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OFS 1996-9

MAPPING THE MAHOMET SAND AND OTHER AQUIFERS OF DE WITT AND PIATT COUNTIES

John P. Kempton
Beverly L. Herzog

PREPARED FOR THE MAHOMET VALLEY WATER AUTHORITY

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Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
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This open file report provides accurate and authoritative information on groundwater geology in the study area. It covers the first phase of an Illinois State Geological Survey project that will continue to collect, study, and interpret data on the region. A more detailed report will be published within 2 years.

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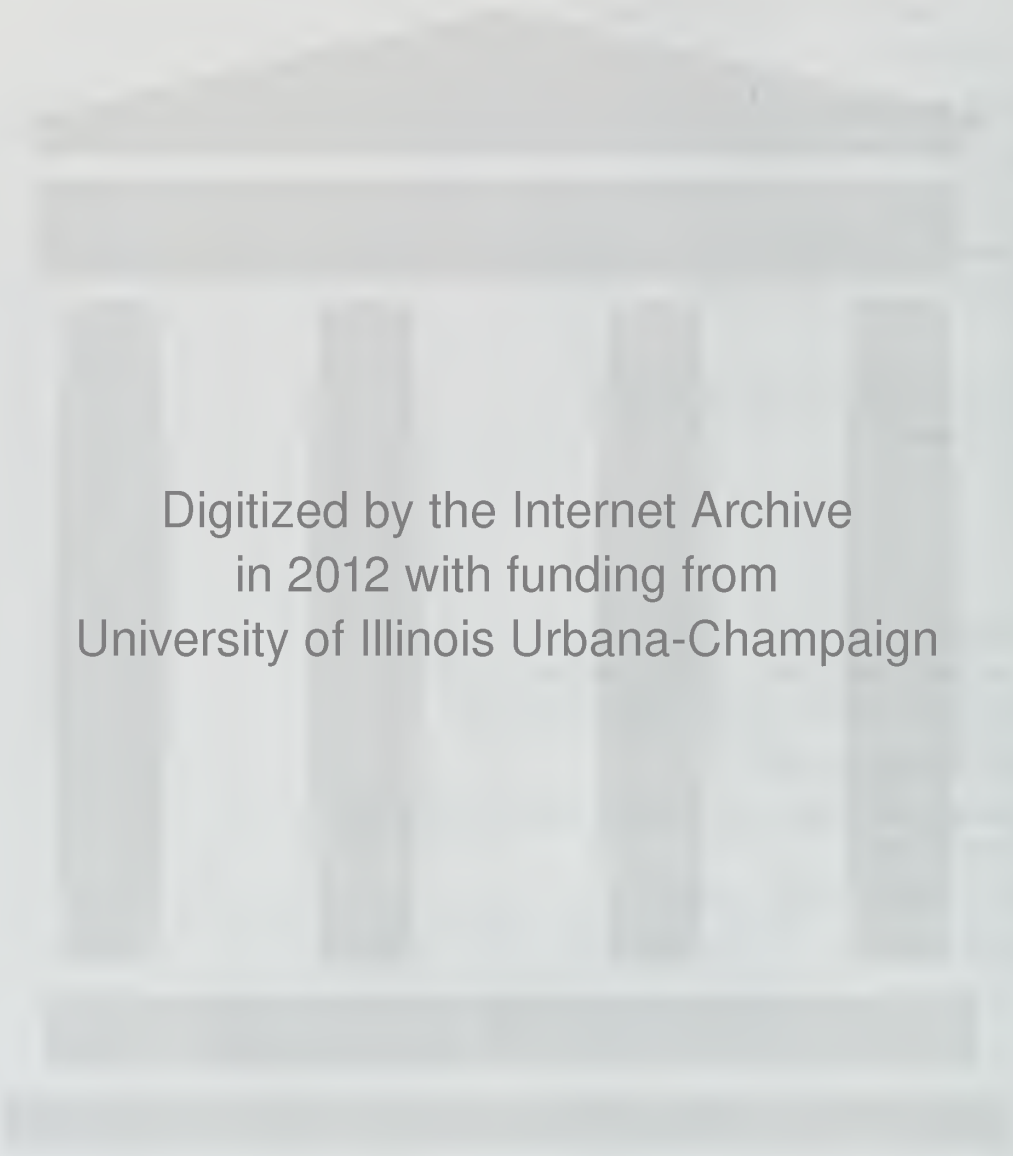
FIGURES



ABSTRACT

Beneath central De Witt and Piatt Counties lies a portion of one of the largest sources of groundwater in Illinois, the Mahomet Sand Aquifer. Additional, shallower groundwater sources are scattered throughout the two-county area. As part of the Mahomet Valley Water Authority's (MVWA) program to understand and successfully manage the groundwater resources in De Witt and Piatt Counties, the MVWA began a cooperative project with the Illinois State Geological Survey (ISGS) in 1994. Their overall goal was to map the distribution and thickness of the aquifers.

The Mahomet Sand Aquifer is understood well enough to know it will meet the near-term water needs of the study area. The distribution of the shallower aquifers is poorly known because the aquifers are discontinuous. For the initial effort to develop preliminary maps and cross sections, the ISGS used 51 stratigraphic control boreholes, 15 sets of samples from boreholes, and approximately 100 of the best drillers' logs for wells in the study area. On the basis on these preliminary maps and cross sections, the MVWA commissioned a comprehensive study that began on January 1, 1996. All available data are being used to update the maps, Geophysical testing is providing additional information on the shallower aquifers in two regions of sparse data.

INTRODUCTION

The sand and gravel aquifers in the sediments formed by continental glaciers in De Witt and Piatt Counties, in particular the Mahomet Sand, have become a focus of attention in the past several years. Interest has arisen because of development by the City of Decatur of an emergency-use well field in the Mahomet Sand and concerns among local residents that increasing use of the aquifer for irrigation and small municipal and commercial water supplies may decrease future groundwater availability for domestic use.

The Mahomet Valley Water Authority (MVWA) has responded to these concerns in De Witt and Piatt Counties by initiating a program to gather information about the aquifers and the consequences of recent and future well field development on water supply potential. A study of the groundwater levels in the area, performed by the Illinois State Water Survey, with support from the MVWA in 1993, provided information on the direction of groundwater flow and, more importantly, provided baseline data on groundwater levels so that future changes can be quantified (Anliker and Sanderson 1995).

Funding of the geologic portion of this study was proposed by the MVWA in 1994 to expand upon the three-dimensional geologic mapping of the Champaign 1:100,000-scale quadrangle—a cooperative project of the Illinois State Geological Survey (ISGS) and the U.S. Geological Survey (USGS). De Witt County and all except the southern tier of townships in Piatt County are included in the larger quadrangle study. In particular, the MVWA wanted customized mapping of the aquifer and nonaquifer units to help them manage water resources. This report presents the results of the project undertaken by the ISGS with partial support from the MVWA. Large-scale versions of the maps were also produced for use by the MVWA.

GEOLOGIC FRAMEWORK

Background

The present landscape of De Witt, Piatt, and northern Macon Counties reflects (1) depositional processes and landforms left by the last continental glacier to cover the area, (2) erosion by rivers that carried glacial meltwater and carved valleys into the glacial deposits (now the present drainageways), and (3) other more recent depositional, weathering, and erosional processes, especially those of water and wind (e.g., loess formation, formation of modern soils, and stream erosion and deposition).

