Compendium of Rock-Unit Stratigraphy in Indiana

BULLETIN 43

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY
SCIENTIFIC AND TECHNICAL STAFF OF THE
GEOLOGICAL SURVEY
JOHN B. PATTON, State Geologist
MAURICE E. BIGGS, Assistant State Geologist
MARY BETH FOX, Mineral Statistician

COAL SECTION
CHARLES E. WIER, Geologist and Head
HAROLD C. HUTCHISON, Geologist
RICHARD L. POWELL, Geologist
MARVIN T. IVerson, Geological Assistant

DRAFTING AND PHOTOGRAPHY SECTION
WILLIAM H. MORAN, Chief Draftsman and Head
ROBERT E. JUDAH, Geological Artist-Draftsman
MURIEL M. MALONE, Geological Draftsman,
JOHN E. PEACE, Senior Geological Draftsman
ROGER L. PURCELL, Senior Geological Draftsman
JAMES R. TOLEN, Senior Geological Draftsman
GEORGE R. RINGER, Photograher

EDUCATIONAL SERVICES SECTION
R. DEE RARICK, Geologist and Head

GEOCHEMISTRY SECTION
R. K. LEININGER, Geochemist and Head
MAYNARD E. COLLER, Chemist
LOUIS V. MILLER, Coal Chemist
MARGARET V. GOLDE, Instrumental Analyst
ALFRED E. WHITE, Geochemical Assistant

GEOLOGY SECTION
ROBERT H. SHAVER, Paleontologist and Head
HENRY H. GRAY, Head Stratigrapher
NED K. BLEUER, Glacial Geologist
CARL B. REXROAD, Paleontologist
ALLAN F. SCHNEIDER, Glacial Geologist

GEOPHYSICS SECTION
MAURICE E. BIGGS, Geophysicist and Head
ROBERT F. BLAKELY, Geophysicist
CHARLES S. MILLER, Instrument Maker
JOSEPH F. WHALEY, Geophysicist
CLARENCE C. HASKINS, Driller
JOHN R. HELMS, Geophysical Assistant

INDUSTRIAL MINERALS SECTION
LAWRENCE F. ROONEY, Geologist and Head
CURTIS H. AULT, Geologist
DONALD D. CARR, Geologist
MICHAEL C. MOORE, Geologist

PETROLEUM SECTION
T. A. DAWSON, Geologist and Head
LEROY E. BECKER, Geologist
G. L. CARPENTER, Geologist
ANDREW J. IREHA, Geologist
STANLEY J. KELLER, Geologist
DAN M. SULLIVAN, Geologist
JAMES T. CAZEE, Geological Assistant
JAMES F. THRASHER, Geological Assistant

PUBLICATIONS SECTION
GERALD S. WOODARD, Editor and Head
DONNA C. SCHULTZ, Sales and Records Clerk
Compendium of
Rock-Unit Stratigraphy in
Indiana

By ROBERT H. SHAVER, ANN M. BURGER, GARY R. GATES, HENRY H. GRAY,
HAROLD C. HUTCHISON, STANLEY J. KELLER, JOHN B. PATTON, CARL B.
REXRoad, NED M. SMITH, WILLIAM J. WAYNE, and CHARLES E. WIER

And dedicated to EARLY INDIANA STRATIGRAPHERS

DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY BULLETIN 43

PRINTED BY AUTHORITY OF THE STATE OF INDIANA
BLOOMINGTON, INDIANA: 1970
Contents
Introduction / 1
Rock-unit names / 4
Literature cited / 192
Index / 223

Illustrations
Cover Edgar R. Cumings, 1874-1967
Plate 1 Map showing locations of type sections and type localities or areas for rock units named for Indiana places / In pocket

Tables
Table 1 Era, period, system, epoch, and series names used in Indiana / 3
2 Quaternary and Tertiary rock-unit names used in Indiana / In pocket
3 Pennsylvanian rock-unit names used in Indiana / In pocket
4 Mississippian rock-unit names used in Indiana / In pocket
5 Devonian and Silurian rock-unit names used in Indiana / In pocket
6 Ordovician and Cambrian rock-unit names used in Indiana / In pocket
7 Some Indiana Geological Survey-abandoned and other little-used names for Cincinnatian rocks in Indiana / 47
8 Nomenclatural history of the Harrodsburg Limestone / 69
Compendium of Rock-Unit Stratigraphy in Indiana

By ROBERT H. SHAVER, ANN M. BURGER, GARY R. GATES, HENRY H. GRAY, HAROLD C. HUTCHISON, STANLEY J. KELLER, JOHN B. PATTON, CARL B. REXROAD, NED M. SMITH, WILLIAM J. WAYNE, and CHARLES E. WIER

Introduction

The Geologic Names Committee of the Indiana Geological Survey has maintained for several years tables of the more important rock-and time-stratigraphic names that have been used in Indiana. These tables show classification and nomenclature that are current and also include obsolete, colloquial, trade, and synonymous terms. First prepared for members of the Indiana Geological Survey, the tables are presented here (tables 1-6), together with descriptive information, for the many persons who use and contribute to geologic knowledge of the state.

This compendium, so composed, serves to clarify, unify, and stabilize stratigraphic terminology that nevertheless must remain in a fluid state in order to accommodate ever-increasing geologic information. It thus adds to, brings up to date, but does not supplant the next earlier nomenclatural summary for Indiana (Cumings, 1922, "Nomenclature and Description of the Geological Formations of Indiana," in Logan and others, Handbook of Indiana Geology), which contains much valuable information, particularly paleontologic, time stratigraphic, historical, and bibliographic, that is not repeated here. In recognition of our debt to our predecessors in the field of Indiana stratigraphy, we here dedicate the Compendium of Rock-Unit Stratigraphy in Indiana to the pioneers of Indiana stratigraphy. Among these, we cannot fail to mention George H. Ashley (1866-1951), Edgar R. Cumings (1874-1967), August F. Foerste (1862-1936), E. M. Kindle (1869-1940), Frank Leverett (1859-1943), Clyde A. Malott (1887-1950), and David Dale Owen (1807-60).
Begun under the direction of John B. Patton, the compilation of the tables and compendium was organized by the Geologic Names Committee, which consists of Henry H. Gray, Robert H. Shaver (chairman), and Charles E. Wier and formerly also of T. A. Dawson, John B. Patton (chairman), Ned M. Smith, Frank H. Walker, and William J. Wayne. All are grateful for contributions to the compendium, whether of authorship or review, that were made by other persons within and without the Geologic Names Committee. We are particularly grateful to T. G. Perry, who reviewed the entire manuscript.

The main body of this report, headed "Rock-Unit Names," is arranged alphabetically and consists of historical, bibliographic, descriptive, and correlative information for each of the Indiana rock-unit names that had had approved use in Geological Survey-sponsored publications or in manuscripts approved for publication as of December 31, 1968. An asterisk (*) indicates new names or conceptually revised names that were first published in this compendium or in other reports and maps as well before their definitive sources were published. Each name should be considered tentative until the definitive source is published.

Names regarded by the Indiana Geological Survey as unofficial for its use are not treated in primary fashion, but readers may consult the index, which lists the pages where the status of these names is reviewed. Neither are time and time-stratigraphic terms given primary consideration, and readers should refer to tables 1 through 6, which show the systematic interrelationships of these and rock-unit terms, both official and unofficial. The locations of type sections and type localities or areas for rock units named for Indiana places are shown on plate 1. The compendium is not intended to have a direct statement of stratigraphic and nomenclatural policy, although the Geological Survey has adopted most of the provisions of the "Code of Stratigraphic Nomenclature" (American Commission on Stratigraphic Nomenclature, 1961); some exceptions were published by the Geologic Names Committee (1963).

Because they had had much first-hand experience, authors of the lexicon were encouraged to be somewhat authoritative rather than
<table>
<thead>
<tr>
<th>Era</th>
<th>Period and System</th>
<th>Epoch and Series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quaternary</td>
<td>Pleistocene</td>
</tr>
<tr>
<td>Cenozoic</td>
<td>Tertiary</td>
<td>Pliocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oligocene*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miocene*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pliocene*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oligocene*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miocene*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pliocene*</td>
</tr>
<tr>
<td>Mesozoic</td>
<td></td>
<td>Cretaceous*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jurassic*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triassic*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permian*</td>
</tr>
<tr>
<td></td>
<td>Pennsylvanian</td>
<td>Monongahelian*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conemaughian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alleghenian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pottsvillian</td>
</tr>
<tr>
<td></td>
<td>Mississippian</td>
<td>Chesterian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valmeyeran</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kinderhookian</td>
</tr>
<tr>
<td>Paleozoic</td>
<td>Devonian</td>
<td>Senecan and Chautauquan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Erian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ulsterian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Holderbergian*</td>
</tr>
<tr>
<td></td>
<td>Silurian</td>
<td>Cayugan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Niagara</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alexandrian</td>
</tr>
<tr>
<td></td>
<td>Ordovician</td>
<td>Cincinnati</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Champlainian</td>
</tr>
<tr>
<td></td>
<td>Cambrian</td>
<td>St. Croixan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Albertan*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taconian*</td>
</tr>
</tbody>
</table>

*No deposits known in Indiana.

merely compilatory in their manner of presentation, so that primary authorship of each article is indicated by initials. An example of correct citation of a part of the compendium follows: Hutchison, H. C., 1969, Mansfield Formation, in Shaver, R. H., and others, Compendium of rock-unit stratigraphy in Indiana: Indiana Geol. Survey Bull. 43, p. 102.
For information relative to the extent and physical characteristics of physiographic provinces that are mentioned in the text, the reader is referred to Malott (1922).

**Rock-Unit Names**

**Alum Cave Limestone Member, Dugger Formation**, AMB & CEW Pennsylvanian System

*Type section:* Logan (1930, p. 168) first used the name Alum Cave in a columnar section for an indefinite interval of rock above the Springfield Coal Member. Although Culbertson (1932) had used the name Arthur Limestone for the limestone above the coal, Wanless (1939, table 2) reverted to Logan's term and called the unit the Alum Cave Limestone. Wier (in preparation) recognized it as the Alum Cave Limestone Member of the Dugger Formation and designated a type section near the site of the former town of Alum Cave, Sullivan County, in the NW¼NE¼ sec. 25, T. 9 N., R. 8 W.

*Description:* Typically a medium to blue-gray fine-grained argillaceous locally sandy fossiliferous limestone, the Alum Cave in most places is separated into two beds by a few inches of shale. The thickness of this member ranges from 0.1 to 11.8 feet; the average thickness is 2.5 feet. It generally contains a fauna rich in crinoid columnals, brachiopods, gastropods, and pelecypods. Fusulinids and ostracods are present in places; trilobites are rarely present.

The thickest exposures of the Alum Cave Limestone Member are in Sullivan and Greene Counties. It is not present in the subsurface of western Sullivan and Vigo Counties and cannot be identified in outcrop in northern Vigo County and Vermillion County. South of Sullivan County, the limestone is thin and nodular. It can be traced as gray to brown calcareous fossiliferous shale containing limestone nodules as far south as Pike and Warrick Counties. It lies 1 to 30 feet above the Springfield Coal Member but is generally less than 6 feet above this coal. (See Wier, in preparation.)

*Correlation:* The Alum Cave Limestone Member is known by the miners in Kentucky as the Pennywinkle rock and is correlated with
the St. David Limestone Member of the Carbondale Formation in Illinois.

*Antioch Limestone Member, Dugger Formation  AMB
Pennsylvanian System

Type section and description: Wier (in preparation) gave the name Antioch Limestone Member (of the Dugger Formation) to a conglomeratic limestone 6.4 feet thick, exposed in its type section in the NE¼SE¼NW¼ sec. 24, T. 8 N., R. 8 W., near Antioch Church, Sullivan County. This unit lies 2 feet below the Bucktown Coal Member (Vb) of the Dugger Formation and above a thin unnamed coal and black shale. Although it is generally 20 feet above the Alum Cave Limestone Member, the Antioch has locally been called the Upper Alum Cave Limestone. (See Wier, 1951, and Kottlowski, 1954). The Antioch has few good fossils, and partly broken and recrystallized remains of gastropods, brachiopods, and crinoid columnals can be identified. The unit is not present south of Knox County but is present northward from its type area to Vermillion County.

Antrim Shale, Senecan and Chautauquan Series, SJK & AMB
Devonian System

Type area: The name Antrim Shale was suggested by A. C. Lane in 1901 for the shale unit, then called the St. Clair, that was well exposed in Antrim County, Mich., and Lane (1902, map) later actually adopted the name. The name is now used north of the Cincinnati Arch in Indiana for the rocks that are coextensive with the Antrim of the Michigan type area, although the term Genesee Shale also has been used in this part of Indiana, by Blatchley (1898, p. 27-28), for example.

Description: The Antrim Shale in Indiana is typically a black fissile shale containing spores, but a greenish-gray shale is present in some places in the lower third of the unit. Pyrite is commonly found in the bottom part. Paraconformably overlying the Traverse Formation, the Antrim Shale ranges from 65 to more than 200 feet in thickness,
attaining the Indiana maximum thickness in Steuben County. It is present at the bedrock surface as far west as Lake County and as far south as Fulton County (Schneider and Keller, in preparation) but does not crop out in Indiana because of the thick cover of glacial drift in the area north of the Cincinnati Arch.

**Correlation:** The unit is correlated with the Blocher and Selmier Members of the New Albany Shale and that part of the New Albany just above the Selmier Member. (See Lineback, in preparation.) The Antrim Shale thins westward, and the upper part of this black shale grades laterally into the lower part of the Ellsworth Shale.

**Atherton Formation, Kansan to Recent Stages, WJW**

*Pleistocene Series*

**Type locality:** No single type section has been selected, but the Atherton Formation was named for Atherton, which is about 10 miles north of Terre Haute along the Vigo County-Parke County line (Rosedale Quadrangle), “an area in which many exposures are available and in which all variations of the formation can be examined” (Wayne, 1963, p. 31-32).

**Description:** The Atherton Formation consists of coarse- to fine-grained sediments deposited by glacial meltwater and closely associated sediments of aeolian or lacustrine origin that intertongue with them. The formation has four distinct lithofacies that have resulted from specific environments and modes of deposition: (1) gravels and sands of glacial outwash deposits (outwash facies); (2) silts, sands, and clays of glacial lake sediments (lacustrine facies), which commonly interfinger with or grade into outwash sediments; (3) sands of dunes (dune facies), commonly derived from and deposited on the surface of outwash sediments by wind action; and (4) silts and clays of loess deposits (loess facies), which also have been derived by wind action from the outwash facies.

The outwash facies is present as a surface unit throughout Indiana; in the northern part of the state it underlies both broad plains and valleys, but in the southern part it is largely restricted to valleys. The
thickness is extremely variable, and nearly 400 feet of sediments referable to the outwash facies have been reported in a few places by well drillers. More commonly, however, thicknesses range from 30 to 100 feet. Distribution of the lacustrine facies is similar to that of the outwash facies. It constitutes the fill of many valleys tributary to the Wabash, White, Ohio, and Whitewater Rivers in the southern half of Indiana. Sand of the dune facies is found along some parts of the lower Wabash Valley and along the valleys of both White River and the East Fork of White River. The most extensive areas underlain by the dune facies are found associated with the outwash and lacustrine facies sediments in the northwestern part of the state. Mappable areas of the loess facies are found only along the Wabash and Ohio Valleys, although tongues of loessal silt are traceable into other facies of the Atherton Formation and other Pleistocene formations.

**Correlation and fossil-bearing beds:** Sediments referred to the Atherton Formation span the entire Pleistocene Series in Indiana. Most of the upper part of the formation, however, is assigned to the Wisconsinan Stage. In a few areas in the southern part of Indiana the surficial part of the unit is Illinoian in age; most of the sediments of Kansan age assignable to the Atherton Formation crop out in the lower parts of steep exposures and thus have little surficial extent.

The loess facies of the Atherton Formation includes four named members: the Cagle Loess Member of Kansan age, the Loveland Loess Member of Illinoian age, and the Farmdale and Peoria Loess Members of Wisconsinan age. The Peoria is further separable into at least two tongues, the lower one of which is called the Morton Loess Tongue.

The Cagle Loess Member also corresponds to the lower *Hendersonia occulta* bed; the middle *Hendersonia occulta* bed is part of the Loveland, the upper *Hendersonia occulta* bed is the Morton Loess Tongue of the Peoria, and the *Vertigo alpestris oughtoni* bed is an unnamed tongue of the Peoria that lies between the Cartersburg and Center Grove Till Members of the Trafalgar Formation (Wayne, 1963, fig. 2, p. 34, 36-38). The unnamed Peoria tongue probably correlates
with the Richland Loess of Frye and Willman (1960) and with the Connersville Interstade of Gooding (1963).

**Aux Vases Formation**, Valmeyeran Series, RHS
Mississippian System

*Type section and use of name in Indiana:* The name Aux Vases Sandstone was given by Keyes (1892, p. 296) to sandstone exposed in the bluffs at the mouth of the Aux Vases River in eastern Ste. Genevieve County, Mo. The name was applied to the Indiana outcrop by Malott (1945, 1946, 1952), but following Gray, Jenkins, and Weidman (1960, p. 49), the Aux Vases of Malott is here considered as part of the Paoli Limestone. The Aux Vases Formation—the surname Formation preferred by us—of this compendium comprises the rocks that were long called the Aux Vases or basin Aux Vases in subsurface work in southwestern Indiana and that were described as such by Pinsak (1957, p. 19, 22) and Swann (1963, p. 18-20, 29, 30). These Aux Vases rocks underlie the Renault Formation (Limestone) of the Illinois Basin, give way eastward in Indiana to the middle and upper parts of the outcropping Levias Member of the Ste. Genevieve Limestone, and are coextensive with the type Aux Vases of Missouri. (See also Swann and Atherton, 1948.)

*Description:* As described by Pinsak (1957), the Aux Vases from Knox County to Perry County and southwestward consists of generally less than 25 feet of interbedded dolomite, green calcareous shale, and green argillaceous dolomite, all grading southwestward into fine- to medium-grained quartz and limestone sand in a green argillaceous matrix; in some places a higher unit, in part separated from the lower by purer carbonate rocks, consists of arenaceous dolomite. According to Swann (1963), the rocks of this lithology extend in tonguing relationship eastward generally to within 20 miles of Indiana outcrop and crop out in places within 10 feet of the top of the Levias, as in Orange County.

*Correlation:* The Aux Vases Formation intertongues, and thus correlates in this sense, with middle and upper parts of the outcropping
Levias Member of Indiana, but the common bounds of these rocks as *named* units, and perhaps their relative ranks, are not yet defined satisfactorily in Indiana. Southward, the Aux Vases Formation extends into the type Rosiclare Sandstone Member of southern Illinois and westward into the Aux Vases Sandstone of deeper parts of the Illinois Basin, which in turn is coextensive with the type Aux Vases of Missouri. The Ste. Genevieve guide fossil *Platycrinites penicillus* has been observed in the Aux Vases of areas west and south of Indiana and in Aux Vases lateral equivalents in Indiana. Thus following Pinsak (1957) and Swann (1963), the Aux Vases Formation of Indiana is assigned to the pre-Chesterian series, although the original description in Missouri provided for assignment to the Chesterian.

**Beaver Bend Limestone, West Baden Group, HHG**

Mississippian System

*Type locality and description:* The Beaver Bend Limestone was named by Malott (1919, p. 9-10) for exposures near Huron, Lawrence County, where Beaver Creek makes a conspicuous bend. A gray oolitic biomericitic limestone, the unit is generally 10 to 14 feet thick (Malott, 1952, p. 13) but may be as thin as 1 foot (Malott, 1952, p. 27) or as thick as 27 feet (Gray, Jenkins, and Weidman, 1960, p. 47). It is known on outcrop from central Putnam County southward to the Ohio River and can be recognized in the subsurface from Parke County southwestward. The Beaver Bend Limestone conformably overlies the Bethel Formation and is overlain conformably by the Sample Formation or disconformably by the Mansfield Formation (lower Pennsylvanian).

*Correlation:* Although other correlations have been suggested, the Beaver Bend Limestone is now thought to be equivalent to the lower part of the Ridenhower Formation of the Illinois standard section (Swann, 1963, fig. 20). In the subsurface of the lower Wabash Valley area, the Beaver Bend commonly has been called the Lower Paint Creek Limestone, but Sullivan (in preparation) has suggested that the latter term be suppressed in favor of the more precise name, Beaver Bend.
Beech Creek Limestone, Stephensport Group, HHG
Mississippian System

Type section, description, and distribution: The Beech Creek Limestone was named by Malott (1919, p. 11-15) for exposures along Beech Creek in Greene County. Later he (1952, p. 73-75) designated a type section at Ray's Cave in the NE\(^4\)NW\(^3\) sec. 13, T. 7 N., R. 4 W. The formation is typically a gray sparry biomicritic limestone ranging from 8 to 33 feet in thickness (Perry and Smith, 1958, pl. 1). The lower third of the formation is characteristically somewhat darker than the upper two-thirds. Typical fossils include large crinoid columnals as much as 25 mm in diameter and a variety of brachiopods. (See Malott, 1952, p. 15.)

The Beech Creek is recognized at the surface from Owen County southward to the Ohio River; in the subsurface, where it has commonly been called the Barlow Lime, it is recognized from Clay County southwestward. It is the most widely recognized marker in the Chesterian Series, and only in a few places can this unit be demonstrated to be absent from its expected position. The Beech Creek conformably overlies the Elwren Formation and is overlain conformably by the Big Clifty Formation or disconformably by the Mansfield Formation (lower Pennsylvanian).

Correlation: The Beech Creek Limestone was considered by Malott (1931, p. 222; 1952, p. 15) to be equivalent to the upper part of the Paint Creek Formation in Illinois. The stated basis for this assignment was paleontologic affinity, but a prominent and widespread sandstone bed above each of these formations was also considered to be significant. Subsurface information, however, has demonstrated physical continuity of the Beech Creek Limestone (Barlow) into the lower part of the Golconda Formation in southwestern Illinois (Swann and Atherton, 1948), and the name Beech Creek has now been accepted as part of the Illinois standard section (Swann, 1963, fig. 20).
**Beechwood Member**, North Vernon Limestone, AMB & JBP
Devonian System

*Type locality and reference section:* The Beechwood Member of the North Vernon Limestone was named by Butts (1915, p. 120) for exposures in the Ohio River area near Beechwood Station, Jefferson County, Ky., of a gray thick-bedded coarsely crystalline crinoidal limestone containing rounded phosphatic pebbles in the basal few inches. A reference section of 3.5 feet of typical Beechwood rocks is in the Berry Materials quarry on the northeast edge of North Vernon, Jennings County (SW\(^4\)SW\(^4\)SE\(^4\) sec. 27, T. 7 N., R. 8 E.).

*Description:* In most of southern Indiana and northern Kentucky, the Beechwood Member is the uppermost unit of the North Vernon Limestone, although in some places the lithology of the Silver Creek Member extends to the top of these rocks of Hamilton age. Where identifiable the Beechwood ranges from a few inches to 10 feet in thickness, and although this thickness is extremely variable in places, the maximum thickness is in Clark County. The unit thins irregularly to southern Bartholomew County, north of which it is covered by glacial drift. Because the associated Silver Creek Member is absent north of southern Scott County, thus commonly making separation from the underlying Speed Member impossible, the name Beechwood and other North Vernon member names are not used, and only the formation name is left in use north of Scott County.

The irregular lower contact and water-worn phosphatic pebbles indicate a disconformity at the base of the Beechwood (Butts, 1915; Dawson, 1941), although Patton and Dawson (1955, p. 42) suggested that some of the Silver Creek was deposited contemporaneously with the type Beechwood.

*Correlation:* Originally known as the Crinoidal or Encrinital Limestone, and later as Siebenthal's (1901) restricted Sellersburg Limestone, the Beechwood was correlated with the Hamilton Group of New York, first by Borden (1874) and later by Hall (1879b) and Kindle (1899, p. 110), on the basis of the brachiopods *Tropidoleptus carinatus* and *Chonetes coronatus*. Savage (1931) reported that the
Beechwood fauna could be recognized as far south as Allen County, Ky. The unit correlates with the Centerfield Limestone of New York (Ludlowville in age) and possibly with the Boyle Limestone of central Kentucky. The Beechwood is represented by the upper parts of the Lingle Limestone of Illinois and the Traverse Group of Michigan and the Traverse Formation of northern Indiana. (See Cooper and Warthin, 1936; Thornbury and Deane, 1955; Stumm, 1964; Pinsak and Shaver, 1964; and Meents and Swann, 1965).

**Belfast Member**, Brassfield Limestone, Silurian System

*Type area and description:* Foerste (1896, p. 163-164) first applied the name Belfast Bed to 3 to 6 feet of argillaceous dolomitic silty-appearing rocks at the base of the Brassfield Limestone, which was well exposed in Highland County, Ohio. He later (1931, p. 184) considered the Belfast to be a member of the Brassfield Limestone. Although this member is widely recognized east of the Cincinnati Arch in Ohio and Kentucky, Rexroad (1967) only tentatively recognized it west of the arch near Elkhorn Falls, south of Richmond, in eastern Indiana (SE¼NW¼ sec. 22, T. 13 N., R. 1 W.). At this outcrop 2½ feet of the Belfast is questionably recognized, and this is the only location of Belfast identification in Indiana. It unconformably overlies the Whitewater Formation (upper Ordovician) strata and is overlain by the rest of the Brassfield Limestone.

*Correlation:* The Belfast Member is equivalent in age to a lower part of the Kankakee Dolomite and (or) the uppermost part of the Edgewood Dolomite of northeastern Illinois.

**Bethel Formation**, West Baden Group, Mississippian System

*Type locality and description:* The name Bethel Sandstone was first used by Butts (1917, p. 63-64) in describing exposures of thick-bedded coarse-grained sandstone and slabby sandstone 10 to 40 feet thick in the vicinity of Bethel School, near Marion, Crittenden County, Ky.

*History of name in Indiana:* When first recognized in Indiana the
unit was identified (Malott, 1919, p. 9) with the Sample Sandstone Member of the Gasper Oolite (Limestone) of Butts (1917, p. 70-73). When the formation was later proved to be older (Cumings, 1922, p. 515), it was given the name Mooretown Sandstone for a village in Lawrence County. This name was used for many years, but the Bethel identification was established by Swann and Atherton (1948) among others. The present name was adopted as the Bethel Formation (Indiana Geological Survey, 1957, p. 6) in recognition of the mixed lithologic character of the unit.

**Description and distribution:** The Bethel Formation encompasses varying lithologies, including gray clayey shales, wavy bedded finegrained sandstones, and a few thin beds of coal. It ranges from 10 to 42 feet in thickness (Indiana Geological Survey, 1957, pl. 2) and generally forms covered slopes. The unit crops out from Putnam County southward to the Ohio River and can be recognized in the subsurface from Parke County southwestward. Over most of this area it conformably overlies the Paoli Limestone of surface nomenclature (Sullivan, in preparation). It is overlain conformably by the Beaver Bend Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

Scattered deposits of poorly consolidated varicolored sand overlying the Salem and St. Louis Limestones in upland areas of Washington, Clark, Floyd, and Harrison Counties were designated the Ohio River Formation by Ashley and Kindle (1903, p. 70). Wayne (1960) restudied these deposits and assigned them a Paleocene age, but equivalent deposits in Kentucky, called the Tip Top Sand by Sutton (1931), have for some time been considered Chesterian in age (Ray, Butler, and Denny, 1946; Swadley, 1963). A recent petrographic study directed by Paul E. Potter (Indiana University Sedimentation Seminar, in preparation) conclusively demonstrated that the Tip Top Sand and the Ohio River Formation are remnants of an extensive channel filling that belongs to the Bethel Formation. In these scattered outliers, the rocks have been “decemented” as a result of prolonged exposure. Consolidation has further been destroyed by physical lowering of the sand bodies as the underlying limestone was dissolved.
**Correction:** Rocks that formerly were referred to the middle part of the Paint Creek Formation in the Illinois standard section are now designated as the Bethel Formation (Swann, 1963, fig. 20).

**Big Clifty Formation,** Stephensport Group, HHG  
Mississippian System

*Type area and description:* The original name, Big Clifty Sandstone, is generally credited to Norwood (1876), who, however, did not make the attribution of the name clear. The source of the name is indicated only indirectly as, for example “... seen in Grayson County (Kentucky), where it received its name” (Norwood, 1876, p. 427), and “the Big Clifty sandstone is then the most prominent rock exposure on Big Clifty Creek” (Norwood, 1876, p. 405). The unit was described as a buff to cream heavy-bedded and cross-laminated fine-grained friable sandstone, 60 to 130 feet thick, passing westward into shales.

*History of name in Indiana:* When adopted for Indiana, the name was modified to Big Clifty Formation (Indiana Geological Survey, 1957, p. 6) because the unit was redefined to include an upper gray shale member (Gray, Jenkins, and Weidman, 1960, p. 40-41). The name Indian Springs Shale had been applied to this shale for a time (Malott and Thompson, 1920, p. 522; Malott, 1931, p. 224), and later the shale was tacitly assigned to the Golconda Formation (Malott and Esarey, 1940; Malott, Esarey, and Bieberman, 1948). The major part of the Big Clifty Formation in Indiana was for many years referred to the Cypress Sandstone, a result of miscorrelation as explained below.

*Description and distribution:* The Big Clifty Formation is composed, in descending order, of 20 feet of gray sparingly fossiliferous shale, 25 to 40 feet of thin-bedded fine-grained sandstone, and in places about 1 foot of black pyritiferous shale at the base. The sandstone member of this formation is a conspicuous cliff former of great lateral extent (Gray, Jenkins, and Weidman, 1960, p. 40-41). The formation is recognized on the surface from Owen County southward to the Ohio River and in the subsurface, where shale is more abundant.
than sandstone from central Clay County southwestward. The name Jackson Sand has sometimes been applied to sandstone bodies within this unit in the subsurface. The Big Clifty Formation conformably overlies the Beech Creek Limestone (Barlow Lime) and is overlain conformably by the Golconda Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

Correlation: Butts (1917, p. 86-90) was apparently the first to equate the Big Clifty Sandstone of western Kentucky with the Cypress Sandstone of southern Illinois. This view was shared by Malott (1919, p. 17; 1952, p. 16), and the name Cypress Sandstone was for many years applied in Indiana to the cliff-forming sandstone that on outcrop forms the major part of the present Big Clifty Formation. The name Cypress, however, is properly applied in Indiana to the subsurface expression of an older unit, the Elwren Formation, as shown by Swann and Atherton (1948) and McFarlan and others (1955). As currently understood, the Big Clifty Formation of Indiana is equivalent to the Fraileys Shale of the Illinois standard section (Swann, 1963), which name, in turn, applies to rocks formerly considered to be the middle part of the Golconda Formation.

Black River Limestone, Champlainian Series, HHG
Ordovician System

Type area: The Black River Limestone was named by Vanuxem (1842, p. 38) for exposures on the Black River, Oneida and Lewis Counties, N.Y. This unit, which is about 100 feet thick, has been extensively studied in New York and adjacent parts of Canada and is most commonly regarded as a group in that area.

Description: The only outcrops of the Black River Limestone in Indiana are in a small structurally disturbed area about 1 mile east of Kentland (Newton County), but in the subsurface the formation is widely recognized. It consists of tan very finely crystalline to lithographic argillaceous and dolomitic limestone and is less than 100 feet thick in the northwest corner of the state and more than 600 feet thick in the southwest (Gutstadt, 1958a, p. 63). The Black River
overlies the St. Peter Sandstone in northwestern Indiana and the Joachim Dolomite in the remainder of the state. It is overlain by the Trenton Limestone (Champlainian) except in southeastern Indiana, where the Trenton is not recognized and the Black River is overlain by the Lexington Limestone (Champlainian and Cincinnatian). In a few wells neither the Lexington nor the Trenton is present, and shales of the Kope Formation (Champlainian and Cincinnatian) overlie the Black River.

Correlation: The Black River Limestone of Indiana subsurface usage is equivalent in age to the Plattin Limestone of Missouri and to the Platteville Group of northern Illinois (Gutstadt, 1958a, p. 61; Buschbach, 1964, p. 23). The Indiana unit thus constitutes only a part of the Blackriveran Stage (table 6). Because of the resulting confusion and because of the distance from the type area, it seems advisable to find another name for the Black River Limestone in Indiana.

In Kentucky equivalent rocks are assigned to the High Bridge Limestone, a name which is used in a group sense by McFarlan and White (1948) and is subdivided into the Tyrone Limestone, Oregon Limestone, and Camp Nelson Limestone (Gutstadt, 1958a, p. 61, 71).

Blocher Member, New Albany Shale, Devonian System AMB

Type section: The name Blocher Formation was first used by Campbell (1946, p. 840) in describing 8 to 10 feet of black shale and layers of sandstone in the basal part of the New Albany Shale. Lineback (1968 and in preparation) redefined the unit to include the section up to the base of the Spatiocaris Zone of Campbell, which is now recognized as the Selmier Member, reduced the rank of the unit to that of member, and designated a type section along Indiana Highway 56 about 1 mile east of the intersection with Indiana Highway 3, near Blocher, Scott County (SE1/4SW1/4SW1/4 sec. 9, T. 3 N., R. 8 E.).

Description: The Blocher Member of the New Albany Shale is a brownish-black carbon-rich calcareous fissile pyritic shale, which is light gray and has brown and yellow stains on weathered surfaces. Beds of dolomite, dolomitic sandstone, and gray shale are present in
places, and a black calcareous limestone-like facies commonly is near the base. In surface exposures the Blocher Member paraconformably overlies the North Vernon Limestone (middle Devonian) and ranges from 3 to 5 feet in thickness. It is overlain conformably by the Selmier Member of the New Albany. The Blocher is thinnest at Lexington, Scott County, but thickens both to the north and south, and reaches its maximum thickness of 85 feet in Pike County. It is widely recognizable in the southeastern Indiana outcrop area and in the subsurface, but where the Selmier Member is absent, the Blocher cannot be separated from the rest of the New Albany (Lineback, in preparation).

