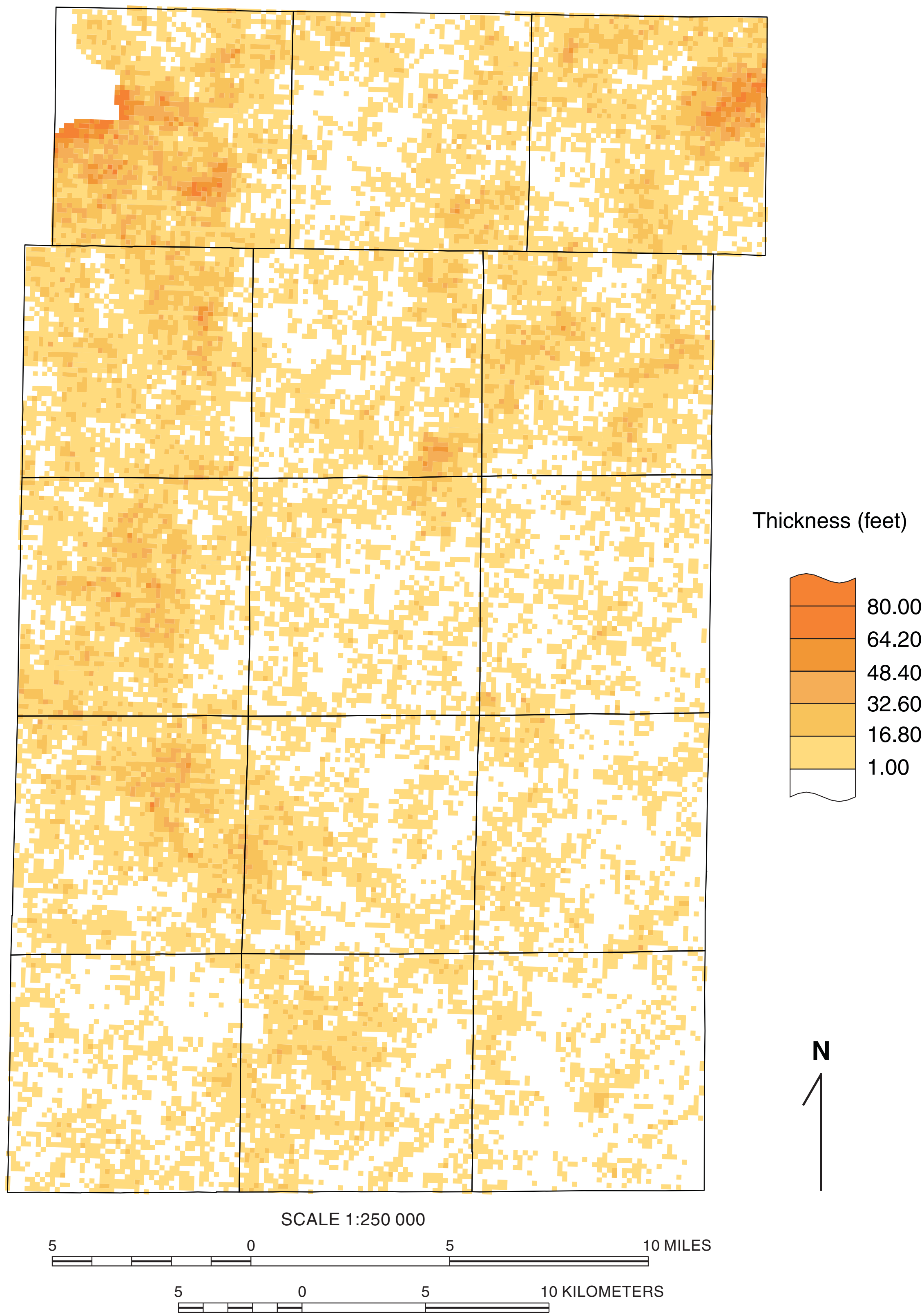


Figure A17 *Thickness of the the Ashmore Tongue of the Henry Formation showing large local variability. This map is the 50th percentile map when Step 2 results are sorted on total thickness.*