Below the uppermost deposits visible at the land surface is a thick sequence of glacial sediments. Most of these glacial sediments were deposited (1) directly from the melting glaciers as a mixture of unsorted gravel, sand, silt, and clay (till), (2) as sorted sand and gravel (outwash) from meltwater streams gushing from beneath the glaciers, or (3) as finer (lacustrine) sediments in backwaters of the main valley and in lakes ponded because of dams formed by sediment or ice debris. Also buried within the glacial sediments are layers of ancient soils, rich in organic matter like modern soils, that mark periods when the surfaces of older glacial sediments were weathered and plants grew on them. This sequence of glacial deposits rests on an eroded bedrock surface of valleys and uplands formed long before the first of the many continental glaciers covered the area.

Several recent studies provide good descriptions of this geologic history, the pertinent geologic units, and the general geologic setting in part or all of the area of interest to the MVWA. These include reports by Herzog et al. (1995), Wilson, Kempton, and Lott (1994), Kempton and Visocky (1992), Kempton et al. (1991), Kempton, Morse, and Visocky (1982), and Hunt and Kempton (1977). The recent report by Wilson, Kempton, and Lott (1994), although not covering the area directly, described the conditions just beyond the northwest edge of De Witt County and provided some new insights on the distribution and character of the Mahomet Sand as an aquifer in northwestern De Witt County. The work of Herzog et al. (1995) added great detail for southwestern McLean County and Tazewell County, adjacent to the northwest corner of De Witt County. Panno et al. (1994) described the hydrochemistry of the groundwater in the Mahomet Sand Aquifer. This recent work has contributed to our growing knowledge and understanding of the bedrock surface and the sequence of glacial sediments that overlie that surface.

This report covers all of De Witt and Piatt Counties and immediately adjacent areas of Macon County to the south, all of which are underlain by the Mahomet Sand. Work maps included an additional buffer area of about one township (6 miles) to improve map accuracy at the edges of the study area. The maps are based primarily on 51 stratigraphic control boreholes used for the Champaign Quadrangle project. These data were supplemented by the study of sample sets from 15 boreholes and approximately 100 of the best drillers' logs for wells in the study area.

Sequence and Distribution of Glacial Deposits

The bedrock topography map (fig. 1) shows the current interpretation of the shape and elevation of the bedrock surface, on the basis of data available at the start of this project. The bedrock surface and its geologic history is described in most of the previously cited reports. On the bedrock surface are two major features: an upland area and a major bedrock valley. The bedrock uplands generally range in elevation from 500 to more than 600 feet above mean sea level. Eroded into these uplands is a major bedrock valley, the Mahomet Bedrock Valley, which underlies the center of Piatt County and trends from southeast to northwest beneath De Witt County. Alongside the main valley, a tributary channel called the Kenney Valley, trends northwest under southwestern De Witt County.

Smaller tributary valleys join the main valley from the bedrock uplands from the south and northeast. The deepest part of the main bedrock valley lies below an elevation of 350 feet, but probably not much lower. The few available data from wells indicate that the deepest part of the Kenney Valley is no lower than 400 feet.

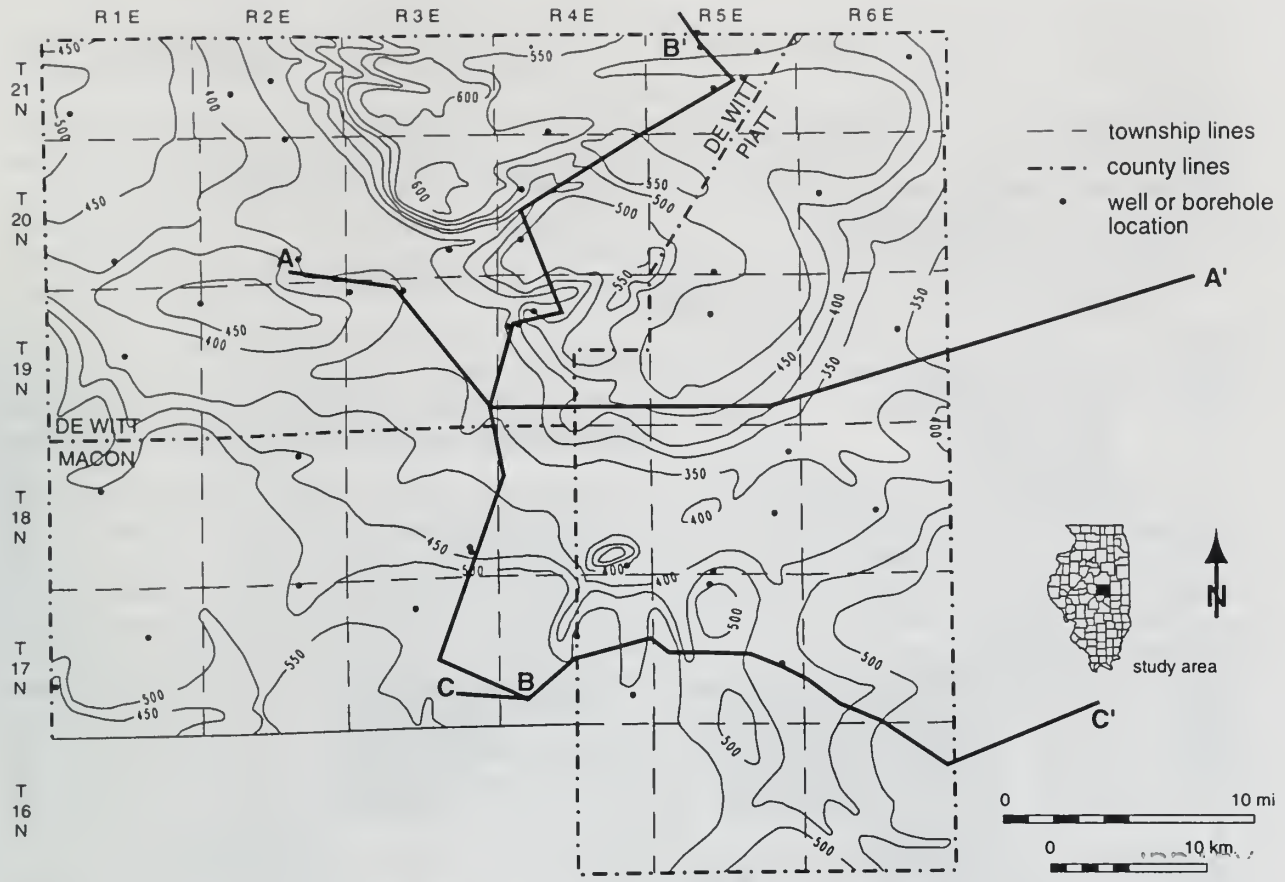


Figure 1 Bedrock topography and lines of cross section.

Principal Glacial Deposits

A relatively thick and generally complex sequence of glacial and related sediments (fig. 2), locally thicker than 400 feet, covers the bedrock of De Witt and Piatt Counties. The shape of the bedrock surface (fig. 1) has influenced, to a significant extent, both the type and distribution of glacial sediments, especially those in the lower part of the glacial sequence. This influence is shown in the three cross sections in figure 3. The glacial and related deposits are identified, separated, and classified in three principal ways: (1) by their physical characteristics of grain size, color, and position (lithostratigraphy), with specific names assigned to the most significant, extensive, and recognizable units; (2) by periods of time during which the materials were deposited (e.g., pre-Illinois, Illinois, or Wisconsin Episodes of glaciation); and (3) by number of buried weathered surfaces, referred to as paleosols. The major paleosols, which suggest long times between episodes of glaciation, can be used to separate the various deposits into bundles, with the deposits within each bundle subdivided in more detail.

