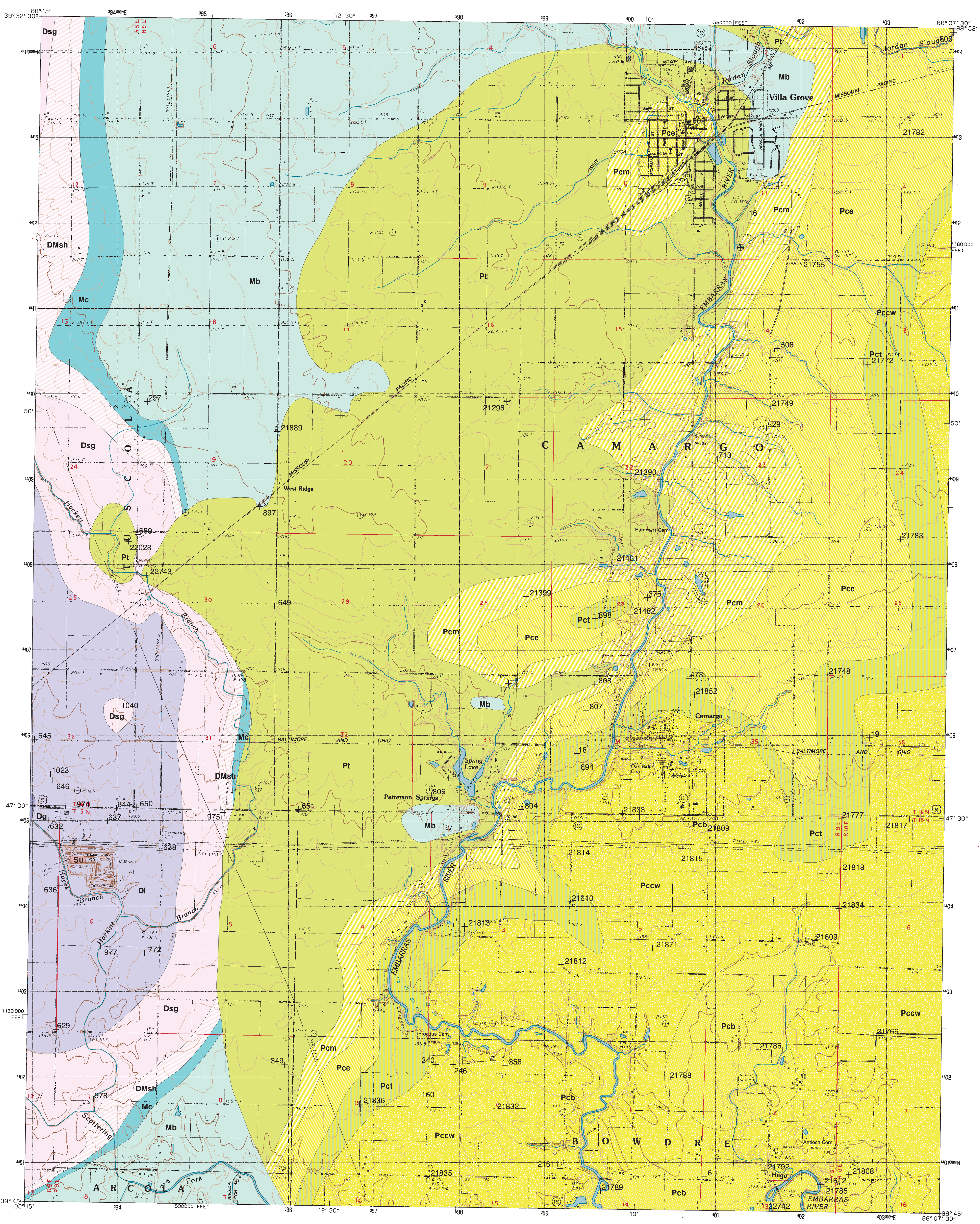
George H. Ryan, Governor

Department of Natural Resources
Brent Manning, Director
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geologic Quadrangle Map: IGQ Villa Grove-BG
William W. Shilts, Chief
2001