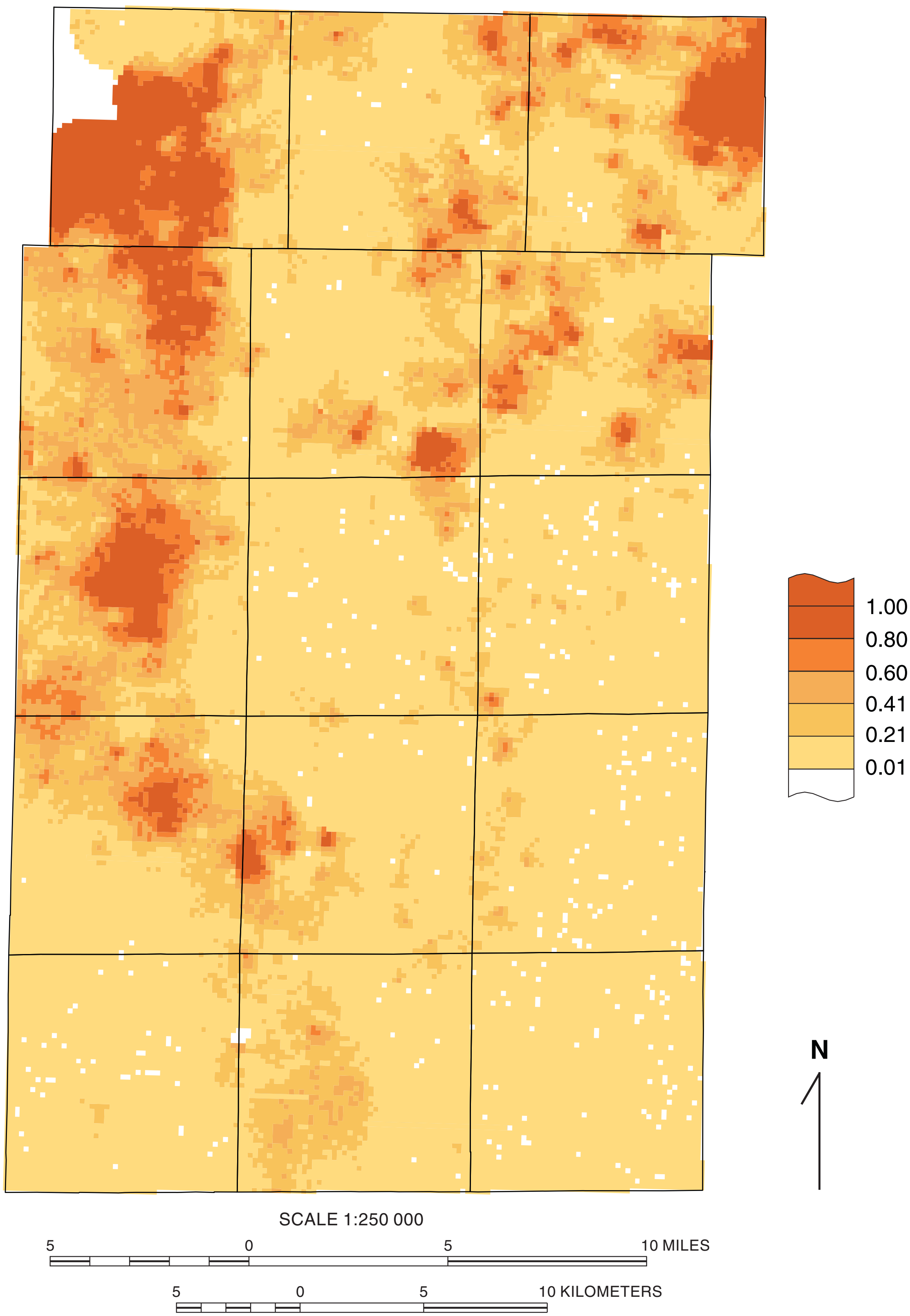


Figure A18 *Probability that the Ashmore Tongue is greater than 10 feet thick. This map was based on the Step 2 simulation results.*