In De Witt, Piatt, and northern Macon Counties, the deposits can be grouped into three bundles: the Banner Formation (oldest), the Glasford Formation, and the Wedron and Mason Groups (youngest). These deposits are separated locally by well developed paleosols with organic horizons (Yarmouth and Sangamon soils). Other features and relationships (such as similar mineral constituents or similar sequences) are also used to identify or trace the formations, tie the formations together, and directly trace units whose characteristics change (e.g., a sand and gravel layer that changes laterally to silty sand, silt, and clay).

Banner Formation This lowermost bundle of units contains several distinct lithologies. It is bounded at the bottom by the bedrock surface and at the top by organic deposits of the Yarmouth Soil (where present) or younger Glasford Formation deposits. For the Champaign Quadrangle study, a map of the elevation

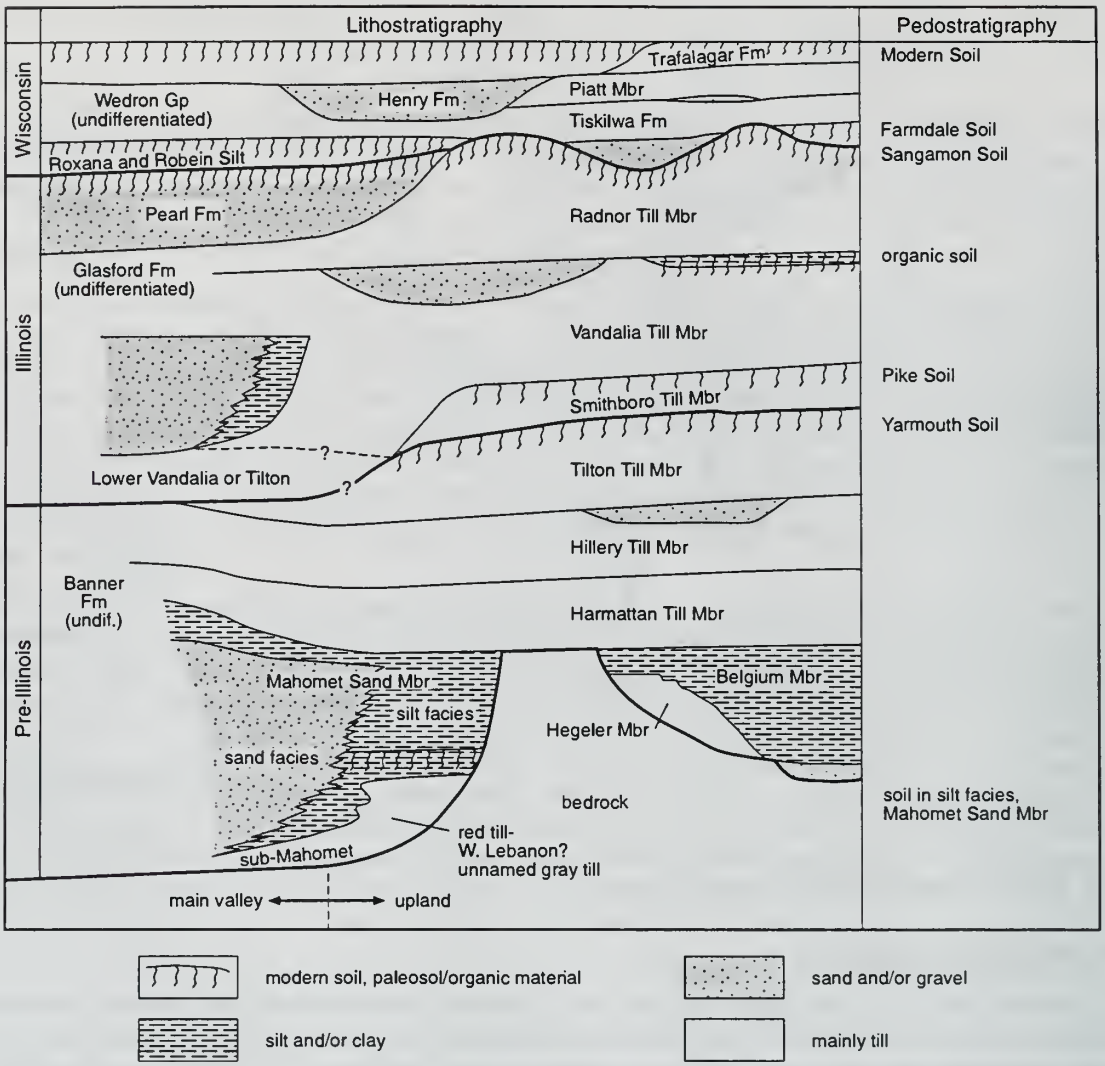


Figure 2 Sequence of glacial deposits in east-central Illinois (modified from Kempton et al. 1991).

of the top of the Banner Formation was prepared to aid in separating the Banner Formation from the Glasford Formation where drillers' logs showed no distinction between them. The cross sections (fig. 3) represent the sequence of units (including those in the Banner Formation) in various parts of De Witt and Piatt Counties.

Three units are present within the Banner Formation: (1) the Mahomet Sand Member, a thick river-deposited sand or sand and gravel deposit that fills the lowermost part of the Mahomet Bedrock Valley, (2) a clayey silt to silty sand lake (lacustrine) sediment that caps the Mahomet Sand or is gradational to it along the valley walls or in tributary valleys, and (3) a sequence of glacial tills that marks the top of the Banner Formation, in which lies a locally significant sand and gravel deposit (fig. 3c). Within the Mahomet Bedrock Valley, the Banner Formation reaches a maximum thickness of about 200 feet. The Mahomet Sand is locally thicker than 150 feet, but it becomes thinner toward the bedrock valley walls (fig. 4). The top of the Mahomet Sand generally decreases in elevation from east to west in the downstream direction along the ancient valley. The top is more than 550 feet above mean sea level in northeast Piatt County and less than 475 feet in northwest De Witt County (fig. 5). Older deposits, primarily lacustrine silty sands and glacial tills, are found below the Mahomet Sand where the sands pinch out and limit its thickness to the east and particularly to the northwest of the study area. Whether older deposits also occur in the

Mahomet Valley in northwestern De Witt County is uncertain because data are limited on the lower part of the Mahomet Sand there.

Glasford Formation This middle bundle of deposits (figs. 2 and 3) lies above the Banner Formation and below the Wedron Group. Throughout the area, the Glasford Formation is about 100 feet thick. Although composed predominantly of two glacial tills (Vandalia and Radnor), the Glasford Formation also contains some locally significant sand and gravel deposits (fig. 6) that generally lie at the bases of the till units. The top of the Glasford Formation is marked by a remarkably persistent paleosol (Sangamon) and a black organic silt (Robein), which is recorded in at least half of the well logs and sample sets from the area.

The sand and gravel deposits are primarily found at two positions within the Glasford Formation: at the base of the Vandalia and between the Vandalia and the overlying Radnor. In northern De Witt County, the sand and gravel may separate two parts of the Radnor (fig. 3c). Some local, elongated, stream-deposited sand and gravel deposits also occur at the top of the Radnor.