GEOLOGICAL MAP OF THE BEDROCK SURFACE

Villa Grove Quadrangle, Douglas County, Illinois

C. Pius Weibel and Zakaria Lasemi

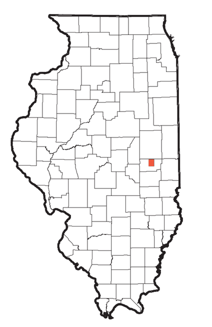


Scale 1:24,000

0 — 2 miles
0 — 2 kilometers
0 — 2000 feet

Water
452 Well location with ISGS county number
Contact

Base map compiled at the Illinois State Geological Survey (ISGS)
from Digital Raster Graphic data (1982) provided by the U.S. Geological Survey.
1927 North American datum
Universal Transverse Mercator projection - 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

FOR FURTHER INFORMATION CONTACT:

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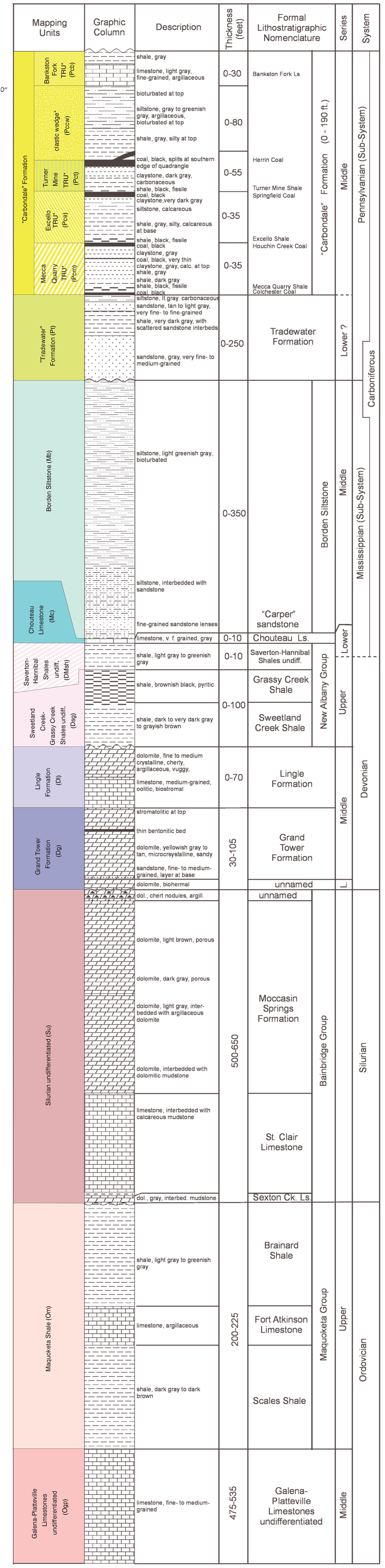

*Informal mapping unit. See text for details.

Regional and Structural Geology

The Villa Grove Quadrangle is situated on the eastern limb and on part of the apex of the Tuscola Anticline (Bell 1943), one of the large folds that constitute the LaSalle Anticlinorium (Mylius 1927, Nelson 1995a) of eastern and north-central Illinois. Bedrock strata along the axis of this double-plunging anticline range in age from Silurian to Late Pennsylvanian (Figure A). Within this quadrangle, subcropping strata (beneath Quaternary sediments) range in age from Middle Devonian to Middle Pennsylvanian, although quarry operations at the Tuscola Quarry (Figure B) have exposed Silurian and Lower Devonian strata at the bottom of the pit.

