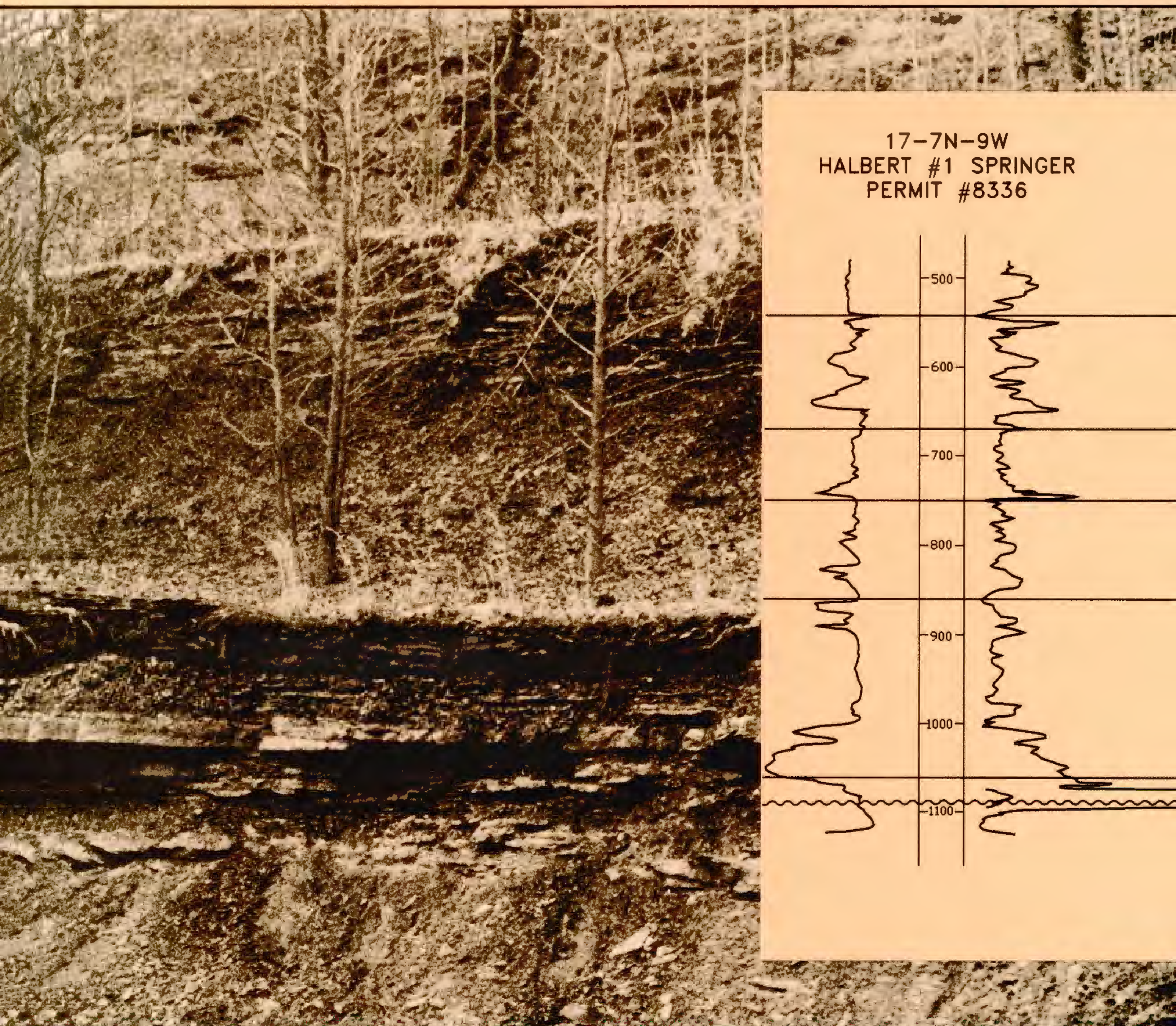
# EARLY PENNSYLVANIAN STRATIGRAPHY AND THE INFLUENCE OF SUB-PENNSYLVANIAN TOPOGRAPHY IN THE SUBSURFACE OF INDIANA

## Special Report 58





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# Early Pennsylvanian Stratigraphy and the Influence of Sub-Pennsylvanian Topography in the Subsurface of Indiana

*By* John B. Droste *and* Lloyd C. Furer

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# EARLY PENNSYLVANIAN STRATIGRAPHY AND THE INFLUENCE OF SUB-PENNSYLVANIAN TOPOGRAPHY IN THE SUBSURFACE OF INDIANA

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## ABSTRACT

The Raccoon Creek Group contains the oldest rocks of the Pennsylvanian System in Indiana and consists in descending order of the Staunton, Brazil, and Mansfield Formations. The major focus of this report is the subsurface distribution of the Mansfield Formation, which contains all the rocks of Pennsylvanian age below the Lower Block Coal Member of the overlying Brazil Formation. The Mansfield Formation is the thickest formation of the Pennsylvanian system in Indiana and ranges in thickness from zero at its present eroded limit to more than 800 feet in sub-Pennsylvanian paleovalleys. The Mansfield herein is subdivided into three informal and approximate chronostratigraphic subsurface units: the upper, middle, and lower divisions. The named members of the Mansfield cannot be traced regionally at the surface or in the subsurface, but the approximate stratigraphic position of these members can be correlated throughout much of the subsurface in Indiana. The top of the lower Mansfield is near the position of the French Lick Coal Member. From zero at its depositional limit to more than 500 feet in the subsurface, the lower Mansfield distribution is controlled partly by sub-Pennsylvanian topography, and in a few places the rocks in the upper part of the lower Mansfield are exposed along the southern half of the outcrop belt. The top of the middle Mansfield is at the stratigraphic position of the Blue Creek Coal Member. In the subsurface the middle Mansfield ranges in thickness from 150 to 250 feet and is present throughout the outcrop belt. The upper Mansfield ranges in thickness from 70 to 180 feet and extends throughout the outcrop belt in Indiana.

## INTRODUCTION

A review of the literature treating the Pennsylvanian System in Indiana reveals that major attention has been focused on the coals contained in these rocks. Information concerning the geology of exposed Pennsylvanian rocks in 18 counties in Indiana has been presented by the Preliminary Coal Map series published by the Indiana Geological Survey. These maps show Pennsylvanian bedrock geology areal distribution of named and unnamed coal beds, and near-surface structure of Pennsylvanian rocks based on key coal bed stratigraphy. Nine quadrangle maps have been published cooperatively by the U.S. Geological Survey and the Indiana Geological Survey in the Coal Investigation Map series. Thirty-five maps in the Coal Map series of the Indiana Geological Survey show the locations of surface and underground mines in 18 counties in Indiana. Coal data have been collected in the National Coal Resource Data System for reserve calculations.

Few reports, however, contain information concerning the subsurface stratigraphy of Pennsylvanian rocks in Indiana. Some papers present subsurface geology in selected localities, and these nearly all are related to economically important coal-bearing rocks in the middle and upper parts of Pennsylvanian System. For example, see the following publications: Eggert and Adams (1985), Harper (1988), and Hasenmueller and Ault (1991).

Study of the Mansfield Formation in the subsurface of Indiana has not been pursued because these rocks do not contain widespread commercial coal beds. A major purpose of this report is to present a preliminary view of the subsurface distribution of Mansfield rocks, to relate the thickness variation of the Mansfield to the topography of the sub-Pennsylvanian surface, and to prescribe an informal subdivisional stratigraphy of the Mansfield so as to facilitate further studies of the intraformational sedimentology that is recorded in the Mansfield Formation. This work could lead to a better understanding of the correlation of the coal beds and therefore lend support to the coal explorationist.