Wedron and Mason Groups The Wedron Group, the unit commonly present at the land surface throughout most of De Witt and Piatt Counties (figs. 2 and 3), directly overlies the Glasford Formation, Sangamon Soil, or Robein Silt. The Wedron Group consists principally of glacial till; only limited sand and gravel deposits are found within the group, mostly at the base (figs. 2 and 3). The thickness of the Wedron Group is quite variable (fig. 3); it ranges from just a few feet up to about 100 feet thick and averages close to 50 feet. Although the undifferentiated Tiskilwa Formation (fig. 2) predominates within the Wedron Group, the Piatt Member of the Tiskilwa is present locally. Thin lenses of sand and gravel can be found locally between the main body of the Tiskilwa and the Piatt members. In a few places, a thin sand and gravel is also found at the base of the Wedron Group. Up to 7 feet of windblown silt (Peoria Silt, fig. 2) caps the till. The outer margin of the Wedron Group lies along a northwest to southeast line across the western part of De Witt County. A detailed map and discussion of that area can be found in Hunt and Kempton (1977).

Sand and gravel, the Henry Formation of the Mason Group (fig. 2), is locally present along the principal streams of the area (Kickapoo and Salt Creeks and Sangamon River) and along the outer margin of the Wedron Group in western De Witt County. Although generally thin and restricted in distribution, these sand and gravel deposits may locally reach a thickness of 60 feet. Data from control boreholes are insufficient to map the Henry Formation.

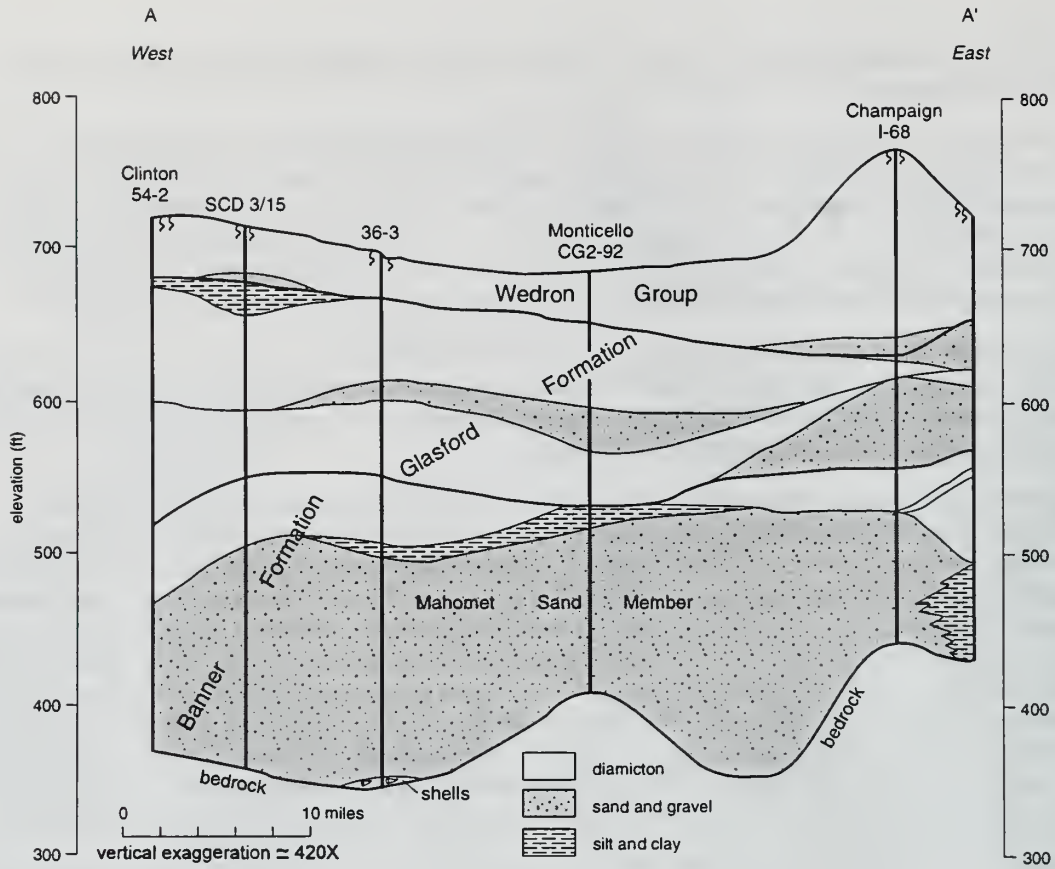
Geologic Units as Aquifers

All geologic units will store and transmit water depending on the physical properties of the material. For example, clay can hold but will not transmit much water; whereas sand and gravel will hold and transmit a lot of water. An aquifer is a unit of earth materials that is saturated with water and sufficiently permeable to provide a steady supply of groundwater sufficient for an intended use. The amount of water available from an aquifer during a given period depends on (1) the rate at which the earth materials transmit water, (2) the size of the aquifer, (3) whether the aquifer is confined or unconfined, and (4) the amount and rate of water recharge or discharge from the aquifer.

Aquifers are bounded on the bottom by aquitards—confining units consisting primarily of glacial tills or fine textured lacustrine materials through which water moves very slowly. Confined aquifers, which include all those in the study area, are also bounded on the top by aquitards. Water in these aquifers is under pressure so that water in a well will rise above the top of the aquifer.

