Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geologic Quadrangle Map: IGQ Villa Grove OI
William W. Shilts, Chief
1999

DIGITAL ORTHOPHOTO IMAGE MAP

Villa Grove Quadrangle, Douglas County, Illinois

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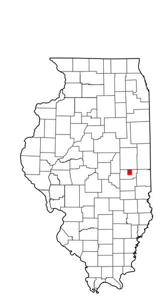
Scale 1:24,000
0 — 2 miles
0 — 2 kilometers
0 — 2000 feet
Contour interval 1.5 meters

Base map compiled at the Illinois State Geological Survey (ISGS) from digital data provided by the U.S. Geological Survey and the ISGS
1927 North American Datum
Universal Transverse Mercator grid, zone 16



1	2	3
4		5
6	7	8

1 Tolono
2 Villa Grove NW
3 Longview
4 Tuscola
5 Murdock
6 Arcola
7 Hindsboro
8 Oakland

ADJOINING 7.5-MINUTE QUADRANGLES

NORTH

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Acknowledgments
This map is one of a set prepared by a multidisciplinary team of geologists from the Illinois State Geological Survey for the 7.5-minute Villa Grove, IL Quadrangle. These maps characterize surface landscapes; surface, bedrock, and engineering geology; and delineate coal, and sand and gravel resources. Zak Lasemi and Donald G. Mikulic were the Project Coordinators, and funding for the project was by the Illinois State Geological Survey. This map was significantly improved through suggestions and comments by the following reviewers: C.C. Abert, R.C. Berg, M.L. Barnhardt, H.H. Damberger, L.R. Folmer, D.A. Grimley, Z. Lasemi, D.G. Mikulic, D.G Morse, B.J. Stiff, C.P. Weibel, and E.M. Wolf.