The axis of the Tuscola Anticline trends N. 20° W. and transects the southwest corner of the quadrangle. The structural trends of Middle Ordovician to Mississippian strata are generally similar. Figure C depicts this structure, using the top of the Middle Devonian Grand Tower Formation. North-northwest of the quarry, the dip of this formation along the axis of the anticline is very shallow (up to 25 feet per mile). South-southeast of the quarry, however, the dip of the axis abruptly increases to about 140 feet per mile. In the central and south-central parts of the quadrangle, the Grand Tower dips eastward at about 185 feet per mile. In the north-central and eastern parts, the formation dips east and southeast at about 90 feet per mile. The structural trend of Pennsylvanian strata, however, as indicated by the structural contours of the top of the Middle Pennsylvanian Springfield Coal Member (Figure C), differs from that of the older strata. In the eastern part of the quadrangle, the coal dips east-southeast at about 35 feet per mile. This structural difference indicates that post-Middle Devonian, pre-Middle Pennsylvanian subsidence occurred in the basin to the south and southeast of the anticline, or uplift occurred on the anticline after the Springfield Coal was deposited. In the northeast corner, the contours of this coal strike north-northeast whereas the Grand Tower Limestone contours strike nearly north-south (Figure C). Subsidence/uplift continued to occur after deposition of the coal as the Pennsylvanian units thin toward the crest of the anticline. This structural difference suggests that a change in basin geometry occurred (e.g., regional uplift occurred to the north) and influenced depositional patterns in at least part of the quadrangle. Siever (1951) and Clegg (1965) reported that major uplift on the LaSalle Anticlinorium occurred in the Late Mississippian/Early Pennsylvanian. This period of deformation coincides with the formation of the widespread erosional unconformity at the Mississippian-Pennsylvanian boundary (Figure D).

Lithologic Mapping Units

The lithologic mapping units used on the geologic map were selected primarily after study of subsurface data (geophysical logs, sample and core descriptions, and core studies).

Pre-Pennsylvanian Units

Pre-Pennsylvanian mapping units are formally defined lithostratigraphic units (see Willman et al. 1975 for original and historic unit definitions, brief descriptions, and regional stratigraphic relationships). Silurian strata were not differentiated on this geologic map because the area of exposure is very small and restricted to the quarry floor. An unnamed Lower Devonian fossiliferous dolomite and the Middle Devonian Grand Tower Limestone are also exposed in the quarry walls. These exposures are too small to be shown on the geologic map. A sandstone bed at the base of the Grand Tower may be equivalent to the Dutch Creek Sandstone Member (Norby and Klug in press, Lasemi in press). The unnamed dolomite is up to 25 feet thick and is mapped as part of the Grand Tower (Figure D). The Upper Devonian Sweetland Creek Shale and the Grassy Creek Shale Members of the New Albany Group are not differentiated because both are dark and organic-rich, and the contact between the shales is gradational. Similarly, the upper members of the New Albany, the Upper Devonian Saverton Shale and the Lower Mississippian Hannibal Shale, are grouped together because both are lithologically similar and difficult to differentiate in this area.

Pennsylvanian Units

A different approach was undertaken in the selection of mapping units for the Pennsylvanian strata. In this quadrangle, these strata consist of a relatively thin, basal sandstone-dominated interval (Tradewater Formation) which is succeeded by a much thicker, shale-dominated interval ("Carbondale" Formation), marked by a distinctive repetition (cyclicity) of units of terrestrial origin deposited over units of marine origin.

The lithology of the basal interval is provisionally correlative with the Tradewater Formation of the southern part of the Illinois Basin (Glenn 1912, Jacobson 1991). Neither the lower nor the upper boundaries of the formation could be recognized. It is possible that the Caseyville Formation, which underlies the Tradewater, and is the oldest Pennsylvanian formation in the basin, may have been deposited at the bottoms of paleovalleys that were eroded down into the Mississippian Borden Siltstone. Well records that penetrated the deeper parts of the paleovalleys in this quadrangle, however, lacked sufficient data to determine specific lithologies. The top of the Tradewater Formation usually has been placed at the base of the Davis Coal (Williams et al. 1982), which is absent in this area. Because of the scarcity of data from this stratigraphic interval, it is not possible to correlate these strata to only the Tradewater without ambiguity.