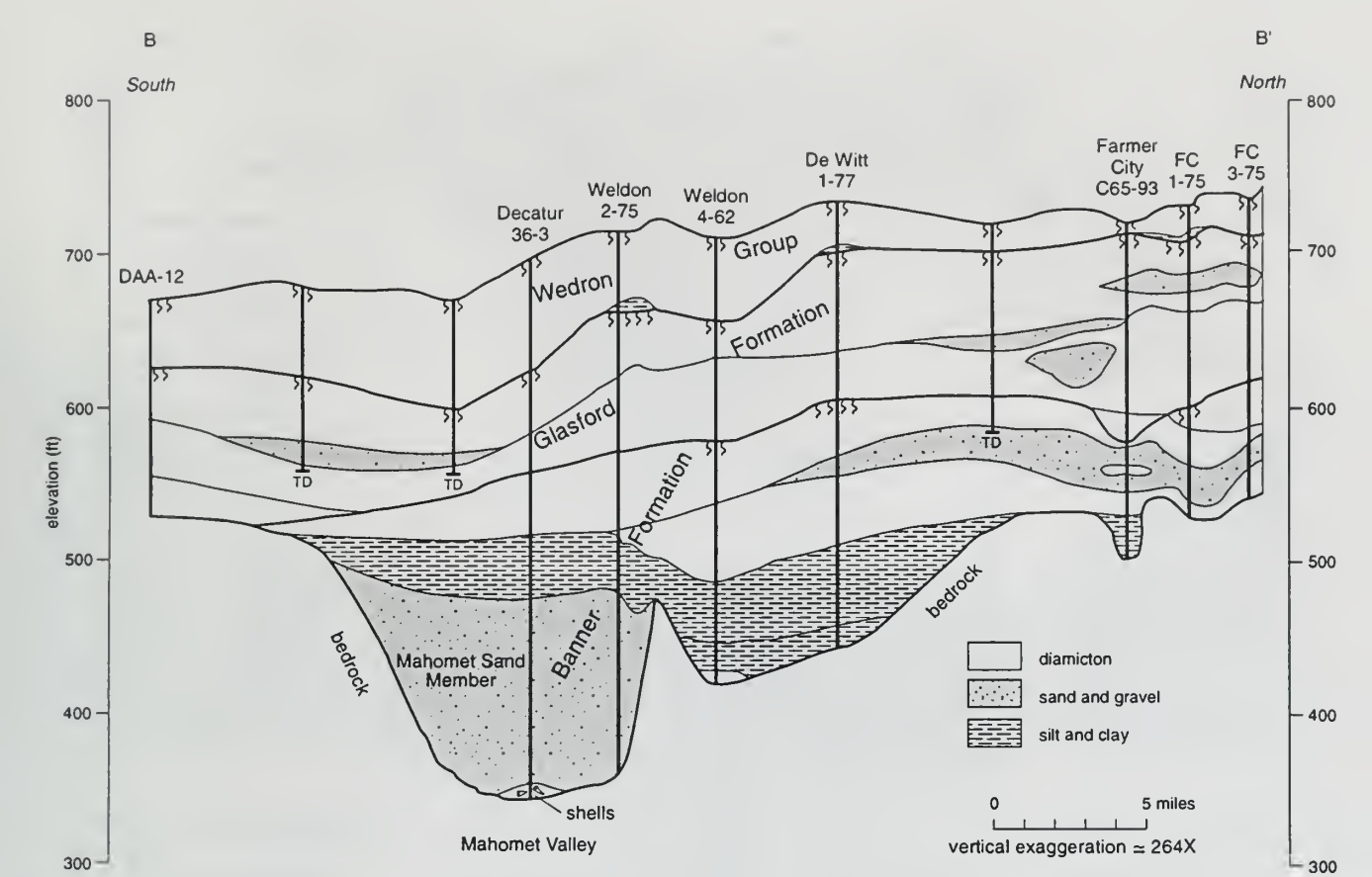
AQUIFERS IN THE STUDY REGION

The main aquifers of the area have been described and generally characterized in the various reports referred to previously. This report discusses the maps developed on the basis of the best available data specifically for this project, and notes some insights that were gained from the concurrent Champaign Quadrangle study and can be applied to De Witt and Piatt Counties. These maps and insights should help interpret the additional data that will be incorporated into future, more detailed maps.



3a

Figure 3 Cross sections of the glacial deposits of east-central Illinois. Drill holes are designated by identification numbers from ISGS files. (**a**) A–A', generalized west-east cross section from Clinton to Champaign. (**b**) B–B', generalized south-north cross section from south of Argenta to the McLean County border. (**c**) C–C', generalized west-east cross section from south of Argenta to west of Pesotum, approximately along the boundary between T16N and T17N.


B
B'
South
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700
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elevation (ft)
DAA-12
Decatur 36-3
Weldon 2-75
Weldon 4-62
De Witt 1-77
Farmer City C65-93
FC 1-75
FC 3-75
Wedron Group Formation
Glasford Formation
Mahomet Sand Member
Banner Formation
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sand and gravel
silt and clay
0
5 miles
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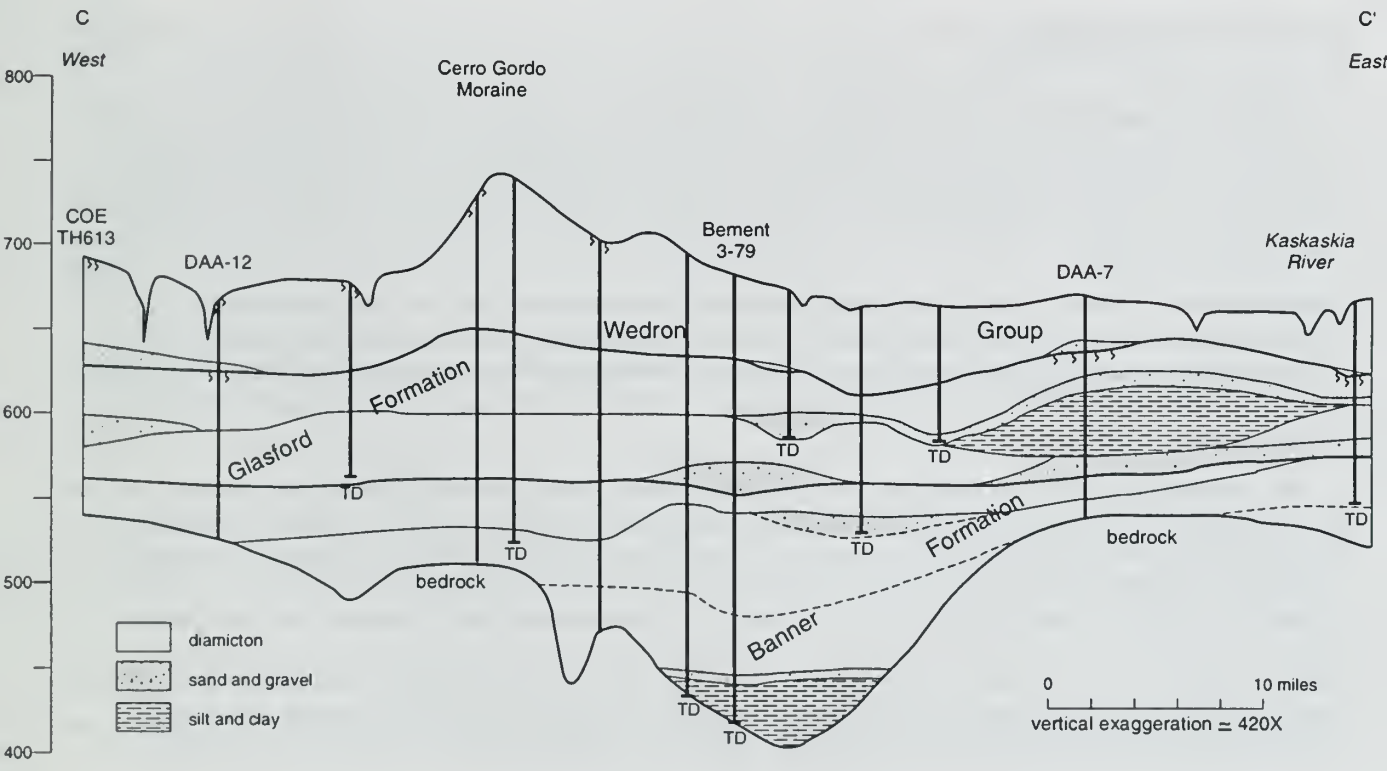
3b


C
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DAA-7
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Wedron Group Formation
Glasford Formation
Banner Formation
bedrock
TD
diamicton
sand and gravel
silt and clay
0
10 miles
vertical exaggeration ≃ 420X