Correlation: The Blocher Member is equivalent to the Alto Formation of Illinois, to the lower part of the Antrim Shale of Michigan, and to the lower part of the Dowelltown Member of the Chattanooga Shale of Tennessee. On the basis of conodont studies, it has been correlated with the lower part of Zone to1 of the German standard. (See Campbell, 1946; Conant and Swanson, 1961; Lineback, in preparation.)

Blue Creek Coal Member, Mansfield Formation, HCH
Pennsylvanian System

Type section: The Blue Creek Coal Member, named by Gray, Jenkins, and Weidman (1960, p. 25, 71, 72), consists of the coal mined extensively on Coal Mine Ridge at the headwaters of Blue Creek in southeastern Martin County and in northeastern Dubois County. The type section is in an abandoned strip mine in the SW¼NW¼ sec. 10, T. 1 S., R. 3 W. (See also Jenkins, 1956, p. 30-31.)

Description and correlation: Near the type section the Blue Creek Coal Member is divided into two benches. The upper bench, 2.0 feet thick, is dull banded and slightly fissile to shaly, and the lower bench, 2.8 feet thick, is bright banded and has blocky to hackly fracture. The roof of the coal is dark-gray carbonaceous ferruginous shale that is 8.0 feet thick and overlain by 6.5 feet of yellow-brown to light-gray carbonaceous micaceous ferruginous sandstone. The floor is white fire clay.
The Blue Creek Coal Member is extremely variable both in quality and thickness within relatively short distances. Near Coal Mine Ridge the coal ranges from less than 1.0 foot to more than 5.0 feet in thickness; in places it is an economically minable coalbed as described above, but at others it is hardly more coaly than a black fissile shale. In this area the coal lies some 60 to 80 feet below the top of the Mansfield Formation and approximately 100 feet above the base.

The Blue Creek coal extends northward to Shoals, Martin County (Gray, Jenkins, and Weidman, 1960, p. 25; pl. 1), south along its outcrop to the southern part of Dubois County, and west and southwest down the structural dip to the west edge of Dubois County (Hutchison, 1964).

Blue River Group, Valmeyeran and Chesterian Series, NMS
Mississippian System

Type area: The Blue River Group was named by Gray, Jenkins, and and Weidman (1960, p. 48) for the Blue River in Washington, Harrison, and Crawford Counties. Many excellent exposures (of as much as nearly half the group in places) are in the valley walls of the Blue River from about 2.5 miles northeast of Fredricksburg, Washington County, to the Ohio River.

Description: The Blue River Group is formed largely of carbonate rocks but has significant amounts of gypsum, anhydrite, shale, and calcareous sandstone. The oldest of three formations in the group is the St. Louis Limestone, which is overlain by the Ste. Genevieve Limestone and by the Paoli Limestone at the top of the group.

The Blue River Group crops out in an area extending from the Ohio River in Harrison County to the vicinity of Sugar Creek in northeastern Parke County and adjacent Montgomery County. The outcrop belt has approximately county width in Harrison County, narrows sharply northward in adjacent parts of Orange and Lawrence Counties, and gradually diminishes northward to its termination, where it is overlapped by Pennsylvanian rocks. The combined thicknesses of the
ROCK-UNIT NAMES

constituent formations are 485 feet in southern Harrison County (McGrain, 1943, fig. 2); about 280 feet in Washington County (Sunderman, 1968); about 400 feet in northwestern Orange County (Gray, Jenkins, and Weidman, 1960, p. 48); and 240 feet in southern Monroe County (Malott, 1952, p. 57). From well records the group is known to be 150 to 170 feet thick in parts of Owen and Putnam Counties, and in other areas the subsurface thicknesses range from 325 to 450 feet near the outcrop to a maximum of 650 feet in Posey County (Pinsak, 1957, pl. 1).

The Blue River Group rests conformably on the Salem Limestone, but in places along the outcrop it is overlain unconformably by rocks of Chesterian, Pennsylvanian, or Cenozoic age. Although the upper boundary, with the West Baden Group, appears to be mostly conformable, the lowermost West Baden rocks in different places consist of sandstone, shale, or limestone, some rocks projecting down into uppermost Blue River (Paoli or Ste. Genevieve) rocks (McGrain, 1947?, p. 200; Malott, 1952, p. 45-49; Perry and Smith, 1958, p. 3637). Generally north of Owen County, Pottsvillian (lower Pennsylvanian) rocks overlap successively older Blue River rocks northward.

**Correlation and the Mitchell problem:** The group has no exact named equivalent in neighboring states, and it spans the Valmeyeran-Chesterian boundary as that boundary generally is recognized. (See "St. Louis," "Ste. Genevieve," and "Paoli Limestones.") In Indiana the Blue River Group includes rocks that at different times were assigned to units having the now-obsolete names Mitchell Formation (Limestone, Group) (Hopkins and Siebenthal, 1897, p. 298-299; Elrod, 1899, p. 259; Ashley and Kindle, 1903, p. 73; Malott, 1919, p. 8-10, and 1921, p. 365; Logan, 1926, p. 343) and Lower Kaskaskia Limestone (Kindle, 1896, p. 331-332). The upper boundary of the Mitchell, in these older uses, was as low as the top of the St. Louis part of the Blue River Group (Elrod, 1899, p. 259) and as high as the top of the Beaver Bend Limestone (Malott, 1919, 1921; Logan, 1926), although the term Mitchell is more nearly synonymous with "St. Louis" than with any other name. Recommendations for abandonment of the term Mitchell are implicit from Cumings (1922, p. 507) and Perry and Smith (1958, p. 19).
**Bond Formation**, McLeansboro Group, Pennsylvanian System

*Type area:* Kosanke and others (1960, p. 38) first used the name Bond Formation for rocks exposed in Bond County, southwestern Illinois. Wier and Gray (1961) and Wier (in preparation) extended usage of this name into Indiana for rocks between the base of the Shoal Creek Limestone Member and the top of the Livingston Limestone Member in the McLeansboro Group.

*Description:* In Indiana the Bond Formation consists, in ascending order, of the Shoal Creek Limestone, St. Wendel Sandstone, Fairbanks Coal, Riverview Limestone, and Livingston Limestone Members and unnamed beds of shale, sandstone, and coal. The formation is made up of about 95 percent sandstone, shale, and siltstone and minor amounts of limestone, clay, and coal. The entire formation is present only in two widely separated areas in the state, western Sullivan County and the area of northwestern Posey County and southwestern Gibson County. Because of the distance between these two areas, exact correlation and corresponding thicknesses are uncertain, but the Bond Formation is at least 150 feet thick in Indiana (Wier, in preparation).

**Borden Group**, Valmeyeran Series

*Type locality:* The name Borden Series was proposed by Cumings (1922, p. 487) to replace the older nongeographic term Knobstone, or Knobstone Group, and to pay tribute to W. W. Borden. The town of Borden (sec. 3, T. 1 S., R. 5 E., Clark County), which was the site of the old academy where W. W. Borden was professor, was formerly called New Providence and is unique in that the same town serves as the type locality of the Borden Group and one of its formations, the New Providence Shale.

The type and standard reference sections of the formations constituting the Borden Group, which are, in ascending order, the New Providence Shale and Locust Point, Carwood, and Muldraugh Formations, provide key sections for understanding the group. Several
ROCK-UNIT NAMES

reports, however, suggest that these formational units are not mappable and cannot be recognized everywhere in the subsurface (Melhorn and Smith, 1959, p. 13; Pinsak, 1957, p. 29).

*Description:* The Borden Group is composed dominantly of gray argillaceous siltstones and shales and interbedded limestones forming innumerable discontinuous lenses and facies. Because of the numerous vertical and lateral changes in lithology, only the New Providence Shale has been recognized with much success by workers other than Paris B. Stockdale. Thus it is convenient to summarize the lithology of the Borden in terms of two units, the New Providence Shale and the overlying formations. Descriptions are given for individual formations elsewhere in the compendium.

The New Providence Shale consists dominantly of greenish-gray fissile shale and of minor amounts of red shale, sandstone, ironstone, limestone, and silty dolomite. Argillaceous micaceous siltstone, varying from fine to coarse grained, dominates the lithology of the Borden Group above the New Providence, and in the Putnam County area the unit is almost entirely a coarse siltstone sequence having a thin crinoidal limestone at the top. This lithology gives way to many beds, lenses, and patches of sandstone, shale, and limestone, the latter becoming more common away from Parke County (Pinsak, 1957, p. 33). Cherty crinoidal limestone, in places biohermal, is particularly common in the upper part of the group. Most of the Borden bioherms are found in the upper part or in beds directly above the New Providence.

The Borden outcrop belt, in places as much as 36 miles wide, extends in Indiana from the Ohio River in southern Harrison County north and northwestward to Benton County, and to the south it covers an extensive area in Kentucky. The Borden ranges from about 485 to 800 feet in thickness in the outcrop area of Indiana (Stockdale, 1939, p. 27), and the maximum subsurface thickness determined by Pinsak (1957, p. 30) is slightly more than 700 feet. The group thins regionally in a southerly direction to about 500 feet on outcrop along the Ohio River. North of Putnam and Parke Counties
thinning of the group apparently is the result of the Mississippian-Pennsylvanian erosional unconformity (Pinsak, 1957, p. 30).

The Borden Group rests on the Rockford Limestone or where that is absent on the New Albany Shale. It is unconformable at the base except in northwestern Indiana, where it apparently is conformable (Rexroad and Scott, 1964, p. 19). The conformable upper boundary with the Harrodsburg Limestone (Smith, 1965) is difficult to recognize.

Correlation: Stockdale (1939, p. 228) indicated that the Borden Group is equivalent to the upper part of the Waverly Group of southern Ohio and probably to the combined Coldwater and Marshall Groups of Michigan. Pinsak (1957, p. 33) pointed out that “the limestone facies of the Borden Group are probably the lithologic equivalents of the Fort Payne chert” of Tennessee, Alabama, Georgia, and Mississippi. Rexroad and Scott (1964, p. 19) showed that the base of the Borden Group in northwestern Indiana is in the *Bactrognathus-Polygnathus communis* Assemblage Zone, a conodont zone, and correlates with the lower part of the Burlington Limestone of the upper Mississippi Valley, but in southern Indiana the base belongs in the *Bactrognathus-Taphrognathus* Assemblage Zone and is no older than late Burlington in age. Conodonts recovered from the type section of the Floyds Knob Formation (Floyd County) and the Stobo bioherm (7 miles east of Bloomington on Indiana Highway 46) by Carl B. Rexroad and by Robert S. Nicoll show that these two sections are correlatives of the Keokuk Limestone of the upper Mississippi Valley.

**Brassfield Limestone**, Alexandrian Series, Silurian System CBR

*Type section:* Foerste (1906, p. 18, 27) named the Brassfield Limestone for exposures along the now-abandoned Louisville and Atlantic Railroad between Brassfield and Panola in Madison County, eastcentral Kentucky. The basal massive limestone, 6 feet thick (Foerste, 1906, P. 176), is now separated as the Belfast Member.

*Description:* Although the Brassfield of Indiana was first called the Clinton Limestone (Foerste, 1896, 1897), it is continuous with the
type Brassfield in east-central Kentucky. In Indiana the Brassfield Limestone is generally a medium- to coarse-grained fossiliferous limestone having numerous irregular blebs and stringers of shale scattered throughout and in many places containing Ordovician pebbles in the lower part. Small amounts of fine-grained dolomite are present in most sections, and in some places dolomite may be an important constituent. Color is variable; yellowish brown to salmon pink is common, but near Richmond the basal portion is nearly white, and above this the limestone is very dark gray and has scattered yellow grains. At Elkhorn Falls, immediately south of Richmond, the lower 2½ feet of the Brassfield has been assigned questionably to the Belfast Member (Rexroad, 1967, p. 3).

In Indiana exposures of the Brassfield are found near Richmond and near Connersville and thence southwestward to the Ohio River near Charlestown. The formation is generally less than 4 feet thick along the outcrop belt except near the north end, where the maximum exposed thickness of 14 feet is found, and in an outlier in Switzerland County, where the unit is about 11 feet thick. The Brassfield is absent from parts of Decatur, Ripley, Jennings, and Jefferson Counties, and the Osgood Member of the Salamonie Dolomite lies directly on rocks of Ordovician age. In southeastern Indiana the Brassfield unconformably overlies the Saluda and Whitewater Formations of Ordovician age and in turn is unconformably overlain by the Osgood Member.

The Brassfield is present in the subsurface in most of the state west and north of the outcrop area. In the Illinois Basin it apparently is continuous with the Sexton Creek Limestone. In the subsurface of the northern part of the state it appears to be an extension of the Kankakee Dolomite of northeastern Illinois, but boundary relationships need clarification.

_Correlation:_ The Brassfield Formation (Rexroad and others, 1965) of the Cincinnati Arch area is time transgressive, and the Brassfield Limestone of Indiana is younger than the type Brassfield. The Indiana Brassfield is the same age as part of the Noland Formation, which
overlies the Brassfield in east-central Kentucky. It also correlates approximately with the Kankakee Dolomite of northeastern Illinois and the Sexton Creek Limestone of southeastern Missouri and western Illinois. Its age with respect to the British standard series is late Llandovery.

**Brazil Formation**, Pottsvillian Series, Pennsylvanian System  

*Type locality:* The Brazil Formation as originally named by Fuller and Ashley (1902, p. 2) for Brazil, Clay County, included the rocks in the interval between the top of the Mansfield Sandstone and the bottom of the Petersburg Coal, that is, Coal V. Cumings (1922, p. 525) emended the Brazil Formation to include only the rocks in the interval between the base of the Lower Block Coal Member and the unconformity above Coal II. Hutchison (in preparation, c) further emended the Brazil to include only those rocks between the top of the Minshall Coal Member and the base of the Lower Block Coal Member.

*Description:* In the Brazil area the formation consists of shale, sandstone, underclay, and coal and ranges from 40 to 90 feet in thickness (Hutchison, 1960). In ascending order the Brazil Formation consists of the Lower Block Coal Member; 25 feet of shale, sandstone, and underclay; the Upper Block Coal Member; 22 feet of shale, sandstone, and underclay; and the Minshall Coal Member. In places a thin coalbed, referred to as the rider of the Upper Block Coal Member, is present in the interval between the Upper Block Coal and the Minshall Coal Members.

Ashley (1899, p. 103) recognized three beds of coal in this interval, namely, Lower Block, Upper Block, and rider coal, or Minshall, but Cumings (1922, p. 525) listed four coals, adding Coal II to the original number. Wier and Esarey (1951, pl. 4) included six coalbeds in the formation, and Guennel (1958, p. 21) described six floral zones in the block coals in addition to floras in the Minshall Coal Member and in Coal II. These floral zones were identified by spore assemblages, in ascending order, Lower Block a Zone, Lower Block b Zone, Lower
ROCK-UNIT NAMES

Block c Zone, Upper Block a Zone, Upper Block b Zone, and Upper Block c Zone. By stratigraphic methods Hutchison (1960) showed that the block coals consist of at least four distinct beds.

Irregularity, both in thickness and persistence of recognizable beds, is characteristic of the Brazil Formation in much of its area of outcrop from Warren County on the north (Hutchison, 1961) to Spencer County (Hutchison, 1959) on the Ohio River. Rather uniform in the area from southern Parke County through Clay, Owen, and Greene Counties, the formation elsewhere is variable and difficult to recognize. North of Clay County, for example, the Lower Block coal is absent or unidentifiable, so that it is nearly impossible to separate the Brazil and Mansfield Formations; in southern Indiana, in Dubois and Spencer Counties, the block coals, although present over most of the area, are difficult to distinguish from the coals of the Mansfield Formation. Numerous drill holes penetrate the Brazil between its area of exposure and the west edge of Indiana, but detailed information on the character of the coals and other marker beds is wanting in extreme western and southwestern Indiana.

Correlation: The Brazil Formation, according to Wanless (1962, table 1), is correlative with the upper part of the Pottsvillian Series of the Appalachian area, the lower part of the Tradewater Formation (or Group) of western Kentucky and Illinois, and the Atokan and lower Desmoinesian rocks of the Midcontinent. Alexander (1943) correlated the Brazil Formation in Fountain, Warren, and Vermillion Counties with rocks of the Tarter, Pope Creek, and Seville Cyclothems and with most of the Lower Delong cyclothemic rocks of western Illinois. The Seville and Lower Delong Cyclothems were thought to correspond in part to the Minshall Coal Member and the Silverwood Limestone Member of Indiana. Siever (1956) correlated the Brazil Formation with part of the Krebs Group of the lowermost part of the Desmoinesian Stage in the Missouri composite section. Kosanke and others (1960, pl. 1) correlated the Brazil Formation with the upper part of the Abbott Formation and the lower half of the Spoon Formation of Illinois, the Tradewater Formation of western Kentucky, and the lower part of the Cherokee Group of Missouri.
Bryantsville Breccia Bed, Ste. Genevieve Limestone, NMS
Mississippian System

Type and reference sections: Although first used by Patton (1949, p. 8), the name Bryantsville Breccia was attributed to Malott (1952, p. 9, 95), who wrote of three specifically located type exposures near Bryantsville, Lawrence County. The section exposed on the north side of U.S. Highway 50 in the NW¼NW¼ sec. 25, T. 4 N., R. 2 W., 1 mile west of Bryantsville, and the sections exposed in two quarries in the NW¼ and the SE¼NE¼ sec. 20, T. 4 N., R. 1 W., 1¼ to 2 miles east of Bryantsville, apparently were considered respectively as the type and reference sections by Perry and Smith (1958, p. 32), although Malott's intentions are in doubt. The breccia was accorded the rank of bed-at the top of the Levias Member of the Ste. Genevieve Limestone-by Gray, Jenkins, and Weidman (1960, p. 50).

Description: The breccia fragments of the Bryantsville Breccia Bed are angular to subangular; consist of dense lithographic limestone and partly to wholly oolitic limestone; and are bound together by a matrix consisting of calcite, finely divided limestone fragments, oolitic limestone, and, rarely, silica. The fragments range from 0.01 to 0.4 foot in breadth and tend to be dark gray or dark blue gray; the binding material ranges in color from lighter to darker than the fragments. A zone of color-banded and wavy-laminated cherty or siliceous limestone, or of nonsiliceous limestone, is found in many exposures of the Bryantsville and in places may be its only expression.

Bryantsville breccia is found in one or more beds totaling as much as 12 feet in thickness, although in places it is only a few inches thick. Other less persistent breccias and other lithologies similar to the Bryantsville are found in the overlying Paoli Limestone and in lower parts of the Ste. Genevieve Limestone (Perry and Smith, 1958, p. 20, 35, 65), but little difficulty is experienced in identifying the Bryantsville where more than 10 feet of rock is exposed. The base of the Bryantsville commonly is difficult to separate from the rest of the Levias Member, but the top, that is, the top of the Ste. Genevieve, generally suggests an unconformity of slight relief, or, in places, of great relief.
Distribution and correlation: The Bryantsville is a marker bed at the top of the Levias Member throughout the outcrop belt of the Ste. Genevieve Limestone in Indiana, and according to Malott (1952, p. 9-10) and McFarlan and others (1955), it extends into western Kentucky and the southern part of the Illinois Basin. It was placed in the Ste. Genevieve on the basis of the presence of the crinoid Platy­crinites penicillus, and on the same basis it should be correlated with part of the Genevievian Stage (Valmeyeran Series) of Swann (1963, p. 20-21).

*Bucktown Coal Member (Vb), Dugger Formation, AMB & CEW
Pennsylvanian System

Type locality: The name Bucktown Coal Member (Vb) (of the Dugger Formation) was applied to the coal about 20 feet above the Springfield Coal Member (V) by Wier (in preparation). This coal is well exposed in abandoned strip mines 1 mile east and southeast of Bucktown in Sullivan County, and its type locality is in sec. 1, T. 6 N., R. 8 W.

The identification of this coal and the underlying unnamed coal has been the source of some confusion. Ashley (1899, p. 91), although giving no specific section, designated coalbeds above Coal V (now the Springfield Coal Member) and below Coal VI (Hymera Coal Member) as Coal Va and Coal Vb. Logan (1922, p. 627) recognized two thin beds of coal above the Springfield Coal Member but said that “the upper coal is generally thicker and is designated as Coal Va.” Wier (1951) and Kottlowski (1954) did not find the lower coal in the area of the Linton and Dugger Quadrangles, so the upper coal was called Coal Va. Wier (1953) and Wier and Stanley (1953) then recognized Coal Va as the lower coal which lies between the Alum Cave and Antioch Limestone Members and Coal Vb as the upper coal which lies above the Antioch Limestone Member. Wier (in preparation) stated that this lower coal can be recognized in a few exposures as a separate and distinct unit, but he did not name it because of lack of information on its distribution.
Description: The Bucktown coal ranges from 0.1 to 4.0 feet and averages 1.2 feet in thickness. In places it contains a shale parting or layer as much as 11 feet thick (Friedman, 1961). The coal lies stratigraphically 10 to 67 feet above the Springfield Coal Member (V) of the Petersburg Formation and is generally overlain by a dark-gray shale which contains sideritic bands. In Vermillion and Vigo Counties, this shale also contains numerous shells of the conchostracan *Leaia tricarinata*.

Correlation: The Bucktown Coal Member is traceable along the outcrop northwestward into Illinois into the Danville area, where it has been extensively mined. Formerly called the Grape Creek Coal in Illinois, it is now known as the Herrin (No. 6) Coal (Kosanke and others, 1960, p. 36). In western Kentucky the correlated coal is known as Coal No. 10.

**Buffaloville Coal Member, Brazil Formation, HCH**

*Pennsylvanian System*

Type section: The Buffaloville Coal Member, here given that rank, was first named by Franklin and Wanless (1944, p. 89, 90) for the coal that was strip mined near Buffaloville, Spencer County. Although not specifically designated as type, the originally described section was in a strip mine in the center of the NE¼NW¼ sec. 9, T. 5 S., R. 5 W.

Description: According to Franklin and Wanless, the Buffaloville coal is blocky and has a floor of underclay some 3 feet thick. The roof of the coal is black sheety unfossiliferous shale, half a foot thick, which is overlain by dark-gray soft calcareous fossiliferous slightly silty shale and in turn by dark-blue to black argillaceous fossiliferous limestone as much as 2 feet thick. In some areas the shale is absent, and the limestone rests directly on the coal.

The Buffaloville Coal Member crops out from the Ohio River northward through Spencer County (Hutchison, 1959), Dubois County (Hutchison, 1964), southern Martin County (Hutchison, 1967), and into Daviess County (Hutchison, in preparation, a). Coal
drilling records from western Spencer County and Dubois County show that the coal is present in the subsurface.

**Correlation:** Franklin and Wanless (1944) tentatively correlated the Buffaloville Coal Member with Coal II of Ashley (1909). Spore assemblages of Buffaloville and Minshall coals are similar (G. K. Guennel, oral communication, 1958), and Hutchison (1959) assigned the Buffaloville to the Brazil Formation, considering that it is continuous with the Minshall of Clay and Parke Counties. Thus if this correlation is correct, a single coalbed, called both the Buffaloville and Minshall, is present from the Ohio River to Warren County at the north end of the Indiana coalfield. According to Thompson and Shaver (1964, p. 20, 21), the limestone in the roof of the Buffaloville marks the lowest known Indiana position containing microfaunas that are characterized by the fusulinid *Fusulinella* and ostracods *Amphissites centronotus* and *A. girtyi*. (See the section on the Perth Limestone Member herein for a discussion of correlations of the coal and associated limestone.)

**Busseron Sandstone Member,** Shelburn Formation, CEW

**Pennsylvania System**

*Type locality:* The name Busseron Sandstone was first used by Cumings (1922, p. 529) for exposures of a sandstone and sandy shale along Busseron Creek in Sullivan County. Cumings placed this unit stratigraphically at the base of his Shelburn Group, noting that, in general, the Busseron Sandstone rested disconformably on Coal VII (Danville Coal Member). Wier (in preparation) designated the unit as the Busseron Sandstone Member of the Shelburn Formation and selected a type section in the SW¼SE¼SE¼ sec. 7, T. 9 N., R. 8 W., Sullivan County.

*Description:* The Busseron Sandstone Member is a gray to tan fine to medium-grained massive sandstone which is interbedded in places with gray shale. The sandstone is thickest south of Sullivan County in southwestern Indiana. It constitutes the basal member of the Shelburn Formation in most places, but in some places it unconformably overlies an unnamed gray shale which also is included in the
Shelburn Formation. The member is variable in thickness, which ranges from 48 to 77 feet in Sullivan County. In parts of southeastern Gibson County, the Busseron sandstone fills earlier erosional areas and thus rests on rocks having stratigraphic position somewhat below the Danville coal. (See Wier, in preparation.)

**Correlation:** The Busseron Sandstone Member was correlated by Cumings (1922) with the Anvil Rock Sandstone of Kentucky; however, the name Anvil Rock has been adopted in Illinois for a unit in the underlying Carbondale Group (Kosanke and others, 1960, p. 34).

**Butlerville Till Member, Jessup Formation**

*Type section:* The Butlerville Till Member of the Jessup Formation was named and described by Wayne (1963, p. 53-54) for a type section that is exposed in road cuts and the streambank beside the spillway for Brush Creek Reservoir northwest of Butlerville in Jennings County, in the NE¼NE¼ sec. 16, T. 7 N., R. 9 E.

*Description:* The Butlerville Till Member is recognized primarily by its stratigraphic position and by the distinctive features of the profile of weathering that is found at the top of the till where it is the surface unit and in many places where it has been overlapped by younger sediments. The Butlerville includes at least three till beds that in some places are separated by thin lenses of fossiliferous silt. Throughout much of its extent it probably overlies the Cloverdale Till Member of the Jessup Formation, but in some places it lies either on Paleozoic rocks or on a tongue of the Atherton Formation or of the Prospect Formation. It is the surface unit in about 20 percent of Indiana, but in the northern two-thirds of the state it is overlain by the Trafalgar Formation.

*Correlation:* The Butlerville was deposited during the Illinoian (glacial) Age. (See also “Jessup Formation, Correlation.”)
**Gagle Loess Member**, Atherton Formation, Pleistocene Series

**Type section**: The type section of the Gagle Loess Member of the Atherton Formation is the exposure of the unit in the east end of the emergency spillway cut for Cataract Lake, a flood control reservoir built at a site formerly known as Cagle's Mill, in the SE¼NW¼ sec. T. 12 N., R. 5 W. (Poland Quadrangle), Putnam County (Wayne, 1958, p. 10; 1963, p. 35).

**Description**: The Gagle Loess Member is readily recognized in only the type section, where it has been well preserved in an unweathered condition. It undoubtedly is present elsewhere, but in the few exposures where it is suspected it is so highly weathered that its recognition is uncertain. In the type section Gagle loess is a dark grayish-brown calcareous silt that is highly fossiliferous. Its maximum thickness is about 3 feet, and it is sandwiched between colluvium derived from Pennsylvanian sandstone and shale below and from the Cloverdale Till Member (Kansan Stage) above.

**Correlation**: The Gagle Loess Member of the Atherton Formation is a wind-deposited sediment derived from proglacial outwash of Kansan age. It was deposited only during the time Kansan ice provided meltwater and outwash sediments to the drainage basin from which the loess was blown.

**Camp Run Member**, New Albany Shale, Devonian System

**Type section and description**: Lineback (1968 and in preparation) named the Camp Run Member of the New Albany Shale for exposures of greenish- to olive-gray mudstone interbedded with brownish-black pyritic fissile shale along the south side of U.S. Highway 3 IW at the Interstate Highway 65 overpass west of Sellersburg, Clark County (W¼S¼ lot 110, Clark's Grant). The name was taken from Camp Run, a nearby creek.

Lying conformably above the Morgan Trail Member of the New Albany Shale and below the Clegg Creek Member, the Camp Run
Member ranges from 14 to 18 feet in thickness. Dolomite concretions as large as 2 feet in diameter are commonly found in the darker beds. The unit is not recognizable in the subsurface but can be traced in the southern Indiana and northern Kentucky outcrop.

**Correlation:** On the basis of conodont studies the Camp Run is correlated with part of the Grassy Creek Shale of Illinois and with the toIII Zone of the German Devonian standard. It is stratigraphically equivalent to the Chagrin Shale of Ohio, to the middle part of the Gassaway Member of the Chattanooga Shale of Tennessee, and to part of the Ellsworth Shale of Michigan and northern Indiana (Lineback, in preparation).

**Carbondale Group, Alleghenian Series, AMB & CEW**

**Pennsylvanian System**

*Type locality:* The name Carbondale Formation was first used by Shaw and Savage (1912, p. 6) in describing 200 to 460 feet of shale, sandstone, coal, and limestone exposed near Carbondale, Jackson County, Ill. The Illinois Geological Survey now recognizes this formation as consisting of the rocks “between the base of the Colchester (No. 2) Coal and the top of the Danville (No. 7) Coal” for the rocks between the top of the Seelyville Coal Member (111) of the Staunton Formation and the top of the Danville Coal Member (VII) of the Dugger Formation (Wier and Gray, 1961; Wier, in preparation) and thus includes the clastic sediments between the Colchester and Seelyville coals that are excluded from the Carbondale Formation of Illinois. Prior to the advent of Wier's classification, the Carbondale rocks in Indiana were assigned by Fuller and Ashley (1902) to the lower part of the Millersburg Formation, to the Petersburg Formation, and to the upper part of the Brazil Formation and by Cumings (1922, p. 525-529) to the Petersburg Group and the upper part of the Staunton Group.

*Description:* In Indiana the Carbondale Group, a variable sequence of rocks including sandstones, shale, limestones, and coals, ranges from
260 to 470 feet in thickness but averages slightly more than 300 feet. It is thickest in central Posey County and generally thins to the north and east. The outcrop belt in Indiana extends from Warrick County northward to Vermillion County. Three formations (the Linton, Petersburg, and Dugger Formations) make up the Carbondale Group, which is overlain by the McLeansboro Group and underlain by the Raccoon Creek Group, and it is in these formations that most of the commercial beds of coal in Indiana are found.

Correlation: The Carbondale Group in Indiana is essentially equivalent to the Carbondale Formation of the Kewanee Group in Illinois. It correlates with the Carbondale Formation and the lower part of the Lisman Formation in western Kentucky.

**Cartersburg Till Member, Trafalgar Formation, **

Pleistocene Series

*Type section:* Described by Wayne (1963, p. 48), the type section of the Cartersburg Till Member is a cut bank of White Lick Creek 2 miles northwest of Cartersburg, Hendricks County (SW¼SE¼SW¼ sec. 23, T. 15 N., R. I W.).

*Description:* The dominantly ice-laid Cartersburg consists principally of till but includes lenses of gravel, sand, and silt. It is recognized primarily by its soil profile and distribution, where it is at the surface, and can be distinguished with certainty from the underlying Center Grove Till Member only where a key bed, a dark-gray fossiliferous silt, separates them. It is virtually coincident with the extent of the soils of the Miami catena, in that it is the surface material over most of the central part of the state. To the north it is overlapped by the Lagro Formation; elsewhere parts of the Atherton and Martinsville Formations overlie the member. Surficially it is expressed by constructional topography on which postdepositional erosion has been slight.

*Correlation:* The Cartersburg was deposited during the Wisconsinan (glacial) Age, probably between 20,000 and 17,000 years B. P., and is thus partly equivalent to Leighton's (1960) Tazewell Substage. (See also “Trafalgar Formation, Correlation.”)
Carwood Formation, Borden Group. GRG
Mississippian System

Type locality: The Carwood Formation was named by Stockdale (1929a, p. 170; 1931, p. 147-148) for exposures of a unit displaying great lateral variations near Carwood (Bridgeport), Clark County, 4¾ miles southeast of Borden. These rocks are exposed in the escarpment south and southeast of Carwood and also in the bluffs along the Muddy Fork of Silver Creek to the west and northwest, where a massive sandstone is exposed in vertical cliffs.

Description: Generally a massive or shaly siltstone, the Carwood was subdivided by Stockdale (1931, p. 149-187) into eight facies (the Evans Landing, Knob Creek, Bennettsville, Delaneys Creek, Sparksville, Gent, Fleener, and Kelly Hill Facies) and two members (Finley Knob Shale Member of the Bennettsville Facies and Lampkins Sandstone Member of the Gent Facies). These names have not been used by subsequent workers, however. The formation, ranging from 105 to 160 feet in thickness, conformably overlies the Locust Point Formation and is overlain by the Floyds Knob Member of the Muldraugh Formation. (See Stockdale, 1931, p. 120-124 for discussion of Locust Point-Carwood relationships and differences.) The Carwood contains the characteristic brachiopods *Orthotetes keokuk* and *Syringothyris texta* as well as a “rich fauna of bryozoans” (Stockdale, 1931, p. 191-192).

Correlation: Stockdale (1939, p. 228) correlated the Carwood and Locust Point Formations with the Brodhead Formation of Kentucky and the Logan Formation of Ohio. The unit also correlates with part of the Keokuk Limestone of the upper Mississippi Valley.

Center Grove Till Member, Trafalgar Formation, WJW
Pleistocene Series

Type section: The Center Grove Till Member was described by Wayne (1963, p. 49) for the type section in a cut bank of a tributary of Honey Creek about 2 miles northeast of Center Grove School, Johnson County (NW3/4SW3/4SE1/4 sec. 2, T. 13 N., R. 3 E.) (Wayne, 1963, p. 72-73).
Description: The Center Grove consists of one or more beds of silty sandy till and associated small lenses of water-laid sediments. It can be recognized, where it is the surface unit, by a thin silt cap at the top of the profile of weathering. Where the Center Grove has been overlapped by the younger Cartersburg Till Member, the silt is present as a thin, discontinuous commonly fossiliferous silt bed, the *Vertigo alpestris oughtoni* bed (Wayne 1963, fig. 2), between the two units. These two members are difficult or impossible to distinguish where silt bed is absent. Throughout most of its extent the Center Grove rests upon the upper part of the Jessup Formation and related sediments, but in some places it rests directly upon Paleozoic bedrock.