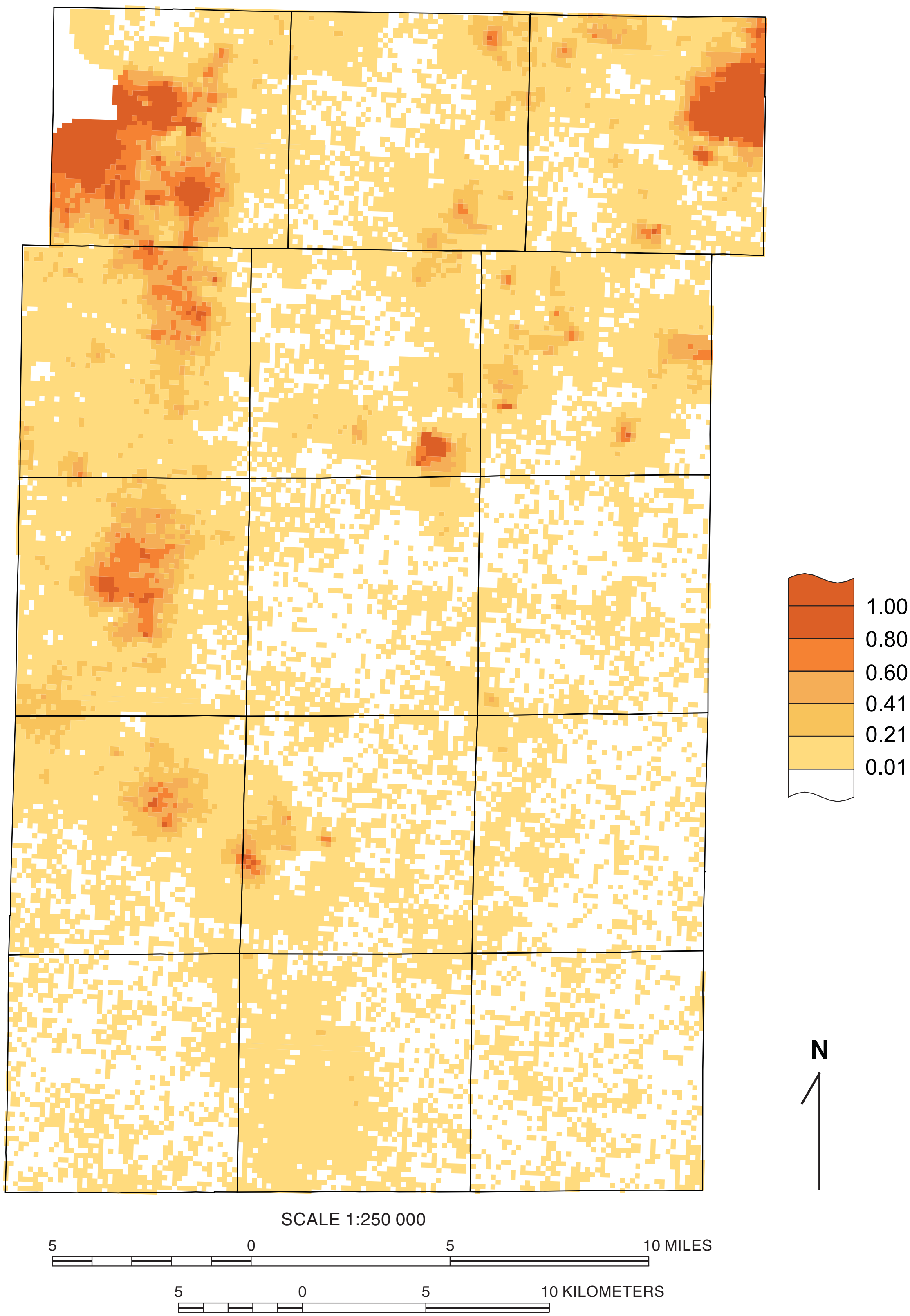


Figure A19 *Probability that the Ashmore Tongue is greater than 20 feet thick. This map was based on the Step 2 simulation results.*

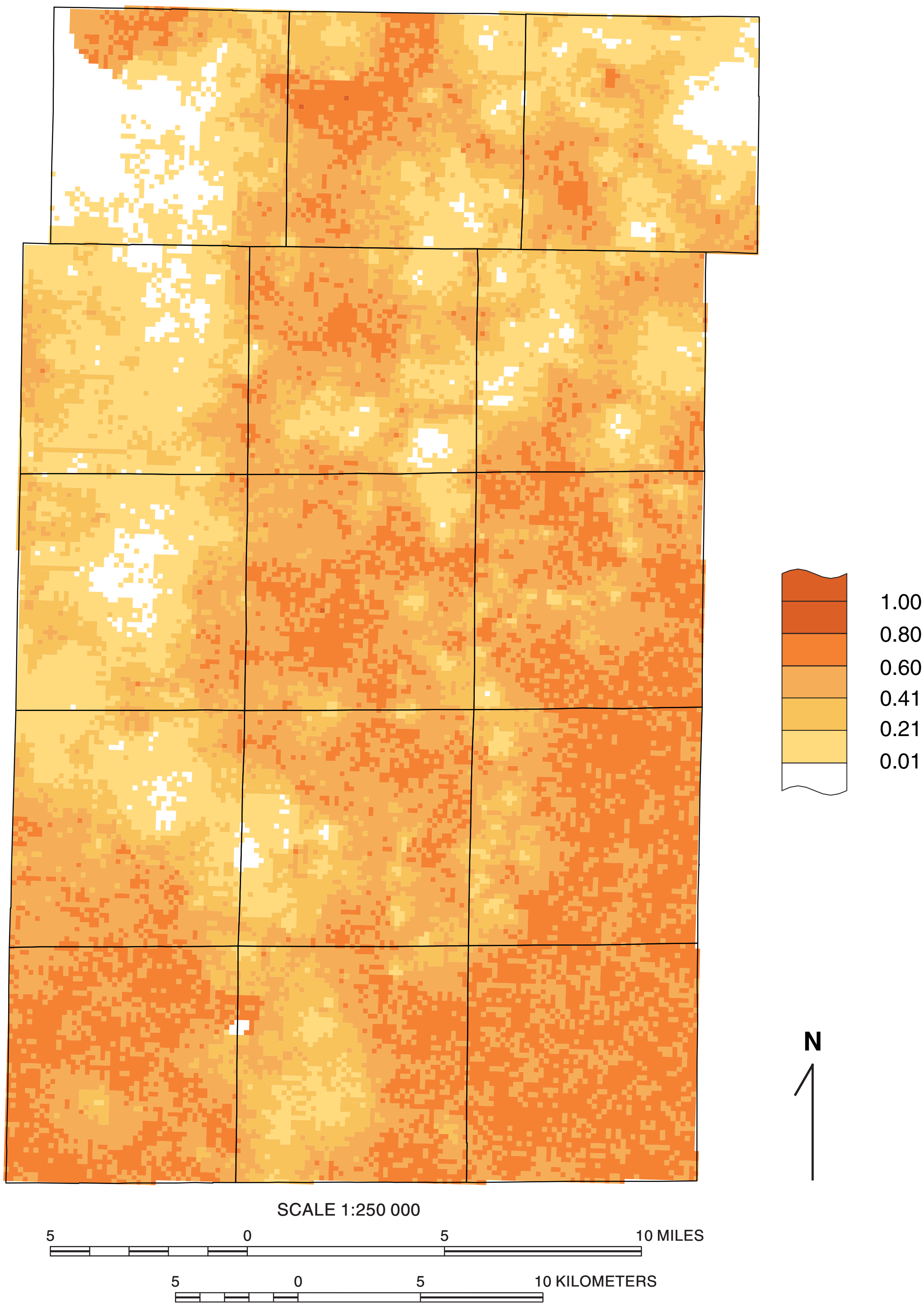
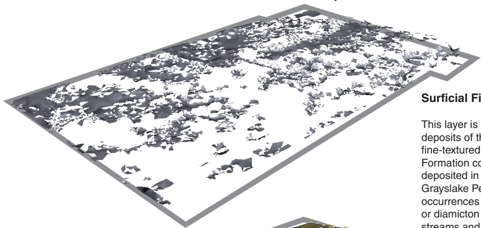


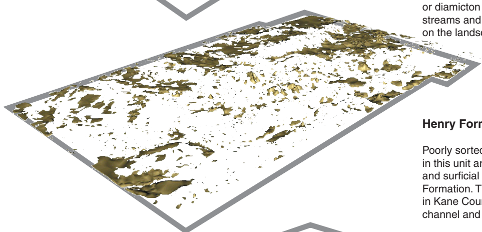
Figure A20 *Probability that the Ashmore Tongue is less than 1 foot thick. This map was based on the Step 2 simulation results.*