c

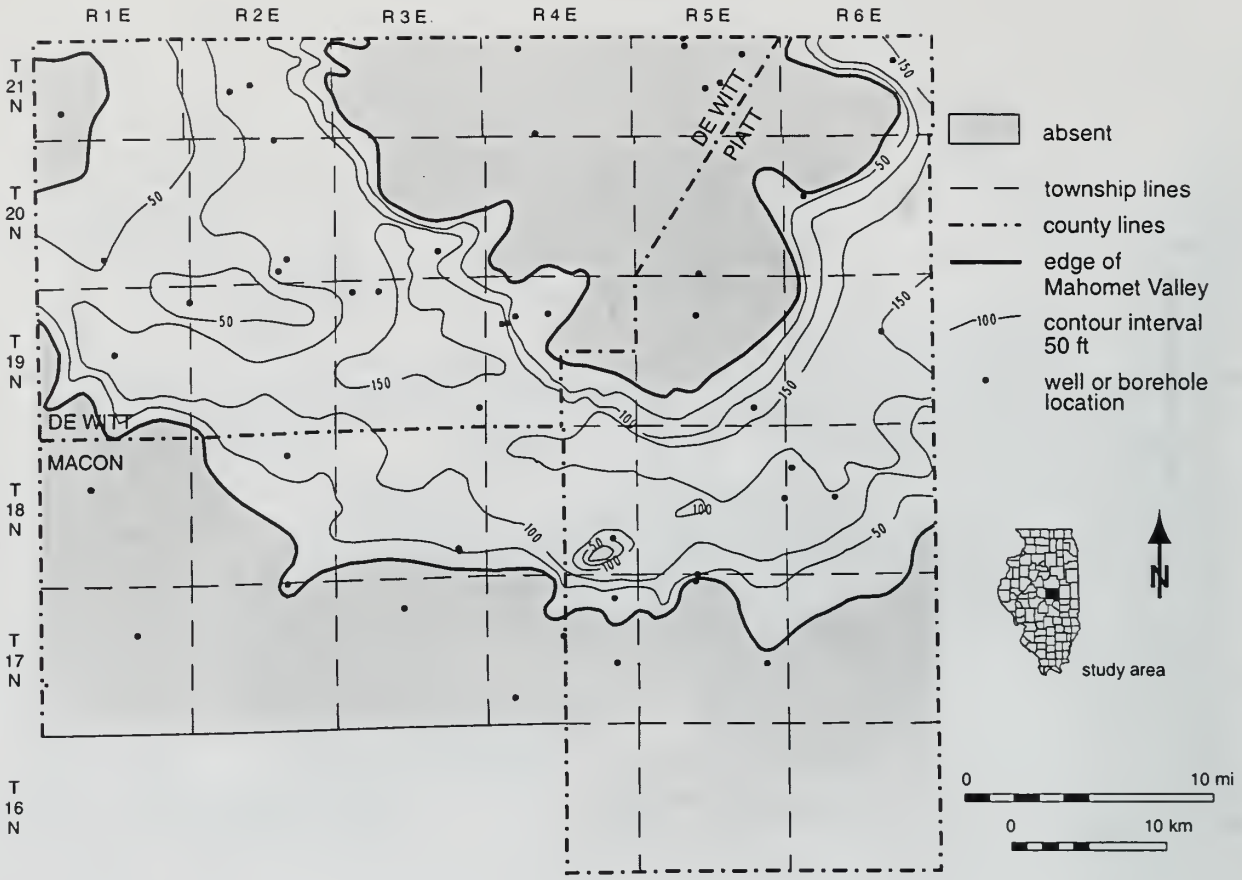

Figure 4 Thickness of the Mahomet Sand.

Mahomet Sand Aquifer

Four aspects of the current maps and information regarding the Mahomet Sand Aquifer and an associated Banner Formation aquifer are addressed: (1) the significance of the bedrock topography as the base and side boundaries of the Mahomet Sand Aquifer, (2) the regional and local changes in the hydrogeologic properties of the Mahomet Sand Aquifer, (3) the potential for the occurrence of local sub-Mahomet Sand deposits, and (4) the local presence of an aquifer between the tills in the Banner Formation above the Mahomet Sand Aquifer.

The topography of the bedrock surface limits the thickness and lateral distribution of the Mahomet Sand Aquifer and its associated deposits. As additional data are incorporated into the study, details of the bedrock topography map will necessarily change. Therefore, the maps of the thickness of the Mahomet Sand (fig. 4), the top of the Mahomet Sand, and the boundaries of the upland Banner Formation aquifers (fig. 5) are also expected to change.

As new data and the well log data recently computerized for this study are interpreted, three features of the existing maps will be revised: (1) the elevation of the top surface of the aquifer, (2) the separation of the finer textured sediments at the top and along the sides, and (3) the character of the aquifer vertically and along the length of the aquifer. Only recently has a somewhat systematic examination been made of vertical and lateral changes in the grain-size distribution of the Mahomet Sand Member; it is now recognized that significant finer textured phases may function more as aquitards than as part of the aquifer. There is also increasing evidence that the grain size of the Mahomet Sand Aquifer decreases in the downstream segment of the Mahomet Valley, near its confluence with the Ancient Mississippi Bedrock Valley (Mackinaw segment) in southwestern McLean County. It is also clear in figure 4 that the top elevation of

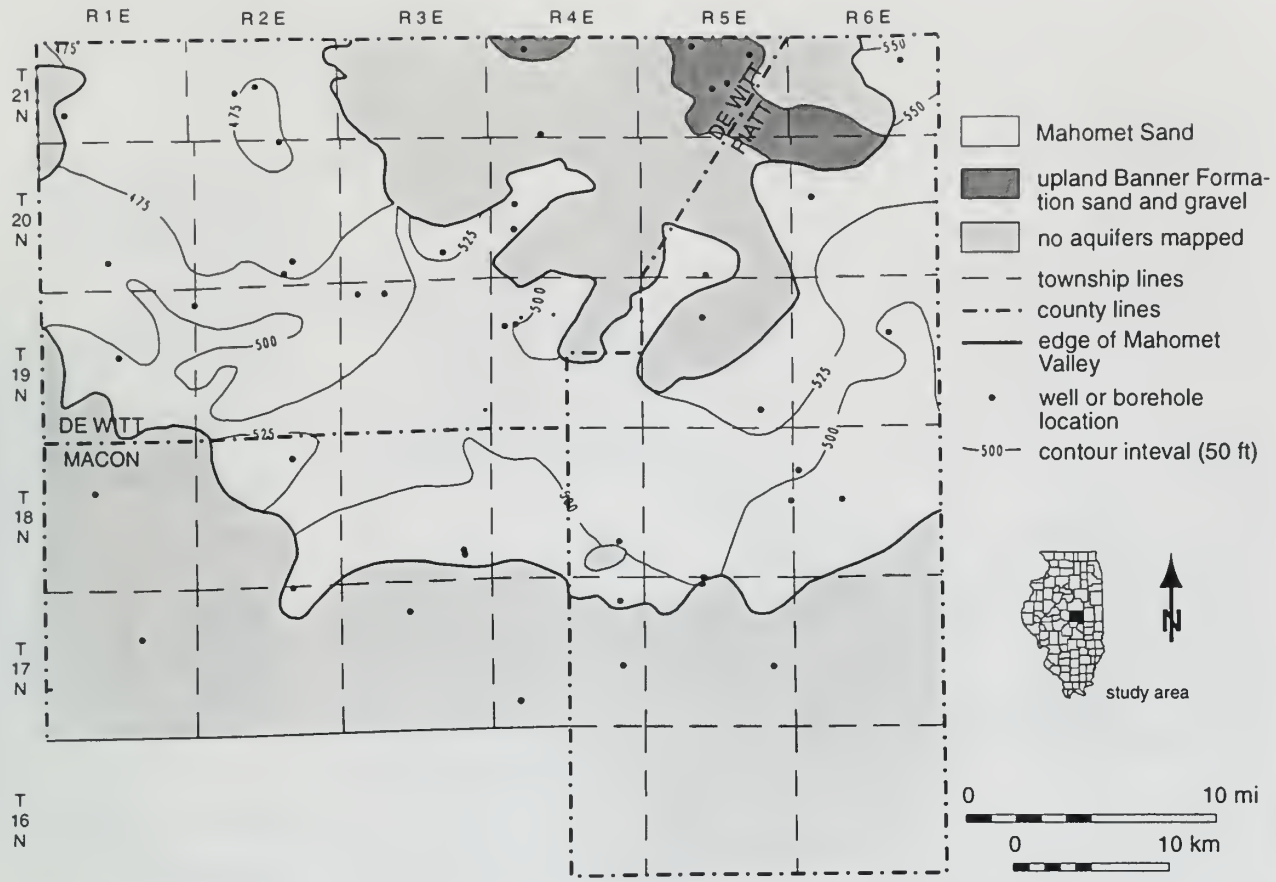

Figure 5 Elevation of the top of the Mahomet Sand and location of the upland Banner Formation aquifer.

the Mahomet Sand is lowest in northwestern De Witt County. All areas shown as less than 50 feet thick on figure 5 may be too fine grained to produce more than 10 to 20 gallons of water per minute.