Correlation: The Center Grove was deposited during the Wisconsinan (glacial) Age, probably between 22,000 and 20,000 years B. P., and is correlative with part of Leighton's (1960) Tazewell Substage. (See also “Trafalgar Formation, Correlation.”)

**Clegg Creek Member**, New Albany Shale, AMB

Devonian and Mississippian Systems

Type section and description: The Clegg Creek Member of the New Albany Shale was named by Lineback (1968 and in preparation) for exposures along a road cut on Indiana Highway 160, 2 miles southeast of Henryville, Clark County (NE4/4E¼ lot 240, Clark's Grant). At this place the Clegg Creek consists of brownish-black fissile siliceous pyritic shale that contains at the top greenish-gray shale and mudstone beds and phosphatic nodules. The name was taken from a tributary to Silver Creek 2 miles from the type section.

Overlain conformably by the Rockford Limestone, the Clegg Creek Member is 42 feet thick in Clark County and 60 feet thick in Jackson County. It cannot be recognized in the subsurface, and thus its known distribution is limited to the outcrop belt of southeastern Indiana and northern Kentucky. This unit overlies the Camp Run Member of the New Albany Shale and includes the upper part of the Blackiston Formation and all the Sanderson (including the Falling Run Member), Underwood, Henryville, and Jacobs Chapel Formations of Campbell (1946). The latter four units named are recognized as
Correlation: The Underwood Bed of the Clegg Creek bears a conodont fauna which is Kinderhookian in age, and the Devonian-Mississippian boundary is at or just below the base of this bed. That part of the Clegg Creek Member below the Falling Run Bed is correlated on the basis of conodont studies with Zones toIV through toVI of the German Devonian standard and is equivalent to the upper part of the Grass Creek Shale, the Saverton Shale, and the Louisiana Limestone of Illinois. The Falling Run, Underwood, Henryville, and Jacobs Chapel parts of the Clegg Creek are correlated with the European Zone c1 and part of Zone cull (Mississippian) and are equivalent to the Hannibal Shale of Missouri. The Clegg Creek Member is stratigraphically equivalent to the Ellsworth Shale, the Sunbury Shale, and the lower few inches of the Coldwater Shale of Michigan; to the Sunbury, Bedford, and Berea Shales and the Cleveland Member of the Ohio Shale of Ohio; and to the upper part of the Gassaway Member of the Chattanooga Shale and part of the Maury Shale of Tennessee (Lineback, 1968 and in preparation).

Clore Limestone, Chesterian Series, Mississippian System

Type locality: This unit was originally named the Clore Formation by Stuart Weller (1913, p. 129) for exposures near Clore School, Randolph County, Ill. Later it was restricted, designated the Clore Limestone (Weller, 1920b, p. 212-213), and described in Illinois as a crystalline to shaly limestone and calcareous shale as much as 40 feet thick. Recently the Clore has been redefined (Swann, 1963, p. 40-41, 64) as a unit 50 to 110 feet thick and having limestone-dominated upper and lower parts and a sandstone-dominated middle part.
Description: Typically blue-gray shale and thin yellow-brown argillaceous micritic limestone, the Clore Limestone in Indiana is stated to be 20 to 45 feet thick (Malott, Esarey, and Bieberman, 1948, p. 25). Reliable thickness estimates are, however, hard to find. (See the discussion of boundary problems under “Tar Springs Formation.”) The unit crops out only in Perry County but is known in the sub surface from Dubois and Knox Counties southwestward. It conformably overlies the Palestine Sandstone and is overlain conformably by the Degonia Sandstone or disconformably by the Mansfield Formation lower Pennsylvanian). In the most definitive study of these rocks in Indiana (Malott, 1925), this unit was not named, but later undocumented correlation of these rocks with the Clore (Malott, 1931, p. 222) has found general acceptance. Malott and Esarey (1940) apparently were the first actually to apply the name Clore Limestone in Indiana.

Cloverdale Till Member, Jessup Formation, Pleistocene Series WJW

Type section: The exposure at the east end of the emergency spillway for Cataract Lake, Putnam County (SE¼NW¼ sec. 13, T. 12 N., R. 5 W., Poland Quadrangle), was designated (Wayne, 1963, p. 54) as the type section for this unit.

Description: The Cloverdale Till Member of the Jessup Formation consists principally of till but includes scattered lenses of stratified sediments. Both top and bottom surfaces normally are bounded by erosional unconformities. Where the member has been identified it normally lies on the eroded surface of bedrock, on colluvial material derived from it, or on a lens of one of the facies of the Atherton Formation. The top of the member is most distinctive where part or all of a profile of weathering remains. This paleosol or a correlative tongue of the Prospect Formation provides the most reliable basis for identifying the member, although Bhattacharya (1962, p. 1016) found that the paleosol on the Cloverdale till contains kaolinite, but the paleosol on the overlying Butlerville till evidently does not. In addition, the Cloverdale till is generally more sandy than that of the overlying member.
Correlation: See “Jessup Formation, Correlation.” The Cloverdale was deposited during the Kansan (glacial) Age when ice from the northeast covered the northern two-thirds of Indiana and extended to the Ohio River in the area east of the Knobstone Escarpment. The member undoubtedly represents only a small segment of Kansan time.

**Cohn Coal Member, Mattoon Formation, CEW**

Pennsylvanian System

*Type locality:* The Cohn Coal was named by Newton and Weller (1937, p. 18) for exposures in the NE¼ sec. 1, T. 11 N., R. 12 W., Clark County, Ill., 2 miles southeast of Cohn. This coal was later designated as the Cohn Coal Member (Kosanke and others, 1960, p. 41) in Illinois. It was accepted by Wier (in preparation) as a member of the Mattoon Formation in Indiana.

*Description:* The Cohn Coal Member is 2 inches thick in the type area and is 20 feet above the top of the Livingston Limestone Member of the Bond Formation. It is underlain by 4 to 5 feet of clay and overlain by a foot of light-gray shale. The only known occurrence of the Cohn coal in Indiana is at Merom, Sullivan County (W ½ sec. 7, T. 7 N., R. 10 W.), where it is more than a foot thick and has been mined on a small scale.

**Colchester Coal Member (IIIa), Linton Formation, AMB & CEW**

Pennsylvanian System

*Type locality:* The Colchester coal was named by Worthen (1868, p. 11) for exposures in secs. 12 and 13, T. 5 N., R. 4 W., near Colchester, Ill. The name Colchester Coal Member (of the Linton Formation) has been adopted in Indiana terminology (Wier and Gray, 1961; Wier, in preparation) for the coal designated Coal IIIa by Ashley (1909, p. 55-57) because of the continuity of this coal with the Illinois type. In Pike and Warrick Counties this unit was previously known as the Velpen Coal (Fuller and Ashley, 1902, p. 2), but the name Velpen is now used for the overlying limestone.

*Description and correlation:* The Colchester Coal Member is a relative-
Ily thin (0.1 to 3 feet) bright-banded coal commonly displaying a thin medial shale parting. It overlies a persistent underclay, 1 to 4 feet thick, which is mined and used for ceramics. It is overlain by a black fissile shale, called the Mecca Quarry Shale Member by Zangerl and Richardson (1963), which is 1 to 7 feet thick and contains abundant vertebrate and invertebrate fossils and iron-rich concretions. Stratigraphically the Colchester lies from a few inches to 40 feet above the Seelyville Coal Member of the Staunton Formation and 5 to 50 feet below the Survant Coal Member of the Linton Formation.

In Indiana the Colchester is traceable on outcrop from Spencer County on the Ohio River to the Vermillion River in northern Vermillion County. It is an excellent and widespread marker in outcrop and is probably equivalent to the Schultztown Coal of western Kentucky (Wier, in preparation).

**Coldwater Shale, Kinderhookian Series, Mississippian System**

*Type area:* The Coldwater Shale was named by Lane (1893, p. 19-20) for outcrops of light-colored greenish or bluish and darker shales along Coldwater River in Branch County, Mich. The name is used here for the southern extension of the Michigan unit into northeastern Indiana, north of the Cincinnati Arch.

*Description:* The Coldwater Shale is known in Indiana only in the subsurface because its position at the bedrock surface is deeply buried by glacial drift (Johnson and Keller, in preparation). It is typically a gray to greenish-gray slightly silty shale bearing red shale stringers near the bottom and in some places brown dolomite or limestone lenses throughout the section. A distinctive red shale, 5 to 20 feet thick and sometimes called the Coldwater Red Rock, is present at the base of the unit and conformably overlies the Ellsworth Shale and what Lineback (1968 and in preparation) considers to be the Sunbury Shale. The Coldwater Shale, because of pre-Pleistocene erosion, is not present everywhere west of Elkhart County, but it reaches a thickness greater than 500 feet in Steuben County.
Correlation: According to Lineback (1968 and in preparation) the lower few feet of the Coldwater Shale is Kinderhookian in age and may be a correlative of the Rockford Limestone and of the Jacobs Chapel Bed of the New Albany Shale in Indiana south and west of the Cincinnati Arch. He believes, however, that the major part of the Coldwater is Valmeyeran in age and is correlative with the lower part of the Borden Group south of the arch.

Coxville Sandstone Member, Linton Formation, AMB & CEW
Pennsylvanian System

Type section: The name Coxville Sandstone was first used by Ashley (1899, p. 300-301,385) in describing a 20-foot sandstone exposed on the northeast side of Raccoon Creek in the NE¼ sec. 16, T. 14 N., R. 8 W., half a mile east of Coxville, Parke County. Friedman (1960, p. 23-28) reduced the rank to that of member in the Linton Formation.

Description: The Coxville is typically a fine- to coarse-grained massive thick-bedded and crossbedded sandstone, but shale partings a few inches thick are present in some sections. Thickness of the sand varies greatly and is 60 feet 1 mile southeast of the type section. The grains are subangular to subrounded and are cemented with clay, iron oxide, or calcium carbonate. The unit lies stratigraphically between the Seelyville Coal Member (III) of the Staunton Formation and the Colchester Coal Member (IIa) of the Linton Formation, although both coals are absent from some places and sandstone is found in their positions. Where the interval between the two coals is composed mostly of shale or shaly sandstone, the Coxville is not recognized. It has been noted in the subsurface records in Sullivan, Pike, Gibson, and Posey Counties, where it ranges from 10 to 50 feet in thickness (Wier, in preparation).

Correlation: The Coxville Sandstone Member correlates with the Palzo and Isabel Sandstone Members of Illinois and with the Sebree Sandstone in western Kentucky.
Cypress Formation, West Baden Group, Mississippian System

**Type locality:** The name Cypress Sandstone was used by Henry Englemann (1863, p. 189-190) for massive sandstone exposures in the bluffs along Cypress Creek, Union County, Indiana. As redescribed by Swann (1963, p. 35) the Cypress is a complex of sandstone bodies totaling 100 feet or more in thickness.

**Description:** The Cypress Formation is widely recognized in the subsurface in Indiana. According to Puscas (1953) the formation is made up of white fine- to medium-grained sandstone, gray siltstone, and shale. It reaches a maximum thickness of 120 feet in western Indiana and is underlain conformably by the Reelsville Limestone where the Reelsville is present. Where the Reelsville is absent, the exact position of the base of the Cypress is difficult to determine because of the lithologic similarity of the Cypress to the underlying Sample Formation. The Cypress Formation is overlain conformably by the Beech Creek Limestone (Stephensport Group) or unconformably by rocks of Pennsylvanian age.

**Correlation:** The Cypress is directly equivalent to the Elwren Formation of Indiana outcrop terminology. Because the name Cypress Sandstone was for many years incorrectly applied in Indiana to the unit now called the Big Clifty Formation, it was considered inadvisable to use the name Cypress for outcropping rocks (Indiana Geological Survey, 1957, p. 6).

Danville Coal Member (VII), Dugger Formation, Pennsylvanian System

**Type section and synonyms:** The name Danville was first used by Bradley (1870, p. 250-252) for a coal near Danville, Ill. Wanless later (1956, p. 11) designated the E½ sec. 7, T. 19 N., R. 11 W., Vermilion County, Ill., as the type locality for this coal, which Kosanke and others (1960, p. 35) recognized as the Danville (No. 7) Coal Member of the Carbondale Formation of Illinois. Wier (in preparation) extended use of the name into Indiana, designating the coal previously known as Coal VII (Ashley, 1899, p. 842), the Millersburg Coal
(Fuller and Ashley, 1902, p. 2), the Upper Millersburg Coal (Wier and Stanley, 1953; Wier, 1958), and the Little Newburg Coal (Owen, 1839, p. 11; 1856, p. 36; Ashley, 1909, p. 97) as the Danville Coal Member (VII) of the Dugger Formation.

*Description and correlation:* The Danville Coal Member is a brightbanded bituminous coal cropping out from the Ohio River at Newburgh, Warrick County, northward to southern Vermillion County. It ranges from 0.2 to 6.5 feet in thickness and thins generally from north to south, averaging 4.3 feet in Vermillion and Vigo Counties, 3.3 feet in Sullivan and Knox Counties, and 2.1 feet in Pike, Gibson, and Warrick Counties. The coal contains clay and shale in thin partings, films of clay in vertical joints, and local concentrations of pyrite or marcasite.

The Danville coal, the uppermost member of the Dugger Formation, has been strip mined in places along its Indiana outcrop. It is erroneously called Coal VI by the miners in northern Vigo County and southern Vermillion County. Wier (in preparation) has traced this coal in the subsurface across Vanderburgh and Posey Counties into White County, Ill., where it is called Coal No. 7 (Harrison, 1951, p. 12). According to Wier, a correlative coal in western Kentucky is called Coal No. 13.

**Degonia Sandstone, Chesterian Series, HHG**

*Mississippian System*

*Type area:* The Degonia Sandstone was named by Stuart Weller (1920b, p. 216) for exposures of a massive cliff-facing crossbedded sandstone and thin-bedded ripple-marked sandstone in Degonia Township, Jackson County, Ill. The total thickness of this unit in its type area is as much as 100 feet (Weller, 1920a, p. 403-405).

*Former name in Indiana:* Although this unit was originally called the Mount Pleasant Sandstone in Indiana (Malott, 1925), its equivalence to the Degonia was soon recognized by the same author (Malott, 1931, p. 222) “after he had made a study of the Chester formations in southern Illinois” (Malott, 1952, p. 6). No other documentation was
given, but the correlation has generally been accepted and the name Degonia was used in subsequent papers (Malott and Esarey, 1940; Malott, Esarey, and Bieberman, 1948).

Description: In Indiana the Degonia Sandstone crops out only in Perry County, where it is a fine-grained quartzitic sandstone that forms low ledges and small waterfalls and typically weathers into rectangular blocks. The total thickness of this unit is 10 to 35 feet (Malott, Esarey, and Bieberman, 1948, p. 25). As a thicker shale and sandstone unit, it is recognizable in the subsurface from Dubois and Knox Counties southwestward. (See the discussion of boundary problems under “Tar Springs Formation.”) The Degonia conformably overlies the Clore Limestone and is overlain conformably by the Kinkaid Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

*Detroit River Formation, Ulsterian? and Erian Series, AMB
Devonian System

Type area: The name Detroit River Series was first proposed by Lane and others (1909, p. 555) for rocks exposed along the Detroit River in southeastern Michigan. Although now recognized as a group in Michigan, the name is used with the rank of formation for the basal Devonian rocks north of the Cincinnati Arch in Indiana. (See Schneider and Keller, in preparation, and Johnson and Keller, in preparation.)

Description: The lower part of the Detroit River Formation of northern Indiana consists of a gray to tan fine grained argillaceous dolomite containing rounded quartz-sand grains. This sandy zone has an average thickness of 10 feet (Pinsak and Shaver, 1964) and is transitional with the overlying lithology. Most of the formation is composed of tan to gray limestone and dolomite and is variably fine grained, argillaceous, bioclastic, sublithographic, and in places brecciated and mottled. Thin green and black shale beds are also present, and in LaPorte County at least, light-gray earthy chert nodules are found. Gypsum and anhydrite, found both as disseminated material in dolomite and as beds as much as 30 feet thick, can be recognized.
across northern Indiana as far south as southern Noble County (Rooney, 1965). A tan lithographic limestone is commonly found at or near the top. Although eroded from parts of Cass and Miami Counties, the formation is recognized as far south as Carroll County and as far west as Jasper and Porter Counties. It thickens northeastward from 0 foot at the presumed depositional limit as described to 140 feet in St. Joseph County (Pinsak and Shaver, 1964, p. 56-57).

The Detroit River Formation overlaps the Wabash and Salina Formations (Silurian) to the south and is itself overlapped by the Traverse Formation, which extends still farther southward in northern Indiana.

*Correlation:* The Detroit River Formation corresponds stratigraphically to the Lucas Formation of the Detroit River Group of Michigan and at least in part to the Jeffersonville Limestone and possibly also to the Geneva Dolomite of southern Indiana. The evaporite section of the Detroit River in LaPorte County was correlated by Rooney (1965, p. 270) with the Reed City Anhydrite of Ells (1958, fig. 8) in southern Michigan. The Pendleton Sandstone of Madison County is possibly correlative with the basal sandy zone in the Detroit River Formation. Several sandstones of Devonian age are found in the Michigan Basin, but the correlation of any of these with the basal Detroit River in Indiana is uncertain. (See Pinsak and Shaver, 1964, p. 51).

**Dicksburg Hills Sandstone Member,**

*Type area:* The Dicksburg Hills Sandstone was named by Malott (1948, p. 131, 137-138) for exposures in the Dicksburg Hills in the SW¼ sec. 18, T. 1 N., R. 10 W., southern Knox County. Wier (in preparation) reduced the rank of this sandstone to member and included the unit in the Patoka Formation.

*Description and correlation:* The Dicksburg Hills Sandstone Member is a massive fine- to coarse-grained crossbedded sandstone containing quartz and clay pebbles. It is exposed from Vanderburgh County to
Vigo County and has been called the Murphys Bluff Formation (Malott, 1937, p. 277) in Clark County, Ill. In southern Indiana it is the upper part of the Inglefield Sandstone of Fuller and Clapp (1904). The member is not as prominent west of its outcrop as is the underlying Inglefield Sandstone Member of the Patoka Formation.

**Dillsboro Formation, Cincinnatian Series, Ordovician System**

Type area and characteristic sections: The name Dillsboro Formation was proposed by Brown and Lineback (1966, p. 1020-1021) for "the sequence of highly fossiliferous argillaceous limestones and calcareous shales that lie between the shale of the Kope Formation and the dolomitic limestone of the Saluda Formation." The type area was designated as southwestern Dearborn County and east-central Ripley County near Dillsboro. Two sections showing relationships with other formations are, for the lower contact, along U.S. Highway 50, 1 mile west of Aurora in southeastern Dearborn County (NW¼ sec. 6, T. 4 N., R. 1 W.) and, for the upper contact, along U.S. Highway 50 in the N½SE¼ sec. 12, T. 7 N., R. 11 E., Ripley County.

**Description:** In its type area the Dillsboro Formation consists mainly of argillaceous limestones and calcareous shales. Southward more shale is present in the lower part, and a distinctive rubbly limestone containing the brachiopods *Platystrophia* and *Rafinesquina* is present in the middle part of the formation. As a whole, the Dillsboro contains about 30 percent limestone (Brown and Lineback, 1966, p. 1020).

The Dillsboro Formation, which is somewhat more than 300 feet thick in Wayne and Decatur Counties, is conformably overlain by the Saluda Formation (Cincinnatian) and underlain by the Kope Formation (Cincinnatian). In southeastern Indiana the Kope-Dillsboro contact in many places must be picked in a gradational sequence, but in some places a sharp increase in the percentage of limestone marks this contact (Brown and Lineback, 1966, p. 1021).

**Cincinnatian faunal zones and collation of older names:** Few areas of the world have become so well known paleontologically as the tristate
area of Ohio, Indiana, and Kentucky. The numbers of species, zones, reports, and paleontologists associated with the richly fossiliferous limestones and shales of this area are legion. During the heyday of stratigraphic paleontology, the naming and correlating of Cincinnati formations were virtually accomplished by describing the species and their ranges. Thus at times the term Dalmanella meeki Zone has been used virtually synonymously with the name Waynesville Formation, Dalmanella multisecta Zone with Utica Formation, Strophomena planumbona Bed with Liberty Formation, Lophospira hammeli Bed with Hitz Bed, Homotrypa wortheni Bed with Whitewater Formation, and so on. Lithology, apart from fossils as lithologic constituents, was ignored deliberately in the definition of many stratigraphic units.

Many of the faunal zones described during this period have proved to be valuable for correlation of rock and time-stratigraphic units, and they have contributed to the use of the locally derived terms Eden, Maysville, and Richmond in the sense of stages in North America. Some of the better known and useful faunal zones are those of the brachiopod Platystrophia for middle and upper Cincinnati rocks (Cumings, 1903; McEwan, 1920), of various bryozoan species for most of the Cincinnati Series (Nickles, 1902; Cumings, 1908; Cumings and Galloway, 1913), such zones as are summarized for the Cincinnati area by Caster, Dalve, and Pope (1955, fig. 3), and the assemblage zones of the Richmond Group of Fox (1962, p. 633-637). Indeed, many of the fossils as lithologic constituents are useful for regional tracing of rock units in Indiana (even of some units whose names are here considered to be abandoned). (See, for example, the coral-zone discussion under “Saluda Formation.”)

In spite of these values, stratigraphers have become increasingly aware of the vertical overlap of biostratigraphic zones that have been the basis of geographically named formations (for example, as illustrated by Fox, 1962, fig. 7), of the vertical recurrence of key species in nontypical formations (for example, as illustrated by Caster, Dalve, and Pope, 1955, fig. 3), and of the scarcity of consistent lithologic criteria by which the classic formations can be recognized in areas distant from the type localities. The classification used in
Table 7. Some Indiana Geological Survey-abandoned and other little-used names for Cincinnatian rocks in Indiana

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Approximate stratigraphic position as used in Indiana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amheim Formation</td>
<td>Foerste, 1905</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Bellevue Formation</td>
<td>Nickles, 1902</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Blanchester Division</td>
<td>Foerste, 1909</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Clarksville Division</td>
<td>Foerste, 1909</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Conyville Formation</td>
<td>Nickles, 1902</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Cynthiana Formation</td>
<td>Foerste, 1906</td>
<td>Champlainian and Cincinnatian Series</td>
</tr>
<tr>
<td>Economy Formation</td>
<td>Bassler, 1906</td>
<td>Kope Formation</td>
</tr>
<tr>
<td>Eden Group</td>
<td>Newberry, 1873</td>
<td>Kope Formation</td>
</tr>
<tr>
<td>Elkhorn Formation</td>
<td>Cumings, 1908</td>
<td>Whittewater Formation</td>
</tr>
<tr>
<td>Fairmount Formation</td>
<td>Nickles, 1902</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Fairview Formation</td>
<td>Bassler, 1906</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Fulton Shale</td>
<td>Foerste, 1905</td>
<td>Kope Formation</td>
</tr>
<tr>
<td>Harmon Formation</td>
<td>Cumings and Galloway, 1913</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Hitz Bed</td>
<td>Foerste, 1903</td>
<td>Whittewater Formation</td>
</tr>
<tr>
<td>Hudson River Group</td>
<td>Mather, 1840</td>
<td>Cincinnatian Series</td>
</tr>
<tr>
<td>Lake Huron Shale</td>
<td>Thompson, 1886</td>
<td>Cincinnatian Series</td>
</tr>
<tr>
<td>Laughery Formation</td>
<td>Foerste, 1912</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Liberty Formation</td>
<td>Nickles, 1903</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Lorraine Group</td>
<td>Emmons, 1842</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>McEicken Formation</td>
<td>Bassler, 1906</td>
<td>Kope Formation</td>
</tr>
<tr>
<td>McMillian Formation</td>
<td>Bassler, 1906</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Madison Beds</td>
<td>Owen, 1838; Borden, 1874; Foerste, 1897</td>
<td>Saluda Formation</td>
</tr>
<tr>
<td>Marble Hill Bed</td>
<td>Owen, 1859</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Maysville Group</td>
<td>Foerste, 1905</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Mount Aurora Formation</td>
<td>Nickles, 1902</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Mount Hope Formation</td>
<td>Nickles, 1902</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Richmond Group</td>
<td>Winchell and Ulrich, 1897</td>
<td>Dillsboro, Saluda, and Whittewater Formations</td>
</tr>
<tr>
<td>Southgate Formation</td>
<td>Bassler, 1906</td>
<td>Kope Formation</td>
</tr>
<tr>
<td>Tanners Creek Formation</td>
<td>Fox, 1962</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Utica Shale</td>
<td>Emmons, 1842</td>
<td>Kope Formation</td>
</tr>
<tr>
<td>Versailles Bed</td>
<td>Foerste, 1905</td>
<td>Dillsboro Formation through Whittewater Formation</td>
</tr>
<tr>
<td>Warren Beds</td>
<td>Nickles, 1902</td>
<td>Dillsboro Formation</td>
</tr>
<tr>
<td>Waynesville Formation</td>
<td>Nickles, 1903</td>
<td>Dillsboro Formation</td>
</tr>
</tbody>
</table>

1See also Cumings, 1922, and Wilmarth, 1938.
2For some names, only one of the more common surnames is given, not necessarily from the original combination.

This compendium recognizes these difficulties; it follows the work and principles of M. P. Wiess and others (for example, Weiss, 1961), of
Among the Indiana Geological Survey-abandoned and other little used terms for Indiana rocks (table 7) are these 11 formation names that had been used widely in Survey publications: Economy, Southgate, and McMicken Formations (replaced by Kope Formation); Mount Hope, Fairmount, Bellevue, Corryville, Mount Auburn, Arneheim, Waynesville, and Liberty Formations (replaced by Dillsboro Formation); and Elkhorn Formation (assigned to Whitewater Formation). The terms Eden, Maysville, and Richmond Groups also are abandoned, although their use as stage and age terms is not precluded (Brown and Lineback, 1966, p. 1020). The Tanners Creek Formation of Fox (1962) was included by Brown and Lineback (1966, p. 1020) in the upper part of the Dillsboro Formation because they could find no regionally and lithologically distinctive lower boundary for the Tanners Creek.

**Ditney Coal Member, Patoka Formation**, CEW

*Pennysylvanian System*

*Type area and reference section:* The name Ditney Formation was first used by Fuller and Ashley (1902, p. 2) for the rocks between the Somerville Limestone (now the West Franklin Limestone Member of the Shelburn Formation) and the Inglefield Sandstone Member. This section included 20 feet of shale, thin sandstone, and thin coal exposed in the Ditney Hills in Warrick County (secs. 4, 5, and 6, T. 5 S., R. 9 W.). Wier (in preparation) assigned these rocks to the Patoka Formation but retained the name Ditney for the coal that was called the Ditney Coal by Fuller and Ashley (1902, p. 2). Wier designated a reference section in the NW¼SW¼ sec. 13, T. 6 S., R. 11 W., north side of Evansville, Vanderburgh County.

*Description:* The Ditney Coal Member, a banded partly shaly coal, is generally less than a foot thick. It is separated from the underlying
West Franklin Limestone Member by 1 to 20 feet of unnamed gray shale and underclay. The northernmost exposure of the Ditney Coal Member in Indiana is in northwestern Vigo County. The coal is not continuously exposed in Vanderburgh and Gibson Counties where it either was not deposited or underwent erosional cutout by the overlying Inglefield Sandstone Member.

**Correlation:** The Ditney Coal Member is equivalent to the Chapel No. 8 Coal in Illinois (Wier, in preparation).

**Dugger Formation, Carbondale Group, AMB**

_Pennsylvania System_

**Type locality:** The name Dugger Formation was used by Wier (1952, p. 17) in describing 70 to 120 feet of rocks exposed 2 miles northeast of Dugger, Sullivan County. This first description placed the lower boundary of the formation at the top of the Alum Cave Limestone Member, but Wier later (in preparation) lowered this boundary to include this limestone and the underlying black shale. As now recognized, the Dugger Formation extends from the top of the Springfield Coal Member (V) of the Petersburg Formation to the top of the Danville Coal Member (VII).

**Description:** The Dugger Formation, the uppermost formation in the Carbondale Group, includes: the Bucktown, Herrin, Hymera, and Danville Coal Members; the Alum Cave, Antioch, Providence, and Universal Limestone Members; and unnamed beds of clay, sandstone, and shale. The basal unit of the formation is commonly an unnamed black fissile shale which contains fish remains and concretions of ironstone and limestone as much as 3 feet in diameter. In places a thin pyritic limestone underlies the black shale (Wier, 1952, p. 15).

The Dugger Formation ranges from 73 to 185 feet in thickness and averages 130 feet. It crops out from the Ohio River in Warrick County to Vermillion County in westernmost central Indiana.
**Eau Claire Formation**, St. Croixan Series, HHG

**Type area:** The names Eau Claire Grit and Eau Claire trilobite beds were first used by Wooster (1878) in a casual manner, and the term Eau Claire Sandstone is generally credited to Walcott (1914, p. 354), who, however, cited a manuscript in preparation by E. O. Ulrich. Apparently this manuscript did not appear in the form seen by Walcott, whose description must thus be considered definitive. The unit was probably named for Eau Claire River, Eau Claire County, Wis., where it consists of about 100 feet of thin-bedded and shaly sandstones.

**Description:** The formation in Indiana is recognized only in the subsurface, where it consists of pink dolomitic sandstones, green, maroon, and black shales, and tan silty dolomites, about 500 to 700 feet in total thickness (Gutstadt, 1958a, p. 27-29). The Eau Claire overlies the Mt. Simon Sandstone (St. Croixan). In northwestern Indiana it underlies the Galesville Sandstone (St. Croixan), and in the rest of the state it underlies the Knox Dolomite (St. Croixan and Canadian).

**Correlation:** The Eau Claire Formation is recognized by this name in the subsurface in Michigan and in northern Illinois. Gutstadt (1958a, p. 20) equated the subsurface Eau Claire with the lower part of the Bonneterre Dolomite of eastern Missouri, but Buschbach (1964, p. 23) equated it with the entire Bonneterre and placed the overlying Galesville Sandstone in equivalence with the lower part of the Davis Formation.

**Edwardsville Member,** Muldraugh Formation, GRG & CBR

**Type locality:** “The Edwardsville formation is named after the village of Edwardsville situated near the center of NE½ sec. 1, T. 3 S., R. 5 E. [in Floyd County]. The formation is completely exposed... along State Highway No. 62, a short distance northeast of the town” (Stockdale, 1931, p. 220). The unit was reduced to the rank of member by Smith (1965).
Description: The Edwardsville Formation was named by Stockdale (1929a, p. 170) for the rocks above the Floyds Knob Member of the Muldraugh Formation and beneath the Harrodsburg Limestone in Indiana. It was originally considered to be the uppermost formation in the Borden Group; Smith (1965), however, assigned the Ramp Creek Limestone Member, formerly of the Harrodsburg Limestone, to the upper part of the Borden Group. Siltstone, sandy shale, and sandstone are the dominant lithologies along most of the outcrop, and limestone is present in places (Stockdale, 1931, p. 220-300). The Edwardsville is 40 to 200 feet thick in Indiana (Stockdale, 1931, p. 220). Six facies (Stewarts Landing, Springler Knob, Medora Knob, Allens Creek, Bear Wallow, and Riverside Sandstone Facies) and six members (Brownstown Hills Sandstone and Dry Creek Sandstone Members of the Medora Knob Facies; Cutright Sandstone, Weed Patch, and Mount Ebel Sandstone Members of the Allens Creek Facies; and the Weed Patch Member of the Bear Wallow Facies) were defined as subdivisions of the Edwardsville by Stockdale (1931), but these names have not been later used by workers other than Stockdale (1939). The Riverside Sandstone of Hopkins (1896, p. 287), exposed in Fountain and Warren Counties, was included by Stockdale as a facies of the Edwardsville because he (1931, p. 295-297) correlated the Riverside with the Edwardsville.

Correlation: Stockdale (1939, p. 228-229) correlated the Edwardsville with the Muldraugh Formation of Kentucky, with part of the Keokuk Limestone of the Mississippi Valley, and with what was then called the Lower Harrodsburg Limestone. The famous crinoid beds at Crawfordsville are Keokuk in age according to Van Sant and Lane (1964, p. 30-33) and are equivalent to the lower part of the Edwardsville according to Stockdale (1939, p. 229). According to Smith (1965, p. 16, fig. 1), however, many of the Borden bioherms north of southern Monroe County, once assigned to the Edwardsville Member, should now be assigned to the Floyds Knob. This practice requires one to interpret much of the Edwardsville and Floyds Knob deposition as contemporaneous.
Ellsworth Shale, Ellsworth Member
(of New Albany Shale), Devonian and Mississippian Systems

Type section: The name Ellsworth Shale was first used by R. B. Newcombe in 1932 (p. 156) and then formally proposed (Newcombe, 1933, p. 49-51) for 30 to 40 feet of greenish-gray shale exposed in the Petoskey Portland Cement quarry in the NE¼NE¼ sec. 26, T. 32 N., R. 8 W., 1½ miles south of Ellsworth, Antrim County, Mich. This exposure constitutes the type section. The name is used here with formation rank for the coextensive section in the area north of the Cincinnati Arch in Indiana and as the Ellsworth Member of the New Albany Shale south of the arch (Lineback, in preparation).

Description: The lower part of the Ellsworth Shale consists of alternating beds of gray-green shale and black shale, the number of black shale beds diminishing upward. The upper part is a grayish-green shale bearing light-greenish limestone or dolomite lenses and in some places dark-gray thinly laminated dolomites. The unit is not exposed in Indiana because of cover by glacial drift, but that part of the Ellsworth north of the Cincinnati Arch is present at the bedrock surface as far west as Lake County and as far south as southern Porter and LaPorte Counties; south of the arch the Ellsworth Member is present in the area between southern Jasper County and southern Warren County. (See Schneider and Keller, in preparation, and Lineback, in preparation.) The Ellsworth Shale is conformable to the overlying Sunbury and Coldwater Shales and to the underlying Antrim Shale, and the Antrim-Ellsworth boundary generally is arbitrarily placed at the base of the lowest green shale bed. The unit thins eastward as the underlying Antrim Shale thickens. A maximum thickness of 300 feet is reported in Elkhart County, and only 60 feet is found in Steuben County.