The study area (fig. 1) of the Mansfield Formation in the subsurface of Indiana extends from northern Warren County southward to the Ohio River in Perry County. Records for about 20,000 wells that have geophysical logs in the files of the Indiana Geological Survey were reviewed. No more than one well per section was selected to compile the thickness maps. In areas of closely spaced drilling, preference for a control well for each section was given to the well drilled through the entire Pennsylvanian System with the most representative log signature. In many areas extensive exploration for oil and gas provides a control well for at least every 40 acres (quarter-quarter section). In areas of less intense drilling, only one well per four to five sections provides control. In fringe areas, particularly in

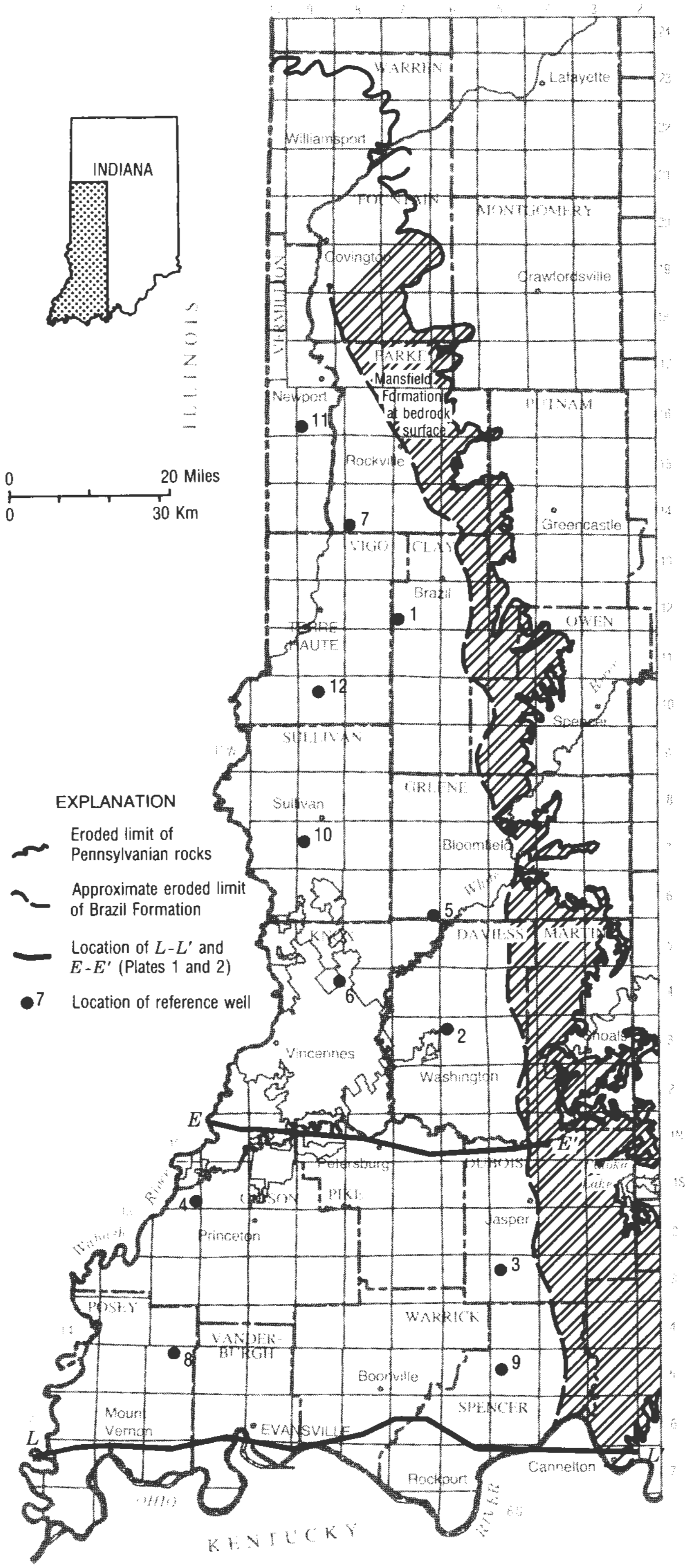


Figure 1. Map of southwestern Indiana showing the location of the study area and the location of reference wells and cross sections mentioned in the text. The eroded limit of Pennsylvanian rocks is generalized after Gray and others, 1987. See Appendix A for precise core locations.

the northern part of the study area, well control is reduced to a few wells per township. In all, about 3,300 wells were chosen to compile the thickness maps represented.

## STRATIGRAPHY

For many years the lithostratigraphy of the Pennsylvanian System in Indiana has been based almost entirely on the recognition of the stratigraphic position of key coal and limestone beds that are persistent laterally. The Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin recommended seven key units for basinwide correlations (Jacobson and others, 1985). Among these seven units are five coal beds (the Herrin, Springfield, Houchin Creek, Survant, and Colchester) that are named members in the Carbondale Group in Indiana (fig. 2).

The numerous named members of the Raccoon Creek Group (fig. 2) unfortunately are not laterally persistent in the subsurface even within Indiana. For example, we cannot identify the stratigraphic position of the Seelyville coal on logs or in samples from many wells in Indiana or in neighboring counties in Illinois and Kentucky. The difficulty of identifying the Seelyville in Indiana and the recognition that the stratigraphic position of the Colchester can be made more accurately made in many places in the Illinois Basin has been reported (Hasenmueller and Ault, 1991). The thickness of the Raccoon Creek Group ranges from less than 300 feet to more than 1,100 feet.

## CORRELATION METHODS

For many years the techniques used to correlate Pennsylvanian strata in the Illinois Basin have been based on identification of the stratigraphic position of key basinwide units such as the Herrin, Springfield, Houchin Creek, and Colchester coals (fig. 2) in the Carbondale Group. The base of the Pennsylvanian rocks must also be established by careful log correlation and sample studies. Thus the rocks of the Raccoon Creek Group occupy the interval between the Pennsylvanian/Mississippian unconformity below, and a stratigraphic position 20 to 40 feet below the Colchester coal (fig. 2).

At the present time the top of the Raccoon Creek Group is defined formally at the top of the Seelyville Coal Member (fig. 2), but we have been unable to correlate this stratigraphic position with certainty at many well locations. The equivalent stratigraphic position of the Minshall (Buffaloville) and Lower Block Coal Members (fig. 2) can be selected in much of the subsurface with reasonable assurance by careful correlation downward from the Colchester coal, thus defining the Brazil equivalent as shown on plates 1, 2, and 3.

The chronostratigraphic subdivision of the Mansfield Formation was accomplished by methods similar to those demonstrated by Van Wagoner and others (1990, fig. 17). The need for marker-defined units (formats) in the subsurface was discussed in detail by Forgotson (1957) before the advent of sequence/seismic stratigraphy. In order to sort out the relative effect that

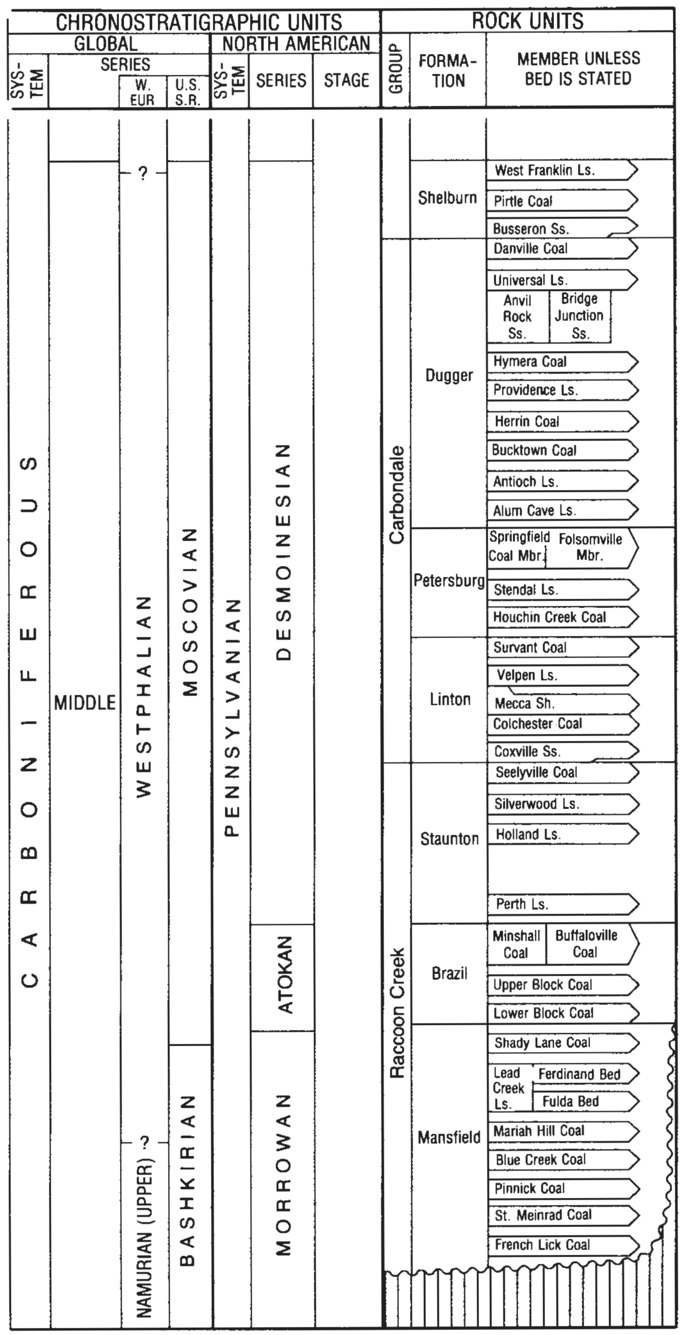


Figure 2. Chart showing Pennsylvanian nomenclature used in this report (from Shaver and others, 1986).

climate, eustasy, and tectonics may have had on the deposition of the Mansfield, it is necessary to establish a chronostratigraphic relationship of the very thin Mansfield Formation in outcrop in the northeastern part of the study area to the very thick Mansfield in the subsurface in the southwestern part of Indiana.