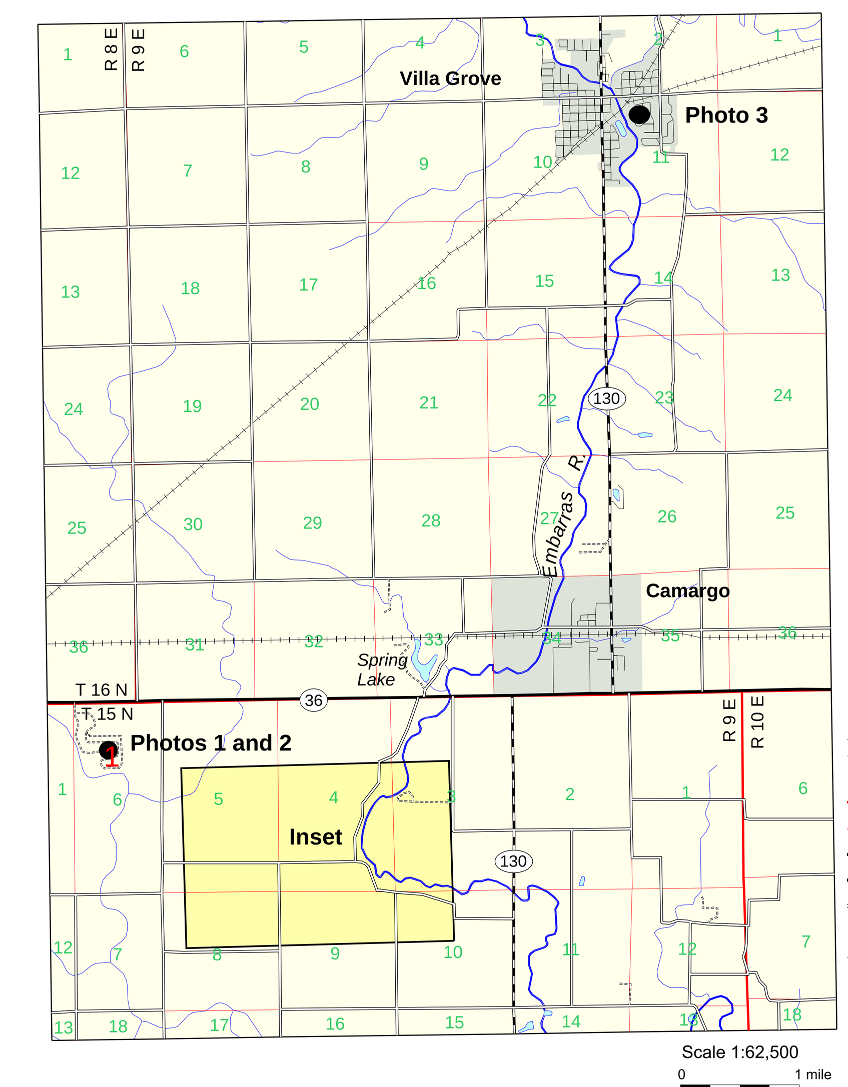

Figure 1 Location Map

township boundaries
section line
U.S. highway
state highway
county road
unimproved roads
railroad
1 quarry

Remote Sensing Inputs to Geologic Mapping

Accurate, detailed information on the characteristics of land surface is an essential component in a geologic mapping program. Geologists use a variety of map data, in addition to field data, to derive information on the landforms and surficial deposits of an area; for example, U.S. Geological Survey (USGS) topographic quadrangle maps, U.S. Department of Agriculture county soil survey maps, and U.S. Fish and Wildlife Service National Wetlands Inventory maps. Maps are important sources of information, nevertheless, they are abstractions and represent the physical landscape in a generalized manner.

Image-based data are a unique information source that portray the physical and cultural landscapes; the usefulness of aerial image interpretation for mapping geologic features has been long recognized (USGS 1994). In Illinois, agricultural lands dominate three-fourths of the surface area of the state (Illinois Department of Natural Resources 1996) and cultivation practices frequently obscure many surficial geologic features. However, remote sensing imagery acquired during the late winter and early spring seasons with optimum surface conditions can detect subtle differences in the uppermost few feet of geologic materials—differences that are directly related to surficial processes.

What Is Digital Orthophotography?

Orthophotography combines the image characteristics of an aerial photograph with the geometric qualities of a map. Unlike a typical aerial photograph, distortions due to relief displacement (hills, stream valleys, buildings), camera lens, and aircraft attitude have been removed so that all ground features are shown in their correct ground positions. This makes possible a true image map and permits direct measurement of distances, areas, angles, and detailed positions of ground features, many of which may be omitted or generalized on traditional maps. In a digital format, orthophotography fulfills a fundamental role as a geometrically accurate base map onto which additional spatial information can be readily incorporated, using a geographic information system (GIS).

This image map has been derived from the interpretation of digital orthophotography produced through the USGS Digital Orthophoto Quadrangle program (DOQ). DOQs are coincident with the USGS 1:24,000-scale quadrangle coverage, have been geometrically corrected to conform to a standard cartographic map projection, and possess a 1×1 meter, ground spatial resolution (USGS 1991). The National Aerial Photography Program (NAPP) and NAPP-like aerial photography are the primary imagery sources used in the production of DOQs. NAPP photography may be either black and white or color infrared, and it is acquired at a nominal scale of 1:40,000. The *Villa Grove Orthophoto Image Map* is based upon NAPP color infrared photography (CIR) acquired on April 19, 1988.