APPENDIX A2: THREE-DIMENSIONAL GEOLOGIC MODEL, KANE COUNTY, ILLINOIS



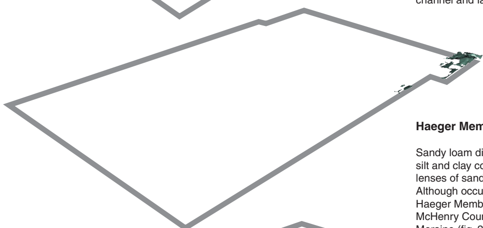
Surficial Fine-textured Layer

This layer is a compilation of the surface and near surface deposits of the Equality Formation, Grayslake Peat and fine-textured facies of the Cahokia Formation. The Equality Formation consists of silt, clay and fine sand that were deposited in lakes under glacial and postglacial conditions. Grayslake Peat consists of peat, marl and sand. Fine-textured occurrences of the Cahokia Formation is composed of silt, clay or diamicton and was deposited by slow moving water along streams and rivers. All three units tend to occupy low lying areas on the landscape and often occur in association in Kane County.



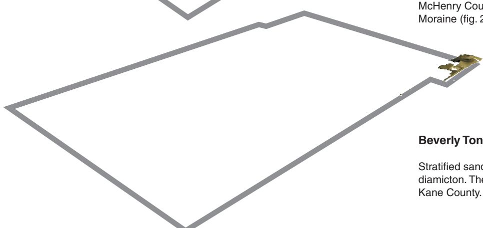
Henry Formation (surficial deposits)

Poorly sorted sand and gravel and well sorted sand, included in this unit are coarse-textured facies of the Cahokia Formation and surficial deposits of the Wasco facies of the Henry Formation. The Surficial Henry Formation is up to 90 feet thick in Kane County and occurs along rivers and streams and as channel and fan deposits in front of moraines.



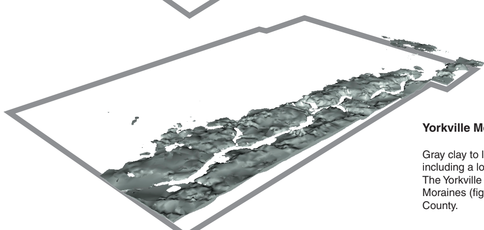
Haeger Member of the Lemont Formation

Sandy loam diamicton (an assorted mixture of gravel, sand, silt and clay commonly called till) with abundant discontinuous lenses of sand and gravel and thin beds of silt and clay. Although occupying a very small part of Kane County, the Haeger Member constitutes much of the surficial diamicton of McHenry County. The Haegar Member forms the Woodstock Moraine (fig. 2).



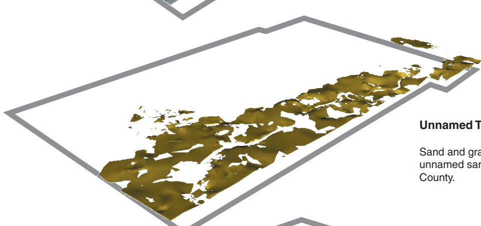
Beverly Tongue of the Henry Formation

Stratified sand and gravel overlain by the Haeger Member diamicton. The Beverly tongue is up to 90 feet thick in Kane County.



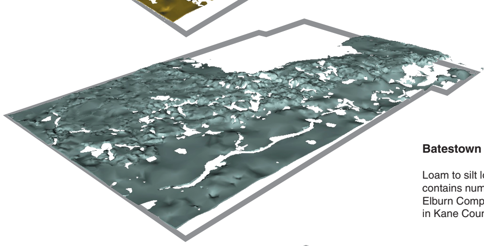
Yorkville Member of the Lemont Formation

Gray clay to loam diamicton. Three textures are recognized, including a lower clay, a middle loam and an upper silty clay. The Yorkville Member forms the St. Charles and Minooka Moraines (fig. 2). The diamicton is up to 100 feet thick in Kane County.



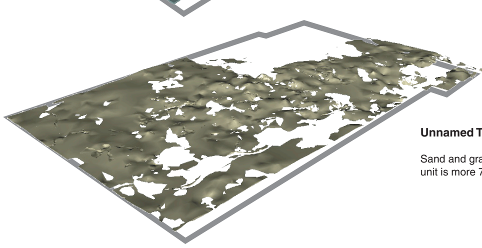
Unnamed Tongue of the Henry Formation

Sand and gravel overlain by the Yorkville Member. This unnamed sand and gravel is up to 50 feet thick in Kane County.



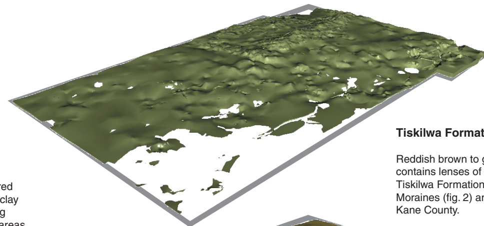
Batestown Member of the Lemont Formation

Loam to silt loam diamicton. The Batestown Member contains numerous beds of sand and gravel and forms the Elburn Complex (fig. 2). The diamicton is up to 90 feet thick in Kane County.



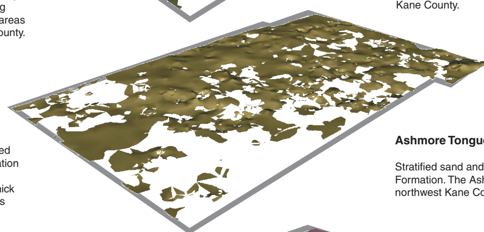
Unnamed Tongue of the Henry Formation

Sand and gravel overlain by the Batestown Member. This unit is more 70 feet thick in parts of Kane County.