A regional network of correlations of geophysical logs was made from Posey County to Parke County. An approximate contact between the Mansfield and Brazil Formations was made based on correlation to a subsurface reference section of the Mansfield in section 3, T. 14 N., R. 7 W., Parke County (Hutchison, 1976). An approximate subsurface correlation to a composite of measured sections by Hutchison (1960) in T. 13 and 14 N., R. 6 and 7 W. was also attempted with limited success. These correlations were carried south to Knox and Gibson Counties where a detailed network of correlations allowed the Mansfield to be divided into three parts as shown on cross section E-E' (plate 1). These correlations were carried into Posey County where detailed correlations of an infill well in every section was completed where possible to construct cross section L-L' (plate 2).

Only selected wells are shown on L-L' to create a cross section of manageable size. Plate 3 illustrates how correlations were made between the wells shown on plates 1 and 2. This plate illustrates that four infill wells not shown on L-L' were used to correlate between the wells in section 12, T. 7 S., R. 14 W. and section 3, T. 7 S., R. 13 W. (third and fourth wells from left on L-L'). The lines on plate 3 reflect approximate time boundaries that subdivide the pre-Staunton Formation section into four informal time equivalent units: the Brazil Formation and the upper, middle, and lower parts of the Mansfield. The subdivisions were modified by correlation to mines and outcrops particularly in Martin, Dubois, and Spencer Counties (Hutchison, 1959, 1964, 1967). Samples of cuttings were examined in many wells to identify gray mudstone beds which are considered key markers. These deposits are usually representative of marine transgression (Kvale, personal commun., 1992). These mudstones are 10 to 30 feet thick and in some places contain an underlying discontinuous coal and an overlying thin marine limestone. Most of these mudstone zones have a lateral extent of a few miles; by correlating a series of such zones, as shown on plate 3, it is possible to subdivide the pre-Staunton section into approximate time-equivalent zones with reasonable confidence where control is sufficient (as it is in most places in the Indiana portion of the Illinois Basin).

Plate 3 demonstrates that the markers are usually not at the boundaries of the subdivisions but within, and that they are sometimes discontinuous because of rapid facies changes along any given time line. This suggests that a very complex set of coastal depositional environments is likely to be involved. Detailed local studies with sufficient core will make it possible to redefine the subdivisions and to delineate parasequences if they exist here. The ultimate aim of such a project would be to interpret the lower Pennsylvanian section of the Illinois Basin in terms of sequence stratigraphy.

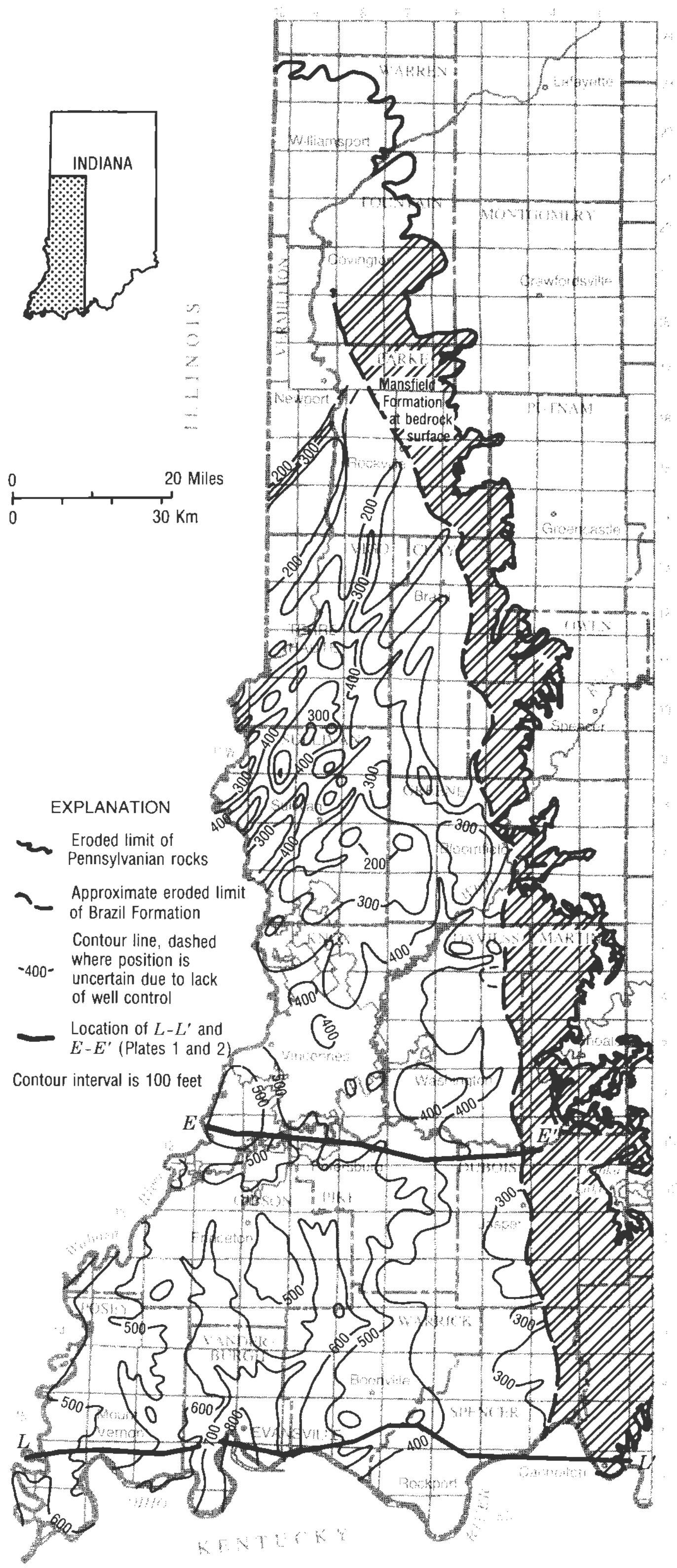


Figure 3. Map of southwestern Indiana showing the thickness of the Mansfield Formation in the subsurface of Indiana.

## MANSFIELD FORMATION

The Mansfield Formation originally was named the Mansfield Sandstone (Hopkins, 1896) for rocks exposed at Mansfield, Parke County, Indiana. Cumings (1922) amended the Mansfield to its current usage (fig. 2) to include all the rocks between the base of the Pennsylvanian System to the base of the Lower Block Coal Member of the overlying Brazil Formation (fig. 2). The Lower Block coal is not continuous throughout the subsurface of Indiana. Where the coal is absent, its stratigraphic position is correlated on the geophysical logs of control wells used in this study to mark the top of the Mansfield Formation.

The Mansfield, composed mainly of sandstone and shale, contains the oldest rocks of Pennsylvanian age in the state. It is the thickest formation of the Pennsylvanian System, and displays a wide range in thickness distribution throughout its surface and subsurface occurrence. Its named members (fig. 2) recognized in outcrop areas are not easily traceable bed-by-bed throughout the subsurface. A major focus of this study is to recognize and map the overall distribution of the rocks of the Mansfield Formation in the subsurface of Indiana and to suggest the stratigraphic positions of some of the named beds recognized in the outcrop to their approximate stratigraphic occurrence in the subsurface section. To this end the Mansfield in the subsurface has been subdivided into three informal units: the upper, middle, and lower. These informal units are interpreted and correlated based on their geophysical log response. These informal divisions are not intended to be formally named stratigraphic units, and they are established only to facilitate the discussion of Mansfield rocks in the subsurface and to provide a format for further studies, including paleogeographic and lithostratigraphic mapping of subdivisions of the Mansfield Formation. In addition to the log correlations shown on cross sections (plates 1, 2, and 3), the subdivisions of the Mansfield as used in this study are given for 12 additional reference wells (locations shown on fig. 1) whose logs show typical geophysical signatures (appendix A).

Throughout the subsurface of Indiana the Mansfield Formation ranges in thickness from less than 200 feet to more than 800 feet in southern Vanderburgh County (fig. 3). The greater thicknesses of Mansfield rocks are clearly related to sub-Pennsylvanian topography as will be discussed later in this report. Structural maps on the top of the Mansfield made in areas of closely spaced control show only regional dip that is seen on structural maps in pre-Pennsylvanian rocks as well.