Interpreting the Image Map

Although black and white aerial photography has long been used as the standard for geologic interpretation, most applications based on natural resources are improved by using color and especially color infrared (CIR) photography. This is because the human eye can discriminate many more shades of color than gray tints, and the interpretation of color on standard color aerial photography more closely mimics human experience in everyday interpretation of the environment. Standard color photography records the "visible" portion of electromagnetic energy on three separate layers or emulsions sensitized to blue, green, and red wavelengths (approximately 400 to 700 nanometers), which is the same reflected radiation perceived by the human eye. In CIR photography, however, the blue sensitized layer has been eliminated and the range of sensitivity has been extended into the "invisible," reflected near infrared by the addition of an emulsion sensitive to 700 to 900 nanometers. What this means is that the discrimination of most landscape features is significantly enhanced using CIR photography, including the following phenomena:

- soil moisture gradients across parent material boundaries are better delineated because the near infrared emulsion is quite sensitive to changes in surface moisture conditions;
- changes in surface color, principally controlled by the green and red emulsions, are emphasized with the addition of the near infrared;
- surface water conditions, such as turbidity and presence of chemical or vegetative matter, are easily distinguished;
- differences in vegetation types and relative vigor, in direct response to the cell structure type and condition, are detectable in the near infrared portion of the electromagnetic spectrum.

Because the emulsion response of CIR photography has been shifted into the longer wavelengths to include the near infrared, CIR photography does not record colors in the environment as they would be seen with normal color photography. For this reason, CIR photography is often referred to as "false color."

Examples of how ground objects on the *Villa Grove Orthophoto Image Map* appear using CIR photography are as follows:

Surface Feature	Color
Winter wheat, oats, rye grass; urban lawns and open space; emerging tree canopies.	Light to dark red colors
Nonturbid surface water; exposed wet soils; asphalt rooftops and parking lots.	Dark gray to black
Dark, saturated soil surfaces; urban structures; deciduous wooded areas (little/no leaf canopy); turbid surface water.	Light to dark, blue-green tones
Exposed, better drained and light colored soils; barren land; commercial buildings, concrete and gravel parking lots and roadways.	Light colored to white

In Figure 2, the red colored areas at (1) denote wheat or oats that are maturing during the early spring period, while the areas shown at (2) includes lawns, pastureland, and open space. Their prominent spectral response effectively obscures the underlying soil surface and prohibits any interpretation of surficial geology. Acquiring CIR photography during the late winter or very early spring period within the Midwest can minimize the influence of this spectral response. The dark red colored areas at (3) are a mixture of woody material and the emerging leaf canopy associated with a lowland, deciduous forested area along the Embarras River. This color will increase in brightness as the leaf canopy matures through the spring and summer.

The areas labelled as (4) denote surface water of the Embarras River and the black color indicates there is little or no turbidity or vegetative matter in the uppermost part of the water column. The dark bluish-green color at (5) delineate areas of exposed, saturated soil surfaces that include medium and fine-textured lake sediments associated with glacial Lake Douglas (see Figures 2-3, Interpretation of Surface Geology). In contrast, the light colored areas at (6) denote better drained surfaces associated with deltaic sand. These oval-shaped areas are also topographically higher than the surrounding, bluish-green colored lake sediments.

Using these examples as a guide, the reader can associate these interpretations with additional areas on the image map. When used in conjunction with other information such as soil survey data in a geographic information system, CIR photography can assist in developing a better understanding of the surficial geology of an area.

Processing the Image Map

Because CIR aerial photography was used for the production of the digital orthophotography, a three-band DOQ resulted, with each band representing the spectral information for the green, red, and near infrared wavelength bands, respectively. Because of the size of the resulting digital file (approximately 500 megabytes), specialized image processing procedures were used to transform the original 1×1 meter, ground resolution cells (grc) to a 2×2 meter DOQ grc, thus reducing the image data to one-quarter of the original file size. The resampling was deemed appropriate because the spatial dimension of the ground features being interpreted exceeds 1×1 meter.

Subsequent to the resampling, the reflectance (brightness) values contained within the three-band DOQ were transformed to a single thematic layer of information that can be used to directly interpret geologic conditions within the study area. Using the three spectral bands as input variables, multivariate clustering and image classification routines (Campbell 1987) produced a map denoting 100 different "spectral" classes of information. Comparison of the resulting image map with the original, unprocessed DOQ image data revealed little or no difference in information content. In traditional applications of image classification, a large number of spectral classes are typically generalized to several, known information classes through field checks and/or direct inspection of large-scale aerial photography. In contrast, the generalization of spectral classes was minimized in the creation of the *Villa Grove Orthophoto Image Map* to ensure that subtle geologic features were preserved.