The boundaries of the Carbondale Formation, originally named by Shaw and Savage (1912), have been modified several times (Hopkins and Simon 1975) and continue to drift (Nelson 1995b). Because of this lack of stability in boundary definition, this formational unit is referred to here as the "Carbondale" Formation. The lower boundary of the "Carbondale," the base of the Colchester Coal Member, is similar to that recognized by Kosanke et al. (1960) and commonly used for several decades. Those geologists recognized the upper boundary at the top of the Danville Coal, which is not present in the quadrangle, probably because it has been eroded.

Wanless and Weller (1932) introduced the term *cyclothem* for the cyclic units within the "Carbondale" Formation. More recent studies (Weibel 1996, Miller and West 1998) indicated that mapping the base of the marine units (i.e., the transgressive surface) is more practical than mapping the basal discontinuity (lowstand unconformity) of cyclothems, as had been advocated by Wanless and Weller (1932). In the Villa Grove Quadrangle, the transgressive surface is a readily mappable horizon and is the boundary between the non-marine (coal) and marine (limestone and black, fissile shale) portions of the cycles. New, informal mapping units, referred to as *trangressive-regressive units* or TRUs (based on nomenclature only from Busch and Rollins 1984) are separated by these mappable horizons. A TRU, thus consists of a lower marine portion overlain by an upper non-marine portion and separated by a transgressive surface. The name of each TRU is derived from the name of the basal marine bed.

Not all of the "Carbondale" strata, however, fit succinctly within this transgressive-regressive framework. In the upper part of the formation, near the southern edge of the quadrangle, thick deposits of deltaic sediments (shale and siltstone) were deposited during and after the time period of Herrin Coal deposition (Treworgy and Treworgy 1983). These deposits are unique to the TRUs and are informally referred to as a clastic wedge. At the southern edge, these deposits are separated by the Herrin Coal into the lower clastic wedge and the upper clastic wedge. In this area, the boundary of the Turner Mine TRU and the lower clastic wedge is undifferentiated, and the two lithologic units are mapped together.