## UPPER MANSFIELD ROCKS

The rocks of the upper Mansfield, as identified by their log signature, are recognized throughout Indiana. The greatest success in correlating log signatures of near-subsurface rocks to named members of the Mansfield mapped in outcrop areas has been attained in southern Martin County, Dubois County, and northern Spencer County. The reports of Hutchison (1959, 1964, 1967) and Gray and others (1960) have been useful for tracing some of the named members of the Mansfield from the surface into their general stratigraphic position in the shallow subsurface. Even though the named members recognized in surface exposures often cannot be traced bed-by-bed from the surface into the subsurface, the interval of rocks at the surface containing the named bed can be assigned to a specific interval of rocks in the subsurface that produces a characteristic log signature. Thus, the general stratigraphic position of the named surface member can be assigned to a specific package of log signatures that reflect the rocks that contain the named surface member. The surface member—for example, a coal bed—may not be specifically identified within the correlatable signature interval.

The interval containing the associated beds of shale, coal, and limestone that are known as the Lead Creek Limestone Member (Shaver, 1986a) is identified on some well logs in the shallow subsurface from Spencer County northward into Martin and Daviess County. Samples from a few wells through this interval show that limestone occurs in the upper part of this section. This limestone is a light- to medium-gray cherty wackestone and probably is the Ferdinand Bed (Shaver, 1986b) of the Lead Creek Limestone Member. Below the middle part of the upper Mansfield in this same area, the silty interval containing the Mariah Hill Coal Member (Hutchison and Hasenmueller, 1986a) also has been recognized on some logs. Well samples from this interval in the deeper subsurface in the southwestern part of the study area show that the interval contains limestone consisting of thin beds of medium- and dark-gray wackestone and packstone.

In the subsurface the top of Mansfield is placed at the stratigraphic position of the base of the Lower Block coal, and the base of the upper Mansfield division is placed at the stratigraphic position of the top of the Blue Creek Coal Member. The upper Mansfield of this report ranges in thickness from a minimum of about 75 feet in the north to a maximum of about 180 feet in the southwest.

## MIDDLE MANSFIELD ROCKS

The middle Mansfield is present at least in part throughout the entire outcrop area of the Mansfield Formation. This statement is given with some reservation as it depends upon the results of ongoing investigations in the northern part of the study area where Mansfield stratigraphy is not well known.

The portion of the middle Mansfield reported on here includes the rocks that at the surface contain several named members (fig. 2) which have type sections or type areas in Spencer, Dubois, Martin, and Orange Counties. The bottom of the middle Mansfield in the subsurface has the approximate stratigraphic position at, or as much as 30 feet below, the French Lick Coal Member (Hutchison and Hasenmueller, 1986c). Neither the Blue Creek nor the French Lick coals can be reliably traced in the subsurface, but the associated rocks in which they occur yield log signatures that identify their approximate stratigraphic

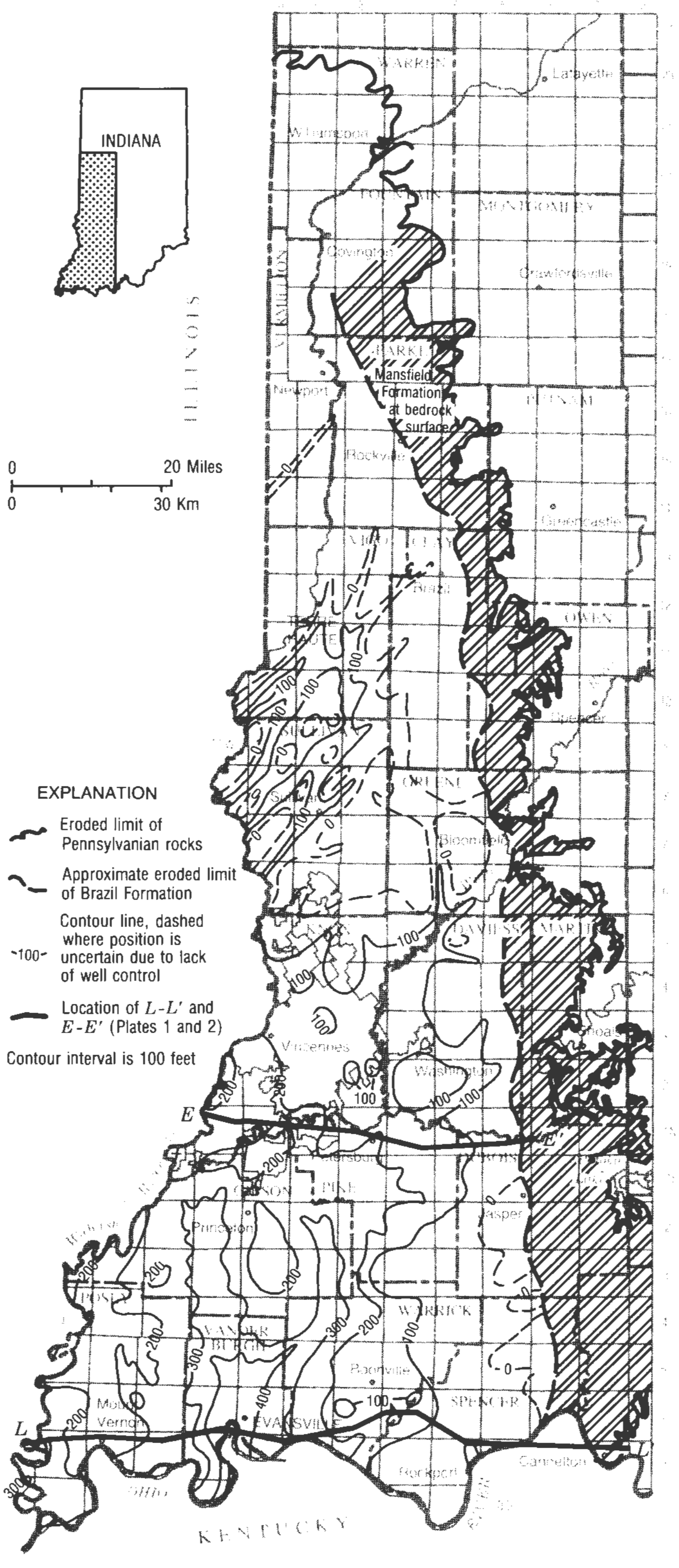


Figure 4. Map of southwestern Indiana showing the thickness of lower Mansfield rocks.

position in some areas. The facies containing the Pinnick Coal Member (Hutchison, 1986) is recognized on some logs in the shallow subsurface above the so-called Hindostan Whetstone Beds (Gray and others, 1960) which have been described as tidalites by Kvale and Archer (1989). The log signature representing the St. Meinrad coal has been tentatively traced in the shallow subsurface to a stratigraphic position about 40 to 50 feet above the position of the French Lick coal.

The middle Mansfield in this area of study ranges in thickness from less than 150 feet in the north to approximately 250 feet in the deep subsurface of southwestern Indiana. The full section of the middle Mansfield identified in the deeper subsurface of Indiana is not always present in numerous subsurface and surface areas due to nondeposition on topographic highs of the sub-Pennsylvanian surface.

## LOWER MANSFIELD ROCKS

The lower Mansfield rocks (fig. 4) are restricted in occurence to the subsurface almost everywhere in Indiana. In a few localities in Martin, Dubois, and Perry Counties as much as several tens of feet of lower Mansfield rocks occur at the surface below the position of the French Lick coal. The lower Mansfield is composed primarily of sandstone and shale, but from place to place thin, discontinuous beds of coal and limestone are identified in samples and on well logs. These thin coal and limestone beds generally occur in shaly intervals in the middle and upper part of the lower Mansfield in the southwestern part of the study area.

South of central Knox County and Daviess County, net sandstone thickness in the lower Mansfield generally is greatest within the areas overlying positions of the major paleovalleys on the sub-Pennsylvanian surface. The lower Mansfield thins northward by nondepositional onlap and usually is absent even within the deepest paleovalleys north of Vigo and Clay Counties where middle Mansfield rocks lie on the sub-Pennsylvanian surface. In some places in the northern part of the study area, where the lower Mansfield is thin, the paleovalley fill may be dominated by shale rather than sandstone. The rocks representing the lower Mansfield range in thickness from their zero depositional limit to more than 500 feet in southernmost Vanderburgh County.

## DISCUSSION

Inspection of thickness maps of the lower Mansfield rocks (fig. 4) suggests a strong control producing extensive variation in the thickness patterns. Because the thickness of the lower Mansfield is so large and variable, the map showing the thickness of the entire Mansfield (fig. 3) inherits the suggestive controlling influence. When the thickness of the lower Mansfield is compared to the geomorphology of the sub-Pennsylvanian surface (Droste and Keller, 1989; Keller, 1990), the considerable influence that paleography (fig. 5) had on Pennsylvanian sedimentation becomes evident.