References

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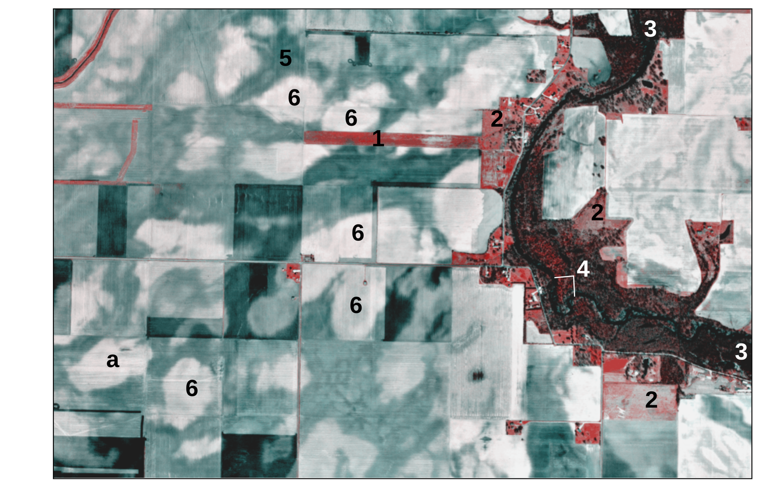

Figure 2 Inset from Figure 1

Interpretation of Surface Geology The light-colored, oval-shaped features (6) in figure 2 are comprised of sandy soils. The sand was deposited in a delta that built into a glacial lake that formed about 18,000 years ago. The lake, called glacial Lake Douglas (Fig. 3), formed when glacial meltwaters were ponded in the low area between the Arcola Moraine (see Generalized Geomorphology Map), which is located south of the Villa Grove Quadrangle, and the retreating glacier margin. Glacial Lake Douglas remained in existence during and after the time that the Pesotum and West Ridge Moraines formed in the northern half of the Villa Grove Quadrangle. As the glacier retreated from the West Ridge Moraine, the glacial Embarras River spilled through a gap in the West Ridge and Pesotum Moraines. The glacial river spread its sediment in a delta that fanned out from the gap in the moraines at the north end of glacial Lake Douglas. The deltaic sands range from over 10 feet thick at the gap to less than a foot thick at the edges of the fan. They overlie silt and clay deposited in the lake bottom. When the delta formed, the lake was about 10 feet deep. The former floor of glacial Lake Douglas is a nearly flat plain with a general elevation of 640 feet. It rises gradually to 650 feet at the apex of the delta. The modern Embarras River is incised across the floor of the former lake and delta to an elevation of about 630 feet.