Throughout the Mahomet Valley, from Paxton in Ford County to the confluence with the Mackinaw Bedrock Valley, older tills, lake deposits, and possibly other sediments occur below the Mahomet Sand Aquifer. At the Village of McLean in southwestern McLean County, a complex sequence of silty sands, silts, and some sand and gravel occurs at the stratigraphic position of the Mahomet Sand Aquifer—conditions that make it difficult for the village to obtain a groundwater supply. It is not clear from sample studies whether all or just part of these sediments are older than the Mahomet or whether they are part of a lacustrine side-valley equivalent (or facies) of the Mahomet Sand. Given these occurrences of fine grained sediments where Mahomet Sand was expected, some aquitard materials might be found below the Mahomet Sand Aquifer. Where these unexpected fine grained sediments occur, they will reduce the total thickness of the Mahomet Sand Aquifer as suggested in figure 5.

A significant sand and gravel unit, used as the aquifer for Farmer City, occurs locally between two tills of the Banner Formation, but it is probably not directly connected to the deeper Mahomet Sand Aquifer. It is thickest, generally greater than 20 feet, in the area shown on figure 5; it also occurs locally elsewhere in northern De Witt County, where it is thinner. Its stratigraphic position is shown in figure 2b, and it appears to be limited to the bedrock uplands north of the Mahomet Valley, where it lies about 50 feet above the top of the Mahomet Sand Aquifer.

Glasford Formation Aquifers

The distribution of Glasford Formation aquifers is shown in figure 6, and the vertical position of these aquifers in the sequence is shown in figures 2 and 3. Figure 6 shows areas where sand and gravel deposits

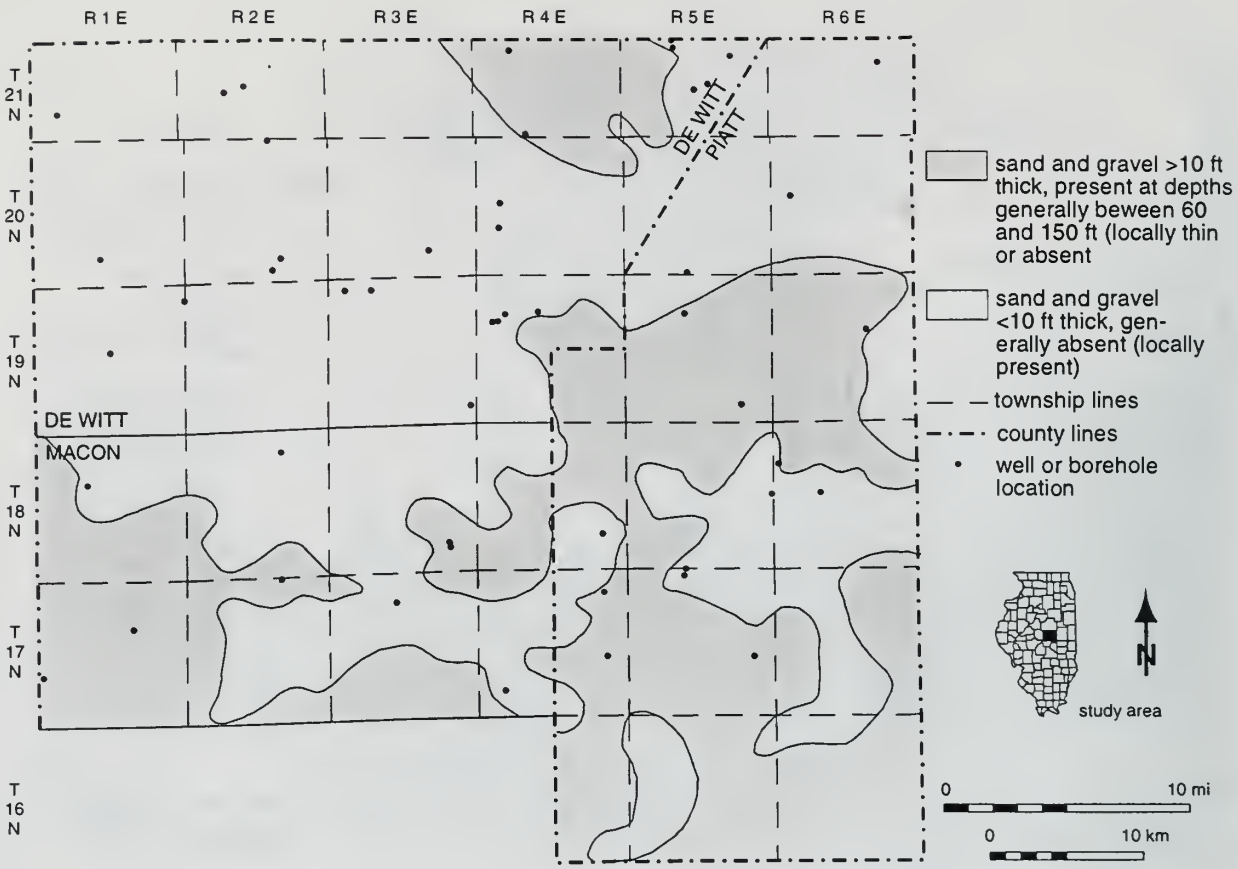

Figure 6 Distribution of Glasford Formation aquifers.

are thicker than 10 feet in at least one stratigraphic position within the Glasford Formation, as indicated by well logs and/or sample descriptions. Although the distribution pattern of this sand and gravel differs in detail from previous maps, the general area of occurrences is the same.

Sand and gravel aquifers between the Radnor and Vandalia tills or at the base of the Vandalia Till are common in the southern two-thirds of the area. Although locally present throughout the remainder of the area, rarely are they more than a few feet thick.

In northeastern De Witt County, generally to the northeast of Farmer City, a sand and gravel aquifer occurs between two parts of the Radnor Till member (fig. 3b). The aquifer generally lies at depths of 60 and 90 feet in this area, and averages slightly more than 10 feet thick.

Only the aquifers in the lower part of the Glasford Formation occur directly over the Mahomet Sand; but apparently they have no direct connection to the Mahomet Sand because the Glasford and Mahomet Sand Aquifers are normally separated by at least 30 to 50 feet of till or other fine textured sediments.

Whereas the Glasford aquifers are not as predictable in occurrence or yield as the Mahomet Sand Aquifer, in some areas, they may be alternative targets for low-production users. Because they are separated from the Mahomet Sand Aquifer by till units or other fine grained deposits, pumping the Mahomet Sand Aquifer would probably have little impact on these aquifers.