Correlation: According to Lineback (1968 and in preparation) the Ellsworth Shale is approximately equivalent to that part of the New Albany Shale that lies above the Selmier Member. The upper part of the unit is also equivalent to the Bedford Shale, the Berea Sandstone, and the Sunbury Shale of eastern Michigan and in part...
to Lineback's Sunbury Shale of northernmost Indiana. (See also McGregor, 1954b.)

**Ewren Formation,** West Baden Group, HHG  
Mississippian System

*Type locality:* The name Elwren Sandstone was first used by Malott (1919, p. 11) for exposures near Elwren, Monroe County. The name was later changed to Elwren Formation because the unit is not dominantly sandstone but includes much shale and siltstone (Gray and Perry, 1956, p. 1005).

*Description:* The formation includes thin-bedded fine-grained sandstone, crossbedded sandstone, and green-gray and red-brown shale and mudstone and ranges from 20 to 60 feet in thickness (Indiana Geological Survey, 1957, pl. 2). It crops out from southern Putnam County southward to the Ohio River. The Elwren equivalent in the subsurface is called the Cypress Formation, which is recognized from southern Parke County southwestward. The Elwren overlies the Reelsville Limestone conformably except in a few places where a sandstone body in the Elwren appears to rest disconformably on the Reelsville or on the underlying Sample Formation (Malott, 1952, p. 14). The hypothesis of a regional unconformity at this horizon was rejected, however, by Gray and Perry (1956, p. 1009). The Elwren is overlain conformably by the Beech Creek Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

*Correlation:* Malott (1931, p. 222; 1952, p. 14) considered the Elwren to be equivalent to the middle part of the Paint Creek Formation of Illinois, but Swann and Atherton (1948) demonstrated its equivalence to the Cypress Sandstone of southern Illinois, and Cypress is the name adopted for equivalent rocks in the Illinois standard section by Swann (1963, fig. 20).

*Concept of naming formations in middle and lower parts of Chesterian Series:* In contrast to his manner of naming units in the upper part of the Chesterian (see under “Tar Springs Formation”) Malott (1919), in naming formations in the middle and lower parts of the Chesterian
Series, recognized from the first that it was necessary to name entire units of sandstone and shale between the more readily identifiable limestone formations. Thus, although he indicated that the Elwren Formation “. . . consists of one or more members of sandstone and frequently considerable thicknesses of shale . . .” (Malott, 1919, p. 11), he named the formation the Elwren Sandstone. Each of the clastic units in the middle and lower parts of the Chesterian Series was likewise designated a sandstone, even though there was never any doubt that each of these units included much shale. The paradox was at first avoided by referring the shales to so-called “sandstone horizons” (Malott, 1919), and then by contradiction: “The Sample below the Reelsville is mostly shale” (Malott and Esarey, 1940, p. 7). The sandstones crop out more conspicuously than their actual abundance would suggest; the Elwren, for instance, is approximately two-thirds shale, siltstone, and mudstone and only one-third sandstone (Gray, Jenkins, and Weidman, 1960, p. 45). Thus the clastic units are more appropriately designated formations in line with the suggestion of Gray and Perry (1956), and ambiguity regarding their proper limits is to some extent avoided.

*Fairbanks Coal Member, Bond Formation, CEW  
Pennsylvanian System

_Type locality:_ The Fairbanks Coal Member (Bond Formation) is the name proposed by Wier (in preparation) for the coal that crops out and has been mined near Fairbanks in Sullivan County. The type locality is in the SW 1/4 SE 1/4 sec. 8, T. 9 N., R. 10 W., 1 1/2 miles northwest of Fairbanks.

_Description:_ The Fairbanks Coal Member is a bright-banded coal ranging from 1 to 4 feet in thickness and containing numerous thin shale partings. Stratigraphically this coal lies 30 to 40 feet above the Shoal Creek Limestone Member in the Fairbanks type area. The Fairbanks is not generally recognized in other areas of the state, although a thin coal is reported at this general stratigraphic level in some places in Posey and Gibson Counties.
Falling Run Bed, Clegg Creek Member, Mississippian System

**Type section:** The Falling Run Bed was named by Guy Campbell (1946) as a member of his Sanderson Formation, a part of the New Albany Shale. The type section is on Falling Run Creek in New Albany, Floyd County (SW¼NE¼ sec. 3, T. 3 S., R. 6 E.) (Lineback, in preparation).

**Description:** Now recognized as a 0.2-foot bed near the top of the Clegg Creek Member of the New Albany Shale (Lineback, in preparation), this unit is a layer of sparsely fossiliferous phosphatic nodules that range in shape from spherical to ellipsoidal and that are as much as 0.7 foot long in the elongate forms. The Falling Run Bed can be traced from Jackson County southward into northern Kentucky. In most of southern Indiana the overlying Underwood Bed is not present, and the Henryville Bed rests directly on the Falling Run (Lineback, 1968 and in preparation).

**Correlation:** The Falling Run is probably earliest Mississippian in age, although no conclusive evidence has been found. (See also “Clegg Creek Member, Correlation.”)

Farmdale Loess Member, Atherton Formation

**Type section:** The term Farmdale Loess was credited to Leighton by Wascher, Humbert, and Cady (1948, p. 390) in a footnote, but its distribution and significance were first discussed in print by Leighton and Willman (1950, p. 616-617); the type section designated is along Farm Creek east of Peoria, 111. (SE¼ sec. 30, T. 26 N., R. 3 W.) (Leighton, 1926; Leighton and Brophy, 1966). A railroad cut at Farmdale, 1 mile south of the type section, was used to illustrate the Farmdale silt and Farmdalian Substage by Frye and Willman (1960, p. 6, 11).

**Description:** The Farmdale Loess Member in Indiana is a grayish-brown fine silt, generally noncalcareous, that lies between the base of the Peoria Loess Member and the top of the weathering profile on the
Butlerville Till Member or its correlative, the Lovelands Loess Member. It is thickest along the lower segments of the Wabash and Ohio Valleys and can be traced downstream along the Mississippi Valley. Though its matrix rarely is calcareous, loess commonly contains secondary CaCO₃ concretions. In some exposures a weakly developed humus band caps it, and large numbers of woodland gastropods have been collected from the top few inches of the unit in southwestern Indiana and in Kentucky.

**Correlation:** The Farmdale Loess Member of the Atherton Formation probably includes both wind-laid silts correlative with the Altonian Substage (Frye and Willman, 1960) and younger colluvially accumulated sediments referred to the Farmdalian Substage. It is buried beneath Peoria loess, deposition of which probably began in Indiana 22,000 to 24,000 years ago.

**Ferdinand Limestone Member, Mansfield Formation, Pennsylvanian System**

*Type locality:* Franklin and Wanless (1944, p. 88-89) applied the name Ferdinand Limestone to a marine zone some 15 feet above the Fulda Limestone Member, stating that it is best developed northeast of Ferdinand, Dubois County, in T. 3 S., R. 4 W. No exposure is present at a location specifically cited by Franklin for that township, but there is a characteristic exposure 1 mile northwest of Ferdinand (NW¹/₄ NW¹/₄ sec. 29, T. 3 S., R. 4 W.). Thompson and Shaver (1964, p. 15-16) assigned the unit member rank in the Mansfield Formation.

*Description:* The Ferdinand Limestone Member lies about 40 feet below the top of the Mansfield Formation, ranges from 2 to 3 feet in thickness, and is dark-blue to gay argillaceous fossiliferous limestone, which in places is very cherty. In these places the member generally consists of medium blue-gray fossiliferous limestone, 1.0 foot thick; black white-spotted fossiliferous chert, 1.0 foot thick; and medium blue-gray fine-grained fossiliferous limestone. The Ferdinand is overlain by black soft shale and massive fine-grained carbonaceous micaceous sandstone and underlain by blue-gray soft shale and a
ROCK-UNIT NAMES

bright blocky coal bed, 1.0 foot thick (Franklin and Wanless, 1944). In the north bluff of the Ohio River near Grandview, Spencer County, the Ferdinand, named Grandview Limestone at this point by Franklin and Wanless (1944), is 5 feet thick and consists of light-gray massive fine-grained fossiliferous limestone that contains large crinoid stems and gray bedded chert.

The Ferdinand is mostly continuous along its area of outcrop in Spencer County and southern Dubois County, but northward it thins and is found only in some places. The Ferdinand, or what probably is the Ferdinand, is present in Owen and Greene Counties (Kottlowski, 1959, 1960) and in Clay County (Hutchison, 1956, 1960).

Correlation: The Ferdinand, which includes the Grandview Limestone of Franklin and Wanless (1944) in southern Spencer County, contains the fusulinid Profusulinella kentuckyensis and lies in the ostracod Zone of Amphissites rothi. Thus, considered together with the Fulda Limestone Member, which lies about 15 feet below the Ferdinand, it probably correlates with the upper part of the Lead Creek Limestone of Hancock County, Ky., and with an upper part of the unnamed limestone at Morgantown, Butler County, Ky. Faunally, it appears to be older than the Lower Mercer Limestone of Ohio and older than the Curlew Limestone of Union County, Ky., Franklin and Wanless' (1944) tentative Curlew correlation notwithstanding (Thompson and Shaver, 1964). In the Midcontinent classification, Cooper (1946, p. 19), on the basis of ostracods, assigned the Ferdinand an early Atokan age, but Thompson and Shaver (1964, p. 20), on the same basis, preferred simply a pre-Desmoinesian age and demonstrated similarity with Morrowan ostracod faunas in the Midcontinent. (See also the “Fulda Limestone Member.”)

Floyds Knob Member, Muldraugh Formation, GRG & CBR
Mississippian System

Type section: The Floyds Knob Member was named originally as a formation for exposures along U.S. Highway 150 through the Knobstone Escarpment at Floyds Knob in the center of sec. 21,
T. 2 S., R. 6 E., three-fourths of a mile east of Floyds Knob post office in Floyd County (Stockdale, 1929a, p. 170; 1931, p. 195-196). The unit was reduced to the rank of member of the Muldraugh Formation by Smith (1965).

Description: The name Floyds Knob was first applied to the thin limestone that Stockdale considered to be the key to mapping the Borden Group in southern Indiana. The member, generally 0 to 6 feet thick, was subdivided by Stockdale into three facies (Cisco Branch, Goss Mill Limestone, and Fordyce Knob Sandstone Facies). (See Stockdale, 1929a, p. 170; 1931, p. 109-110, 197.) These names have not been used by subsequent workers. The Floyds Knob is a limestone as far north in Indiana as Jackson County, but is “expressed by a peculiar light buff to ochorous zone of slightly calcareous, shaly and arenaceous rock with many variations” north of here (Stockdale, 1931, p. 197). According to Smith (1965, p. 16), however, “in and north of southern Monroe County the Floyds Knob Limestone Member thickens as bioherms, which are commonly contiguous with, indistinguishable from, and herein included within that unit, become prominent.” The Floyds Knob is overlain by the Edwardsville Member of the Muldraugh Formation and underlain by the Carwood Formation, but in its biohermal facies the member also is in juxtaposition with the Edwardsville.

Correlation: “The Floyds Knob formation, heretofore identified only throughout the area of the Borden group in Indiana, at the top of the Carwood division, extends across the Kentucky outcrop belt to the Ohio boundary” (Stockdale, 1939, p. 228) and is also equivalent to part of the Keokuk Limestone of the upper Mississippi Valley.

Fredonia Member, Ste. Genevieve Limestone, NMS
Mississippian System

Type locality and use of name in Indiana: The name Fredonia originally was applied to rocks exposed in the immediate vicinity of Fredonia, Caldwell County, Ky., by Ulrich and Smith (1905, p. 24, 39, 40). It was first applied in Indiana by Cumings (1922, p. 507).
who suggested equivalency of the classic Fredonia and Elrod’s (1899, p. 259) Paoli Limestone, and was later applied by Malott (1945, p. 1180; 1946, p. 322-326; 1952, p. 8) to rocks above the St. Louis Limestone and below his Rosiclare Member. Although the term Fredonia has been used with different surnames, the full name used here is the Fredonia Member—lowermost in the Ste. Genevieve Limestone—and it is applied in the sense of Malott.

**Description:** The Fredonia Member in Indiana consists dominantly of oolitic limestone that is light gray to gray, dense, medium grained, and generally thick bedded or massive and of limestone that is gray, light gray, or tannish gray, dense, and thin bedded and that contains some sand-sized fossil debris. Rarely, the limestone is white, pure, and poorly cemented oolite, and beds of tan to brown granular limestone are present in places. In and north of Monroe County, breccia commonly marks the top of the Fredonia. The Lost River Chert Bed is an important marker near the base of the Fredonia.

The Fredonia ranges from 30 to 70 feet in thickness on outcrop and is 100 feet thick in the subsurface. Its base is common with that of the Ste. Genevieve Limestone, and its upper contact, with the Rosiclare Member of Indiana outcrop, appears to be a surface of local unconformity.

**Correlation:** According to Pinsak (1957, p. 21-22) and Swann (1963, p. 27, 49, 51), the Fredonia of Indiana outcrop correlates with the lower part of the Fredonia of Ulrich and Smith (1905), which part is below the Spar Mountain Sandstone Member of southern Illinois, and thus corresponds to the restricted Fredonia of Swann. The Fredonia is in the zone containing *Platycrinites penicillus* (Malott, 1952, p. 8) and therefore is in the Genevievian Stage of Swann (1963).

**French Lick Coal Member,** Mansfield Formation, HCH Pennsylvanian System

*Type section:* Franklin (1939, p. 9) applied the name French Lick to an exposure of coal in a whetstone quarry said to be in the SW¼NW¼ sec. 4, T. 2 N., R. 2 W., near French Lick, Orange County. Gray,
Jenkins, and Weidman (1960, p. 26, 27) accorded this coal member status in the Mansfield Formation and stated that Franklin's intended type section probably is in the NE\(\frac{3}{4}\)NE\(\frac{3}{4}\) sec. 5, T. 1 N., R. 2 W.

Description: In the type area the coal was commercially mined, and it was described by Franklin as bright, blocky, 2.4 feet thick, and having no partings. The roof of the coal is carbonaceous shale that is overlain by sandy siltstone. The floor is underclay. Stratigraphically, the coal lies immediately below the so-called Hindostan Whetstone Beds and 40 to 50 feet below the Pinnick Coal Member.

The French Lick Coal Member has been recognized along its outcrop in northwestern Orange County, southeastern Martin County (Hutchison, 1967), and in northeastern Dubois County (Gray, Jenkins, and Weidman, 1960, pl. 1; Hutchison, 1964). This bed is one of several coals that in different areas were identified as Coal I by Ashley (1899, p. 1086), who reported its maximum thickness as 1.8 feet.

Fulda Limestone Member, Mansfield Formation, HCH Pennsylvanian System

Type locality: Franklin and Wanless (1944, p. 88-89) called a limestone bed that is exposed along the road between Fulda and New Boston in eastern Spencer County the Fulda Limestone. The stated type locality is in the S\(\frac{1}{2}\)SW\(\frac{1}{4}\) sec. 33, T. 4 S., R. 4 W. Thompson and Shaver (1964, p. 16) assigned it member rank in the Mansfield Formation, doubted the accuracy of Franklin's stated location, and mentioned a good exposure in the type locality (NE\(\frac{3}{4}\)SW\(\frac{3}{4}\) sec. 11, T. 5 S., R. 4 W.).

Description: The Fulda Limestone Member lies some 15 feet below the Ferdinand Limestone Member and approximately 55 feet below the top of the Mansfield Formation. It is, according to Franklin and Wanless (1944), dark blue-gray dense pure brittle sparsely fossiliferous limestone, which is 2.5 feet thick at the type locality. Overlying the limestone in places is light blue-gray shale, and below are light bluegray soft shale and coal. The dark blue-gray limestone reported by
Franklin as being found 13 feet below the Ferdinand (Grandview Limestone of Franklin and Wanless) east of Grandview in Spencer County is probably the Fulda (Hutchison, 1959). The Fulda, although persistently present in southern and eastern Spencer County, cannot be traced northward.

Correlation: The Fulda is among the oldest marine limestones, if not the oldest, known in the Illinois Basin, and possibly as the name has been applied it consists of more than one bench. At the type-locality exposure given by Thompson and Shaver (1964, p. 16), it is barren of spindle-shaped fusulinids but contains the ostracods *Polytylites wapanuckaensis*, *Amphissites weaveri*, and *A. rothi* and other early Pennsylvanian forms. Thus Cooper (1946, p. 19) assigned the Fulda to the Morrowan Series, and Thompson and Shaver (1964, p. 20) preferred simply a pre-Desmoinesian age, pointing out, however, that similar Midcontinent ostracod faunas are known only in Texas and Oklahoma rocks classically called Morrowan in age. (Lack of satisfactory knowledge of type Morrowan, and Atokan, faunas from the Midcontinent suggests the broad use of “pre-Desmoinesian” for fossiliferous rocks as low as the Fulda.) The first-listed two ostracods are absent from other so-called Fulda sections, which do contain the normal fauna of the Zone of *Amphissites rothi* and the fusulinid *Profusulinella kentuckyensis*, and which are not faunally distinct from the overlying Ferdinand (Thompson and Shaver, 1964, table 2). Considering both faunas and stratigraphic position, the Fulda, of southern Spencer County at least, probably is coextensive with the lower part of the Lead Creek Limestone of Hancock County, Ky., and it may be the limestone above the Mariah Hill Coal Member of Spencer County. Together with the Ferdinand, it is faunally similar to the Poverty Run Limestone of Ohio that is above the Vandusen Coal of the Pottsvillian Series and to unnamed limestones of the Mansfield Formation in Parke and Warren Counties.

**Galesville Sandstone**, St. Croixan Series, Cambrian System HHG

Type locality: The Galesville Sandstone was named by Trowbridge and Atwater (1934, p. 45) for exposures near Galesville, Wis., where it is about 90 feet thick.
Description: In Indiana the Galesville is known only from the subsurface and is restricted to the northwestern part of the state. It ranges in thickness from a wedge edge near the center of the state to 170 feet at the northwest corner. It consists of dolomitics and stone, sand, dolomite, and loosely consolidated sandstone (Gutstadt, 1958a, p. 32-34). The Galesville is probably laterally equivalent to the lower part of the Knox Dolomite (St. Croixan and Canadian), is overlain by the upper part of the Knox (Gutstadt, 1958a, p. 82), and overlies the Eau Claire Formation (St. Croixan).

Correlation: The name Galesville Sandstone is used in the sense described above in the subsurface in Indiana, Michigan, and Ohio. In Wisconsin, Iowa, Minnesota, and northern Illinois, the name is restricted to the lower part of this unit, and the upper, somewhat coarser part is referred to the Ironton Sandstone (Buschbach, 1964, p. 35). Rocks equivalent to the Galesville (in either sense) are found in the lower part of the Davis Formation in eastern Missouri (Buschbach, 1964, p. 23).

Geneva Dolomite, Ulsterian Series, Devonian System AMB & JBP

Type locality and reference sections: The name Geneva Limestone was first used by Collett (1882) for exposures of a “buff magnesian limestone” along the Flat Rock River near Geneva, Shelby County. Foerste (1898, p. 234) called the Geneva the Shelby Bed, a term now considered to be obsolete. Dawson (1941) referred to this unit as the Geneva Formation, but the name Geneva Dolomite is more commonly used and is preferred here for that reason and because of its dolomitic nature.

Good exposures of the Geneva Dolomite can be seen in the following quarries: 23.7 feet in the McCorkle Stone Co. quarry near Milroy, Rush County, in the SW¼ sec. 8, T. 12 N., R. 9 E.; 28.6 feet in the Meshberger Stone Co. quarry, Bartholomew County, in the SE¼SE¼NE¼ sec. 6, T. 8 N., R. 7 E.; and 20 feet in the Standard Materials quarry near Hanover, Jefferson County, in the SE¼SE¼ sec. 16, T. 3 N., R. 9 E.
Description: Typically a dolomite that is buff to chocolate brown, rather soft, sparingly unfossiliferous, granular, and calcareous and that contains bands and partings of carbonaceous material, the Geneva Dolomite is massive and thick bedded in the lower portions and more commonly thin bedded in the upper portions. The dark color is due to a high organic content, and near-surface beds are commonly oxidized to pale tan, cream, or even white. White crystalline calcite masses ranging from 1 inch to more than 1 foot in cross section, resulting from over calcification of fossils, are scattered throughout the fine-grained saccharoidal dolomite. Although some vestigial fossil outlines are visible, dolomitization and replacement by calcite, chert, and quartz have almost completely destroyed the original texture of the unit.

In outcrop the Geneva thins southward from a thickness of 35 feet in the type locality to nothing in northern Clark County. It is buried by glacial drift and is not exposed north of Milroy in southern Rush County. It attains a subsurface thickness of more than 60 feet in Sullivan and Monroe Counties but is truncated by erosion both northward in Montgomery, Fountain, and Boone Counties and southward in Greene, Lawrence, Jackson, and Scott Counties (Becker, in preparation; Perkins, 1963).

The Geneva Dolomite underlies the Jeffersonville Limestone and unconformably overlies various Silurian units ranging from the Laurel Member of the Salamonie Dolomite to the Mississinewa Shale Member of the Wabash Formation but most commonly overlies the Louisville Limestone.

Correlation: Because identifiable fossils are virtually absent from the Geneva Dolomite, much debate about its age and correlation with other units has arisen. Early 20th century geologists thought that it is a northerly facies of the Jeffersonville or of the Jeffersonville and North Vernon Limestones combined. Curnings (1922, p. 446) suggested that the Geneva is a separate formation, older than the Jeffersonville. An Onondaga age was assigned to the Geneva by Sutton and Sutton (1937, p. 331), and they, on the basis of fossil evidence,
considered the Geneva to be a “northward lithologic facies of the Jeffersonville Formation.” Dawson (1941, p. 27), after detailed study of the problem, stated that “the Geneva is a distinct formation older than the Jeffersonville.” Patton and Dawson (1955, p. 37) considered the Geneva sections described by Sutton and Sutton to be part of the Jeffersonville itself, thus invalidating the earlier conclusions. Later quarry deepening did reveal a full 33-foot Geneva section beneath the controversial beds. A Schoharie age was suggested by Kindle (1913, p. 313), but the paucity of fossils has left early age determinations questionable as has the questionable identification of the rocks whence came the fossils. (See Dawson, 1941, p. 25, who apparently assigned Kindle's preserved Geneva fossils to the Jeffersonville.) Meents and Swann (1965) correlated the Geneva with the lower part of the Grand Tower Limestone of Illinois.

**Glen Dean Limestone**, Stephensport Group, HHG

Mississippian System

*Type locality:* The Glen Dean Limestone was named by Butts (1917, p. 97-102) for exposures near Glen Dean, Breckinridge County, Ky., where, in descending order, the formation consists of 40 to 100 feet of gray and red shale and thin beds of limestone, 30 to 60 feet of gray crinoidal limestone, and 0 to 10 feet of red and green shale.

*History of name in Indiana:* Rocks equivalent to the lowest of the three parts described above apparently have long been considered to be a part of the Hardinsburg Formation in Indiana (Malott and Thompson, 1920, p. 521-522; Malott, Esarey, and Bieberman, 1948, pl. 2). Equivalents of the upper part, formerly assigned to the Glen Dean (Indiana Geological Survey, 1957, pl. 2, p. 28), are now included in the Tar Springs Formation (Gray, Jenkins, and Weidman, 1960, p. 38). The name Glen Dean is therefore applied only to the so-called main or massive limestone unit which is equivalent to the middle part of the formation as originally described by Butts (1917).

*Description:* The Glen Dean Limestone is a thick-bedded micritic to biomicrotic limestone, 20 to 40 feet thick (Perry and Smith, 1958,
p. 92). Its typical fauna consists of brachiopods, blastoids of the genus Pentremites, and bryozoans including Archimedes (Perry and Smith, 1958, p. 94). Among the major faunal elements described in detail are the bryozoans (Uggaard and Perry, 1960; Perry and Horowitz, 1963) and the crinoids (Horowitz, 1965). The unit is known in surface exposures from south-central Greene County to the Ohio River and is recognized in the subsurface from Greene County southwestward. It conformably overlies the Hardinsburg Formation and is overlain with apparent conformity by the Tar Springs Formation or disconformably by the Mansfield Formation (Pennsylvanian).

Correlation: Horowitz and Perry (1961) studied the crinoids of the Glen Dean Limestone, in which they included fossiliferous shales now assigned to the Tar Springs Formation, and concluded that the Glen Dean should be assigned a position near the Visean-Namurian boundary in European chronology.

Golconda Limestone, Stephensport Group, Mississippian System

Type locality: The origin of the name Golconda is variously stated. Butts (1917, p. 91) said that E. O. Ulrich first used the name in a paper presented orally in 1915. Wilmarth (1938) credited it to Brokaw (1917), who, however, used the name only on a columnar section. Butts (1917, p. 91-95) was apparently the first to describe the unit adequately in print, under the name Golconda Formation. The type locality is a bluff on the Ohio River near Golconda, Pope County, Ill. In this area the section typically consists in descending order of 30 to 40 feet of limestone, 80 feet of shale and limestone, 10 feet of dark-colored argillaceous crystalline limestone, and 20 feet of dark-colored shale.

Description: In Indiana this name has always been used in a restricted sense and now is applied as the Golconda Limestone to gray thick-bedded micritic to bimicroitic limestone and interbedded yellow-brown thin-bedded argillaceous limestone equivalent to only the upper member of the type area (Gray, Jenkins, and Weidman, 1960, p. 39-40).
This unit is 20 to 40 feet thick and contains abundant blastolds of the genus *Pentremites*, crinoid plates, and the bryozoan *Archimedes* (Malott, Esarey, and Bieberman, 1948, p. 24; Rodriguez, 1960). The Golconda Limestone can be recognized in surface exposures from northern Greene County to the Ohio River and is known in the subsurface from southwestern Owen County Southwestward. It conformably overlies the Big Clifty Formation and is overlain conformably by the Hardinsburg Formation or disconformably by the Mansfield Formation (lower Pennsylvanian).

**Correlation:** The Golconda Limestone of Indiana usage is equivalent to the Haney Limestone of western Kentucky (McFarlan and others, 1955, p. 18). The name Haney has also been placed in the Illinois standard section, in which the name Golconda in nearly its original sense has been raised to group rank (Swann, 1963). Thus it is clear that the name Golconda is applied in Indiana in a confusing and possibly improper sense, and despite long and consistent use in this area the name should be replaced.

**Guthrie Creek Member, Harrodsburg Limestone, AMB**

**Mississippian System**

**Type section:** Stockdale (1929b, p. 240) proposed the name Guthrie Creek Member for the shaly to siliceous geode-bearing limestone lying immediately above the Leesville Member of the Harrodsburg Limestone. Seven feet of this unit is exposed at the type section along U.S. Highway 50, near the center of the NE¼ sec. 27, T. 5 N., R. 2 E., one-fourth mile southeast of Leesville, Lawrence County. The name was taken from Guthrie Creek in the southeastern part of the county.

**Description:** According to Smith (1965) the Guthrie Creek Member is variable in thickness and in lithology, ranging from a parting of calcareous shale to 10 feet of siliceous shaly calcilutite. The unit is fossiliferous in places and contains bryozoan-rich lenses of carbonate rocks. Stockdale (1931) recognized the Guthrie Creek Member from southwestern Jefferson County, Ky., northward to Monroe County,
Ind. It overlies the Leesville Member of the Harrodsburg Limestone and is overlain by the rest of the Harrodsburg Limestone.

**Hardinsburg Formation**, Stephensport Group, HHG

*Mississippian System*

*Type locality:* The name Hardinsburg, generally credited to Brokaw (1917, p. 23; pl. 1), was presented by him as "tentative and subject to revision." A more complete description was offered by Butts (1917, p. 96) under the name Hardinsburg Sandstone. This unit in its locality is 35 to 40 feet thick and contains in descending order shaly sandstone, massive cliff-forming sandstone, and thin-bedded fine-grained well-indurated sandstone. The formation was named for Hardinsburg, Breckinridge County, Ky.

*Description:* The name Hardinsburg Sandstone was first used in Indiana by Malott and Thompson (1920, p. 522). Later the name was modified to the Hardinsburg Formation in recognition of the large quantity of shale in the unit. It is characteristically gray soft carbonaceous shale and very fine-grained wavy-bedded sandstone that is cliff forming in some places (Indiana Geological Survey, 1957, pl. 2). The thickness of this unit, which is known in surface exposures from central Greene County to the Ohio River and is recognized in the subsurface from Greene County southwestward, ranges from 20 feet (Indiana Geological Survey, 1957, pl. 2) to 62 feet (Gray, Jenkins, and Weidman, 1960, p. 39). It conformably overlies the Golconda Limestone and is overlain conformably by the Glen Dean Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

**Harrodsburg Limestone, Valmeyeran Series, RHS**

*Mississippian System*

*Type and reference sections:* The Harrodsburg Limestone was named for Harrodsburg, which is immediately west of Indiana Highway 37 in southern Monroe County, but the original type section in the NE3/4 SW3/4 sec. 32, T. 7 N., R. 1 W., specified by Hopkins and Siebenthal
(1897, p. 296-297), was destroyed by highway construction. Although never designated subsequently as the type section, the good exposure of Harrodsburg rocks 1 mile north of Harrodsburg in cuts along Indiana Highway 37 (along a north-south line through the center of the SE¼ sec. 20, T. 7 N., R. 1 W.) generally has been used as the standard section of reference. Another excellent reference section, here designated, is the road cut along the Monroe Reservoir dam-access road in the NE¼SE¼ sec. 28, T. 7 N., R. 1 W. Exposures around Judah Hill in the SE¼ sec. 32, T. 7 N., R. 1 W., also are close to the original type section and are useful reference sections.

History of name: The name originally was applied (Hopkins and Siebenthal, 1897, p. 296-298) to the rocks now mostly assigned (in ascending order) to the Ramp Creek Member of the Muldraugh Formation and to the Leesville and Guthrie Creek Members and the upper unnamed member of the Harrodsburg. Thus the Harrodsburg then included the section bearing great numbers of geodes (Ramp Creek) that Hopkins and Siebenthal called the “beds of passage” from the silty Knobstone Group to the crinoidal upper Harrodsburg rocks; the overlying massive-bedded limestone often called the waterfall limestone (Leesville); and the crinoidal limestone occupying most of the interval between the Leesville and the Salem Limestone.

Because the upper part of the Borden Group and the lower part of the original Harrodsburg are characterized in many sections by interbedded lithologies respectively characteristic of Borden and Harrodsburg rocks and because there are interfingering facies relationships of these lithologies that increase in complexity southward, the Borden-Harrodsburg boundary has not been consistently placed, and the history of nomenclatural changes is involved (table 8).

The Leesville Member, however, generally has been recognized as a key marker useful for (1) collating the concepts of the now-abandoned terms Upper Harrodsburg Limestone (Division) and Lower Harrodsburg Limestone (Division) and the terms Ramp Creek Member (now of the Muldraugh Formation) and Guthrie Creek Member (all these names from Stockdale, 1929b, 1931); (2) understanding the various
Table 8. Nomenclatural history of the Harrodsburg Limestone

<table>
<thead>
<tr>
<th>Stockdale, 1929b</th>
<th>Stockdale, 1939</th>
<th>Pinsak, 1957</th>
<th>Smith, 1965</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Harrodsburg Limestone</td>
<td>Upper Harrodsburg Division</td>
<td>Upper Harrodsburg Limestone</td>
<td></td>
</tr>
<tr>
<td>Guthrie Creek Member</td>
<td>Guthrie Creek Member</td>
<td></td>
<td>Guthrie Creek Member</td>
</tr>
<tr>
<td>Lower Harrodsburg Limestone</td>
<td>Leesville Member</td>
<td></td>
<td>Leesville Member</td>
</tr>
<tr>
<td>Ramp Creek Member</td>
<td>Ramp Creek Member</td>
<td></td>
<td>Ramp Creek Member</td>
</tr>
<tr>
<td>Borden Group</td>
<td>Borden Group</td>
<td></td>
<td>Borden Group</td>
</tr>
<tr>
<td>Edwardsville Division</td>
<td></td>
<td></td>
<td>Edwardsville Member</td>
</tr>
</tbody>
</table>
Borden-Harrodsburg boundaries of Stockdale (1929b, 1931, 1939), Pinsak (1957), and Smith (1965); and (3) recognizing the base of the Harrodsburg as defined here (Smith, 1965).

**Description:** In ascending order the generally tripartite Harrodsburg consists of 1 to 11 feet of light-colored to bluish-gray coarse-grained biofragmental thick-bedded ledge-forming limestone (Leesville); less than 1 foot to 10 feet of calcareous shale and siliceous shaly calcareous siltstone (Guthrie Creek); and about 30 feet (on outcrop) to more than 100 feet (in the subsurface) of light-colored coarse-grained crinoidal and otherwise biofragmental limestone that grades lithologically upward into the Salem Limestone. In some places from Monroe County southward, however, a few feet of shale is present at the top of the Harrodsburg. This is the shale termed the Somerset Shale (Butts, 1922, p. 89, 104-107) in Kentucky, a name that also has been applied in Indiana as the Somerset Member of the Salem Limestone (Stockdale, 1939, pls. 6 and 25); Smith (1965, p. 13-14) included the shale in the Harrodsburg but recommended abandonment of the name Somerset in Indiana.

In Indiana the Harrodsburg is exposed west of the edge and along the dip slope of the Knobstone Escarpment extending northwestward from the Ohio River in Harrison County to the area of Pennsylvanian overlap and of extensive drift cover in the Parke County area. The thickness increases southeastward along the outcrop and southwestward into the subsurface. (See Stockdale, 1931; Pinsak, 1957; and Smith, 1965.)