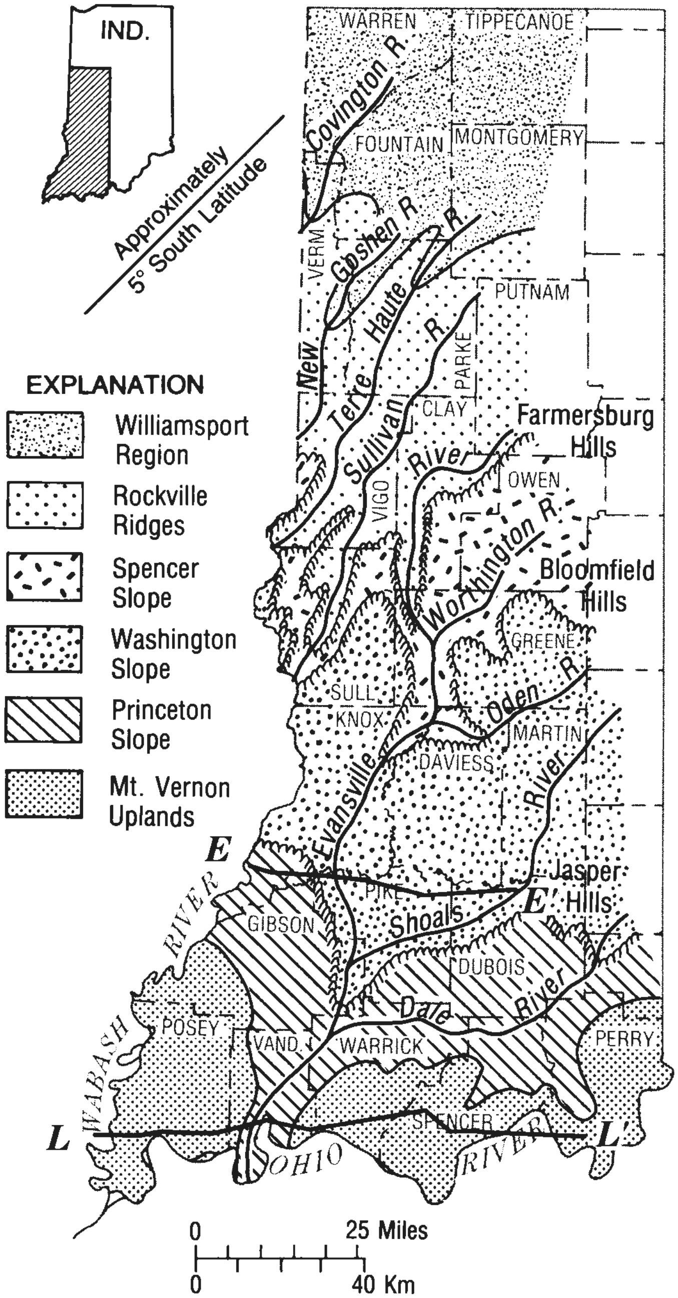


Figure 5. Map of southwestern Indiana showing the major physiographic regions prior to the onset of Mansfield deposition (from Droste and Keller, 1989).

The pronounced areas of greater thickness of lower Mansfield (fig. 4) and Mansfield rocks in general (fig. 3) from Vanderburgh County northward into Greene County lie above the trend of the paleovalley of the Evansville River (fig. 5). Somewhat less pronounced thickness trends of lower Mansfield rocks are evident above the trends of the paleovalleys of the Dale, Shoals, Odon, and Worthington Rivers (see figs. 4 and 5).

The Evansville River (fig. 5) transected several paleophysiographic regions in a broad, open-flaring valley throughout most of its course southward from its tributary junction with the Worthington River (fig. 5). This valley was the locus of initial deposition of Pennsylvanian sediments in Indiana; the oldest sediments being in the south and youngest ones northward. Correlated electric logs (fig. 6) from wells in Posey and Vanderburgh Counties illustrate typical complex facies relationships as illustrated by variation in log signatures of the Pennsylvanian rocks below the Colchester coal. The Mississippian–Pennsylvanian unconformity in this part of Posey County (fig. 6) lies somewhat above the middle of the Cave Hill Member (Droste and Keller, 1995) of the Kinkaid Limestone (fig. 7). In the 7 miles eastward into Vanderburgh County, the unconformity drops stratigraphically to a position within the Menard Limestone (fig. 7); in this area the interval change represents 250 to 260 feet of erosional stratigraphic relief. Records from wells between the Posey and Vanderburgh County locations (fig. 6) indicate that the regional slope of the uncomformity was generally uniform. The physiographic location of the well in Posey County with respect to the sub-Pennsylvanian surface is within the western Mt. Vernon Uplands (fig. 5). The physiographic location of the well in Vanderburgh County is on the Princeton Slope (fig. 5) and is very near to the central position of the bottom of the paleovalley of the Evansville River. Less than 15 miles to the east of the well in Vanderburgh County, the unconformity rises in a generally uniform slope to lie on the Negli Creek Limestone Member of the Kinkaid Limestone in the paleohills in the eastern parts of the Mt. Vernon Uplands (fig. 5). The general regional indication of the relationship between the thickness of Pennsylvanian rocks and the topographic expression of the Mt. Vernon Uplands and the Evansville paleovalley (fig. 5) is seen on cross section L-L' (plate 2). Cross sections E-E' and L-L' (plates 1 and 2) show the west side of the Evansville paleovalley to have greater relief than the more gentle open-flaring east side.

The wide, open-flaring valley of the Evansville River in the south differs significantly in cross-sectional shape from river valleys found farther north in the Rockville Ridges and where these valleys cross the Spencer Slope (fig. 5). Correlated electric logs from closely spaced wells in Sullivan County (fig. 8) show facies relationships and variation in log signatures among the stratigraphic units below the Colchester coal. Pennsylvanian rocks lie on the top of the Beech Creek Limestone in the eastern well and on rocks in the lower part of the Paoli Limestone in the western well (fig. 7). About a mile west of the western well, the unconformity again rises to the stratigraphic position of the Beech Creek. At this location the stratigraphic relief from Beech Creek on the paleo-upland to Paoli Limestone in the paleovalley bottom is 170 to 180 feet. The paleovalleys of the major rivers are narrower in the north than in the south, and stratigraphic relief along the former is less than in the latter.

Clearly the sub-Pennsylvanian surface influenced the thickness of the Mansfield rocks. The oldest Mansfield rocks are found