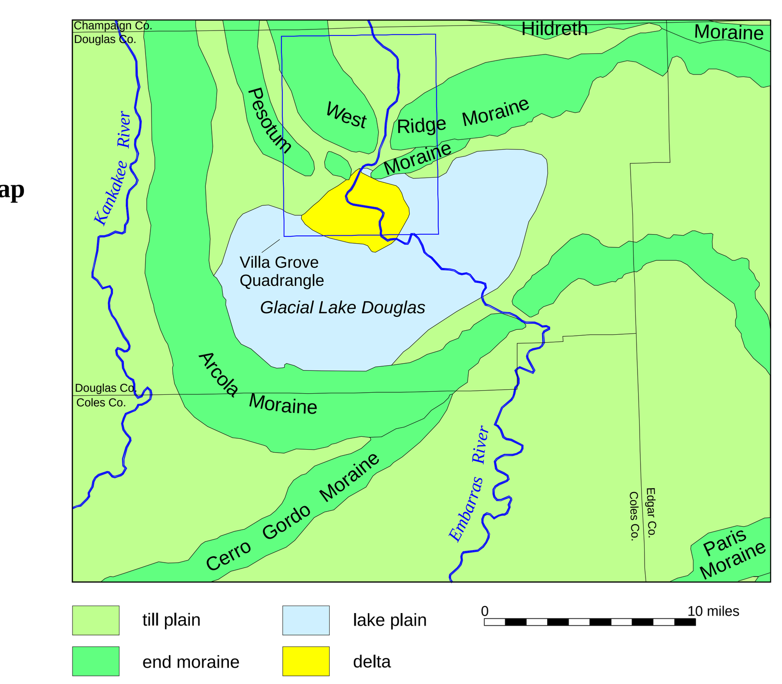

Figure 3 Generalized Geomorphology Map (modified from Lineback, 1979)

Photo 1 Because of the thick cover of glacial deposits, Tuscola Quarry is the only exposure of bedrock that shows the nature of the bedrock surface within the Villa Grove Quadrangle. Well borings and bedrock exposures at this quarry indicate that the eastern portion of the quadrangle is underlain by Pennsylvanian rocks and the western portion underlain by Devonian rocks. Typical for the western area, the Tuscola quarry exhibits a section of Devonian and upper Silurian rocks overlain by up to 50 feet of Quaternary sediments.

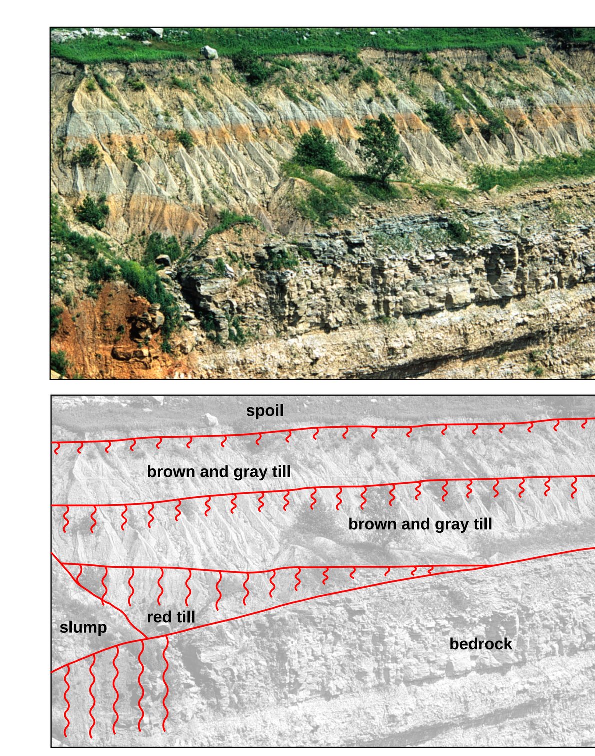

Photo 2 The 35 to 50 feet of material that overlies the bedrock at Tuscola Quarry was deposited during the Quaternary Period. It consists predominantly of till, a mixture of sand, silt, clay, and rocks, that was deposited by ice during glacial episodes, and soils that formed during interglacial episodes when the climate warmed and was similar to what it is today. This exposure is unusual in that there are deposits of at least 3 glacial episodes and 4 interglacial episodes. During interglacial episodes, weathering resulted in soil formation and oxidation, shown by the darker or redder zones in the slopes above the quarry walls (Red lines on gray-tone photo indicate soil profiles). These buried soils help identify the complex glacial sequences in the glacial succession. The Quaternary exposures at the Tuscola Quarry are unusual in containing so little sand and gravel deposited by glacial meltwater streams. However, in other parts of the Villa Grove Quadrangle, glacial sand and gravel deposits are present between tills of different glacial episodes. Such sand and gravel beds were deposited as the glacier was advancing or melting back, and their presence helps to separate tills of different glacial events. These sand and gravel deposits are important drift aquifers and the source of many farm wells.

Photo 3 Flooding frequently occurs along the Embarras River and covers the city streets of Villa Grove.