**Correlation:** Before the Harrodsburg was restricted as defined here, it was assigned in two nearly equal parts to the Osage and Meramec Series and was correlated at times both with part of the Warsaw Limestone of Kentucky and of the upper Mississippi Valley and with a part of the Keokuk Limestone of the upper Mississippi Valley; these names, in fact, often were applied directly to Indiana rocks as late as the period of P. B. Stockdale’s work.
**Hazelton Bridge Coal Member, Patoka Formation**, CEW

Pennsylvanian System

*Type section:* Malott (1939, p. 114) applied the term Hazelton Bridge Formation to 20 to 25 feet of shale and one or two thin coalbeds, some black shale, and a thin limestone that were exposed in a road cut south of Hazelton Bridge, which spans the White River in northern Gibson County. Wier (in preparation) included these rocks in the Patoka Formation but retained the name Hazelton Bridge with member rank for the thin persistent coal lying below the Vigo Limestone Member. The type section of the coal member is at the east edge of the Dicksburg Hills, 1 mile north of Hazelton Bridge in the NE¼NW¼ sec. 20, T. 1 N., R. 10 W.

*Description:* The Hazelton Bridge Coal Member of the Patoka Formation varies in lithology from a normal bright-banded coal to smutty streaks of coal in shale. The coal ranges from 0.1 to 1.5 feet in thickness, is overlain in most places by 1 to 2 feet of black shale, and generally lies above an underclay, underclay limestone, or calcareous siltstone.

In a few places another thin coal lies below the Hazelton Bridge Coal Member. In some areas both of the coals are absent and sandstone is found in the stratigraphic position of these coals. The Hazelton Bridge member is a prominent coal in Gibson County and in southern Knox County and is the coal lying just below the Vigo Limestone Member in Sullivan County and in southern Vigo County.

**Henryville Bed, Clegg Creek Member**, AMB

Mississippian System

*Type section:* The Henryville Bed was originally named as a formation by Campbell (1946), and its type section is the exposure of dark shale on Caney Fork Creek, lot 252, Clark's Grant, ½ miles southwest of Henryville, Clark County.

*Description:* Now recognized as a bed in the Clegg Creek Member of the New Albany Shale (Lineback, in preparation), the Henryville
consists of brownish-black to black fissile shale and is overlain by the Jacobs Chapel Bed and underlain by the Falling Run Bed or by the Underwood Bed where the latter is present. It contains a few plant remains and a fauna of conodonts and phosphatic brachiopods. The Henryville ranges from 0.4 to 1.4 feet in thickness and can be recognized throughout the southeastern Indiana outcrop area.

Correlation: The unit is correlated with the middle part of the Hannibal Shale of the upper Mississippi Valley, with part of the Sunbury Shale of Michigan, Ohio, and northeastern Indiana, and with part of the Maury Shale of Tennessee (Lineback, in preparation). (See also “Clegg Creek Member, Correlation.”)

Herrin Coal Member, Dugger Formation, Pennsylvanian System

Type locality: The name Herrin, taken from Herrin, Williamson County, Ill., where the coal was extensively mined, was first used by Worthen (1870, p. 93) and later by Shaw and Savage (1912, p. 6). The name was adopted for Indiana usage by Wier (in preparation) as the Herrin Coal Member of the Dugger Formation.

Description: The Herrin is represented by streaks of coal and thin smut streaks that are found below the Providence Limestone Member along its outcrop in Warrick County. This coal is thin and discontinuous on Indiana outcrop and has not been mined in the state, but it thickens westward in Vanderburgh and Posey Counties, where it ranges from 2 to 5 feet in thickness. It is a bright-banded coal that contains clay or shale partings and has the same general appearance as in the type area. The Herrin is known as Coal No. 11 in Henderson County, Ky.

Holland Limestone Member, Staunton Formation, Pennsylvanian System

Type section: The Holland Limestone Member, here assigned that rank in the Staunton Formation, was named by Wanless (1939, p. 87) for the limestone roof of the so-called Holland Coal, near Holland,
Dubois County. This coal, together with its limestone roof, had been noted by that name by Ashley (1909, p. 112-131) and by Fuller and Ashley (1902, p. 2). The section that probably should be considered as the type is in the SE¼NW¼NE¼ sec. 26, T. 3 S., R. 6 W., where it was first described by Franklin and Wanless (1944).

**Description:** At the stated location, the Holland Limestone Member, in descending order, consists of (1) chert that is light gray to dark gray blue and ferruginous, has a porous zone at top, and is 1 foot thick; (2) shale and clay that contain limestone pebbles and that have an aggregate thickness of 1.5 feet; and (3) limestone that is light gray, knobby, dense, and 0.5 foot thick (Franklin and Wanless, 1944, p. 91). The Holland lies about 30 feet above the Buffaloville Coal Member of the Brazil Formation and 70 feet below the Seelyville Coal Member (111) and has been recognized in Spencer and Dubois Counties (Hutchison, 1959, 1964).

The Holland is difficult to distinguish, unless its identifying chert bed is present, because at least two other thin variable limestones and coals are present in the lower part of the Staunton Formation. It can be traced along its outcrop through Spencer County (Hutchison, 1959) and most of Dubois County (Hutchison, 1964). The Holland in Dubois County has been called the Upper Huntingburg Chert (Franklin and Wanless, 1944). A stratigraphic sequence that as yet is identified only as similar to that of the Holland area extends more or less continuously northward to Warren County (Hutchison, 1961).

**Correlation:** The Holland possibly correlates with the Stonefort Limestone of southern Illinois, according to Wanless (1939, p. 87), and according to St. Jean (1947), the Holland fauna includes the fusulinids *Profusulinella*, *Fusilina*, and *Wedekindellina*, which indicate both early and middle Pennsylvanian ages. The presence of *Profusulinella*, however, was denied by Thompson and Riggs (1959, p. 773), and the Holland lies well above the lower Pennsylvanian ostracod zone called the Zone of *Amphissites rothi* by Thompson and Shaver (1964) and in the middle Pennsylvanian zone containing *Amphissites centronotus*. It also lies above the lowest rocks containing...
Fusulinella, which are the Perth Limestone Member and the limestone above the Buffaloville Coal Member. Thus, considering both faunas and stratigraphic position, the Holland probably is early Desmoinesian in age in Midcontinent terminology.

Houchin Creek Coal Member (IVa), AMB & CEW
Petersburg Formation, Pennsylvanian System

_Type section:_ The name Houchin Creek Coal was first used by Fuller and Ashley (1902, p. 2) for the coal that is prominent along Houchin Creek in southeastern Pike County. This unit had previously been designated as Coal IVa by Ashley (1899, p. 90). Wier (in preparation), included this coal as a member of the Petersburg Formation and designated the exposure in the SE¼NE¼SW¼ sec. 3, T. 3 S., R. 7 W., as the type section.

_Description:_ The Houchin Creek Coal Member is a bright-banded coal which ranges from 0.2 to 3.6 feet in thickness. Cropping out from west of Newport, Vermillion County, to east of Boonville in Warrick County, the coal is underlain by a thin underclay and overlain by a black fissile shale and the Stendal Limestone Member. Subsurface data show that west of the outcrop a medial shale parting as thick as 3 feet is present in the coal.

_Correlation._ The Houchin Creek Coal Member is correlated with the widespread Sumnum (No. 4) Coal in Illinois (Wier, in preparation) and with Coal No. 8b near Henderson, Ky. (Walker, Puryear, and Cathey, 1951, p. 12).

*Hymera Coal Member (VI), DLigger Formation, AMB
Pennsylvanian System

_Type locality and reference section._ The Hymera Coal Member of the Dugger Formation was named by Wier (in preparation) for exposures near Hymera, Sullivan County. Natural exposures are rare because of stripping operations in the area, but Wier designated a reference section in the NE¼NW¼NE¼ sec. 10, T. 8 N., R. 8 W. Ashley (1909, p. 56) had previously designated this unit in Sullivan County as Coal VI.
Description: The Hymera Coal Member is a bright-banded coal which ranges from 0.5 to 11.0 feet in thickness. The coal contains numerous small shale-and-pyrite partings; two of them, lying in the upper part of the coal, can be traced throughout Sullivan County and northern Knox County. In northwestern Knox County one shale-and-pyrite parting thickens, so that the coal is split into two benches. The Hymera coal, which contains a characteristic spore content comprised almost entirely of the genera *Laevigatosporites* and *Lycospora* (Guennel, 1952, p. 29), is overlain in most places by a dark-gray to gray silty shale or fine-grained sandstone.

The Hymera Coal Member is traceable from its type area southward to southern Knox County and northward to southern Vigo County. It is not present in northern Vigo County or in Vermillion County. It thins abruptly in southern Knox County but is present in Gibson, Pike, and Warrick Counties, where it has been called the Lower Millersburg Coal. (See Wier, in preparation.)

Correlation: The Hymera is probably correlative with the Jamestown Coal in southern Illinois and with the No. 12 Coal in Kentucky.

**Inglefield Sandstone Member**, Patoka Formation, CEW

*Type locality:* Fuller and Ashley (1902, p. 3) used the name Inglefield Sandstone for 80 to 100 feet of sandstone exposed near Inglefield in northern Vanderburgh County. The original definition included all the sandstone in what is now known as the Patoka Formation. Wier (in preparation) restricted the name Inglefield to the sandstone that is above the Ditney Coal Member and below the Hazelton Bridge Coal Member, assigning it member rank in the Patoka Formation. The name is thus applied to the lower part of the Inglefield Sandstone of Fuller and Clapp (1904).

*Description:* The Inglefield Sandstone Member is a gray to tan crossbedded and thin-to thick-bedded fine-grained sandstone that grades laterally into a sandy shale. The sandstone is thickest in Vanderburgh and Posey Counties, where most well records indicate
that it ranges from 20 to 80 feet in thickness. North of Knox County the sandstone rarely is thicker than 20 feet.

The Inglefield was miscorrelated with the Merom Sandstone Member of the Mattoon Formation by some early workers.

**Jacobs Chapel Bed, Clegg Creek Member, Mississippian System CBR**

*Type section:* The name Jacobs Chapel Shale was applied by Campbell (1946, p. 855-856) to less than a foot of greenish plastic shale overlying black shale of the New Albany Shale and underlying the Rockford Limestone in southern Indiana. He stated, “A typical section occurs near Jacobs Chapel church and school.” The best exposure in this area is about three-quarters of a mile northwest of Jacobs Chapel in the banks of Lewis Branch on the line between lots 86 and 107, Clark’s Grant, Floyd County. Campbell considered the Jacobs Chapel to be a formation, but it is now recognized as the uppermost bed of the Clegg Creek Member of the New Albany Shale (Lineback, 1968 and in preparation).

*Description:* The Jacobs Chapel Bed has been recognized in Scott, Clark, and Floyd Counties, where its thickness generally is between 0.2 and 0.6 foot, although the bed is absent from some places. The Jacobs Chapel is a plastic greenish to dark-green glauconitic sparsely fossiliferous shale. It is similar to some shale beds lower in the New Albany but contains more glauconite and calcite, which suggests transition to the Rockford Limestone. In some earlier reports the shale was considered to be the basal phase of the Rockford Limestone (for example, by Newsom, 1903, p. 256; Huddle, 1934, p. 11).

*Correlation:* The Jacobs Chapel Bed belongs in the Kinderhookian Series and correlates approximately with the upper part of the Hannibal Shale of the Mississippi Valley. The conodonts are only slightly older than are those found in the overlying Rockford Limestone, and the latter represent the *Siphonodella isosticha-S. cooperi* Assemblage Zone found in the Chouteau Limestone of the Mississippi Valley (Rexroad, 1969).
Jeffersonville Limestone, Erian Series, AMB & JBP
Devonian System

Type locality and reference sections: Named by Kindle in 1899 for Jeffersonville, Clark County, where the formation is well exposed in the Falls of the Ohio, the Jeffersonville Limestone was originally described as the limestone between the “Sellersburg beds [North Vernon Limestone] and the Catenipora beds of the Niagara” (p. 8). At the type locality and in most of Clark County, this unit does rest on rocks of Niagaran age, but farther north the Geneva Dolomite lies beneath the Jeffersonville. The descriptive term Corniferous Limestone was used by Borden in 1874, but this restricted meaning has not been followed and “Corniferous” has been used in Indiana to refer to the entire Devonian carbonate section.

Reference sections of the Jeffersonville Limestone may be seen at the following quarries: Mesliberger Stone Co. quarry, Bartholomew County (SE¼SE¼NE¼ sec. 6, T. 8 N., R. 7 E.), where 36 feet of the unit is exposed; Berry Materials quarry on the northeast edge of North Vernon, Jennings County (SW¼SW¼SE¼ sec. 27, T. 7 N., R. 8 E.), 27.6 feet exposed; and the T. J. Atkins and Co. quarry, 1 mile northeast of Claysburg, Clark County (W½ lot 10, Clark’s Grant), 39.7 feet exposed.

Description: In its type section the Jeffersonville Limestone can be divided into three distinct lithologic and paleontologic zones. The lower coralline zone (Coral Zone of common reference) is 10 to 12 feet thick and consists of a brown to gray crystalline dolomitic limestone, which includes the Amphipora beds of Perkins (1963). The bedding planes and upper surface of this unit are undulatory because of the large colonial coralline masses, and beds are commonly separated by thin carbonaceous partings. The middle zone, 10 feet thick, is white to gray or brown dense to crystalline hard massive limestone containing the Brevispirifer gregarius Beds (Zone) of Kindle (1901, p. 539). The upper zone is an extremely fossiliferous (especially Paraspirifer acuminatus in the zone of that name) tan or light-gray thin- to thick-bedded crystalline limestone, which is 13 feet thick.
in the type area. Layers of chert are present at different levels in the upperzone.

The upper zone of the Jeffersonville retains its lithologic and paleontologic identity northward, but the basal coralline zone is unrecognizable north of Jennings County, and outcrops in Jennings, Bartholomew, and Shelby Counties indicate that the middle zone in that area is an unfossiliferous light-gray and tan conspicuously laminated limestone containing small calcite crystals. In places the laminated beds are crumpled and brecciated and have been recemented with calcite and pyrite. Bands of rounded frosted sand grains are present in the more massive beds. (See Dawson, 1941; Patton and Dawson, 1955; and Perkins, 1963.)

A bed of silicified corals and stromatoporoids is found in eastern and northern Jennings County. This zone has been called “burrstone” by Owen (1839, p. 16), “Buhrstone bed” by Kindle (1901, p. 553), and “silicified bed” by Dawson (1941, p. 19-20), who placed it stratigraphically at the base of the Jeffersonville. Float of the same description was reported by Kindle (1901, p. 545, 548) in Jefferson County.

In measurable outcrop in southern Indiana, the Jeffersonville Limestone ranges from 26 to 46 feet in thickness, attaining its maximum thickness 35 miles north of the type area. The basal coralline zone thins from southern Jennings County northward, but the middle zone reaches a thickness of 26 feet in Bartholomew County. The upper zone thins only slightly from Clark County to Bartholomew County. North of southern Shelby County, outcrops are scarce owing to cover by glacial drift, but Jeffersonville limestone has been reported along the Wabash River in Cass and Miami Counties. (See Thornbury and Deane, 1955, p. 18-19.)

Subsurface data (Becker, in preparation) indicate a general southwestward thickening of the Jeffersonville, which reaches a thickness of more than 150 feet in Knox, Gibson, and Posey Counties. A bentonite bed 15 feet below the top of the formation is present in southwestern Indiana and adjoining Illinois.
Correlation: The Jeffersonville Limestone, the only proven southern Indiana representative of the Onondaga Group of New York, is recognized in northern Kentucky and is correlated with the Grand Tower Limestone, of Illinois. The Jeffersonville is also at least in part equivalent to the Detroit River Group (Formation) of Michigan and northern Indiana and the Columbus Limestone of Ohio. (See Stumm, 1964, p. 8; Meents and Swann, 1965; and Pinsak and Shaver, 1964, p. 57; also “Geneva Dolomite.”)

Jessup Formation, Kansan to Sangamonian Stages, Pleistocene Series

Type section: A stream cut along a tributary of Strangers Branch in the center of the SE¼ sec. 2, T. 14 N., R. 7 W. (Catlin Quadrangle) serves as the type section of the Jessup Formation. It was named for Jessup in southern Parke County (Wayne, 1963, p. 52).

Description: The Jessup Formation consists dominantly of till but includes minor amounts of gravel, sand, and silt and lenses of peat. The formation includes two members, the Butlerville Till Member and the underlying Cloverdale Till Member. Throughout most of southeastern and southwestern Indiana, where the Jessup Formation is the surficial geologic unit, the Cloverdale member is observed only in the lower parts of fairly deep exposures. Recognition of the formation and its members is based in large part on the characteristics and thickness of the soil profile or paleosol that caps the particular unit and that serves as a marker. Where it is the surficial unit, the Jessup Formation has been leached of carbonates to a depth of 10 to 12 feet. Where buried by younger deposits, the paleosol at the top of the Jessup Formation ordinarily is orange brown and contains a carbonate free zone as much as 5 feet thick.

In the southeastern and southwestern parts of Indiana, the Jessup Formation is the surface unit except along the Wabash and Ohio Valleys, where it is overlain by the Peoria Loess Member of the Atherton Formation. It is unconformably overlain by the Trafalgar Formation in central Indiana, and in some places it is overlain by the Atherton Formation or the Martinsville Formation.
Correlation: The Jessup Formation includes sediments deposited during the Kansan, Yarmouthian, Illinoian, and Sagamonian Ages. Tills of the lower member are Kansan in age and those of the upper member are Illinoian in age. Yarmouthian and Sangamonian sediments are dominantly silts and sands of alluvial derivation and lenses of peat, marl, or humic sand and silt.

Each member of the Jessup Formation contains two units or more of till separated by a thin discontinuous bed of fossiliferous silt (Wayne, 1963, p. 55-56; Wayne and Zumberge, 1965, p. 66-68). Gooding has found similar units in the Whitewater basin and has provided them with stadial terminology. Gooding's (1963, p. 672) Abington Interstade probably corresponds to the unit Wayne (1963, p. 14, 51) called bed e; thus the Richmond Stade would be the youngest recognized glacial readvance of the Illinoian, and the older Centerville Stade could represent the advance of ice that reached the Illinoian glacial boundary in western and central Indiana. In western Indiana fossiliferous bed d and another till are known to underlie this central major till unit of the Butlerville.

The Cloverdale Till Member also includes two tills separated by a fossiliferous silt bed in western Indiana; Gooding (1966, p. 432) designated names for the parts of a similar sequence in the Whitewater basin. The basal unit, till, represents the Alpine Stade, and the upper one represents the younger Columbia Stade. He named the intervening fossiliferous bed the Garrison Creek Interstade.

Joachim Dolomite, Champlainian Series, HHG
Ordovician System

Type locality: The name Joachim Dolomite first appeared in a table (Winslow, 1894, p. 331) and apparently was not formally proposed. It was probably named for exposures of a dark dolomitic brecciated limestone about 100 feet thick exposed on Joachim Creek, Jefferson County, Mo.

Description: In Indiana the Joachim, a light-tan finely crystalline dolomite, is recognized mainly in the subsurface. It is 70 feet thick
ROCK-UNIT NAMES

over most of the state. Though Gutstadt (1958a, p. 53-54) indicated that the Joachim is absent from northwestern Indiana, it is shown to crop out in the structurally disturbed area east of Kentland, Newton County (Wayne, Johnson, and Keller, 1966). The Joachim Dolomite overlies the St. Peter Sandstone (Champlainian) and is overlain by the Black River Limestone (Champlainian).

Correlation: Rocks equivalent to the Joachim of Indiana are placed in the Ancell Group of northern Illinois (Templeton and Willman, 1963).

Kenneth Limestone Member, Salina Formation, RHS

Silurian System

Type section and description: The Kenneth Limestone Member was named as a formation by Cumings and Shrock (1927, p. 77) for about 30 feet of light-colored dense to fine-grained bedded cherty limestone that is typically exposed in an abandoned France Stone Co. quarry near Kenneth, Cass County. Pinsak and Shaver (1964, p. 81) thought that according to Cumings and Shrock (1928a, p. 134), the Kenneth type section is in the large composite quarry in the center of sec. 30 and in the N½SW¼ sec. 30, T. 27 N., R. 1 E. But some question remains about the exact location of the type section because Cumings and Shrock (1928a, p. 177) also mentioned quarrying in the adjoining section (sec. 25, T. 27 N., R. 1 W.), and because still another large quarry, once operated by the same company that operated the composite quarry, is present in the SW¼SE¼ sec. 30. The Kenneth Limestone in this area both overlies and appears to be interlensed with laminated dolomitic limestone assigned to the Kokomo Limestone Member. Pinsak and Shaver (1964, p. 51) reduced the rank of the Kenneth to member (of the Salina Formation).

Distribution and correlation: The lithology generally is present in the areas of certain Kenneth recognition, in Cass and Howard Counties, in thicknesses as much as 45 feet. Similar rocks, some possibly Devonian in age, have been assigned questionably to the Kenneth, and its distribution and recognition are poorly understood. The brachiopod Coelospira congregata is abundant in places, in both
Cass and Howard Counties. Although A. J. Boucot (written communication, June 2, 1961) said that an age more definite than Silurian cannot be assigned to the species, the species nevertheless provides considerable assurance that the Kenneth, as well as the underlying Kokomo, is Silurian rather than Devonian in age, as some geologists, for example, Logan (1932) and Patton (1949, p. 13; 1956), have thought. (See Cumings and Shrock, 1928a, and Pinsak and Shaver, 1964.)

**Kinkaid Limestone**, Chesterian Series, Mississippian System HHG

*Type locality:* The Kinkaid Limestone was named by Stuart Weller (1920b, p. 218) for exposures of gray and yellow-gray cherty limestones, varicolored shales, and some thin beds of sandstone along Kinkaid Creek, Jackson County, Ill. The total thickness of this unit is as much as 140 feet (Weller, 1920a, p. 406-407). As redescribed (Swann, 1963, p. 42-45, 72) it consists of upper and lower massive limestones and middle shale and limestone that have an aggregate thickness of about 120 feet.

*Description:* According to Swann (1963, p. 48) only the lower part of the Kinkaid of southern Illinois is represented in Indiana, where the unit is characterized by gray to yellow-gray thick-bedded micritic to biomicritic limestone. Varicolored shale intervenes between the limestone and the sandstones characteristic of the underlying Degonia Sandstone, but how much of this shale should be included in each formation has never been specified. (See Malott, 1925; Malott, Esarey, and Bieberman, 1948; and the discussion of boundary problems under “Tar Springs Formation.”) Outcrop data indicate that the Kinkaid is about 20 to 35 feet thick (Malott, Esarey, and Bieberman, 1948, p. 25), but it is somewhat thicker in the subsurface. Although the outcrop is restricted to Perry County, the Kinkaid Limestone is recognized in the subsurface from Dubois and Knox Counties southwestward. It conformably overlies the Degonia Sandstone and is overlain disconformably by the Mansfield Formation (lower Pennsylvanian).

*Former name in Indiana:* Rocks now assigned to the Kinkaid Lime-
stone in Indiana were originally designated the Negli Creek Limestone (Malott, 1925), but the name was changed when equivalence to the type Kinkaid was recognized (Malott, 1931, p. 222). No documentation of this correlation was given, but continued use of the term in this sense suggests its validity.

Knox Dolomite, Canadian and St. Croixan Series, HHG
Ordovician and Cambrian Systems

Type area: The Knox Dolomite was named by Safford (1869, p. 151) for exposures of limestones and dolomites about 4,000 feet thick in Knox County, Tenn.

Description: In Indiana, where the formation is known only from the subsurface, it is a gray to tan finely crystalline dolomite, very cherty in the upper part. The Knox is about 500 feet thick in the northern part of the state; it thickens southward to more than 1,500 feet in southern Indiana. It overlies the Galesville Sandstone (St. Croixan) in northwestern Indiana and the Eau Claire Formation (St. Croixan) in the rest of the state and is overlain by the St. Peter Sandstone (Champlainian). (See Gutstadt, 1958a, p. 35-42.)

Correlation: The name Knox is a blanket term and expresses ignorance of stratigraphic details; nevertheless in northwestern Indiana the Knox equivalents of the Prairie du Chien Group and the Gunter, Trempealeau, and Franconia Formations, in descending order, can be recognized. Knox equivalents where exposed are more finely subdivided, and Gutstadt (1958a, p. 36-37) equated the Knox to (in descending order) the Shakopee Dolomite, New Richmond Sandstone, and Oneota Dolomite of the Prairie du Chien Group; the Madison Formation; the Jordan, Lodi, and St. Lawrence Members of the Trempealeau Formation; and the Bad Axe, Hudson, Goodenough, and Ironton Members of the Franconia Formation in the upper Mississippi Valley outcrop area; and to the Cotter Dolomite, Jefferson City Group, Roubidoux Formation, Gasconade Dolomite, Eminence Dolomite, Potosi Dolomite, and the Doe Run Dolomite, Derby Dolomite, and Davis Formation of the Elvins, Group in Missouri. In
part these rocks are now differently classified by others. (See Buschbach, 1964, p. 23.)

Kokomo Limestone Member, Salina Formation, RHS
Silurian System

Type and principal reference sections: The Kokomo Limestone Member was considered to be a formation by Cumings and Shrock (1927, p. 76) and was named for the approximately 50 feet of color-banded thinly laminated eurypterid-bearing waterlime beds of Foerste (1904, p. 33) that were exposed in the Markland Avenue Quarry in Kokomo, Howard County (SW¼ sec. 36, T. 24 N., R. 3 E.). This use restricted Foerste's more or less informal use of the term Kokomo, which also was applied to rocks now assigned to the overlying Kenneth Limestone Member. In 1961 the type-section quarry was being filled, so that following the suggestion of Shaver and others (1961, p. 23), the Kokomo rocks cored at the edge of the type quarry in Indiana Geological Survey drill hole 72 are here designated as the principal reference section. The core is in the Indiana Geological Survey core library. Pinsak and Shaver (1964, p. 50) reduced the rank to member (of the Salina Formation). (See also Cumings, 1922, p. 459-461.)

Description: The Kokomo Limestone Member characteristically consists of strikingly banded tan and gray very fine-grained and thinly laminated dolomite and dolomite limestone. These strongly banded rocks overlie faintly color-banded cherty Salina rocks unnamed to member at Kokomo, but they also are present lowermost in thicker Salina rocks in other places in the area of Kokomo recognition. Intraformational corrugation, dessication features, breccias, and sandy rocks are present in places.

The distribution of the Kokomo as a single laminated rock unit is poorly known, although the name has been used considerably in Howard, Cass, Miami, and Allen Counties, where thicknesses are mostly recorded as less than 50 feet. Considered altogether, the Kokomo lies both on other Salina rocks and on rocks of the Wabash Formation and is overlain both by other Salina rocks (the Kenneth Limestone Member southward) and by Devonian rocks.
**ROCK-UNIT NAMES**

**Correlation:** Possibly the Kokomo in characteristic lithology extends without interruption into an upper, laminated part of the thick Salina section of northeastern Indiana, where Pinsak and Shaver (1964, p. 55) suggested a correlation with the upper (A₂ of Evans, 1950, p. 59) part of the A unit (of Landes, 1945) of Michigan. Thus recognized, the Kokomo also has some equivalency with the Greenfield Dolomite of Ohio.

Kokomo fossils are uncommon, although the member is famous for its eurypterids, which Kjellesvig-Waering (1958, p. 295) considered to be middle Ludlow in age in the British standard. The unit has been assigned to the Cayugan Series as that series conventionally has been recognized in the Midwest. During an earlier period of geologic study in Indiana the Kokomo was correlated with the so-called Waterlime of New York and thus at times with both Silurian and Devonian rocks. In fact the term Waterlime was commonly used in Indiana for the thinly laminated Kokomo rocks, by Blatchley and Ashley (1898, p. 19), for example.

(See also Cumings and Shrock, 1928a; Curnings, 1930; Pinsak and Shaver, 1964; and the Salina discussion herein.)

**Kope Formation, Cincinnatian and Champlainian Series, AMB**

*Ordovician System*

**Type area:** Weiss and Sweet (1964) proposed the name Kope Formation for 240 feet of shale and minor amounts of interbedded limestones exposed in the Maysville area of Kentucky and Ohio. The name for this sequence, which represents generally the lowermost Cincinnatian rocks in this area, was taken from Kope Hollow north of Levanna, Ohio. Brown and Lineback (1966, p. 1020) extended the use of the name into Indiana.

**Description:** In Indiana the Kope Formation is recognized as a northward-thickening unit of bluish- to brownish-gray clay shale and widely scattered discontinuous beds of fossiliferous limestone that are extensively exposed in the southeastern counties. Complete characteristic sections may be examined in the cores taken from
Indiana Geological Survey drill holes 57, Wayne County, and 124, Decatur County, which are on file in the Indiana Geological Survey core library. The Kope Formation thickens northward from 220 feet in Switzerland County to 550 feet in Wayne County and is distinguished from the overlying Dillsboro Formation by its low limestone content. The Kope has only 5 percent limestone, most of which is concentrated in the upper one-half to one-third of the formation. The Kope overlies the Lexington Limestone (Champlainian) in the subsurface of Dearborn, Ohio, and Switzerland Counties, and the northward thickening of the Kope most probably represents in part a complementary facies relationship with the Lexington, which thins in the same direction (Brown and Lineback, 1966, p. 1020). North of Franklin County, the Kope overlies the Trenton Limestone of Indiana subsurface usage. According to Rooney (1966) this upper contact of the Trenton is disconformable.

_Collation of older names and correlation:_ In Indiana the Kope encompasses the units formerly assigned to the Eden Group, which are the Economy, Southgate, and McMicken Formations. Thus it correlates with rocks assigned to the Eden Group in Ohio, but studies by Ford (1967) in the Cincinnati area indicate that the top of the Kope rises northward to include rocks younger than the classical Eden. Because of the Lexington relationships discussed above, the lowermost Kope may be in part Champlainian in age. (See the discussion of Cincinnatian faunal zones and older names under “Dillsboro Formation.”)

**Lafayette Gravel, Miocene? and Pliocene Series,**

_Tertiary System_

**Type area:** The Lafayette Gravel was named for Lafayette County, Miss., by Hilgard (1891, p. 13), who used the term to replace “Orange sand” then in use for a group of sediments of the Gulf coastal area.

_Description:_ Scattered deposits of deeply weathered iron-stained siliceous gravels that are found at altitudes well above modern streams in southern Indiana are included in the Lafayette Gravel. Normally
they consist of chert, geodes, and some rounded vein-quartz pebbles in an admixture of sand. No indigenous fossils are known, and good exposures are rare. The unit is thin and its distribution is discontinuous, but small deposits have been reported throughout the unglaciated part of Indiana and Kentucky as well as in the rest of the Interior Low Plateau and Ozark Plateau Provinces (Malott, 1922, p. 132-134; Leverett, 1929, p. 13-18). All authors have considered it to be a fluviatile deposit.

**Correlation and history of nomenclature:** The term Lafayette Gravel was adopted originally for gravel and sand beds of the Gulf Coast region that had gone under a broad spectrum of names. It was extended by Chamberlin and Salisbury (1906, p. 301-308) into the upper Mississippi Valley to include scattered deposits of similar gravels in that region. Restudy of the original Lafayette showed it to be Eocene in age, so the name Citronelle Formation was proposed for coastal nonmarine deposits formerly included in the Lafayette. Lafayette, however, became the name most frequently used for the isolated fluviatile deposits well away from the original type area (Potter, 1955, p. 1-3).

“Lafayette Gravel” is the name used in Indiana for a distinctive deposit that is related to older erosion surfaces and that generally has been considered to be the remains of the deposits of Tertiary streams that once crossed the area. Relationships of the modern streams to the deposits are not everywhere clear. Local names have been given to the deposit in some areas, so the Lafayette in Indiana probably is partly or completely correlative with the Irvine Formation in Kentucky and with the Grover Gravel of southwestern Illinois.

**Lagro Formation, Wisconsinan Stage, Pleistocene Series**

**Type section:** The Lagro Formation is named for Lagro in Wabash County (Wayne, 1963, p. 43), and the type section is along Lagro Creek in the SW¼NE¼ sec. 26, T. 28 N., R. 7 E. (Lagro Quadrangle).

**Description:** The Lagro Formation has three laterally intertonguing members, which were deposited more or less contemporaneously, and
which, therefore, for mapping purposes have been considered to be a single stratigraphic unit. The easternmost of these, called the New Holland Till Member, and the westernmost member (unnamed) are gray clay-rich tills. The third member (also unnamed), which lies between the other two geographically, is composed of silty, sandy, and gravelly till. A thin (1.5 to 2.7 feet) soil profile having a brown B horizon has developed in the surficial part of the formation.

The Lagro Formation is at the surface in much of the northern one-fourth of the state, primarily in the area north of the Mississinewa, Wabash, Tippecanoe, and Kankakee Rivers. It overlies, apparently with only minor disconformity, the Trafalgar Formation in most places, although in some places it overlies tongues of the Atherton Formation or Paleozoic bedrock units. It is overlain by sands, gravels, silts, and clays of the Atherton Formation and by alluvial and paludal sediments of the Martinsville Formation.

Correlation: The Lagro Formation is of glacial origin and has been correlated with an upper part of the Wisconsinan Stage, probably the Caryan Substage. Radiocarbon dates suggest that deposition took place in Indiana between about 15,000 and 14,000 years ago. (See Wayne, 1963.)

**Laurel Member.** Salamonie Dolomite, Silurian System

*Type locality and reference sections:* The Laurel Member was named as the Laurel Formation by Foerste (1896, p. 191) for exposures near Laurel in Franklin County, but no type section was designated. The once numerous quarries near Laurel are now abandoned, and one of the best sections in the type locality is a natural exposure in the northeast bluff of Sanes Creek in the NW\(^1\)/4NE\(^1\)/4 sec. 7, T. 12 N., R. 12 E. A better and completely exposed reference section is in the Standard Materials Corp. quarry in the NE\(^1\)/4 sec. 6, T. 11 N., R. 8 E., 1\(\frac{1}{4}\) miles south of Waldron, Shelby County. The unit was reduced in rank to a member of the Salamonie Dolomite by French (1967).