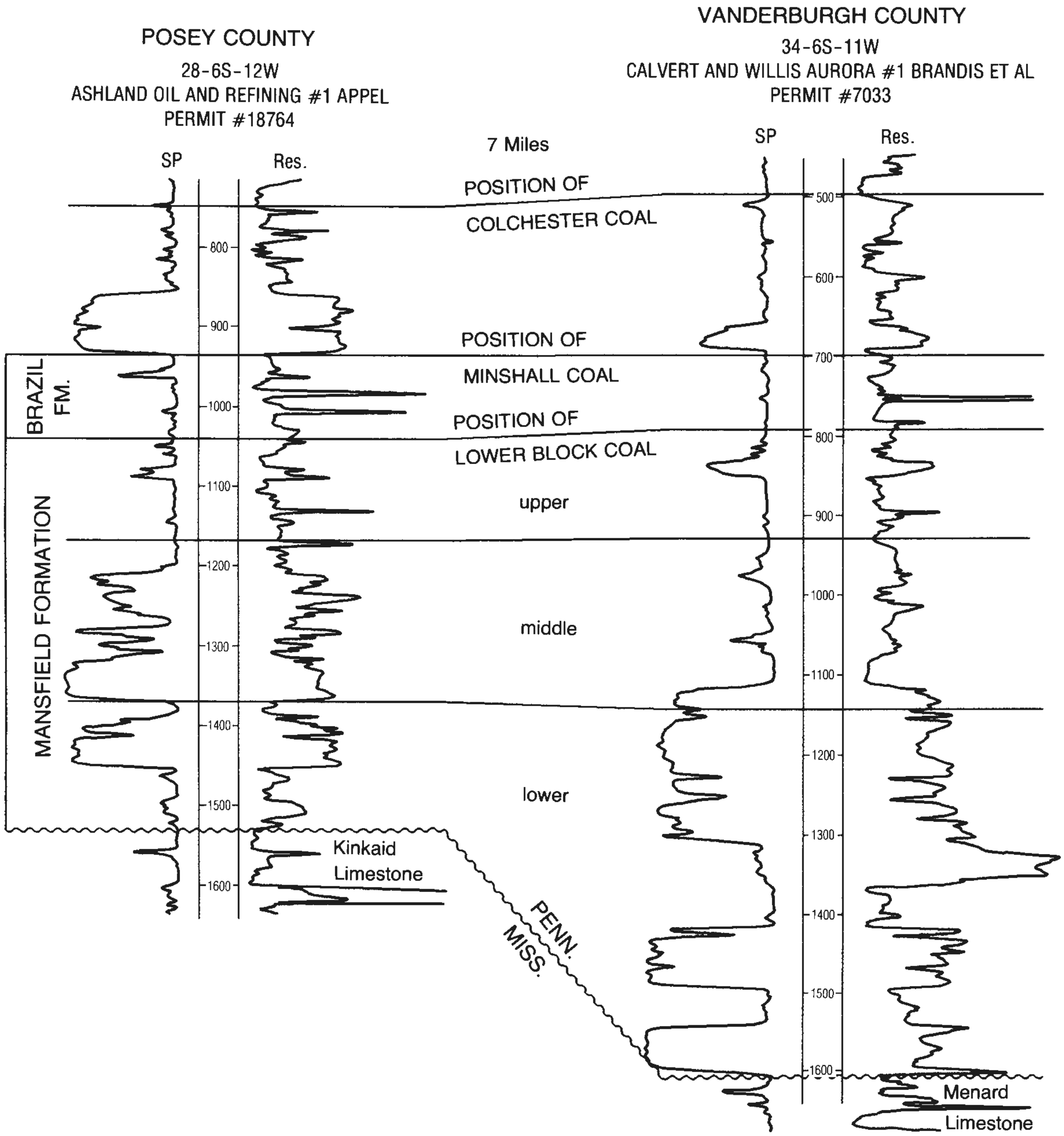


Figure 6. Correlated electric logs for two wells in Posey and Vanderburgh Counties.

in paleovalley bottoms, and presumably, the oldest Mansfield rocks in Indiana are those at the base of the Mansfield section in southernmost Vanderburgh County (fig. 4). Pennsylvanian sedimentation continued to fill the paleovalleys, and by the time the latest lower Mansfield sediments accumulated, the sub-Pennsylvanian topography was buried in southern and central part of the study area including several localities along the present outcrop. The paleohills of the sub-Pennsylvanian surface in many locations in the north were not buried until middle Mansfield time. As presently interpreted the whole of the sub-Pennsylvanian surface was not covered until the time marked by the stratigraphic position between the Pinnick and Blue Creek coals (fig. 2). Although sandstones dominate the paleovalley fills in many locations in the southern and central parts of the study area, shale valley fill is more common in many northern areas even where sandstone is commonly the basal Pennsylvanian

| System | Group | Formation | Member | Age |
|---|---|---|---|---|
| MISSISSIPPIAN SYSTEM | BUFFALO WALLOW GROUP | Grove Church Shale | | 330 M.Y. |
| | | Kinkaid Limestone | Goreville Ls. Mbr. | |
| | | | Cave Hill Mbr. | |
| | | | Negli Ck. Ls. Mbr. | |
| | | Degonia Sandstone | | |
| | | Clore Limestone | | |
| | | Palestine Sandstone | | |
| | | Menard Limestone | | |
| | | Waltersburg Sandstone | | |
| | | Vienna Limestone | | |
| | | Tar Springs Formation | | |
| | STEPHENS-PORT GROUP | Glen Dean Limestone | | |
| | | Hardinsburg Formation | | |
| | | Haney Limestone | | |
| | | Big Clifty Formation | | |
| | | Beech Creek Limestone | | |
| | WEST BADEN GROUP | Cypress Formation | | |
| | | Reelsville Limestone | | |
| | | Sample Formation | | |
| | | Beaver Bend Limestone | | |
| | | Bethel Formation | | |
| | BLUE RIVER GROUP | Paoli Limestone | | 340 M.Y. |
| | | Ste. Genevieve Limestone | | |
| | | St. Louis Limestone | | |
| | SANDERS GROUP | Salem Limestone | | |
| | | Harrodsburg Limestone | | |
| | | Muldraugh Formation | | |
| | BORDEN GROUP | | | 355 M.Y. |
| | | Rockford Limestone | | |
| | | New Albany Shale (upper part) | | 365 M.Y. |

Figure 7. Chart showing Mississippian nomenclature in this report.

rock type. As presently correlated, the lower Mansfield of Indiana is generally equivalent to the Caseyville Formation of Illinois as defined by Nelson (1989). The correlation is open to question because Nelson suggested that the informal Hindostan Whetstone beds of Indiana correlate to the Wayside Member of the Caseyville Formation in southern Illinois. Because stratigraphic position of the Hindostan beds is within the lower part of the middle Mansfield in Indiana and the Wayside rocks in Illinois occupy the lowest stratigraphic position in the Caseyville, the Hindostan and Wayside correlation of Nelson is rejected here. A better understanding of the relationship between the lower Mansfield in Indiana and the Caseyville in Illinois will be reached after subsurface studies are made of the Caseyville in Illinois and integrated with this study.

Devera's (1989) suggestion that marine to brackish conditions of sedimentation were much more extensive in southern Illinois during the early Pennsylvanian than has been recognized needs to be considered in future studies of the Mansfield in Indiana. Samples of the lower Mansfield from a few wells in southwestern Indiana contain fragments of marine limestone; the much more extensive evidence that is provided by outcrops in Illinois is lacking in Indiana. Rexroad and Merrill (1985) reported that in some places in southern Illinois marine fossils in shale and sandstone overlying the Grove Church Shale are earliest Pennsylvanian in age; they therefore concluded that deposition in marine environments continued without interruption across the Mississippian and Pennsylvanian boundary. However, Droste and Keller (1995) concluded that the Grove Church Shale, the youngest Mississippian formation in Indiana, occurs unconformably below the Mansfield on high paleohills in the western part of the Mt. Vernon Uplands. Correlations made in the present study show that the thickest sections of Grove Church Shale are in western Posey County and are overlain by rocks in the upper part of the lower Mansfield. The stratigraphic relationship proposed by Rexroad and Merrill (1985) might be explained as fortuitously preserved erosional remnants on high paleohills of the very earliest Pennsylvanian rocks below the regional unconformity, which would thus be interpreted as lying within the early Pennsylvanian.

## SUMMARY

The destination of a formation is valid if its limits can be documented by mapping at the surface. It has significant stratigraphic value if it can be reliably mapped in the subsurface. The top of the Staunton Formation and Raccoon Creek Group (fig. 2) in Indiana is placed at the top of the Seelyville Coal Member. The Seelyville coal (or its stratigraphic position) has not been mapped throughout the outcrop belt and cannot be traced reliably throughout the subsurface of Indiana. The nearest key bed with basinwide recognition to the stratigraphic position of the Seelyville is the Colchester Coal Member of the Linton Formation (fig. 2). The Lower Block coal, whose base defines the top of the Mansfield Formation, has not been mapped throughout the outcrop belt in Indiana, however, the approximate stratigraphic position of the Lower Block coal can be recognized throughout the subsurface in Indiana. The Caseyville Formation has been mapped at the surface in parts of southern Illinois and western Kentucky. The usefulness of the Caseyville as a worthy basinwide formation awaits documentation that Caseyville rocks can be mapped in the subsurface.

The erosional topography and regional geology of the sub-Pennsylvanian surface (Keller, 1990; Droste and Keller, 1989) facilitate the understanding of why there is so much variation in the thickness of the Mansfield Formation in Indiana. The depositional history of the Mansfield was strongly influenced by topographic relief developed prior to the onset of Pennsylvanian sedimentation. The lower Mansfield division of this report contains the thickest section of Mansfield rocks, and the variation in thickness of these rocks is most strongly influenced

by topography on the sub-Pennsylvanian surface. Except for several places where a few tens of feet of the uppermost part of this division are exposed above Mississippian rocks along the present outcrop, the depositional limit of the lower Mansfield is restricted to the subsurface in Indiana.

Initial Mansfield deposition occurred in the lowest elevations in major paleovalleys in southern Vanderburgh County. Except for several places along the eastern outcrop, sub-Pennsylvanian topography was buried during deposition of the lower Mansfield in the southern part of the study area. In the northern part of the study area, the oldest Pennsylvanian rocks are of the upper part of the lower Mansfield and are preserved only in the bottom of the deepest paleovalleys. In the northern area the highest paleohills on the sub-Pennsylvanian topography were eventually buried during the accumulation of rocks in the middle Mansfield division.