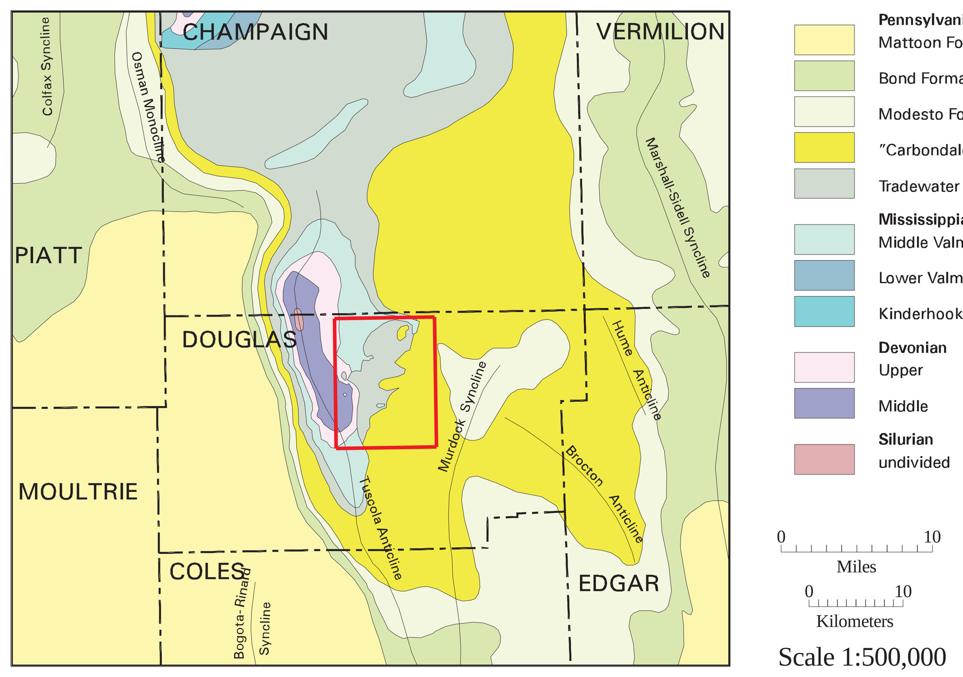

Figure A. Regional geologic map of the bedrock surface. Villa Grove Quadrangle outlined in red. Geological map modified from Willman et al. (1967).

Figure B. Tuscola Quarry. This quarry (Section 6,T. 15 N., R. 9 E.) is the only site within the quadrangle where bedrock is exposed. The top of the quarry wall is capped by the Lingle Formation. Grand Tower Formation constitutes most of the quarry wall. At the very bottom of the pit, the uppermost Silurian is exposed. Photo by Zakaria Lasemi.

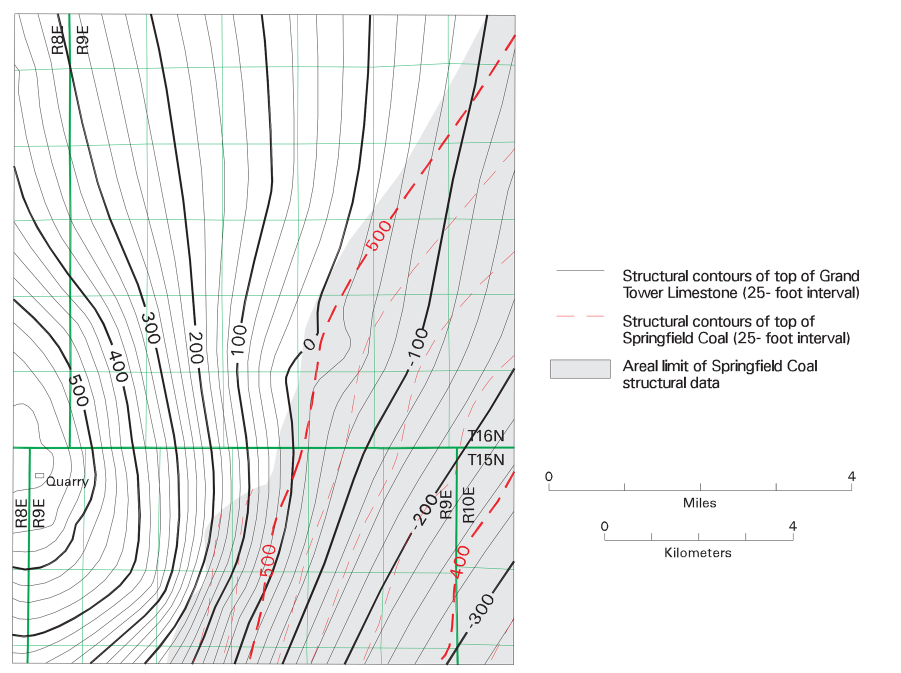

Figure C. Structural contour maps of the Grand Tower Formation and the Springfield Coal Member of the Carbondale Formation.