*Description:* The Laurel originally was defined as the unit between the Brassfield Limestone, which then was called the Clinton Limestone,
and the Waldron Shale, and it thus included rocks now assigned to the Osgood Member. Later the Laurel was restricted to the beds above the Osgood (Foerste, 1897, p. 217), which it overlies gradationally in lithology, and below the Waldron, which overlies the Laurel with apparent conformity. The term is now used in that sense. In places pre-middle Devonian erosion has removed Waldron and higher rocks, so that the Geneva Dolomite (Devonian) rests on the Laurel, commonly with some angularity.

Generally, the Laurel is a light-gray to tan dense dolomitic limestone that has lenticular and nodular chert especially in the upper part. Although fossiliferous, recrystallization has destroyed many of the fossils. The formation on outcrop ranges from 27 to 55 feet in thickness, and it thickens northward.

*Distribution and correlation:* The Laurel outcrop belt extends south of Laurel to the Ohio River and into Kentucky; northward the Osgood Laurel type relations become vague as carbonate purity increases, so that undifferentiated rocks of these ages are assigned to the Salamonie Dolomite. On the east side of the Cincinnati Arch in Ohio the Laurel as a thin named unit is restricted to rocks between the Osgood and Euphemia Dolomite. The Laurel extends westward into the Illinois Basin, but its recognizable bounds have not been described in published reports.

The Laurel Member probably correlates with the Bisher Formation of southern Ohio, which in British terms is latest Llandovery and (or) early Wenlock in age. It also apparently correlates with the Laurel Limestone, Euphemia Dolomite, and Springfield Dolomite of Ohio usage and with an upper part of the Joliet Dolomite of northeastern Illinois.

(See Pinsak and Shaver, 1964, and French, 1967.)

**Leesville Member,** Harrodsburg Limestone, AMB

*Mississippian System*

*Type section:* The Leesville Member of the Harrodsburg Limestone
was named by Stockdale (1929b, p. 239) for exposures of a blue-gray heavy-bedded coarse-grained crystalline and crinoidal limestone along U.S. Highway 50 near the center of the NE¼ sec. 27, T. 5 N., R. 2 E., one-fourth mile southeast of Leesville, Lawrence County.

Description: The Leesville Member is a relatively pure, bryozoan- and crinoid-rich calcarenite, 1 to 11 feet thick, which forms the basal part of the Harrodsburg Limestone (Smith, 1965). This member, where overlain by the Guthrie Creek Member of the Harrodsburg Limestone, is an excellent marker bed, which, because of its resistance, forms ledges and overhanging benches. It is especially useful as a key horizon in southern Floyd County and southeastern Harrison County and has been recognized as far north as Monroe County (Stockdale, 1931). It overlies the Ramp Creek Member of the Muldraugh Formation.

**Levias Member**, Ste. Genevieve Limestone, NMS
Mississippian System

Type locality: The name Levias Limestone Member was given by Sutton and Weller (1932, p. 430,439) to the part of the Ste. Genevieve Limestone that is above the Rosiclare Sandstone Member in the area just east of Levias, Crittenden County, Ky. A reference locality in Indiana has not been designated.

Description: The Levias Member in Indiana, so designated in Indiana with omission of the term Limestone, consists generally of gray to light-gray thin- to medium-bedded limestone that is 22 to 60 feet thick along its outcrop and as much as 75 feet thick in the subsurface. Much of the Levias is dense and calcarenitic and is bound by microcrystalline calcite; the grains consist of fossil debris, oolites, and limestone pellets. Thin beds of lithographic limestone commonly are separated by very dark thin shale beds, and macrocrystalline calcite and argillaceous dolomitic limestone constitute some beds. The uppermost part of the member commonly consists of a limestone breccia called the Bryantsville Breccia Bed, and other (lower) breccias are found in some places (Perry and Smith, 1958, p. 35). In places
unconformities mark the boundaries of the Levias Member, including its common (upper) boundary with the Ste. Genevieve.

**Correlation:** The Levias, considered here as the upper member of the Ste. Genevieve, extends as a rock unit into the Illinois Basin and to the Illinois standard section. The Levias of the Illinois standard is a lower member of the Renault Formation (Swann, 1963, p. 50, 72). The Levias of Indiana also has age equivalency with the Aux Vases Formation of the Illinois Basin, which intervenes between the Ste. Genevieve and Renault of that area. (See also Malott, 1946, p. 323; Pinsak, 1957, p. 20-22; and for a discussion of *Platyurites penicillus* and its correlative significance, the “Bryantsville Breccia Bed” herein.)

**Lexington Limestone, Champlainian Series, HHG**

**Ordovician System**

**Type locality and redefinition:** The name Lexington Limestone was first used by M. R. Campbell (1898) for thin-bedded cherty limestone about 150 feet thick in central Kentucky. No type section was given, but presumably the name was taken from the city of Lexington in Fayette County, near which the formation is well exposed. The Lexington Limestone has undergone several schemes of subdivision and reclassification; most recently rocks formerly assigned to the Cynthiana Formation have been reassigned to the Lexington (Black, Cressman, and MacQuown, 1965). As thus redefined, the Lexington Limestone is 200 to 300 feet thick and includes rocks as high as those formerly called the Point Pleasant Beds and River Quarry Beds in the Cincinnati area.

**Description and correlation:** As adopted for Indiana usage (Gray, Brown, and Lineback, 1966), the Lexington Limestone consists of limestone interbedded with subordinate shale to a maximum thickness of 250 feet near Patriot in Switzerland County. Only the upper 50 feet or so is exposed. For some years these rocks were called the Trenton Limestone or were assigned to the Cynthiana Formation (Patton, Perry, and Wayne, 1953, p. 18-19). Except for jumbled
exposures in the Kentland structure in Newton County, these are the oldest exposed rocks in Indiana.

The Lexington Limestone is overlain by and is in part laterally equivalent to the shales of the Kope Formation (Champlainian and Cincinnatian); it is underlain by the Black River Limestone (Champlainian). In part it also may be laterally equivalent to the Trenton Limestone (Champlainian).

**Linton Formation, Carbondale Group, AMB Pennsylvania System**

_Type locality and reference section:_ The Linton Formation was named by Wier (1950) for exposures along the tributaries of Lattas Creek in secs. 26 and 27, T. 8 N., R. 7 W., 4 miles north of Linton, Greene County. Because the upper and lower limits of the formation were based on stratigraphic breaks which proved to be discontinuous, the original boundaries were altered by Wier (in preparation); the lower boundary was moved down a few feet to the top of the Seelyville Coal Member (III) of the Staunton Formation, and the boundary with the overlying Petersburg Formation was similarly moved down to the top of the Survant Coal Member (IV). An exposure in an abandoned strip mine in the SW¼ sec. 25, T. 8 N., R. 7 W., was designated by Wier as a good reference section.

_Description:_ The Linton Formation is the lowermost formation in the Carbondale Group. It includes four named members, in ascending order, the Coxville Sandstone, Colchester Coal, Velpen Limestone, and Survant Coal Members, and unnamed units of sandstone, shale, and clay. Although most commonly about 80 feet thick on the outcrop, the unit varies markedly in thickness, which ranges from 43 to 162 feet. Lateral lithologic variations are common. The Survant Coal Member is absent in places, and the interval between the Colchester and Seelyville coals varies from about a foot of underclay to 30 feet of sandstone and shale. The Linton Formation crops out along the east edge of the Illinois Basin from Warrick County to Vermillion County, Ind.
Correlation: The Linton correlates with the lower part of the Carbondale Formation in western Kentucky.

Liston Creek Limestone Member, Wabash Formation, RHS
Silurian System

Type and reference sections: The Liston Creek Limestone Member, formerly having formation rank, was named by Cumings and Shrock (1927, p. 75) for its type exposure on Liston Creek in southwestern Wabash County (NE¼SW¼ sec. 24, T. 26 N., R. 5 E.). There it consists of about 30 feet of cherty limestone and dolomitic limestone that is light gray and tan, fine to medium grained, fossil fragmental, and slabby bedded and that rests with sharp contact upon the Mississinewa Shale Member (Wabash Formation). Pinsak and Shaver (1964, p. 38-39) recognized nearly 100 feet of Liston Creek rocks in more western, noneroded sections, reduced the rank to that of member (in the Wabash Formation), and designated a reference section for the expanded concept of the unit as the rocks cored in the Northern Indiana Public Service Co. Gale M. and Glada Skinner No. 1 well near Royal Center, Cass County (NW¼NW¼ sec. 10, T. 28 N., R. 1 W.). (See Pinsak and Shaver, 1964, p. 80.)

Description: Except for slabby bedding, which is surficial, the type lithology is characteristic of the unit in its few-county area of recognition around the type county. Mississinewa-like rocks are intimately intercalated in places, however. Like the Mississinewa, the Liston Creek has a biothermal, reef, and bank facies of nearly pure dolomite (Huntington Lithofacies), and it terminates northward in this facies. As already implied, thickness is affected by erosion (post-Devonian) in several counties, more so eastward, and it is reduced in places where the Salina Formation is overlying. (See discussions of the Wabash and Salina Formations.) The type Liston Creek has the 1- to 3-foot Red Bridge Limestone Bed at its base. (See Cumings and Shrock, 1928a, and Pinsak and Shaver, 1964.)

Correlation: In north-central Indiana the member is uppermost in the Wabash Formation and thus correlates with an upper part of the
Racine Dolomite of northeastern Illinois. In northwestern and western Indiana Liston Creek lithology is not regionally dominant, and the member is not recognized. Although it has age equivalence with much of the upper Wabash section that is unnamed to member in northwestern and western Indiana, the Liston Creek probably is nowhere as young as the youngest Wabash rocks. Reefy facies contain the brachiopod *Conchidium*, which, together with a very high stratigraphic position among Niagaran rocks of the Midwest, suggests an age similar to that of the Guelph Dolomite of the Great Lakes area and of rocks within the Ludlow Series of Great Britain. The pelecypod *Megalomus canadensis*, reported in Indiana by Shimer and Shrock (1944, p. 381), comes from a stratigraphic position in White County that is near, possibly above, the top of the Liston Creek, and it supports the stated late Niagaran age.

**Livingston Limestone Member, Bond Formation, CEW**

*Pennsylvanian System*

*Type locality:* Worthen (1875, p. 11-19) first used the name Livingston Limestone for exposures near Livingston in Clark County, Ill. Two limestones separated by a 4-foot shale unit that in places contains a thin coal were exposed. This unit is now recognized as a member of the Bond Formation both in Illinois (Kosanke and others, 1960) and in Indiana (Wier, 1960, p. 219-220; Wier, in preparation).

*Description:* The Livingston Limestone Member is the upper member of the Bond Formation and is present in only two areas in Indiana. In western Sullivan County near Merom and Graysville, the unit consists of two beds of limestone separated by as much as 25 feet of gray to black shale and a thin coal. The upper bed is buff to light-gray crystalline fossiliferous limestone containing abundant fenestelloid bryozoans and small brachiopods. The lower bed is dark gray, argillaceous, and nodular and contains crinoid columnals. In the Mumford Hills in northwestern Posey County and southwestern Gibson County, the Livingston Limestone Member is not conspicuously present but has been noted in drilling records as a thin limestone.
**Correlation:** The Livingston member in Indiana was early miscorrelated with the West Franklin Limestone Member of the Shellburn Formation (Collett, 1874; Ashley, 1899; Shrock and Malott, 1929). This member of the Bond Formation, however, correlates with the Livingston, LaSalle, and Millersville Limestone Members of Illinois.

**Locust Point Formation, Borden Group, GRG & CBR**
Mississippian System

**Type and reference sections:** The type section of the Locust Point Formation is along a road ascending the Ohio River bluff from Locust Point immediately south of Locust Point Hill, Harrison County, and in the immediate vicinity of the road (NW¼NE¼ sec. 13, T. 4 S., R. 5 E.). The section extends upward about 125 feet above the base of the bluff, and only the lowest few feet of the formation is not exposed. Stockdale indicated that the Locust Point post office was in the center of the SE¼ sec. 12, T. 4 S., R. 5 E., and thus 0.3 mile from the road, but the Lanesville Quadrangle (Indiana and Kentucky, 1960) shows the community of Bridgeport at this locality and Locust Point just south of the line between sections 12 and 13. The formation name replaced the preoccupied name St. Joseph Formation used for this interval in an abstract published by Stockdale (1929a, p. 170).

Stockdale (1931, p. 127-146) named four facies of the Locust Point Formation, and the type section of each of these is a key reference section for the formation. The type section of the Spickett Knob Facies is along the road up the Knobstone Escarpment at Spickett Knob about 3½ miles northwest of New Albany, Floyd County, and is mainly in the NE¼NE¼ sec. 21, T. 2 S., R. 6 E. The type section of the Schooner Hill Facies is on Schooner Hill, particularly in exposures along Indiana Highway 46 about 3½ miles southwest of Nashville, Brown County, in the NE¼ sec. 3 and in the NW¼ NW¼ sec. 2, T. 8 N., R. 2 E. The type section of the Nelson Hills Facies is along Indiana Highway 46 and in adjacent gullies for a distance of half a mile east of the top of Nelson Hill, which lies on the Bartholomew County-Brown County line. For the Belmont Facies Stockdale did not describe a section at Belmont but mentioned...
exposures 0.4 mile south of the town in Brown County and along Indiana Highway 46 west of Belmont in Brown and Monroe Counties. The Belmont Facies is described in several measured sections (Stockdale, 1931, p. 118, 144).

Description: The Locust Point Formation is a mixture of sandstone, siltstone, shale, and transitional combinations of these. Southward from northwestern Jackson County to the Ohio River sandy shale and siltstone dominate the lithology, and northward interbeds of sandstone are an important constituent. In some localities in western Bartholomew County and along the east edge of Brown County the sandstone beds are sufficiently massive and resistant that they have been quarried for building stone. Although the pattern is not consistent, the finer grained material is more important in the lower part, and coarseness tends to increase upward. Greenish or bluish gray to gray is the typical color on fresh surfaces. The formation commonly weathers buff or is iron stained because ferruginous concretions are present in places. Fossils are rare except for numerous and widely distributed tubes and burrows.

The Locust Point Formation overlies the New Providence Shale and underlies the Carwood Formation. The Carwood and Locust Point are lithologically similar and in places are identical, although in some sections the Carwood is more fossiliferous. In continuous gradational sequences it is impossible to determine the contact between the two formations, but the New Providence-Locust Point contact is more distinct because of contrast in dominant lithologies.

Correlation: Stockdale (1939, p. 228) equated the Locust Point and Carwood Formations of the Borden Group with the Brodhead Formation of Kentucky and the Logan Formation of Ohio. The Locust Point also correlates with a part of the Keokuk Limestone of the upper Mississippi Valley. (See also “Borden Group.”)

Lost River Chert Bed, Ste. Genevieve Limestone, NMS
Mississippian System

Type area, characteristic sections, and history of name: The Lost
River Chert Bed, here considered to have that rank, was named by Elrod (1899, p. 259) for exposures along the dry bed of Lost River in Orange County. It is particularly well exposed in Wesley Chapel Gulf in the W½E½ sec. 9, T. 2 N., R. 1 W., which is erroneously called Elrod Gulf on the French Lick Quadrangle, and near Orangeville in the SE¾ sec. 6, T. 2 N., R. 1 W. Elrod considered Lost River chert to be an interformational marker between his Paoli Limestone and his Mitchell Limestone (see under “Blue River Group” and “St. Louis Limestone”), but Cumings (1922, p. 507) included it in the St. Louis Limestone. Especially through the work of Malott (1952, for example), it is now assigned to the lower part of the Ste. Genevieve Limestone.

**Description:** The Lost River Chert Bed consists of one stratum or more of very fossiliferous and siliceous limestone, distributed through as much as 6 stratigraphic feet, that contains abundant bryozoans and that is an oolite in places. Characteristically, Lost River chert is bluish gray and on weathered surfaces is hackly and rust brown. The bryozoan limestone is differentially silicified, so that weathered, carbonate-leached surfaces have a distinctive aspect. The Lost River Chert Bed constitutes an important stratigraphic marker 10 to 37 feet above the base of the Fredonia Member of the Ste. Genevieve Limestone. It is especially persistent in and south of Lawrence County, but northward the bed is mostly absent, although it has been reported as far north as Greencastle, Putnam County (Malott, 1952, p. 8, 23). It probably is present in the subsurface of western Indiana (Pinsak, 1957, p. 20). (See also McGrain, 1943, p. 156; Perry, Smith, and Wayne, 1954, p. 28, 30; and Perry and Smith, 1958, p. 20.)

**Louisville Limestone, Niagaran Series, RHS**

*Silurian System*

**Type area:** The Louisville Limestone was named by Foerste (1897, p. 218, 232) for about 60 feet of light-colored to brown fine-gained thick-bedded argillaceous limestone and dolomitic limestone exposed in and just east of Louisville, Jefferson County, Ky. (See also Butts, 1915, p. 88-89.)
Description: The formation is underlain by the Waldron Formation in northern Indiana through apparent conformity and transitional beds, although southward in Indiana and adjoining states the lower contact commonly was thought to be disconformable (Pinsak and Shaver, 1964, p. 30; Cumings, 1922, p. 455). In southern Indiana it is overlain in the subsurface by Mississinewa shale, as first shown by John B. Patton (see Shaver and others, 1961, p. 61), and in exposures by either the Geneva Dolomite or Jeffersonville Limestone, both of Devonian age. In northern Indiana it is overlain everywhere by the Mississinewa Shale Member of the Wabash Formation, commonly through transitional, apparently conformable beds.

The type lithology applies to much of the southern Indiana outcrop area west of the Cincinnati Arch, where, in the Ohio River counties, the formation also is characterized by many coral species. Northward, tan to brown fine-grained thick-bedded dolomitic limestone and dolomite that has few recognizable fossils is characteristic, although mottled sublithographic facies are common as are cherty zones, the chert and dolomite especially common in the northeast. The thickness ranges from 50 feet in the south, except where pre-Devonian erosion has reduced the thickness, to as much as 85 feet in the north. The area of distribution is similar to that for the Waldron Shale. (See also French, 1967; Patton, 1953; and Pinsak and Shaver, 1964.)

Correlation: On an interval basis, the Louisville lies near the middle of rocks long assigned in the Midwest to the Niagaran Series. Traced on a rock-unit basis, at least part of the formation passes laterally into part of the Moccasin Springs Formation of the Bainbridge Group of southern Illinois and into a lower part of the Racine Dolomite of northeastern Illinois. In the Newton County area of northwestern Indiana, where Pinsak and Shaver (1964, p. 30) did not recognize the Waldron Formation, the lower part of the Louisville has some equivalency with the Waldron and with the Waukesha Limestone of northeastern Illinois. The Louisville lies mostly beneath the prominent reef-bearing Niagaran rocks of northern Indiana exposures, although at the edge of the Michigan Basin, in subsurface sections, and in Mercer County, Ohio, at the surface, the Louisville apparently
correlates with older reef-bank and reef facies of the Niagaran Series. At the south edge of the Michigan Basin in northern Indiana, the Louisville stratigraphic position is occupied northward by rocks of the Salina Formation; whether in facies or unconformable relationship is unknown.

Although especially older reports refer to the brachiopods *Pentamerus oblongus* and *Conchidium* in the formation, the genus *Rhipidium*, so recognized in modern taxonomic treatment, certainly is present, and it suggests a middle Niagaran position in North American rocks and a Wenlock age in the British standard. (See Pinsak and Shaver, 1964, p. 32-33, and Berry and Boucot, in preparation.)

**Loveland Loess Member**, Atherton Formation, WJW

**Pleistocene Series**

*Type section:* The site of the original type section of the Loveland Formation, which was named by Shimek (1909), is the NW¼ sec. 3, T. 77 N., R. 44 W., Pottawattamie County, Iowa. The section was destroyed by excavation in 1957, and a new exposure 100 yards north of the original one was described by Daniels and Handy (1959) as a replacement type section.

*Description:* In Indiana the Loveland Loess Member (Atherton Formation, Wayne, 1963) is a brown clayey silt that is exposed on steep slopes and in natural and artificial cuts along the Ohio River and lower Wabash River. Generally only a few feet thick, it is recognizable largely because it is capped by a distinctive orange-brown zone of weathering beneath younger wind-deposited sediments (Wayne, 1963, p. 35). Most commonly it overlies the local bedrock, although in a few places deeply weathered remnants of the Cagle Loess Member may be at the base; generally it is overlain by the Farmdale Loess Member, although where that unit is absent or unrecognizable it is overlain by the Peoria Loess Member. Along the Wabash Valley and north of the Illinoian glacial boundary, tongues of the Loveland have been found beneath and intercalated with the Butlerville Till Member of the Jessup Formation. In only these exposures have fossils been recovered from the Loveland in Indiana.
Correlation: The Loveland Loess Member of the Atherton Formation was deposited during the Illinoian (glacial) Age.

Lower Block Coal Member, Brazil Formation, HCH

Pennsylvanian System

Type locality: The term Lower Block Coal was used originally by Ashley (1909, p. 57-58). This was the trade name for the lower of two block coalbeds near Brazil, Clay County. Ashley (1899) included numerous descriptions of Lower Block coal from the deep mines and outcrops around Brazil and apparently meant that the type locality for that bed was some 2 to 3 miles northeast of Brazil near the old mining town of Cardonia. Because the term has long commercial and geologic application, the Indiana Geological Survey recognizes it as a valid rock-unit name, even though it lacks geographic derivation, and has added the term of rank (that of member in the lower part of the Brazil Formation).

Description: In northern Clay County the Lower Block Coal Member consists of moderately dull banded slabby coal and has two conspicuous sets of vertical joints, called slips by miners, which trend approximately N. 20° W. and N. 70° E. and are 0.3 to 2.0 feet apart. The coal ranges from 0.7 to 5.8 feet in thickness (Hutchison, 1960, p. 14). At many localities the Lower Block member has a bone coal at the base upon which the main part of the coal rests directly. In places the upper portion of the coalbed is separated from the bone coal by as much as 12 feet of gray shale (Ashley, 1899, p. 522-596).

Gray hard sandy thin-bedded to massive shale and interbedded light-gray fine-grained sandstone laminae generally form the roof of the coal, and the floor consists of a gray sandy underclay or silty shale (Hutchison, 1960, p. 15-16).

The Lower Block is the basal member of the Brazil Formation and, in typical relationship, has been recognized from southern Parke County through Clay, Owen, and Greene Counties (Logan, 1922, p. 624). North of southern Parke County, it is absent or unidentifiable (Hutchison, 1961; Hutchison, in preparation, c). South of Greene...
County in Martin, Daviess, Dubois, and Spencer Counties, a coalbed is present at about the same stratigraphic position, but it lacks a blocky character (Logan, 1922, p. 624).

**Correlation and floral zones:** Wanless (1939, p. 34; 1962, p. 31) correlated the Lower Block Coal Member with the Bell Coal of western Kentucky, the Willis Coal of southern Illinois, and the Tarter Coal of western Illinois. Kosanke and others (1960, pl. 1) correlated it with the Rowe Coal of Missouri. Guennel (1958, p. 23-27), on the basis of miospore assemblages, assigned exposures of Lower Block coal to three floral zones, which he called, from the top down, the Lower Block c Zone, Lower Block b Zone, and Lower Block a Zone.

McLeansboro Group, Conemaugian Series, AMB & CEW Pennsylvanian System

**Type area:** DeWolf (1910, p. 181) first used the name McLeansboro Formation for all rocks of Pennsylvanian age above the Herrin (No. 6) Coal of Illinois exposed near McLeansboro, Hamilton County, Ill. The name McLeansboro was later (Kosanke and others, 1960, p. 36) used in Illinois with the rank of group for all Pennsylvanian rocks above the Danville (No. 7) Coal; Wier and Gray (1961) and Wier (in preparation) extended the use of this name into Indiana.

**Description:** The McLeansboro Group as recognized in Indiana extends from the top of the Danville Coal Member (VII) of the Dugger Formation to the top of the Pennsylvanian sequence. This group encompasses, in ascending order, the Shelburn, Patoka, Bond, and Mattoon Formations, but in Indiana it does not include the entire section represented in the type area because of eastward erosional truncation. In Indiana the outcrop belt of the McLeansboro Group extends from western Warrick County northward to southwestern Vermillion County. The maximum thickness of 770 feet is reached in the Mumford Hills in northern Posey County. Shale and sandstone make up almost 90 percent of this sequence, but minor amounts of siltstone, limestone, clay, and coal are present (Wier, in preparation).
Type locality: The Mansfield Formation was named originally the Mansfield Sandstone by Hopkins (1896, p. 199-200) for rocks exposed at Mansfield, Parke County. Kottlowski (1959), recognizing that the unit contains much shale and thin beds of coal, clay, and limestone, designated the unit as the Mansfield Formation.

Description: Hopkins described the Mansfield as “coarse-grained gray, yellow, red, brown, or variegated massive sandstone ... at the base of the Coal Measures, [which lies] unconformably upon the Lower Carboniferous limestone, or in the absence of the limestone on Lower Carboniferous sandstone or shale .... [and] is overlain by a series of shales, sandstones, and coal beds.” Cumings (1922, p. 527-528) described the Mansfield more precisely to include all the rocks between the Mississippian rocks and the base of the Lower Block Coal Member, and this definition is followed here.

The Mansfield rests unconformably, with as much as 150 feet of local relief, on Mississippian rocks that generally are progressively older northward. Progressive northward overlap also is suggested by the 50- to 300-foot range in thickness of the exposed Mansfield. The lowermost part of the Mansfield commonly consists of sandstone, generally crossbedded and containing a quartz-pebble and chert conglomerate in places, but also consists of dark carbonaceous shale in many places. The quartz-pebble conglomerate also is found in higher parts of the formation.

In the Shoals area of southwestern Indiana, the Mansfield has two broad, more or less distinct, vertically separate divisions, the lower consisting mostly of sandstone and the upper dominantly of shale and mudstone (Gray, Jenkins, and Weidman, 1960, p. 23). The divisional boundary is at the position, or inferred position, of the Pinnick Coal Member, which near Shoals lies 50 to 150 feet above the base, and 200 feet below the top, of the formation. Three lithofacies, passing laterally into one another, also have been recognized in
ROCK-UNIT NAMES

The term Coal I was intended to apply to the lowest Mansfield coalbed, but as used by Ashley (1899) it actually refers to the lowest commercial coal at any given place. Therefore the name, applied to more than one bed, has not been used widely. The French Lick Coal Member is the lowest named member and is overlain by approximately 50 feet of mudstone, siltstone, and fine-grained sandstone of remarkably even bedding. These silty rocks, best exhibited and formerly quarried near French Lick in Orange County, were called the Hindostan Whetstone Beds as early as 1838 by Owen (1859, p. 16) and were described in detail by Cox (1876, p. 6-8). The Pinnick Coal Member lies some 50 feet above the French Lick in the French Lick area. The Upper and Lower Cannelton Coals were mined extensively near Cannelton, Perry County, and were first described by Lesley (1862, p. 343-344). Apparently, these coals are the same coals described as the Troy Coal and Upper Troy Coal at Troy, Perry County, by Franklin and Wanless (1944, p. 86-87).

The Upper Troy Coal of Franklin and Wanless (1944, p. 88) appears to be the same as the St. Meinrad Coal Bed, which is sufficiently thick to be mined extensively near St. Meinrad, Spencer County, and throughout northwestern Perry County. The precise stratigraphic relations of these coals to the French Lick and Pinnick members are unknown, but the coals are in the same part of the Mansfield.

The Blue Creek Coal Member, lies some 100 feet above the Pinnick member, is separated from it by interbedded sandstones, siltstones, and shales, and is characteristically present in northeastern Dubois County. Overlying some 25 feet of shale and sandstone, which forms

Denotes those units for which separate articles may be found herein.
the roof of the Blue Creek, is the Mariah Hill Coal Bed. It has been mined extensively through central and northern Spencer County and near Huntingburg and Jasper in Dubois County.

The Fulda Limestone Member of Spencer County probably lies in or near the position of the Mariah Hill roof. The Ferdinand Limestone Member, together with a coal that is moderately thick in places below it, is some 20 to 40 feet above the Mariah Hill. In the northern part of the coalfield, particularly in eastern Clay County, a minable coalbed called the Shady Lane Coal Member lies about 12 feet above a limestone tentatively considered to be the Ferdinand. This bed does not appear to be present in southern Indiana. Approximately 40 feet of sandstone and shale complete the stratigraphic section to the top of the Mansfield, which is marked by the base of the Lower Block Coal Member of the Brazil Formation.

Other member and bed names having limited, colloquial, or outdated use are the Cannelton Sandstone, which was the name applied by Hopkins (1896, p. 314) to the massive sandstone which crops out in the bluff of the Ohio River behind the town of Cannelton, Perry County; the Cannelton Coal of Logan (1922, p. 623), which probably was applied to both the Upper and Lower Cannelton Coals, especially the upper nearer Tell City and the lower nearer Cannelton, Perry County; the Lower Huntingburg Coal, which is Franklin and Wanless’ (1944, p. 87) designation for what also is the Mariah Hill Coal Bed, the Shoals Coal (Logan, 1922, p. 623), which is near the base of Pennsylvanian rocks in the railroad cut west of Shoals, Martin County; the Kirksville Coal (Logan, 1922, p. 623-624), which is found in the southwestern part of Monroe County near Kirksville; and the Grandview Limestone of Franklin and Wanless (1944, p. 89-90), which is probably coextensive with the Ferdinand Limestone Member.

Correlation: The Mansfield corresponds approximately to the Caseyville Formation of western Kentucky and Illinois, to a part of the Pottsvillian Series of the Appalachian area, and possibly to parts of both the Morrowan and Atokan Series of the Midcontinent. (See Wanless, 1939, p. 94; 1962, p. 12; and Kosanke and others, 1960,
(pl. 1.) The Hindostan flora was described by Read (1947) as early Pottsvillian in age.Unnamed Mansfield limestones in Parke County are in the ostracod Zone of *Amphissites rothi*, and unnamed Mansfield limestones near Troy and Cannelton, Spencer and Perry Counties, contain the fusulinid *Profusulinella* and, in addition to the *Amphissites rothi* fauna, the ostracod *Cavellinella casei*. All suggest a pre-Desmoinesian age and, for the ostracods, correspondence with the lower part of the Dornick Hills Group of Oklahoma that generally is called Morrowan in age. (See Thompson and Shaver, 1964, and for additional faunal evidence, the “Ferdinand and Fulda Limestone Members” herein.)

**Maquoketa Shale**, Cincinnatian Series, HHG

*Ordovician System*

*Type area:* The Maquoketa Shale was named by White (1870, p. 180182) for exposures of about 80 feet of blue and brown shales on the Little Maquoketa River in Dubuque County, Iowa. It is widely recognized in the upper Mississippi Valley region, where it is about 200 feet thick.

*Description:* In western Indiana 300 to 400 feet of Maquoketa has been identified in the subsurface (Gutstadt, 1958b), and about 70 feet crops out in the structurally disturbed area east of Kentland, Newton County (Wayne, Johnson, and Keller, 1966). The upper and lower parts of the formation are shale, and the middle part is gray dolomite and calcareous shale. The Maquoketa overlies the dolomitic phase of the Trenton Limestone (Champlainian); according to Rooney (1966), the contact is conformable. It is underlain unconformably by rocks of Silurian age that are tentatively assigned to the Brassfield Limestone or to the Salamonie Dolomite by Pinsak and Shaver (1964).

*Correlation:* The Maquoketa Shale is thought generally to be equivalent to the Kope, Dillsboro, Saluda, and Whitewater Formations, that is, to rocks assigned to the Cincinnatian Series in southeastern Indiana. In the Indiana subsurface and in northeastern Illinois, however, these rocks are unconformably bounded both at the top...
Thus as used in Indiana the Maquoketa may not everywhere be equivalent to all the exposed Cincinnatian rocks.

**Mariah Hill Coal Bed**, Mansfield Formation, HCH

*Pennsylvanian System*

_Type locality:_ Franklin and Wanless (1944, p. 87, 89) first applied the name Upper Mariah Hill Coal to a coalbed mined by the Mariah Hill Super Block Coal Co. in secs. 19 and 20, T. 4 S., R. 4 W., 1½ miles southeast of Mariah Hill, Spencer County. Hutchison (1959) mapped this coal as the Mariah Hill Coal, which is here considered to have the rank of bed in the Mansfield Formation.

_Description:_ The Mariah Hill Coal Bed consists of moderately bright slightly pyritiferous semiblocky coal ranging from 2.0 to 4.4 feet in thickness. The roof of the coal is a dark-gray silty carbonaceous shale that in places is calcareous and fossiliferous and that encloses lenticular shaly to massive argillaceous fossiliferous locally cherty limestone. The floor of the coal is gray carbonaceous underclay or clay shale.

The Mariah Hill can be traced along its outcrop throughout Spencer County (Hutchison, 1959) and into Dubois County (Hutchison, 1964), where it was called the Lower Huntingburg Coal by Franklin and Wanless (1944, p. 87). Toward the north edge of Dubois County, the coal becomes spotty in its distribution and is difficult to identify.

_Correlation:_ Franklin and Wanless (1944) tentatively correlated the Mariah Hill Coal Bed with the Upper Block Coal Member to the north, thus assigning this coal to the Brazil Formation, but Hutchison (1959) showed that the coal lies within the Mansfield Formation, some 20 to 40 feet below the Ferdinand Limestone Member. (See Thompson and Shaver, 1964, and “Fulda Limestone Member” herein for faunal correlation.)