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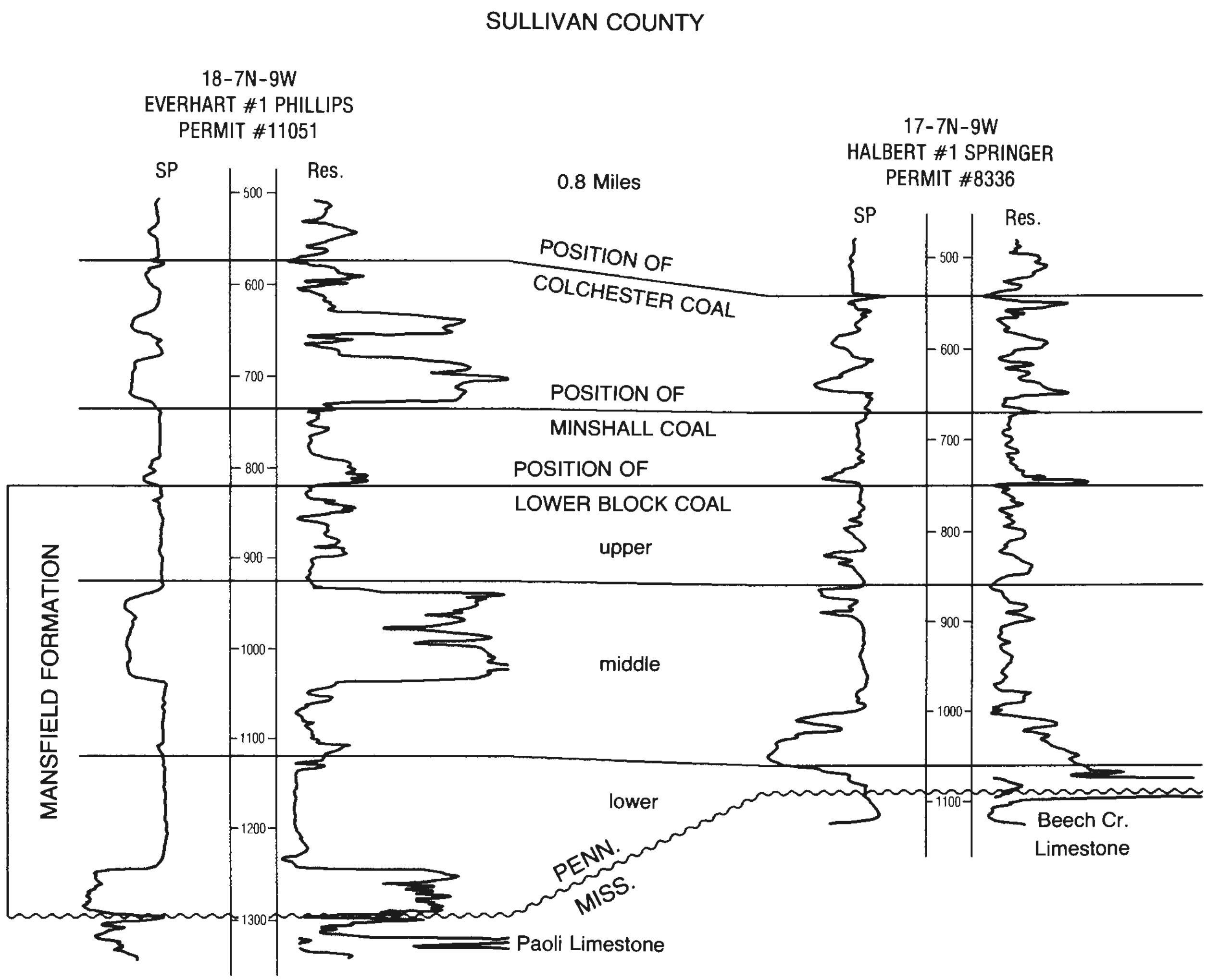


Figure 8. Correlated electric logs for two wells in Sullivan County.

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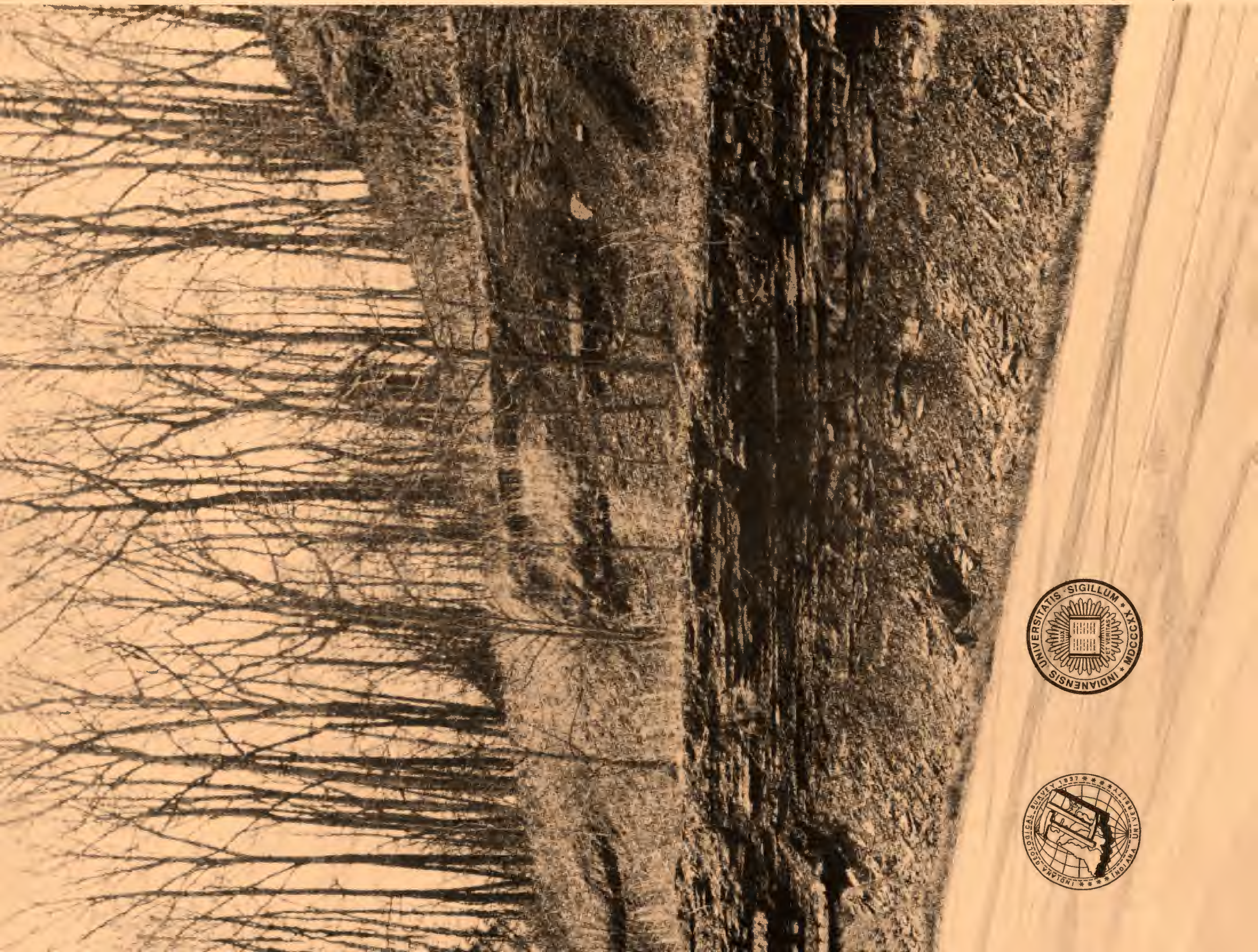