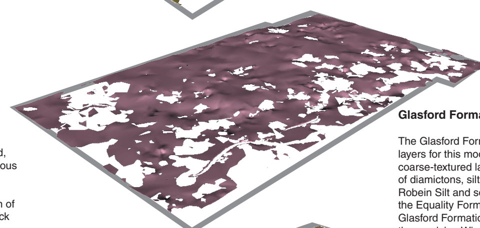
Tiskilwa Formation

Reddish brown to gray clay loam to loam diamicton that contains lenses of gravel, sand silt and clay. The Tiskilwa Formation forms the Bloomington and Marengo Moraines (fig. 2) and is as much as 270 feet thick in Kane County.



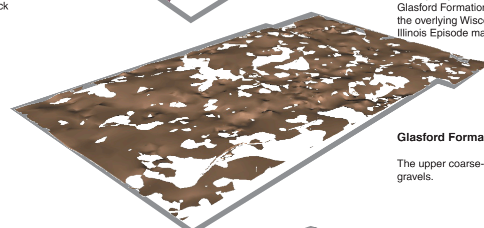
Ashmore Tongue of the Henry Formation

Stratified sand and gravel overlain by the Tiskilwa Formation. The Ashore Tongue is over 80 feet thick in northwest Kane County.



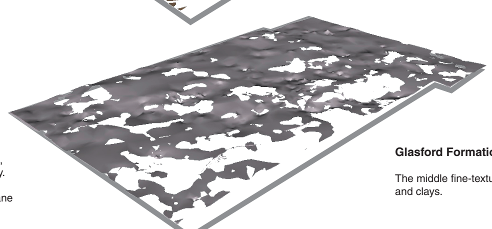
Glasford Formation

The Glasford Formation was separated into 5 hydrogeologic layers for this model, three fine-textured layers and two coarse-textured layers. The upper fine-textured layer is consists of diamictons, silts and clays, it includes occurrences of the Robein Silt and some occurrences of the Peddicord Tongue of the Equality Formation. Though the Robein is younger than the Glasford Formation, it is an important marker bed in delineating the overlying Wisconsin Episode materials from the underlying Illinois Episode materials such as the Glasford Formation.



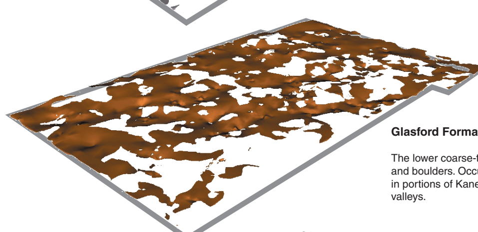
Glasford Formation

The upper coarse-textured layer consists of sands and gravels.



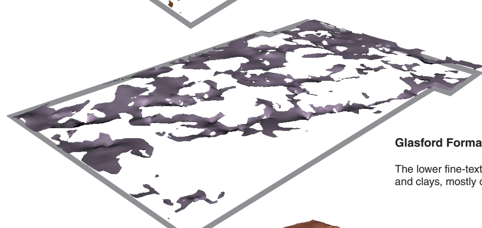
Glasford Formation

The middle fine-textured layer consists of diamictons, silts, and clays.



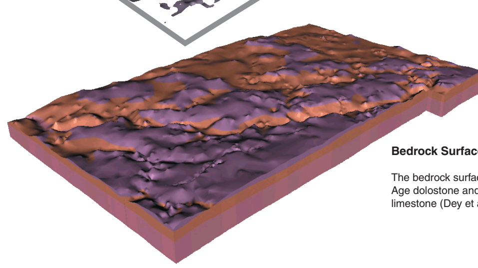
Glasford Formation

The lower coarse-textured layer consists of sands, gravels, and boulders. Occurs as a basal unit in contact with bedrock in portions of Kane County and is thickest in bedrock valleys.



Glasford Formation

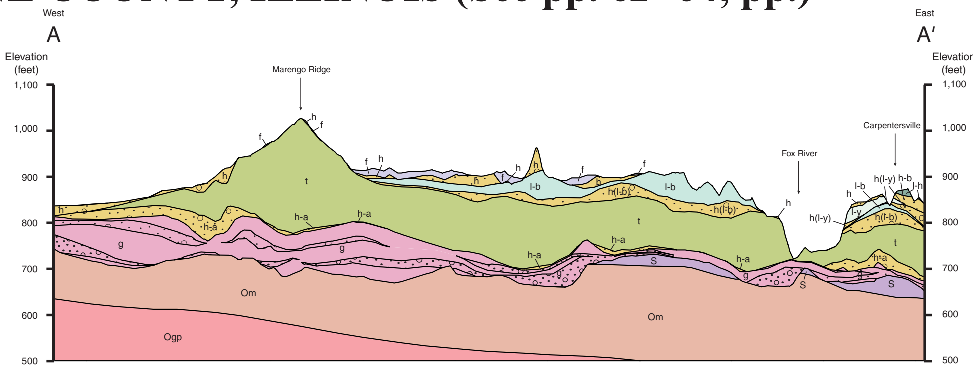
The lower fine-textured layer consists of diamictons, silts, and clays, mostly occurs in the bedrock valleys.