**Martinsville Formation**, Wisconsinan and Recent Stages, WJW

*Pleistocene Series*

_Type area:_ No specific section was selected as a type for the Martins-
ville Formation because most exposures are short lived, but the type area was
designated along White River between Martinsville and Mooresville, Morgan
County (Wayne, 1963, p. 29).

**Description:** The Martinsville Formation includes two facies, alluvial and
paludal. The alluvial facies consists of muds, silts, sands, and gravels that are
primarily fluviatile sediments of nonglacial origin deposited on modern
floodplains throughout the state. The paludal facies is comprised of peat, gyttja,
marl, clay, and silt, which are nonglacial sediments deposited in quiet water
environments of sloughs, lakes, and bogs. Most of the deposits of the paludal
facies are found in the northern half of the state. Both facies contain fossils, but the
paludal sediments commonly are more highly fossiliferous.

**Correlation:** The upper part of the formation has been deposited during the
Recent Age, and deposition is still in progress. Basal sediments in many of the
lenses of paludal sediments are Wisconsinan in age.

**Mattoon Formation, McLeansboro Group.**

*Pennsylvanian System*

**Type area:** The Mattoon Formation was named for exposures near Mattoon in
Coles County, Ill. (Kosanke and others, 1960, p. 39). It has a maximum thickness
of 500 to 600 feet in Illinois, 750 feet or more in western Kentucky, but only 150
feet in Indiana, where most of this formation has been eroded. This formation
name was accepted for use in Indiana by Wier and Gray (1961) and further
defined by Wier (in preparation).

**Description:** The Mattoon Formation in Indiana includes all Pennsylvanian rocks
that are younger than the Livingston Limestone Member of the Bond Formation
and contains the Cohn Coal and Merom Sandstone Members. Only the lower 40
feet of this formation is present near Merom in western Sullivan County, where
the formation consists of a few feet of shale, the Cohn Coal Member, and the
Merom Sandstone Member. Near Mumford Hills, northwestern Posey
County, the lower 150 feet is present. It consists of the Merom Sandstone and unnamed shales and thin clay, limestone, and coal.

Named members of the Mattoon Formation in Illinois that may be present in the Mumford Hills area in Indiana but that have not been positively identified are, in ascending order, the Friendsville Coal, McCleary's Bluff Coal, and Grayville Limestone Members (Kosanke and others, 1960).

**Menard Formation, Chesterian Series, Mississippian System**

*Type locality:* This unit was first named the Menard Formation by Stuart Weller (1913, p. 128) for exposures near Menard, Randolph County, Ill. Later Weller, describing the unit as 80 to 120 feet of dark-gray thin-bedded fine-grained limestone, changed the name to the Menard Limestone (Weller, 1920b, p. 202, 205-206). Swann (1963, p. 38-40, 74) redescribed the Menard as 30 to 150 feet thick and consisting of three named limestone members and three unnamed shale members.

*History of nomenclature in Indiana:* The name Siberia Limestone was first casually applied to this unit in Indiana in an abstract (Malott and Thompson, 1920, p. 521). Later Malott (1925, p. 109) defined the unit, and still later he correlated the Siberia with the Menard of Illinois (Malott, 1931, p. 222). Malott and Esarey (1940) used the name Menard (lithology unspecified) for the first time in southern Indiana, and Malott, Esarey, and Bieberman (1948) first applied the full name Menard Limestone. Rexroad and Nicoll (1965) changed the name, for Indiana usage, to the Menard Formation and recognized the Siberia Limestone Member as a part of the formation.

*Description:* In Indiana the Menard Formation is gray biomicritic limestone, yellow-brown micritic limestone containing sparse fossils, and green-gray shale (Malott, 1925). Sandstone and siltstone are present in minor amounts (Rexroad and Nicoll, 1965). Malott, Esarey, and Bieberman (1948, p. 25) recognized the predominance of noncarbonate rocks by stating that although the limestone is only 2 to 20 feet thick, the entire interval regarded as the Menard ranges from 40
to 65 feet in thickness. (See the discussion of boundary problems under “Tar Springs Formation.”) The outcrop of the Menard Formation extends from southeastern Dubois County southward to the Ohio River. A thinner basically limestone unit is recognized in the subsurface from southern Daviess County southwestward. The Menard marks the base of the *Kladognathus-Cavusgnathus navicula* Assemblage Zone (based on conodonts) (Rexroad and Nicoll, 1965). The unit overlies the Waltersburg Sandstone conformably and is overlain with apparent conformity by the Palestine Sandstone or disconformably by the Mansfield Formation (lower Pennsylvanian).

**Merom Sandstone Member**, Mattoon Formation, CEW

*Pennsylvanian System*

*Type locality:* Sandstone that crops out at Merom, Sullivan County, was first described by John Collett in 1871 (p. 199-200). He stated that “the stone work of the college edifice [at Merom] was quarried from massive ledges of the ‘Merom Sandstone’ north of town ...” The Merom Sandstone was assigned member status in the Mattoon Formation by Wier and Gray (1961). The type locality as designated by Wier (in preparation) is at Merom Bluff in secs. 7 and 18, T. 7 N., R. 10 W.

*Description:* The sandstone ranges from 10 to 35 feet in thickness at most exposures and is not known to exceed a thickness of 40 feet. The Merom Sandstone Member consists of two distinct lithologies: an upper crossbedded medium- to coarse-grained sandstone and a lower conglomerate that is gray to brown and that is composed of a mixture of rounded to subrounded pebbles of limestone, chert, sandstone, coal, and clay that are cemented with calcium carbonate. In Indiana the Merom Sandstone Member is recognized only near its type area in Sullivan County and in the Mumford Hills area in Posey County.

*Correlation:* The Merom has been incorrectly correlated with numerous outcrops of other units in southern Indiana. The Inglefield Sandstone Member and some higher sandstones in Knox County were
erroneously called the Merom by Collett (1874, p. 321-338), and G. H. Ashley (1899, p. 1051-1079) repeated this error. Other workers (Logan, 1932; Culbertson, 1932; Malott, 1948; and Friedman, 1954) followed Ashley and mistakenly identified the Inglefield as the Merom in southern Indiana.

Minshall Coal Member, Brazil Formation, HCH
Pennsylvanian System

Type locality: The name Minshall was first applied to the coal below a limestone at the now-abandoned mining town of Minshall, Parke County, where it was mined extensively underground in secs. 8 and 17, T. 14 N., R. 7 W. (Ashley, 1909, p. 57). In now-obsolete usage, the name also was applied to the closely overlying limestone as well as to other limestones (collectively the so-called “Minshall Limestone”), and contrary to common opinion, the limestone part of the Minshall roof is subsurface at Minshall rather than being the well-exposed bench. (See Hutchison, 1960, p. 19-21, and “Perth Limestone Member” herein.) The full unit name is here considered to be the Minshall Coal Member (of the Brazil Formation).

Description: Minshall coal is moderately bright to extremely dull, pyritiferous, semiblocky to blocky, and extremely irregular in extent and thickness. In the northern part of the coalfield, it ranges from less than 1 to more than 6 feet in thickness, probably averaging 4 feet where mined. The roof is gray clayey to silty locally fossiliferous shale, which in many areas contains the Perth Limestone Member, a lenticular gray fossiliferous limestone as much as 18 feet thick. In some places the limestone lies directly on the coal. The floor is gray carbonaceous plastic underclay. Stratigraphically, the Minshall Coal Member lies some 15 to 20 feet below the top of the Brazil Formation and on the average 22 feet above the Upper Block Coal Member.

Distribution and correlation: The member has been recognized as far north as Warren County (Hutchison, 1961) and as far south as Switz City in Greene County (Kottlowski, 1960). Possibly it is coextensive
with the Buffaloville Coal Member of Spencer and Dubois Counties (Hutchison, 1959, 1964) because the Buffaloville occupies a similar stratigraphic position and contains a similar assemblage of miospores (G. K. Guennel, oral communication, 1958).

Although the Minshall has been correlated as low as the coal below the Lead Creek Limestone in Hancock County, Ky., it more likely correlates with a higher Kentucky coal, at least as high as that once mined southwest of Lewisport in Daviess County. Moreover, it has been thought to correlate with either the Mannington Coal or Empire Coal of western Kentucky, either the New Burnside Coal or Bidwell Coal of southeastern Illinois, the Murphysboro Coal of southwestern Illinois, the Rock Island (No. 1) Coal of western Illinois, and the Bluejacket Coal of Missouri (Wanless, 1939, 1962; Siever, 1956; and Kosanke and others, 1960). The fauna of the overlying Perth Limestone Member bears on Minshall correlation, and it has a late preDesmoinesian or early Desmoinesian age.

**Mississinewa Shale Member, Wabash Formation, RHS**

*Type area:* The Mississinewa Shale Member, formerly having formation rank, was named by Cumings and Shrock (1927, p. 72) for shaly weathering argillaceous silty dolomite and dolomitic siltstone, more than 50 feet thick in single exposures, along the Mississinewa River between Marion, Grant County, and the southwest corner of Wabash County, north-central Indiana. Its rank was reduced to a member of the Wabash Formation by Pinsak and Shaver (1964, p. 35).

*Description:* The Mississinewa Shale Member typically consists of dolomitic siltstone and silty dolomite, fairly calcareous in places, that is gray, dense to fine grained, and thick bedded to massive although appearing shaly in many surficial sections. The bottom several feet commonly is gradational into coarser grained fossil-fragmental limestone of the Louisville Limestone. Rocks of type lithology occupy interreef positions, and the member also includes small amounts of interreef cherty granular limestone and dolomitic limestone and of
granular vuggy nearly pure dolomite in bioherms, banks, and reefs (Huntington Lithofacies). The bank and reef facies dominates the member especially in the Allen County area and in a sinuously linear area between Fort Wayne and Lake Michigan (Fort Wayne Bank).

Except where reduced by erosion, the type thickness is about 110 feet, but thickness increases to about 200 feet near the member’s northern limit in Fulton and Pulaski Counties and decreases to as little as 50 to 75 feet in far western sections, where the member’s upper boundary has been placed at the level below which the type lithology is regionally predominant. The member is absent from far northern counties and from the higher part of the Cincinnati Arch in eastern and southeastern Indiana. (See Cumings and Shrock, 1928a, b; Patton, 1955; Sangree, 1960; and Pinsak and Shaver, 1964).

Correlation: The member is lowermost in the Wabash Formation and correlates with a middle part of the Racine Dolomite and probably in part with an upper part of the Moccasin Springs Formation, both formations in neighboring parts of Illinois.

The Mississinewa stratigraphic position, together with the brachiopod Conchidium and the graptolite Monograptus falciformus (=? Monograptus bohemicus), referenced under “Wabash Formation,” shows that the member belongs well up in the Niagaran Series that is conventional to the Midwest and that it has an early Ludlow age in British terminology. (See Berry and Boucot, in preparation; Pinsak and Shaver, 1964; and “Salina Formation, Correlation” herein.)

Morgan Traff Member, New Albany Shale, Devonian System

Type section: The Morgan Trail Member of the New Albany Shale was named by Lineback (1968 and in preparation) for a roadside park 1 mile southwest of the type section in the NW¼ sec. 16, T. 3 N., R. 8 E., Scott County.

Description: At the type section the Morgan Trail consists of brownish-black fissile siliceous pyritic shale. Thin hard pyritic beds are characteristic of this member, which is recognizable throughout the southern
Indiana and outcrop area but cannot be traced in the subsurface. It lies northern Kentucky above the Selmier Member and below the Camp Run Member of the New Albany Shale and ranges from 25 to 40 feet in thickness. The only fossils found are silicified logs of the genus Callixylon.

Correlation: The Morgan Trail Member is considered to be stratigraphically equivalent to the lower part of the Grassy Creek Shale of Illinois, to parts of the Antrim and Ellsworth Shales of Michigan and northern Indiana, to the Huron Member of the Ohio Shale of Ohio, and to the lower part of the Gassaway Member of the Chattanooga Shale of Tennessee (Lineback, 1968 and in preparation).

Morton Loess Tongue, Peoria Loess Member, Pleistocene Series

Type section: The Morton Loess Tongue of the Peoria Loess Member (Atherton Formation) was named originally in Illinois as the Morton Loess by Frye and Willman (1960, p. 7, 11). Their type section is a railroad cut near Farm Creek, Tazewell County, Ill., in the center of sec. 31, T. 26 N., R. 3 W. Wayne (1963) accorded the unit tongue rank in Indiana.

Description: A calcareous fossiliferous gray to tan massive silt, commonly 1 to 4 feet thick, the Morton lies below the Center Grove Till Member (Trafalgar Formation) and above a soil profile on the Butlerville Till Member (Trafalgar Formation) or the Farmdale Loess Member where it is present (Wayne, 1963, p. 34). In their original description, Frye and Willman placed the Morton Loess above the Farmdale Silt and below the till of the Shelbyville Moraine. Physically the Morton resembles somewhat the Cagle and Loveland Loess Members (Atherton Formation) where they are in similar positions intercalated between an overlying till and an underlying paleosol, but it can normally be distinguished by its stratigraphic position and by its fossil snail content.

Correlation: The Morton Loess Tongue was deposited during the Wisconsinan Age while glacial ice advanced to its maximum position. Radiocarbon dates indicate that it had accumulated and was over-
ridden 21,000 years ago in central Indiana. South of the overlap of the Trafalgar Formation, the Morton Loess Tongue merges with and is represented by the lower part of the Peoria loess. The upper *Hendersonia occulta* bed of Wayne (1965, fig. 2) coincides mostly with the Morton loess.

**Mount Simon Sandstone, St. Croixan Series, HHG**

_Cambrian System_

*Type locality:* The name Mount Simon is generally credited to Walcott (1914, p. 354), who, however, credited a manuscript in preparation by E. O. Ulrich. Apparently Ulrich's manuscript was not published, at least not in the form seen by Walcott, whose description must thus be considered definitive. A coarse sandstone about 235 feet thick in its type area, the unit was probably named for an escarpment called Mt. Simon, at Eau Claire, Wis.

*Description:* The Mount Simon Sandstone is known in Indiana only in the subsurface, where it is a pink to white fine- to coarse-grained sandstone ranging from about 200 feet in thickness in the southeastern part of the state to about 2,000 feet in the northwest (Gutstadt, 1958a, p. 22-23). This thickness in northwestern Indiana includes at the base about 300 to 400 feet of pink to red sandstone that may represent the so-called “Red Clastics” of the northern Illinois and Wisconsin subsurface (Gutstadt, 1958a, p. 19). The Mount Simon Sandstone overlies the basement complex of probable Precambrian age and is overlain by the Eau Claire Formation (St. Croixan).

*Correlation:* The Mount Simon Sandstone is known by this name in the subsurface in northern Illinois, southern Wisconsin, and across Michigan and Ohio. In the subsurface in southern Illinois and in the outcrop area in eastern Missouri, equivalent rocks are known as the Lamotte Sandstone (Gutstadt, 1958a, p. 20).

**Muldraugh Formation, Borden Group, Mississippian System AMB**

*Type section:* The Muldraugh Formation was named by Stockdale (1939, p. 72, 200-201) for a sequence of argillaceous cherty carbonate
rocks exposed along a secondary road which descends the Muldraugh Escarpment south of Phillipsburg, Marion County, Ky. The unit, as originally defined, was correlative with the Indiana section between the base of the Edwardsville Member (Muldraugh Formation) and the top of the Guthrie Creek Member (Harrodsburg Limestone), thus including the lower two members of the Harrodsburg Limestone as it is now recognized. Smith (1965) redefined the Muldraugh Formation in Indiana to include, in ascending order, the Floyds Knob Limestone Member, the Edwardsville Member, and the Ramp Creek Limestone Member, the latter previously having been assigned to the Harrodsburg Limestone.

**Description:** The Muldraugh Formation in Indiana is a heterogeneous, geode-bearing unit, ranges from 60 to more than 200 feet in thickness, and consists of siltstones and shales, which may or may not be calcareous, and of siliceous cherty echinodermal limestones. The partly biohermal Floyds Knob Limestone Member and the Ramp Creek Limestone Member are chiefly limestones interbedded with calcareous shales, and the Edwardsville is primarily a unit of clayey and quartzose rocks having local biothermal development. Lithologies associated with the contacts between these units are gradational, and in places the Edwardsville Member lies laterally adjacent to the Floyds Knob Limestone Member because of biohermal upbuilding from the Floyds Knob. The formation is recognizable throughout the southern Indiana outcrop along the Knobstone Escarpment, although the upper and lower members are not mappable over wide areas. Northward from Harrison County the Ramp Creek thins as the Edwardsville thickens; the Floyds Knob thickens in southern Monroe County where bioherms become more prominent. (See Smith, 1965; Stockdale, 1931; and "Edwardsville Member, Correlation" herein.) The Muldraugh Formation, as the upper unit of the Borden Group, conformably overlies the Carwood Formation and is overlain by the Leesville Member of the Harrodsburg Limestone.

**New Albany Shale,** Senecan to Kinderhookian Series, AMB, Devonian and Mississippian Systems

**Type locality:** The name New Albany Black Slate was first used by
Borden (1874, p. 158) in describing 104 feet of well-exposed rocks along the Ohio River at New Albany, Floyd County. The unit had previously been known as the Louisville-Delphi Black Slate. Blatchley and Ashley (1898, p. 19-20) discussed the unit as both the New Albany Shale and Genessee Shale, but the term New Albany has been used in the literature since that time.

Description: The New Albany Shale, although widely known as a typical black shale, is composed principally of dark shale containing much organic matter, greenish-gray shale, and minor amounts of dolomite and dolomitic quartz sandstone (Lineback, in preparation). Five members have been described in Indiana. In ascending order they are: the Blocher Member, calcareous to dolomitic pyritic shale rich in organic matter; the Selmier Member, greenish-gray mudstone; the Morgan Trail Member, black fissile siliceous pyritic shale; the Camp Run Member, alternating greenish-gray mudstone and black shale; and the Clegg Creek Member, black silty or dolomitic pyritic shale. These members are recognizable in northern Kentucky, but only the Blocher and Selmier Members can be recognized in the Indiana subsurface (Lineback, in preparation). The Selmier, Morgan Trail, and Camp Run Members and part of the Clegg Creek Member are equivalent to the Blackiston Formation of Campbell (1946), and his Sanderson, Underwood, and Henryville Formations and Jacobs Chapel Shale are included in the upper part of the Clegg Creek Member.

The New Albany Shale is widespread west and southwest of the Cincinnati Arch in Indiana and lies conformably beneath the Rockford Limestone and paraconformably above the North Vernon Limestone. It crops out in southeastern and north-central Indiana and attains a maximum thickness of 307 feet in Posey County and a minimum thickness of 87 feet in Harrison County.

Correlation: The New Albany Shale is in large part Devonian in age and includes equivalents of Zones to I through to VI of Ziegler’s (1962) zonation, based on conodonts and ammonites, of the upper Devonian sequence in Germany. The upper 2 to 6 feet of the New Albany is Mississippian in age and includes equivalents of the European Zone.
cuI and the lower part of Zone cuII. A conodont fauna corresponding to that in the Siphonodella sulcata Zone in the Hannibal Shale of the upper Mississippi Valley has been recognized in the Underwood Bed of the New Albany Shale (Lineback, in preparation.)

The New Albany Shale is a widely recognized unit and is in large part correlative with the Antrim, Ellsworth, and Sunbury Shales and the lower part of the Coldwater Shale of Michigan; the Olentangy, Ohio, Bedford, Berea, and Sunbury Shales of Ohio; the Chattanooga Shale of Tennessee; and the New Albany Group of Illinois. (See Huddle, 1934; Campbell, 1946; and Lineback, in preparation).

**New Holland Till Member**, Lagro Formation, WJW

Pleistocene Series

*Type section:* The easternmost of three laterally intertonguing till units of the Lagro Formation, the New Holland Till Member was defined by Wayne (1963, p. 44, 78) for an exposure in Wabash County along Rush Creek half a mile south of New Holland (NE¼NE¼ sec. 29, T. 27 N., R. 8 E., Lagro Quadrangle).

*Description:* The unit is composed of slightly pebbly clay-rich till that has a thin (1.5 to 3.0 feet) soil profile. It is variable in thickness, ranging from a few feet to as much as 60 feet. The member at the surface is limited to an area in eastern Indiana that seems to be marked by the Union City Moraine from Winchester to the Wabash River, thence by a line running northward and northeastward along the Eel River to Columbia City, and thence to Angola. It overlies till of the Trafalgar Formation and stratified sediments of the Atherton Formation and is overlain in places by sediments of the Atherton and Martinsville Formations.

*Correlation:* The New Holland till was deposited during the Caryan Subage of the Wisconsinan Age, probably between 15,000 and 14,000 years ago.

**New Providence Shale**, Borden Group, Mississippian System CBR

*Type locality:* Both the New Providence Shale and the Borden Group
were named for the town of New Providence, which is now incorporated under the
name Borden, but typical New Providence Shale exposures “are not seen nearer
than about four miles east of the town, in the vicinity of Broomhill and Carwood”
(Stockdale, 1931, p. 85), and the base of the formation is exposed about 4½ miles
further east. A specific type section within this area has not been designated.

Reference sections and subordinate nomenclature: The New Providence Shale has
several named subdivisions, and their type or standard reference sections provide
a number of key sections for the formation. (None of the subunit names is treated
in a separate article herein, as none has had extensive use in Indiana by persons
other than its author.) The Broomhill Facies of Stockdale (1931, p. 100) is the
facies of the type area of the New Providence, and this facies is displayed in the
lowlands and lowest part of the Knobstone Escarpment both north and south of
Broomhill, which is in the southwest comer of sec. 5, T. 1 S., R. 6 E. The next of
Stockdale’s (1931, p. 96) facies to the south in Indiana is the Silver Hills Facies,
whose type section is in the abandoned Goetz Quarry and on the hill slopes above
in the SW¼SW¼ sec. 3, T. 3 S., R. 6 E., in the southwest part of New Albany. The
Silver Hills Facies differs from the Broomhill Facies by having in its upper part the
Kenwood Formation (Sandstone, Member, or beds), which was named as a
formation by Butts (1915, p. 148) for excellent exposures on Kenwood Hill in
south Louisville, Ky. The facies north of the type area facies of the New
Providence is the Dowell Hill Facies (Stockdale, 1931, p. 102), named for Dowell
Hill, 5½ miles west of Columbus, where the unit is typically displayed in the NE¼
sec. 25, T. 9 N., R. 4 E. Conkin (1961) extended the use of his Coral Ridge and
Button Mold Knob Members into Indiana from adjacent Kentucky, where they
were named by him (1957) for well-known fossiliferous sections at Coral Ridge
and Button Mold Knob in Jefferson and Bullitt Counties, Ky.

Description: Greenish-gray, blue-gray, or dark lead-gray shale bordering on
claystone is the dominant lithology of the New Providence. A sequence of
alternating sandstones and shales in the upper part of
the formation (equivalent to the Kenwood Formation of Butts, 1915, in Jefferson County, Ky.) is present in southern Indiana but loses its identity to the north. Ironstone lenses or beds generally less than 1 foot thick and composed mainly of iron carbonate are irregularly distributed throughout most of the formation in southern Indiana. Both fossiliferous and unfossiliferous limestones are present as concretionary bands, beds, or biohermlike patches, but these are more common in Kentucky than in southern Indiana. Minor amounts of red shale are present, most commonly in the northern half of the outcrop area of the formation. To the north beds of siliceous silty dolomite several feet thick are present in places.

In Indiana exposures of the New Providence Shale extend from New Albany on the Ohio River northward along the outcrop belt, situated mainly in the Scottsburg Lowland, into Brown and Bartholomew Counties. North of these two counties the glacial drift obscures the formation as the outcrop belt swings northwestward to the southwest corner of Benton County. The formation is recognized in the subsurface west and south of the outcrop area.

Stockdale (1931, p. 96) recorded thicknesses ranging from 200 feet at New Albany to 290 feet in Bartholomew County. Pinsak (1957, p. 30) stated a range of 30 to 125 feet in the subsurface and indicated thinning both to the north and south from a central area between T. 4 N. and T. 12 N.

Borden (1874) defined the New Providence Shale as lying above the ferruginous limestone (Rockford Limestone) and below the micaceous shale of the “true knob shale” (Locust Point Formation). The Rockford-New Providence contact is sharp, although the two apparently are conformable in northern Indiana. The contact is erosional in southern Indiana, and where the Rockford Limestone is absent the New Providence rests on the New Albany Shale. The lithology associated with the boundary between the New Providence and the overlying Locust Point is transitional, and thus a contact is difficult to pick in most areas. The top of the Kenwood where present provides a marker.
Correlation: Conodont studies (Rexroad and Scott, 1964) show that the New Providence Shale is time transgressive and is oldest in its northern outcrop area, where the lower part is equivalent to the lower part of the Burlington Limestone or the Fern Glen Formation of some authors of the Mississippi Valley and is a part of the *Bactrognathus-Polygnathus communis* Assemblage Zone. To the south the basal part of the New Providence can be no older than the upper part of the Burlington Limestone, and it may be as young as the lowermost part of the Keokuk Limestone of Iowa. The upper limit of the correlation is indefinite but probably is within the lower part of the Keokuk Limestone.

**North Vernon Limestone**, Erian Series, AMB & JBP

Devonian System

Type area and reference sections: The North Vernon Limestone was named by Borden (1876, p. 148, 160) for North Vernon, Jennings County, where a gray crystalline limestone was exposed above the so-called “Corniferous Limestone” (Jeffersonville) in quarry operations. In his definition Borden related the type North Vernon to what was called the hydraulic limestone (Silver Creek Member) of Clark County, indicating his regional understanding of the unit.

Reference sections of the North Vernon Limestone can be seen at: the Scott County Stone Co. quarry in the center of the N½ sec. 20, T. 3 N., R. 8 E., where 17.9 feet of the unit is exposed; the Louisville Cement Co. quarry 1 mile northeast of Speed, Clark County, lots 131 and 132, Clark's Grant, 21.4 feet exposed; and the Sellersburg Stone Co. quarry on the southeast edge of Sellersburg, Clark County, lot 90, Clark's Grant, 21.4 feet exposed.

Description: The North Vernon Limestone is a unit of vertically and horizontally varying lithologies. The uppermost unit, the Beechwood Member, is typically a dark-gray thick-bedded coarsely crystalline crinoidal limestone bearing small black rounded phosphatic pebbles in the basal few inches. Two distinct lithologies, existing in facies relationship, are discernible in the lower part of the formation. The
drab-gray homogeneous argillaceous dolomitic limestone, known locally as the cement beds and formally as the Silver Creek Member, thins northward from Clark County as the blue-gray thin-bedded fossilsiferous crystalline limestone known as the Speed Member thickens. These two lithologies represent contemporaneous deposits (Patton and Dawson, 1955) and are interbedded in some places. North of southern Scott County, the Speed lithofacies makes up all the North Vernon Limestone below the Beechwood Member. Where division of the unit into the various members is difficult, only the term North Vernon should be used.

The North Vernon ranges from 1 to 26 feet in thickness in its southern Indiana outcrop. It is not exposed northward from southern Shelby County owing to the cover of glacial drift, although rocks of Hamilton age formerly called the Sellersburg Limestone have been described along the Wabash River in north-central Indiana. (See Thornbury and Deane, 1955, p. 18-19.) The unit has been recognized in the subsurface as far north as Warren County by Becker (in preparation) and Pulaski County by Wayne, Johnson, and Keller (1966). It thickens to more than 80 feet in southwestern Indiana (Becker, in preparation). (See also French, 1967.)

*History of nomenclature:* Study since 1875 has resulted in duplication and overlap of the nomenclature for these rocks of Hamilton age. Kindle (1899, p. 8, 23, 110) introduced the name Sellersburg Beds for the section “from the New Albany Shale down to the lowest beds worked at the cement quarries”—essentially the same section named the North Vernon by W. W. Borden 24 years before. Siebenthal (1901) then restricted the name Sellersburg to the unit, known also as the Crinoidal Limestone, above the cement rock and gave the name Silver Creek Hydraulic Limestone to the cement beds. Butts (1915) returned to the original definition of the Sellersburg, proposed that Siebenthal’s Sellersburg be known as the Beechwood Limestone Member, and reduced the Silver Creek to member rank. Sutton and Sutton (1937) recognized the Hamilton age of a fossilsiferous zone below the cement beds and proposed that this zone be called the Speeds Member of the *Sellersburg Formation (North Vernon Lime-
Campbell's proposed units are now considered to be faunal facies of previously recognized members or combinations of members of the North Vernon Limestone. Whitlatch and Huddle (1932, p. 367) gave the name New Chapel Chert Bed to a cherty zone in the upper part of the Silver Creek Member in Clark County. In north-central Indiana, Cooper and Warthin (1941) and Cooper and Phelan (1966) gave the names Logansport Limestone, Miami Bend Formation, and Little Rock Creek Limestone to rocks here recognized as belonging to the North Vernon Limestone. The basis for establishing these units is largely faunal.

*Correlation:* Correlation of the North Vernon Limestone with part of the Hamilton Group of New York (a term often used in the past in Indiana, by Blatchley and Ashley, 1898, p. 19, for example) has been well established for Indiana and northern Kentucky by Borden (1874), Hall (1879b), and Kindle (1899). This unit is also correlated with the Lingle Limestone of Illinois and with the Delaware Limestone of Ohio and is at least in part equivalent to the Traverse Group of Michigan and the Traverse Formation of northern Indiana. (See Stumm, 1964; Meents and Swann, 1965; Thornbury and Deane, 1955; and Pinsak and Shaver, 1964.)

**Osgood Member, Salamonie Dolomite, Silurian System**

*Type area and reference section:* The term Osgood Beds was applied by Foerste (1896, p. 191) to the fossiliferous lower part of what was then called the Laurel Formation near Osgood in Ripley County. A type section was not designated, and although no complete sections of the unit are exposed in the immediate vicinity of Osgood, the upper few feet of the member is exposed in the Southeastern Materials Corp. quarry at the south edge of town (SW¼SW¼ sec. 32, T. 8 N., R. 11 E.). Good reference sections are: (1) the exposure in the New Point Stone Co. quarry 1 mile north of New Point in the SW¼SW¼ sec. 8, T. 10 N., R. 11 E., Decatur County; (2) the east cutbank of
Square Run 1 mile southwest of Millhousen in the SE¼NE¼ sec. 30, T. 9 N., R. 10 E., Decatur County; and (3) the road cut on the south bank of Graham Creek half a mile north of New Marion in the W½NE¼ sec. 36, T. 7 N., R. 10 E., Ripley County. The Osgood Beds attained formation status when Foerste (1897, p. 217, 230) restricted the Laurel, and the Osgood Formation was reduced in rank to member by French (1967), who assigned it to the Salamonie Dolomite.

**Description:** As recognized by Foerste (1897), the Osgood consisted of lower and upper clay units and an intervening carbonate unit. A thin basal dolomitic limestone also is included in the Osgood Member in a number of places. Although Foerste’s subdivisions are readily recognizable in some places, most lithologic units in this member have limited lateral extent. The shales are dolomitic or calcareous, the dolomitic limestones and dolomites are highly argillaceous, and all lithologies are gradational. Shale generally is more prominent to the south. Near Laurel in Franklin County and northward, carbonate rocks are dominant, and in northern Indiana, where relations are obscure, the undifferentiated beds of Osgood and Laurel age are referred to the Salamonie Dolomite. The thickness ranges from 10 to 30 feet and averages about 15 feet. The Osgood unconformably overlies the Brassfield Limestone or, where the Brassfield is absent, rocks of Ordovician age; it is overlain conformably and, in places, gradationally by the Laurel Member.

In Indiana the Osgood outcrop belt extends from near Utica, on the Ohio River in Clark County, northward to near Richmond, but the member cannot be distinguished certainly in much of the northern part of the outcrop. In western Ripley County and in adjacent counties, Osgood exposures are present in Silurian outliers. In adjacent parts of Ohio, the name Osgood is applied to a shaly section above the Dayton Limestone. The Osgood Member or rocks of Osgood age extend westward into the subsurface of southwestern Indiana, but its bounds as a distinct, named unit have not been described in published reports.

**Correlation:** Although the Osgood generally has been correlated with
all or part of the Rochester Shale of the Clinton Group of New York (Foerste, 1935, p. 191; Esarey and Bieberman, 1948, p. 16), it may be somewhat older than once thought. On the basis of the arenaceous foraminifers of Dunn (1942), Browne and Schott (1963), and Mound (1968), the member is considered to have a low position in the Niagaran Series as that series is recognized in the Midwest, correlating with a part of the Joliet Dolomite of northeastern Illinois and a lower part of the undivided Salamonie Dolomite of northern Indiana. Conodont studies (Nicoll and Rexroad, 1968; Liebe, 1962) show that the Osgood correlates with the upper part of the Estill Shale of central Kentucky, as well as part of the Joliet rocks, and that it belongs to Zone III, that is, the amorphognathoides-Zone, of western Europe as that zone was defined by Walliser (1962, 1964). Thus the Osgood is early late Llandovery in age in the British standard and is older than the Rochester, which is thought to be Wenlock in age (Fisher, 1960). (See also Pinsak and Shaver, 1964, fig. 3.)

Palestine Sandstone, Chesterian Series, HHG
Mississippian System

Type locality and description: Stuart Weller (1913, p. 128-129) named the Palestine Formation for exposures of thick-bedded sandstone, thin-bedded ripple-marked sandstone, and sandy shale, 75 feet in total thickness, Palestine Township, Randolph County, Ill. The name was later changed without explanation to the Palestine Sandstone (Weller, 1920b, p. 209).

Former name in Indiana: Although this unit was first called the Bristow Sandstone (Malott, 1925), its equivalence to the Palestine Sandstone was soon recognized (Malott, 1931, p. 222). This correlation has been generally accepted, although no evidence was cited, and since its first use in Indiana by Malott and Esarey (1940), the name Palestine Sandstone has gradually come into general use.