Mapping Methods

This map is based on data derived from well records in the Geologic Records Library of the Illinois State Geologic Survey. The well types used included water, petroleum, coal, and stratigraphic borings. The map was produced using Dynamic Graphics EarthVision (EV) software. Well location and elevation data of the stratigraphic contacts were entered into the program. Individual digital grids of elevations of each stratigraphic surface (horizon) were produced using EV's Geologic Structure Builder (GSB). EV permits the shape of the underlying or overlying horizons to be used, along with the well elevation data, to model individual horizons. Visual examination of each horizon grid and of the thickness of the interval between the grids revealed the need for additional projected, "false" points in areas where well data are lacking or in areas where the strata had been eroded, such as on the axis of the Tuscola Anticline. In addition, some of the grids were manually modified using EV's Graphic Editor. Using EV's Formula Processor, the revised horizon grids subsequently were subtracted from a digital grid of elevations of the top of the bedrock surface (Figure E). The resultant grid was contoured using EV and converted to a GIS data set. These contours contained zero isopachous lines, which represent the subcropping geologic contacts shown on the map. Positive isopachs indicated areas where the mapping units are present. Environmental Systems Research Institute, Inc.'s Arc/Info software was used for a final refining of the contours and for the overall compilation of the map. The three-dimensional view and the cross sections (Figure D) were produced using EV's GSB. The depiction of the geology of the bedrock surface in Figure D differs slightly from the 1:24,000 scale version of the map to the left because Figure D was produced by the GSB, whereas the map was produced using the GSB and the Formula Processor.