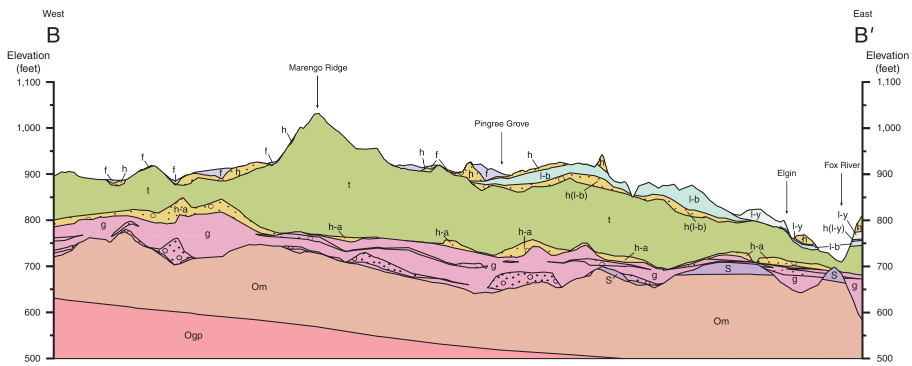


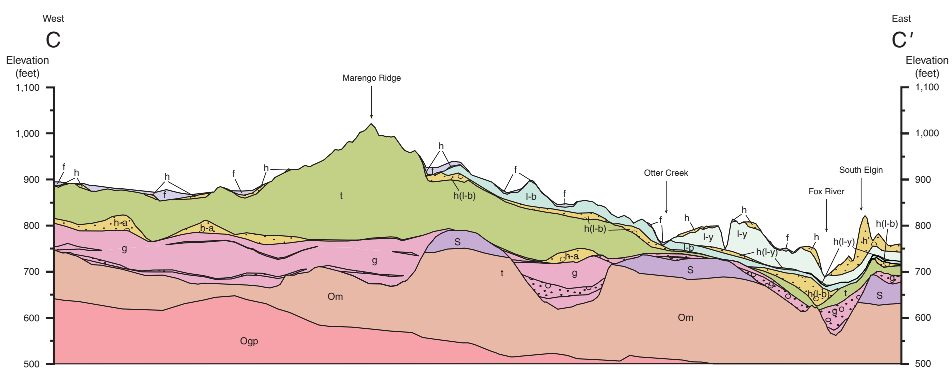
Bedrock Surface

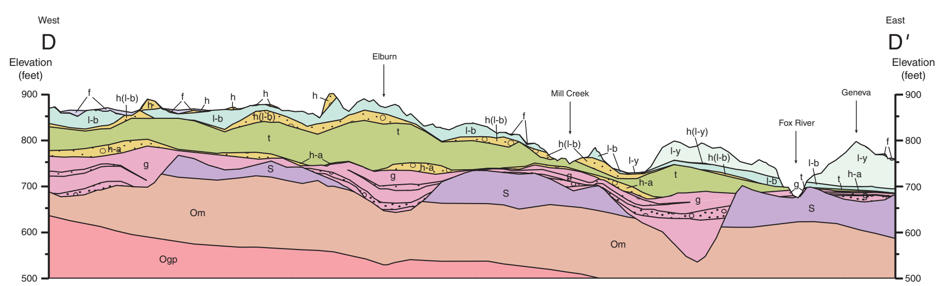
The bedrock surface varies in composition from Silurian Age dolostone and Ordovician Age shale, dolostone and limestone (Dey et al. 2007d).

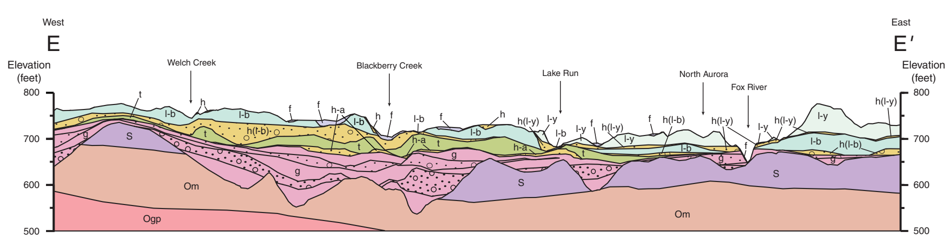
APPENDIX A3: CROSS SECTIONS, KANE COUNTY, ILLINOIS (See pp. 62–64, pp.)