Aquifers in Units Overlying the Glasford

Within the Wedron Group, aquifers for development of small water supplies occur in two settings: (1) locally occurring sand and gravel or (2) patches of sand and gravel (Henry Formation) along the major

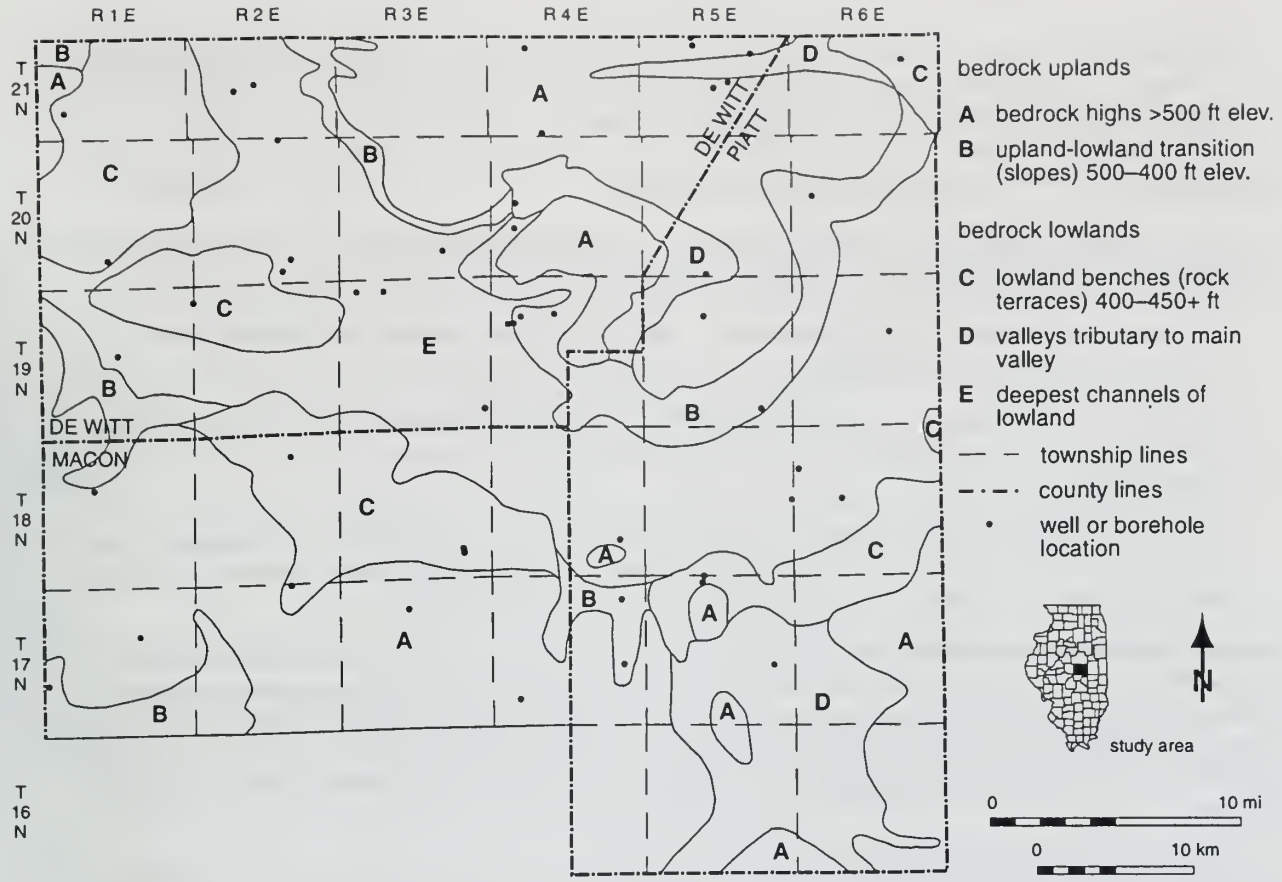

Figure 7 Geologic provinces.

streams of the area. Better delineation of these minor aquifers may help those seeking sources for local domestic water supplies and should be undertaken in future mapping of the region.

SUMMARY

The geologic province map (fig. 7) summarizes the relevant major geologic settings of the De Witt and Piatt County study area. Because the bedrock topography limits the thickness and distribution of the water-bearing subsurface glacial materials, the geologic province map is a valuable way of representing the bedrock geometry and overlying sediments. As additional information is incorporated, subdivisions may be added to the geologic provinces map.

A combination of the cross sections (fig. 3) and aquifer maps (figs. 4, 5, and 6) to supplement the geologic province map (fig. 7) can be used to form a clear, three-dimensional concept of the sequence and position of the buried units. Generally, the five bedrock topographic settings of the geologic province map can be described as follows:

Province A Glacial deposits, approximately 200 feet thick, overlie the bedrock upland. These deposits are mainly composed of glacial till, but include some sand and gravel aquifers in the Banner and Glasford Formations, as noted on figs, 5 and 6.

Province E Glacial deposits approximately 400 feet thick overlie the Mahomet Bedrock Valley. These deposits represent the full sequence of material in the study area. The lower part of the valley is filled with up to 150 feet of the Mahomet Sand and its associated deposits in the Banner Formation. Above is approximately 250 feet of mainly glacial tills and the minor layers of sand and gravel in the Glasford Formation.

Provinces B, C, and D These areas may be similar to provinces A and E in the upper 200 feet, but they become slightly more complex in the lower portions. The Mahomet Sand Aquifer may be replaced by less permeable units that act as aquitards.

RECOMMENDATIONS AND FURTHER ACTION

The following recommendations are based on the various types of data available, the above discussion, and experience working in the various geologic settings throughout Illinois.

1. Thorough and systematic study, evaluation, and geologic interpretation of all subsurface data are time consuming but necessary steps that must be taken to accurately interpret the geologic setting.

2. Data and interpretations for all well logs and sample sets that were not studied, interpreted, or used previously for this study need to be incorporated into the maps to provide an updated version of each map.

3. After all available pertinent data have been interpreted and incorporated into existing maps, a program should be developed and implemented to conduct additional drilling and sampling in the areas where data are insufficient. Some data deficiencies are already obvious.

These recommendations were adopted by the MVWA in the form of a 30-month project that began in January 1996. In response to the first two recommendations, the ISGS will review the approximately 2,000 well logs from the study region already in our data system and study all available sample sets to update the bedrock topography and aquifer maps produced for this study. For samples large enough to allow such analysis, studies of sample sets will be enhanced by laboratory determinations of clay minerals and grain size.

In response to the third recommendation, the MVWA decided to target for further study areas outside of the Mahomet Bedrock Valley because aquifers in these areas are small and sporadically distributed, and the areas are geologically complex. Two specific areas were targeted for reconnaissance geophysical studies. The first is the Farmer City–Mansfield area (T21N, R4–6E). Whether the aquifer that supplies Farmer City is connected to the Mahomet Valley Aquifer will be investigated by using a seismic refraction survey to better define the tributary valley (figs. 2 and 7). An electrical earth resistivity (EER) survey will investigate the extent of the upper Banner Formation aquifer in the same general area (fig. 5). Farmer City obtains its water from the upper Banner Formation aquifer.

The second field area is southern Piatt County. South of the Mahomet Valley (in T16–18N, R4–6E), EER will better define the extent and thickness of the Glasford Formation aquifer in southern Piatt County (fig. 6). Many shallow, bored wells have been installed in this area, partly because of the lack of information about the aquifer's depth, thickness, and extent. Because small drilled wells are less susceptible to contamination than larger bored wells, a better map of the Glasford Formation should help encourage the use of drilled wells where a sufficient aquifer is present. Mapping of the Glasford will be completed in 1998.

ACKNOWLEDGMENTS

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Mary J. Mushrush, with assistance from Richard J. Rice, digitized the maps and prepared them for publication. David R. Larson, E. Donald McKay, and Jonathan H. Goodwin provided valuable review comments. Pam Carrillo drafted the cross sections.

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