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3- D Block Diagram

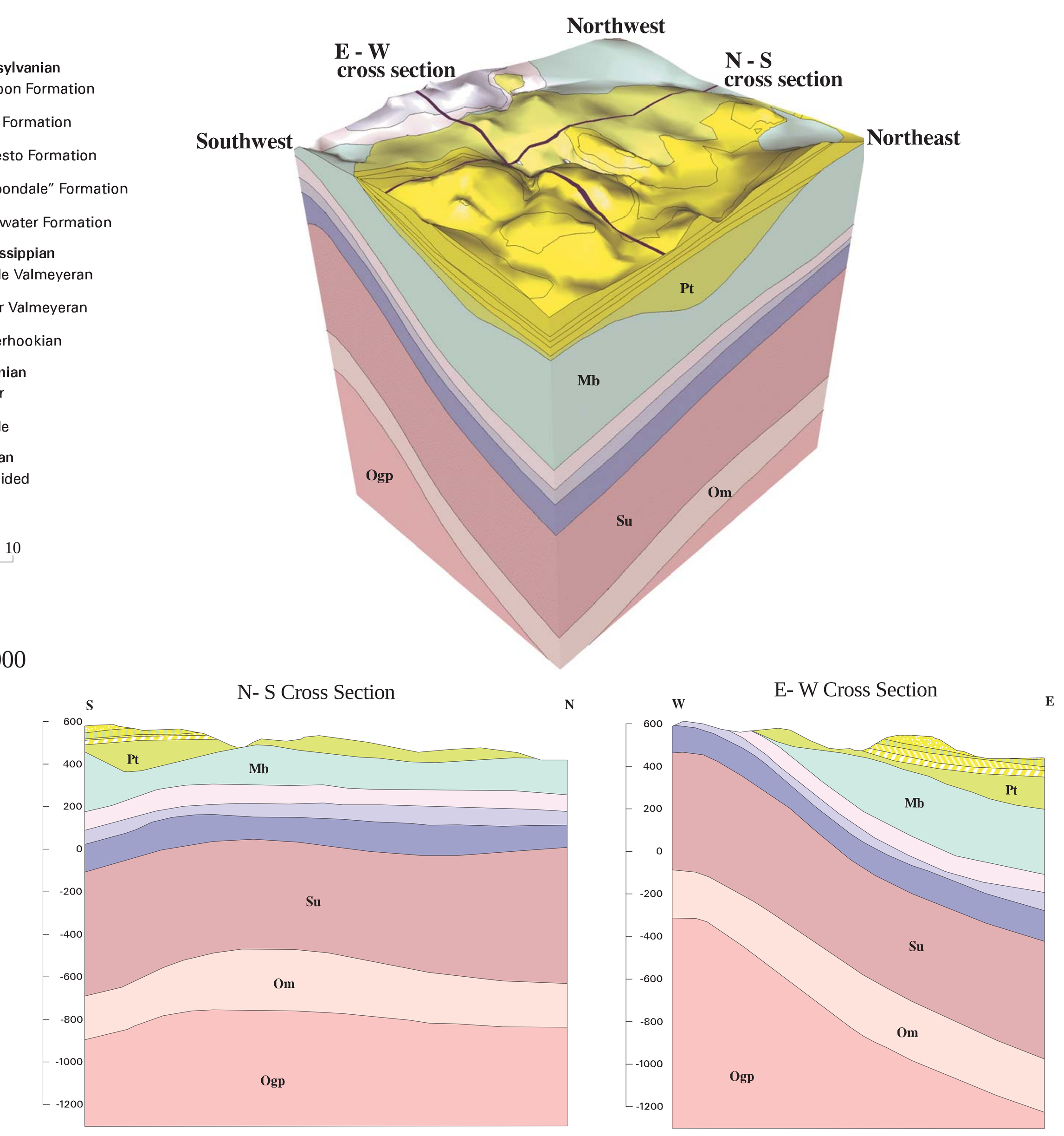

Figure D. Three-dimensional block diagram and cross sections of bedrock. These depictions of the bedrock geology were computer generated. Colors are similar to, but not the same as, mapping unit colors on the geological map of the bedrock surface. The thicker units additionally are identified by mapping unit abbreviations: Galena-Platteville Limestone (Ogp), Maquoketa Shale (Om), Silurian undifferentiated (Su), Borden Siltstone (Mb), and Tradewater Formation (Pt). The "Carbondale" mapping units are not color differentiated in the 3-D block diagram. The Chouteau Limestone is too thin to be depicted. Vertical exaggeration is 20X.

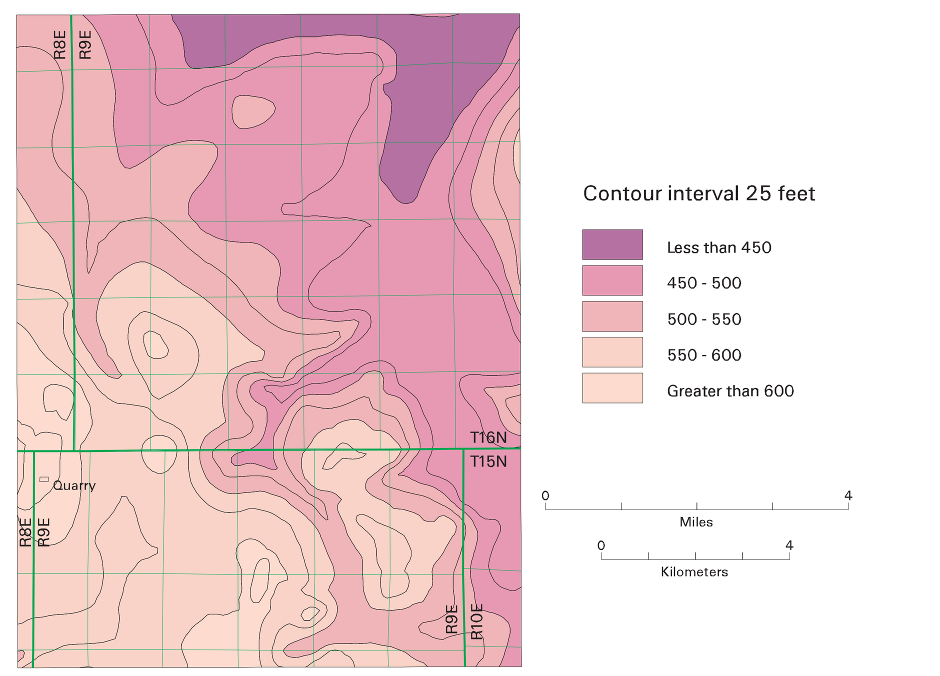

Figure E. Topography of the bedrock surface. Modified after Weibel (1999).