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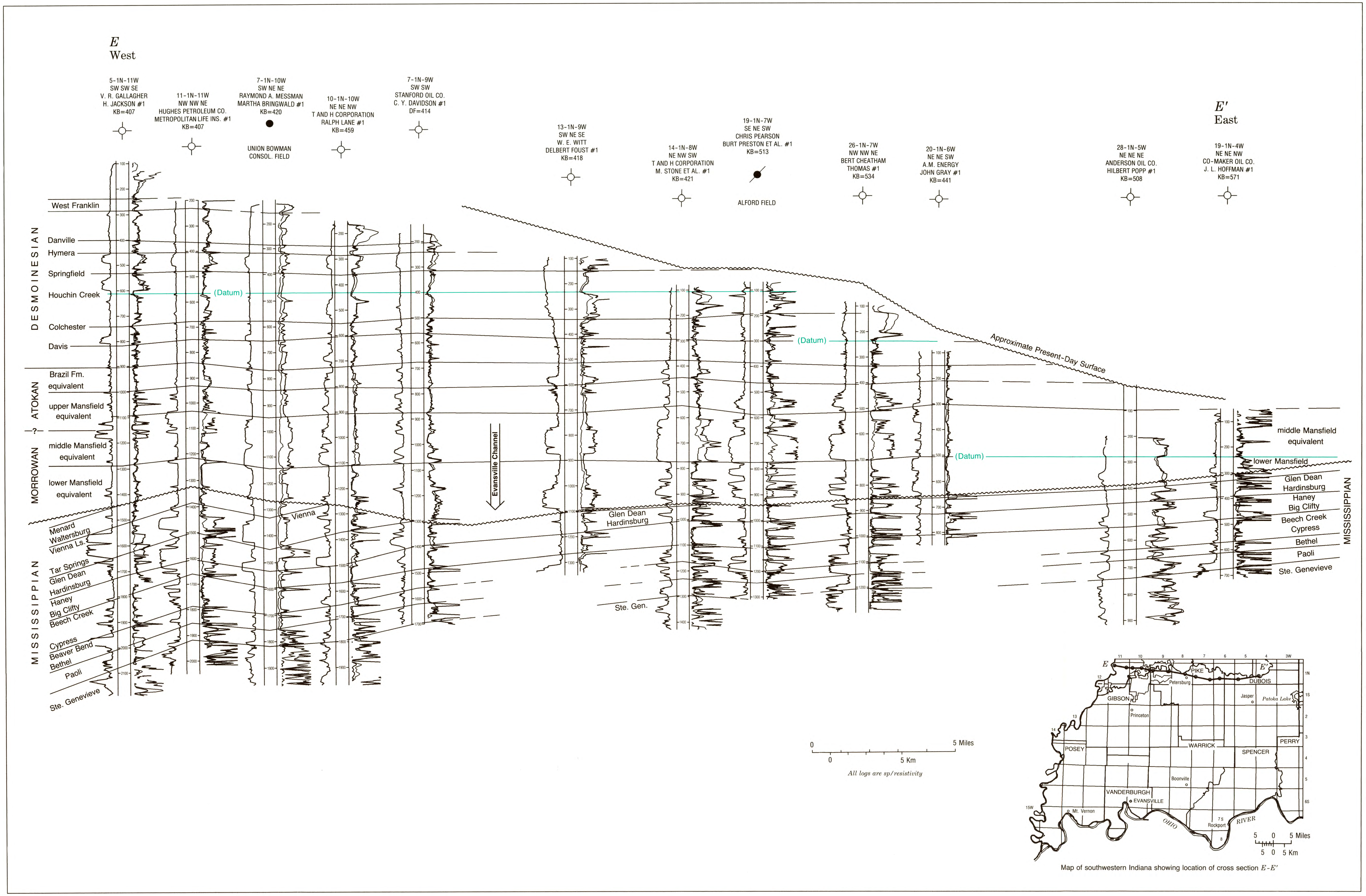


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# STRATIGRAPHIC CROSS SECTION $E$-$E'$ OF MISSISSIPPIAN AND PENNSYLVANIAN ROCKS IN SOUTHWESTERN INDIANA

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1995


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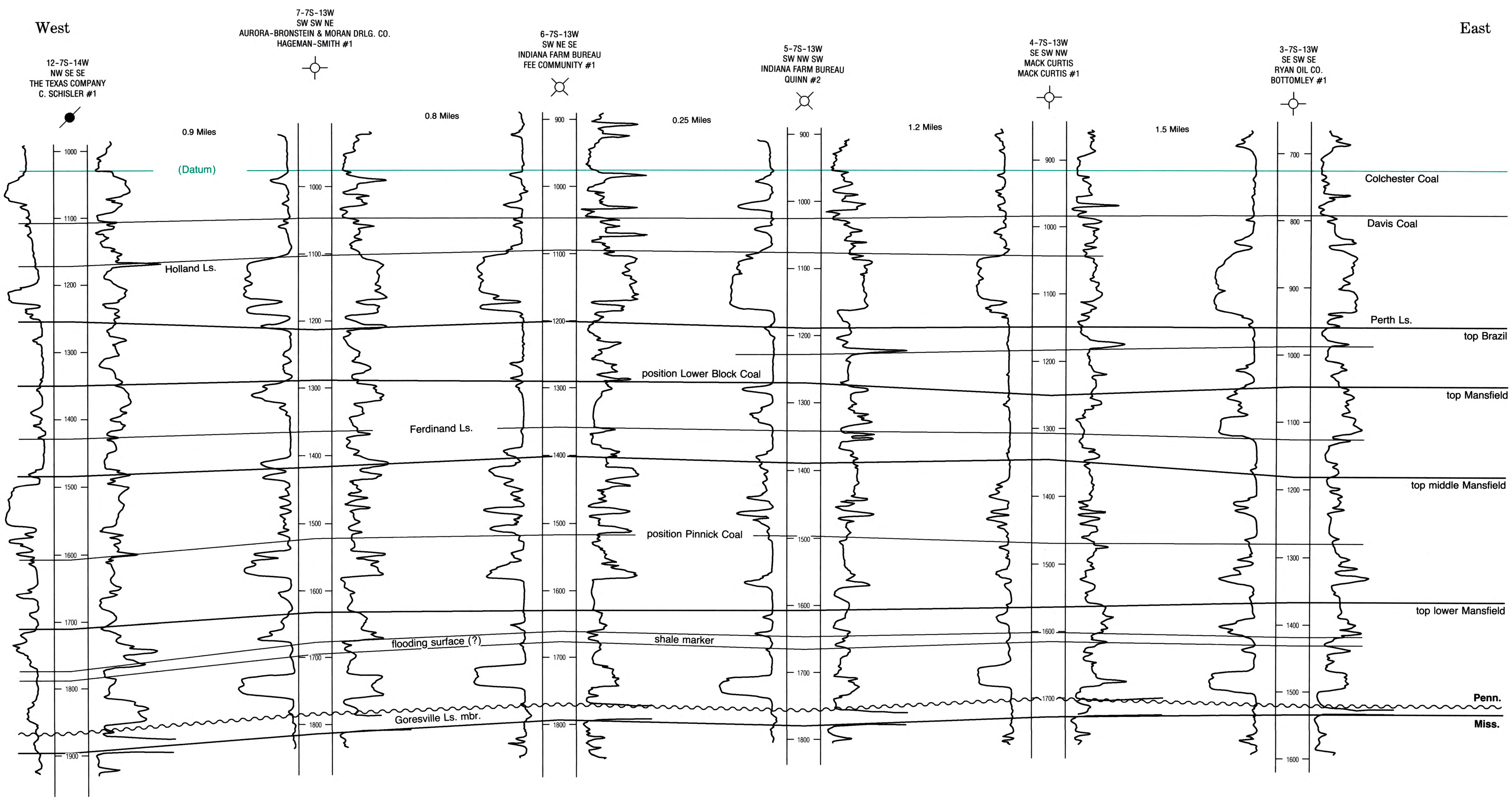


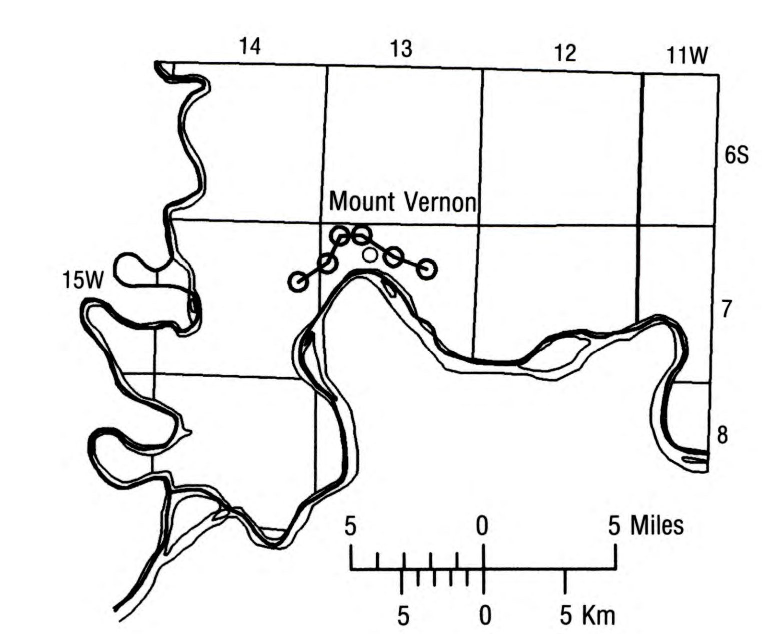


Map of southwestern Indiana showing location of cross section

*All logs are sp/resistivity*

Drafted by Rea Williams Kersey

# DETAILED STRATIGRAPHIC CROSS SECTION IN POSEY COUNTY, INDIANA

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1995