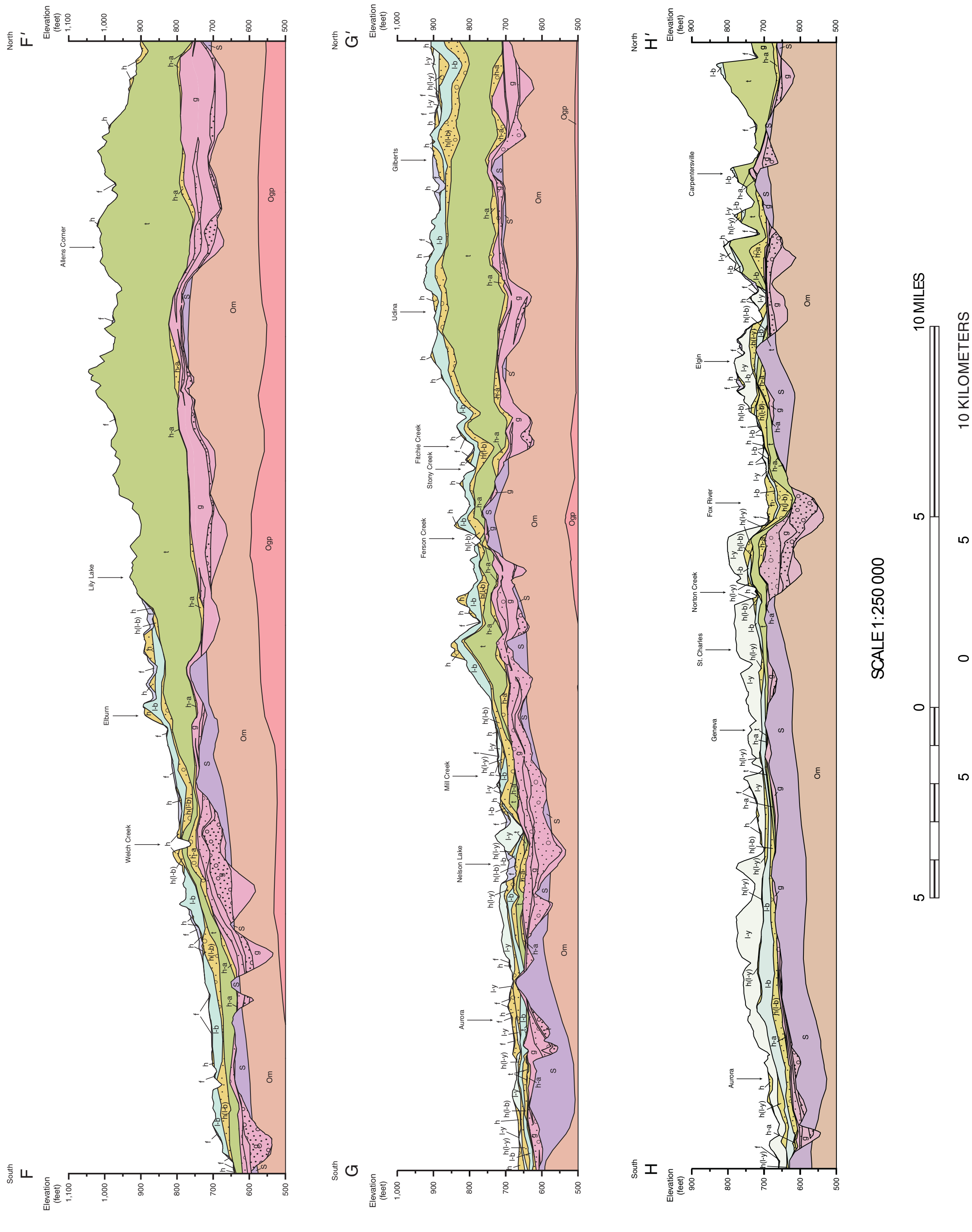




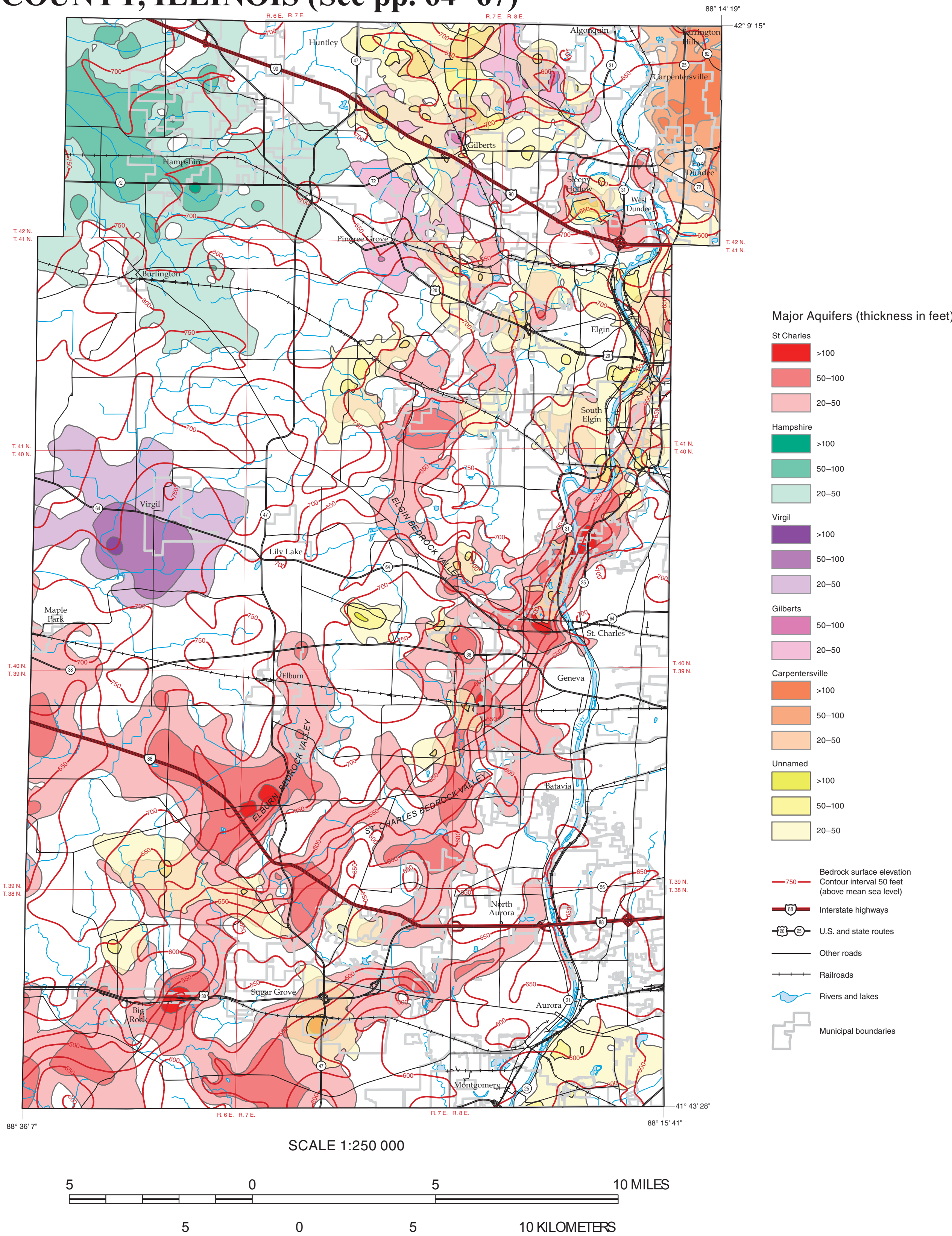




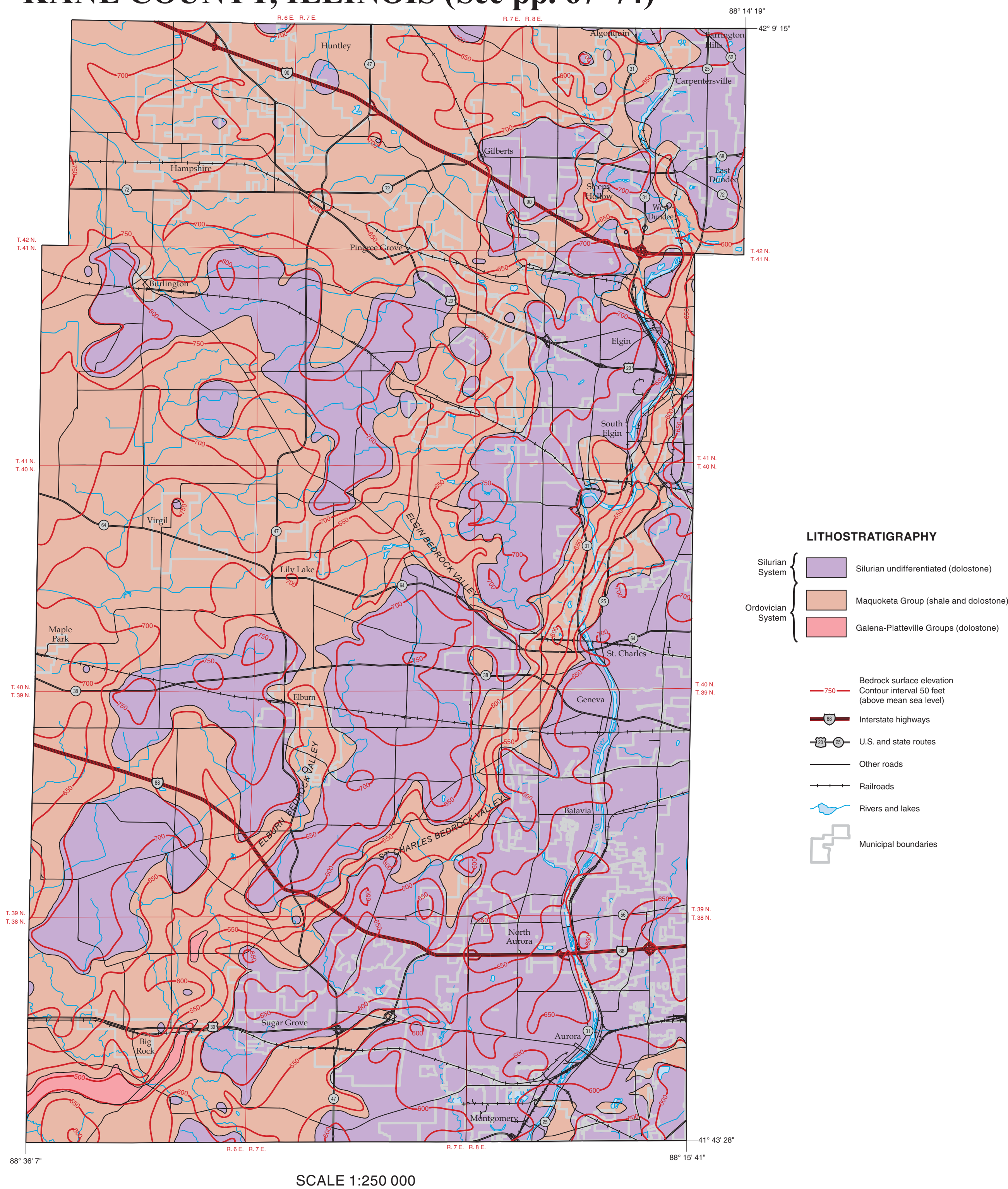



South
F
North
F′
Elevation (feet)
Welch Creek
Elburn
Lily Lake
Allens Corner
South
G
North
G′
Elevation (feet)
Aurora
Nelson Lake
Mill Creek
Ferson Creek
Stony Creek
Fitchie Creek
Udina
Gilberts
South
H
North
H′
Elevation (feet)
Aurora
Geneva
St. Charles
Norton Creek
Fox River
Elgin
Carpentersville
SCALE 1:250 000
10 MILES
10 KILOMETERS

APPENDIX A4: MAJOR QUATERNARY AQUIFERS, KANE COUNTY, ILLINOIS (See pp. 64–67)



APPENDIX A5: BEDROCK GEOLOGY, KANE COUNTY, ILLINOIS (See pp. 67–74)



SCALE 1:250 000

5 0 5 10 MILES

5 0 5 10 KILOMETERS

APPENDIX A6: AQUIFER SENSITIVITY TO CONTAMINATION, KANE COUNTY, ILLINOIS (See pp. 74–77)