Description: In Indiana the Palestine Sandstone is composed of fine-grained quartzitic sandstone, thin-bedded sandstone, and sandy shale. In some places the quartzitic sandstone, which weathers to rectangular
blocks and forms low ledges and waterfalls, is in a single bed, but in other places there are
two or three sandstone beds and interbedded shale (Malott, 1925). The unit is restricted on
outcrop to Perry County, where it is 5 to 30 feet thick (Malott, Esarey, and Bieberman,
1948, p. 25). In the subsurface a thicker unit of sandstone and shale between units
composed principally of limestone is recognized from Dubois, and Knox Counties
southwestward. (See the discussion of boundary problem under “Tar Springs Formation.”)
The Palestine Sandstone overlies the Menard Formation with apparent conformity (but see
Weller, 1913, p. 129; 1920b, p. 206-207) and is overlain conformably by the Clore
Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

Paoli Limestone, Blue River Group, NMS
Mississippian System

*Type locality:* The Paoli Limestone was named by Elrod (1899, p. 259) for Paoli, Orange
County, near which are many typical exposures of the formation. A type section has not
been properly designated, but an excellent exposure of the formation is in an abandoned
quarry north of the Monon Railroad in the west part of Paoli (SW¼SE¼SE¼ sec. 35, T.
2 N., R. 1 W.). This may be the exposure referred to as the type section by C. A. Malott and
R. E. Esarey on page 5 of the mimeographed itinerary for the 1940 field trip of the Indiana-
Kentucky Geological Society (“Outcrop of the Chester Series of Southern Indiana,” May
18, 1940).

*Definition and relation to the Aux Vases Formation:* Here considered to comprise
the rocks between the Ste. Genevieve Limestone (below) and the Bethel Formation, the
Paoli of M.N. Elrod in 1899 included the rocks above the Lost River Chert Bed, in the
lower part of the Ste. Genevieve, and below the lowest Chester sandstone (Bethel). In later
use (Cumings, 1922, p. 507, 515), the Paoli was considered to be the lowest Chester unit­
and a member of the Gasper Limestone of Butts (1915)-a definition that requires a time
connotation that may conflict with definition of the Paoli and the subjacent Ste. Genevieve
as rock units. In one practice of this concept the Paoli is
separated from the underlying Ste. Genevieve just above the highest position of the crinoid *Platycrinus penicillus*. The Paoli of Malott (1952), who followed Cumings in part, excluded the lower sandy and shaly rocks, assigned here to the Paoli, that Malott (1945, p. 1180; 1946, p. 322-323) had correlated with Keyes’ (1892, p. 296) Aux Vases Sandstone of Missouri. (A tentative correlation had been made as early as 1940 in the field trip itinerary cited above.) A number of reports followed Malott, that of Perry and Smith (1958) for example, in recognizing an outcropping Aux Vases Formation in Indiana, but Gray, Jenkins, and Weidman (1960, p. 49) reassigned these rocks to the lower part of the Paoli because they do not correspond either to the classical Aux Vases or to the Aux Vases Formation of subsurface usage in the Illinois Basin.

These sandy lower Paoli rocks were named the Popcorn Sandstone Bed by Swann (1963, p. 31, 78-79), the name coming from Popcorn Spring in the SE\(^2\)SW\(^1\), sec. 5, T. 6 N., R. 2 W., Lawrence County.

**Description:** Much of the exposed Paoli is characterized by four principal lithologies, in descending order: (1) gray to light-gray dense thin- to thick-bedded oolite or oolitic limestone, which generally is chemically pure and whose oolites generally are of medium-sand size and bound by microcrystalline calcite; (2) gray or greenish-gray calcareous shale, in about the middle of the formation and called the middle shale break (Perry and Smith, 1958, p. 23); (3) gray to greenish-gray dense to lithographic limestones, which tend to be thinner bedded and less pure than the limestone above the shale break, which generally weather into earthy smelling blocky rubble, and which in places are replaced by calcareous shale that grades upward through argillaceous limestone into the calcareous middle shale break; and (4) gray calcareous sandstones, dark shales, and impure limestone, which grade without apparent break into the overlying part (Perry and Smith, 1958, p. 36), and which at times have been called the Aux Vases Formation of Indiana outcrop. (See Perry and Smith, 1958, p. 23, 37, for greater detail on surface aspect and Pinsak, 1957, p. 15, 17, for subsurface characters that are not entirely parallel.)
The upper hard part, consisting variously of oolites, fossil debris, and crystalline calcite, is especially conspicuous in many outcrops. In many places a gray and dark-gray limestone breccia is found at the position of the middle shale break, and a similar breccia is found in some exposures of the upper part of the Paoli. Both breccias resemble that in the underlying Bryantsville Breccia Bed of the Ste. Genevieve Limestone.

The Paoli ranges from about 3 to 40 feet in thickness on outcrop, averages 20 feet, and has a maximum subsurface thickness of 65 feet in Posey County. It rests unconformably, according to some opinion (for example, Perry and Smith, 1958, p. 32-33, 36), on the Ste. Genevieve Limestone, and it is associated with that formation in the outcrop belt extending from Crawford and Harrison Counties, on the Ohio River, to central Owen County, where the Bethel Formation cuts at the Paoli (Malott, 1952, p. 45-49), and to west-central Putnam county, where Pennsylvanian rocks overlap the Paoli. Thus the Paoli overlain unconformably along much of its outcrop, even in part of the area where the Bethel lies next above. (See Perry and Smith, 1958, 36-37.)

Correlation: The Paoli is correlated approximately with the middle and upper parts of the subsurface Renault Formation of western Indiana and, in the Illinois standard section, with the ascending sequence consisting of the Shetlerville Member of the Renault, the Yankeetown Sandstone, and the Downeys Bluff Limestone (Pinsak, 1957, p. 17-18; Gray, Jenkins, and Weidman, 1960, p. 36; Swann, 1963, p. 32-33, 51, 77), although at times it has been correlated with the lower part of the Renault of southwestern Illinois. Shetlerville-equivalent rocks are thought to extend to the middle shale break, a determination borne out by conodont ratios of *Cavusgnathus*, *Gnathodus*, and *Spathognathodus* (Rexroad and Liebe, 1962).

The Paoli of Indiana contains the crinoid *Talarocrinus* (Malott, 1952, p. 12), and on this basis it has been correlated with the lower part of presumably post- *Platycrinites penicillus* rocks in the *Talarocrinus* Range Zone of other areas, for example, with a part of the
Gasper Oolite of Butts (1917, p. 64) in Kentucky. (See Cumings, 1922, p. 515, 518; Perry and Smith, 1958, p. 30-31; and Swann, 1963, p. 33, 83.)

**Parker Coal Member**, Patoka Formation, CEW  
Pennsylvanian System

*Type locality:* The name Parker Coal was used by Fuller and Clapp (1904, p. 2) for a coal exposed near Parkers Settlement in Posey County. A discrepancy concerning the stratigraphic position of the coal exists between Fuller and Clapp’s text and columnar section, which has created some confusion in the literature. This coal is a few feet below the Parker Limestone of Fuller and Clapp (Shoal Creek Limestone Member of present usage). Wier (in preparation) assigned this coal member rank in the Patoka Formation and designated the type locality in the NW¼ SE¼ sec. 30, T. 5 S., R. 11 W., which is near the Posey-Vanderburgh county line in Vanderburgh County.

*Description:* The Parker Coal Member is a bright-banded coal, 0.5 to 1.7 feet thick, overlain by 1 to 3 feet of black shale and underlain by underclay. In places it is represented by streaks of coal in black shale. Parker coal is thickest in Posey, Vanderburgh, and Gibson Counties, where it lies 190 feet above the West Franklin Limestone Member of the Shelburn Formation. This coal is thin or absent and is not generally recognized in western Knox County and western Sullivan County.

**Patoka Formation**, McLeansboro Group, CEW  
Pennsylvanian System

*Type area:* The name Patoka Formation was first used in a stratigraphic column by Wier and Gray (1961) following Wier (in preparation). The type area includes numerous exposures of parts of the formation along the tributaries of the Patoka River near Patoka in Gibson County. Other good exposures are along the tributaries of White River near Hazelton.

Rocks now recognized as belonging to the Patoka Formation were called the Merom Group in southern Indiana by Logan (1932) and were included in part of the Shelburn Group of Cumings (1922).
**Rock-Unit Names**

*Description:* The Patoka Formation is a southward-thickening unit of ale, sandstone, clay, limestone, and coal. The formation encompasses, in ascending order, the Ditney Coal, Inglefield Sandstone, Hazelton Bridge Coal, Vigo Limestone, Dicksburg Hills Sandstone, Raben Branch, and Parker Coal Members and includes unnamed beds of shale, clay, and sandstone. Shale and sandstone make up more than 5 percent of the formation. The formation ranges in thickness from 100 feet in northern Sullivan County to 310 feet in southwestern Posey County.

**Pendleton Sandstone**, Ulsterian Series, AMB & JBP

*Devonian System*

*Type Section:* The Pendleton Sandstone was named by Cox (1869, p. 7) for Pendleton, Madison County, where a soft white sandstone was exposed at the falls of Fall Creek in sec. 16, T. 18 N., R. 7 E. Damming of the stream since then has resulted in partial obscuring of the section.

*Description:* At the type section, the Pendleton Sandstone is a bluish-drab fine-grained calcareous sandstone in its lower part and a massive white fossiliferous calcareous sandstone in its upper part. A conglomerate is reported at the top at the type section. The unit is 15 feet thick and is overlain by a sandy Devonian limestone (Jeffersonville Limestone?) and underlain disconformably by the Mississinewa Shale Member of the Wabash Formation (Silurian). Other good exposures of the Pendleton Sandstone are unknown; however, the unit is reported in scattered drilling records in many other Indiana counties. (See Logan, 1931.) Many of these reports probably are of discontinuous sand zones that are commonly found in the Jeffersonville Limestone and the Detroit River Formation and that are not necessarily contiguous with the type Pendleton, and some reports may even be for sandy lenses that are common in some northern counties in uppermost Silurian rocks.

*Correlation:* Hall (1879a, p. 60), considering the faunal evidence, correlated the Pendleton with the Schoharie Sandstone of New York, but Sutton (1944) regarded it as correlative with the basal part of the
Jeffersonville Limestone and with the Geneva Dolomite. It is possibly correlative with the Dutch Creek Sandstone of Illinois.

**Peoria Loess Member, Atherton Formation, WJW**

Pleistocene Series

*Type locality:* Leverett (1898, p. 246; 1899, p. 185-190) designated exposures east of Peoria in Tazewell County, Ill., particularly along Farm Creek and the Toledo, Peoria and Western Railway, as those best illustrating the so-called “Peorian soil.” Leighton (1926, 1931) regarded a cut along Farm Creek 7 miles east of Peoria as a type exposure of the Peorian [sic] loess.

*Description:* The Peoria Loess Member of the Atherton Formation in Indiana consists almost entirely of yellowish-brown calcareous massive barren to fossiliferous silts that were deposited by wind currents. Although the member is present throughout most of southern Indiana only as a very thin surficial veneer, it is thick enough to have stratigraphic significance in a zone a few miles wide along the Wabash and Ohio Valleys and, to a lesser extent, along the White and Whitewater Rivers. Its maximum thickness in Indiana probably is about 50 feet.

The Peoria loess overlies the Jessup Formation along the Wabash Valley, but it overlies the Loveland Loess Member of the Atherton Formation along the Ohio Valley. In the unglaciated parts of southern Indiana it also lies upon soils derived from Paleozoic bedrock units. Within and beneath the Trafalgar Formation, it splits into two or more tongues.

*Correlation:* The Peoria Loess Member is a unit of Wisconsinan age that interfingers with all other facies of the Atherton Formation in Indiana. The term Peorian originally was proposed for a unit of geologic time between the Iowan and Wisconsinan glacial ages as they were then (Leverett, 1898, 1899) understood. The term came to be used for a body of loessal silt that was thought to have been deposited during the “Peorian period of deglaciation.” Even though the hypothesis that loessal silts represent interglacial deposits has been abandoned and the original time concept of the Peorian deglaciati...
not be demonstrated after more detailed studies of the type sections ad been made (Leighton, 1926, 1931), the name remained for the silt body, so that the Peoria(n) now is a firmly established stratigraphic unit.

(See “Atherton Formation” for information on the fossil beds in the Peoria.)

**Perth Limestone Member, Staunton Formation, HCH**

*Pennsylvanian System*

*Type section:* The Perth Limestone Member was named by Hutchison (1960, p. 19-21) for exposures in the abandoned strip mine in the SW¼NE¼ sec. 3, T. 13 N., R. 7 W., near Perth, Clay County. Here and in adjacent counties, this limestone earlier had been known as the Minshall Limestone, and the name Minshall had also been mistakenly applied to other limestones as well as to coals. This limestone lies 0.2 foot to 15 feet above the Minshall Coal Member.

*Description:* At the type locality, the limestone is gray, hard, argillaceous, and fossiliferous. It weathers brown and contains a 2-foot medial band of blue hard fossiliferous vuggy chert. The limestone is not continuously present and varies considerably in character and in thickness, from 0.5 foot to 19 feet. Where absent, its position is occupied by gray soft locally calcareous and fossiliferous shale or by gray to brown fine- to medium-grained locally calcareous sandstone.

*Distribution and correlation:* The Perth or a limestone of similar stratigraphic position has been recognized from central Warren County southward to the Ohio River. In southern Indiana the Perth seems to correspond closely to the limestone above the Buffaloville Coal Member, and drilling records indicate that a limestone of similar or identical position is present in the subsurface of most of the Counties of southwestern Indiana.

Understanding of Perth correlation is complicated by the substitution of this name for the ambiguously used term Minshall, and in guise of the older name, the Perth has been correlated as low as the Lead
Creek Limestone and as high as the Curlew Limestone of western Kentucky. And in interpolating from the Minshall to the Perth, one cannot ascribe all the listed Minshall fauna to the Perth. For example and contrary to several published reports, the Perth (old Minshall in part) lies below the lowest position of the fusulinid *Wedekindellina*, which is found in what at times has been called the Minshall Limestone (Thompson and Shaver, 1964, p. 21, and oral communication, 1965). The Perth of this report, however, and the limestone above the Buffaloville Coal Member do mark the lowest known Indiana positions of *Fusulinella* and of the ostracod fauna characterized by *Amphissites centronotus* and *A. girtyi*, and it is a limestone close above the highest known *Profusulinella* and ostracods of the *Amphissites rothi* fauna. Collectively, the Perth microfauna is generally similar to that in the Seville Limestone Member of western Illinois, the Lower Mercer Limestone of Ohio, and the Curlew Limestone of western Kentucky. But a Kentucky limestone that is also a possible correlative is the unnamed limestone, possibly lower than the Curlew, containing *Fusulinella* and associated with the Lewisport Coal that was mined near Lewisport, Daviess County, Ky. Altogether, an early Desmoinesian age in Midcontinent terms seems most probable for the Perth. (See Crider, 1913; Wanless, 1962, p. 31, 35; Thompson and Riggs, 1959, p. 772-774; and Thompson and Shaver, 1964.)

**Petersburg Formation, Carbondale Group, AMB & CEW**

Pennsylvanian System

*Type area and reference section:* The name Petersburg, taken from Petersburg, Pike County, by Fuller and Ashley (1902, p. 2), was used for a coal in that area as well as for a formation consisting of the rocks between the base of their Petersburg Coal and the base of the Millersburg Coal. Cumings (1922, p. 529) extended this formation to include “the interval from the disconformity over Coal IV to the disconformity over Coal III,” but Wier (1950, 1952, and in preparation) has restricted the formation, so that now the Petersburg includes only the rocks between the top of the Survant Coal Member (IV) of the Linton Formation and the top of the Springfield Coal Member (V).
A reference section for this formation can be seen in the core taken from Indiana Geological Survey drill hole 81 (core 228 on file in the Survey core library), which was bored 4 miles northeast of Petersburg in the NE 4 NE 4 NE 4 sec. 7, T. 1 N., R. 7 W.

**Description:** Three named members, in ascending order, the Houchin Creek Coal (IVa), the Stendal Limestone, and the Springfield Coal (V) Members, and unnamed beds of shale, sandstone, and underclay are included in the Petersburg Formation. This unit ranges from 70 to 193 feet in thickness. Occupying a middle position in the Carbondale Group, the Petersburg is underlain by the Linton Formation and overlain by the Dugger Formation and crops out from the Ohio River in Warrick County to Vermillion County in westernmost central Indiana.

**Pinnick Coal Member, Mansfield Formation,**

Pennsylvanian System

**Type section:** The term Pinnick Coal was first used by Franklin (1939, p. 9-10) for the coalbed exposed in a small mine opening west of Thomas Pinnick’s house in the SE 4 SW 4 sec. 32, T. 2N., R. 2W., Orange County. The coal was given the rank of member in the Mansfield Formation by Gray, Jenkins, and Weidman (1960, p. 26).

**Description:** The Pinnick Coal Member at the aforementioned mine was described by Franklin as shiny, blocky, and 2.1 feet thick. Generally this coalbed is less than 1 foot thick and is difficult to trace. The roof of the coal is carbonaceous shale or massive medium-grained ferruginous sandstone. The floor is underclay. The Pinnick coal lies immediately above the Hindostan Whetstone Beds, and in the area where it is thickest, it is some 50 to 150 feet above the base of the Mansfield Formation (Gray, Jenkins, and Weidman, 1960, p. 24).

The Pinnick has been recognized in northwestern Orange County, southeastern Martin County, and northeastern Dubois County. Correlation with other named coalbeds in the Mansfield Formation to the north or the south has not been established.
*Pirtle Coal Member, Shelburn Formation, \textit{CEW}

\textbf{Pennsylvanian System}

\textit{Type section:} The Pirtle Coal Member of the Shelburn Formation was named by Wier (in preparation) for exposures of Ashley's (1899) Coal VIIa near the Pirtle Cemetery in secs. 15 and 27, T. 8 N., R. 8 W., Sullivan County. The type section is in the SE\textsuperscript{1/4}SE\textsuperscript{1/4}SW\textsuperscript{1/4} sec. 15, T. 7 N., R. 8 W.

\textit{Description:} The Pirtle Coal Member is thickest in Sullivan County and in northern Knox County, where the coal is bright banded and shaly in places. It averages 1 to 1.5 feet in thickness and lies more than 60 feet above the Danville Coal Member (VII) of the Dugger Formation. The Pirtle coal is very thin or absent in Vigo and Vermillion Counties. It is rarely seen in outcrop in Gibson and Posey Counties, but it can be recognized on most electric logs (Wier, in preparation).

\textbf{Prospect Formation, Pliocene? and Pleistocene Series, \textit{WJW}}

\textit{Quaternary System}

\textit{Type section:} The type section of the Prospect Formation is a road cut exposure along U.S. Highway 150 in the SW\textsuperscript{3/4}NE\textsuperscript{3/4} sec. 27, T. 2 N., R. 2 W. (French Lick Quadrangle) at Prospect in Orange County (Wayne, 1963, p. 43).

\textit{Description:} The Prospect Formation is composed of sandy and gravelly silts, generally yellow brown to orange brown. The sediments are unconsolidated, and where at the surface and weathered, they exhibit a zonal soil profile. Thickness of the formation is variable because it is bounded by erosional unconformities at both top and bottom; generally, however, its thickness ranges from about 3 to 15 feet. The unit is discontinuous and has been found primarily on abandoned floodplains preserved as strath terraces in the unglaciated part of Indiana. It may overlie almost any older rock and has been recognized in section beneath the Butlerville Till Member of the Jessup Formation and related sediments of the Atherton Formation.

\textit{Correlation:} The Prospect Formation may be a composite unit of
more than one age because it is partly old alluvium of streams that have entrenched their valleys to a lower level. Most of the abandonments of valley flats of this type in Indiana probably are Sangamonian in age or older.

**Providence Limestone Member, Dugger Formation, AMB & CEW**

*Pennsylvanian System*

*Type area:* The name Providence Limestone was first used by Glenn (1922, p. 98) in describing exposures of a 1- to 4-foot limestone bed near Providence, Webster County, Ky. This limestone had been called the Main Newburg Limestone in Indiana by Owen (1839, p. 40), but Wier (in preparation) accepted the term Providence Limestone Member because of the more general use of this name in the state.

*Description and correlation:* The Providence Limestone Member of the Dugger Formation lies stratigraphically between the Herrin and Hymera Coal Members. It is actually a sequence of one to five beds of blue-gray to brown finely crystalline fossiliferous limestone and intervening shales. The unit, including the shales, is more than 50 feet thick in some places but more commonly is about 20 feet thick. Limestones in only a few places make up more than 20 feet of this interval, and most of them are about 5 to 10 feet thick. Fusulinids, including *Fusulina girtyi*, the coral *Chaetetes*, brachiopods, and crinoid columnals have been found in this limestone in Pike and Warren Counties. A thin coal is present between two of the limestone beds at one locality in Posey County.

The Providence is thick in Warrick, Pike, and Gibson Counties but is thin or absent north of these counties. The lowest limestone bed is correlated with the Brereton Limestone Member in southern Illinois (Wier, in preparation).

**Raben Branch Member, Patoka Formation, CEW**

*Pennsylvanian System*

*Type locality:* The name Raben Branch was first used for exposures of a thin coalbed along the small stream of Raben Branch in the SE1/4
Description: The Raben Branch Member, a thin coal or smut streak about an inch thick lying on a thin underclay, is a persistent marker bed in Vanderburgh and Posey Counties. This unit is overlain by a thin sideritic clay containing numerous shells and imprints of the conchostracan *Estheria*. The Raben Branch lies 20 feet below the Parker Coal Member and 1 to 5 feet above the Dicksburg Hills Sandstone Member, both of the Patoka Formation.

*Raccoon Creek Group*, Pottsvillian and Alleghenian Series,
CEW

Pennsylvanian System

Type area: The term Raccoon Creek Group was first used by Wier and Gray (1961) in a generalized columnar section, and Wier (in preparation) proposed this name for those lower Pennsylvanian rocks that crop out along Raccoon Creek in southern Parke County, in T. 14 N., Rs. 6, 7, and 8 W., and T. 15 N., R. 8 W.

Description: The Raccoon Creek Group includes, in ascending order, the Mansfield, Brazil, and Staunton Formations, is overlain by the Carbondale Group, and is underlain by rocks ranging in age from middle Devonian to late Mississippian.

Shale and sandstone comprise more than 95 percent of the group, and clay, coal, and limestone make up nearly all the remainder; small amounts of chert and sedimentary iron ore are present in the lower part of the group. Shale is more common than sandstone, and most of it ranges from light gray to dark gray and from soft nonsilty shale to hard silty and sandy shale; a small amount of black fissile shale is also present. The sandstone is mostly fine grained and coarse-grained size is rare. Where the sandstone is present in the subsurface, massive crossbedded sandstone seems to be most common. Except for the Seelyville Coal Member, which is at the top of the Raccoon Creek Group, the clays, coals, and limestones are lenticular and discontinuous.
ROCK-UNIT NAMES

The Raccoon Creek Group generally thickens toward the southeast but in some places has thickness variations of approximately 100 feet because of irregular unconformity on the surface of underlying rocks. It ranges in thickness from less than 100 feet in some locations in Parke and Vermillion Counties to more than 900 feet in Posey County. It crops out in southwestern Indiana along the easternmost margin of Pennsylvanian rocks.

Correlation: The Raccoon Creek Group correlates with the McCormick Group and the lower part of the Kewanee Group in Illinois and with the Caseyville and Tradewater Formations in western Kentucky. (See also “Correlation” under “Mansfield Formation,” “Brazil Formation,” and “Staunton Formation.”)

Ramp Creek Limestone Member, Muldraugh Formation, AMB
Mississippian System

Type section: Stockdale (1929b) proposed the name Ramp Creek Member for variably siliceous and argillaceous limestone in his Lower Harrodsburg Limestone. Twenty-one feet is exposed in the type section at the east line of the NW¼NW¼sec. 35, T. 8N., R. 1 W., 1¼ miles northeast of Sanders, Monroe County. Smith (1965) called this unit the Ramp Creek Limestone Member and reassigned it to the Muldraugh Formation of the Borden Group because it forms a sequence of alternating carbonate and noncarbonate rocks related to the Borden Group rather than to the overlying Harrodsburg Limestone as restricted by Smith.

Description: Hopkins and Siebenthal (1897) applied the name “beds of passage” to the rocks now recognized as the Ramp Creek Limestone Member because they appeared to span the gap between the predominantly noncarbonate rocks of the Osage Series and the carbonate rocks of the Meramec Series. As the uppermost member of the Muldraugh Formation, the Ramp Creek is overlain by the Leesville Member of the Harrodsburg Limestone and is a unit of siliceous cherty echinodermal geode-bearing limestones interbedded with calcareous shales and siltstones. It is not mappable over wide areas.
and especially in Harrison County is found laterally adjacent to the Edwardsville Member, which generally is seen only in underlying relationship. The Ramp Creek, which ranges from 17 to 28 feet in thickness, is well exposed in Harrison County but thins northward as the Edwardsville Member thickens. (See Smith, 1965.)

**Correlation:** Ramp Creek rocks, or what have been presumed to be correlative rocks in Indiana, have abundant geodes and thus have been called the Geode Bed, a term that was used in some of the early classifications of Mississippi Valley rocks for the geode-bearing bed between the Keokuk and Warsaw Limestones. The Ramp Creek has been considered to be partly equivalent to both the Keokuk (Stockdale, 1939, pl. 6) and Warsaw (Stockdale, 1931, pl. 2) as well as to an upper part of the geode-bearing Fort Payne Limestone (Chert) of the southeastern United States.

**Red Bridge Limestone Bed, Liston Creek Limestone Member, RHS**

Silurian System

*Type section and description:* The Red Bridge Limestone Bed was named by Cumings and Shrock (1927, p. 74) as a formation and later (Cumings and Shrock, 1928a, p. 72) was regarded as a member for 1 to 6 feet of light-colored fine-grained glauconitic dolomitic limestone that commonly weathers reddish brown and appears as a single bed on outcrop. The type section is at Red Bridge in the bluff of the Mississinewa River, Wabash County (south-central part of Reserve 26, T. 26 N., R. 6 E.), and the unit is recognized essentially only in Wabash County at the very base of the Liston Creek Limestone Member.

Pinsak and Shaver (1964, p. 39) reduced the rank to that of bed to agree with their nomenclatural handling of the Liston Creek.

**Reelsville Limestone, West Baden Group, HHG**

Mississippian System

*Type section:* The Reelsville Limestone was named by Malott (1919, p. 10-11) for exposures of a gray biomicritic somewhat ferruginous
locally sandy limestone near Reelsville, Putnam County. Later he designated a type section on the south bluff of Walnut Creek, immediately south of Reelsville (near the center of sec. 21, T. 13 N., R. 5 W.) (Malott, 1952, p. 26-27).

Description: Characteristically the Reelsville is a single bed which is much as 10 feet thick but which is absent from many places (Indiana Geological Survey, 1957, pl. 2). Gray and Perry (1956) concluded that the absence of the Reelsville is not as a rule the result of erosion, but of nondeposition. In the southern part of the outcrop area are many places where two or three beds of limestone separated by 10 to 20 feet of shale occupy this stratigraphic position. Ross (1962) concluded that the lowermost bed in such exposures is the Reelsville. The Reelsville Limestone crops out from southwestern Putnam County southward to the Ohio River and is recognized in the subsurface from Parke County southwestward. The Reelsville conformably overlies the Sample Formation and is overlain conformably by the Elwren Formation or disconformably by the Mansfield Formation (lower Pennsylvanian).

Correlation: The Reelsville Limestone was considered by Malott (1931, p. 222) to be equivalent to the lower part of the Paint Creek Formation of southwestern Illinois; later it was shown to represent the upper part of the Paint Creek (Swann and Atherton, 1948). The term Paint Creek has now been abandoned for the Illinois standard section (Swann, 1963), and the name Reelsville has been adopted, with member status, as the upper part of the Ridenhower Formation Swann, 1963, p. 35).

Renault Formation, Blue River Group, AMB
Mississippian System

Type locality and reference section: The Renault Formation was named by Stuart Weller (1913) for exposures in Renault Township, Monroe County, Ill., but he designated no type section in this area. Warm (1963, p. 79) designated a reference section on the south side of Dry Fork in the type area (SE¼SW¼ sec. 23, T. 4 S., R. 9 W.).
Description: The Renault Formation in Indiana is recognized only in the subsurface, where it overlies the Aux Vases Formation conformably and is overlain conformably by the Bethel Formation or unconformably by rocks of Pennsylvanian age. According to Puscas (1953), it consists principally of tan dense limestone and creamy white oolitic limestone. A thin dark-gray calcareous shale generally forms the middle part of the formation. The Renault ranges from a few to 30 feet in thickness.

Correlation: Spanning the Valmeyeran-Chester boundary, the Renault is equivalent to the Paoli Limestone and at least the upper part of the Levias Member of the Ste. Genevieve Limestone of Indiana outcrop terminology and is equivalent to the Downeys Bluff Limestone, the Yankeetown Shale, and the Renault Limestone of Illinois. (See Swann, 1963.)

*Riverview Limestone Member, Bond Formation, CEW

Pennsylvanian System

Type section: The Riverview Limestone Member of the Bond Formation was named by Wier (in preparation) for exposures of a thin limestone at the northeast edge of Riverview, Sullivan County, in the SW¼SE¼ sec. 24, T. 9 N., R. 11 W.

Description: The Riverview Limestone Member is one bed, 0.3 to 0.8 foot thick, of medium- to dark-gray argillaceous gastropod-rich limestone. It lies 40 feet above the Fairbanks Coal Member in the type area and is directly underlain by black shale and an unnamed thin discontinuous coalbed. The limestone is best exposed in the type area and near New Harmony in northwestern Posey County.

Rockford Limestone, Kinderhookian and Valmeyeran Series, CBR

Mississippian System

Type section: Owen and Norwood (1847, p. 5) first used the term Goniatite Limestone at Rockford, Jackson County. Through usage the name Rockford became associated with the goniatite-bearing limestone, and the fossiliferous exposure in the bed of the East Fork
White River at Rockford became accepted as the type section. This exposure is in the SW¼SE¼ sec. 6, T. 6 N., R. 6 E. Wilmarth (1938, 1828) credited Meek and Worthen (1861, p. 167) with formalizing the name Rockford Limestone.

Description: Limestone dominates the lithology of the formation, but shale, siltstone, and dolomite may be present. The limestone is typically gray, fine grained, argillaceous, ferruginous, and sparingly fossiliferous. It has a characteristic green mottling and weathers to a rusty brown. It may be argillaceous or dolomitic, particularly in the upper part to the north. Crinoidal debris and other fossils, such as the cephalopods, may be concentrated in places. To the north thin gray-green shales are interlaminated with the limestones. In several exposures in southern Indiana an upper unit of bluish-gray to yellowish-brown shale containing calcareous nodules is present.

The Rockford is exposed in a belt extending northward from the southernmost exposure in New Albany, Floyd County, to a point a short distance north of Rockford. From this area the outcrop belt forms a northwestward-trending arc to the Indiana-Illinois state boundary at the southwest corner of Benton County. Exposures are not found along this part of the belt but are present just to the north in an outlier in Benton and Jasper Counties. The Rockford is present in the subsurface of most of the state west and south of the outcrop belt. In southern Indiana thickness is commonly 2 or 3 feet, and maximum thickness is more than 4 feet. The greatest recorded thickness is about 22 feet in the northern area (Melhorn, 1958, p. 196).

The Rockford Limestone overlies the New Albany Shale with apparent conformity. It is in turn overlain by the New Providence Shale with apparent conformity in northern Indiana but unconformably in southern Indiana.

Correlation: Historically, age assignment of the Rockford Limestone has ranged from middle Devonian to middle Mississippian. Conodont studies (Rexroad and Scott, 1964) show that it includes strata of both the Kinderhookian and Valmeyeran Series. The part of Kinderhookian age (in the Siphonodella isosticha-S. cooperi Assemblage
Zone) correlates with the upper part of the Chouteau Limestone of the Mississippi Valley; the part of Valmeyeran age (in the Gnathodus semiglaber-Pseudopolygnathus-multistriata Assemblage Zone) with the so-called “Sedalia” Formation of Illinois. This amplifies the generally accepted correlation based on cephalopods from only a part of the formation. Lineback (1963) inferred that the Rockford cephalopod fauna is present principally in the earliest Valmeyeran portion of the Rockford in “the rubbly nodular zone above the main massive beds.” The cephalopod Protocanites lyoni (Meek and Wortman), which is present in the Rockford, is found in the Chouteau Limestone and Northview Shale of the Mississippi Valley standard section and has a circumpolar distribution in the Northern Hemisphere in rocks of late Tournaisian age (Tn3c) (Miller and Collinson, 1951, p. 481; Gordon, 1964, p. 283-284).

**Rosiclare Member**, Ste. Genevieve Limestone, Mississippian System

*Type locality and use of name in Indiana:* The Rosiclare Sandstone Member was named by Ulrich and Smith (1905, p. 24, 39, 40) for exposures in the Ohio River bluffs in the SE¼ sec. 5, T. 13 S., R. 8 E., near Rosiclare, Hardin County, Ill., and introduced into Indiana by Malott (1945, p. 1180; 1946, p. 323), who cited exposures at Cataract Falls in the NE¼SE¼ and SE¼NE¼ sec. 35, T. 12 N., R. 4 W., Owen County. The term is applied, as the Rosiclare Member in Indiana, to limestone, shales, and calcareous sandstones found approximately in the middle part of the Ste. Genevieve Limestone.

*Description:* The Rosiclare of the Indiana outcrop commonly consists of a few inches to a few feet of coarse-grained thin-bedded silty or sandy limestone containing some shale. The Rosiclare also consists of sandy oolitic limestone, shale, or thin argillaceous sandstone and in places contains limestone conglomerate and breccia. In and north of Monroe County, the Rosiclare commonly is medium-grained calcareous quartz and chert sandstone that is markedly crossbedded, is in lenses of small areal extent, and is as much as 40 feet thick.
Correlation: Although Malott (1945, p. 1180; 1946, p. 322-326) correlated his Rosiclare with the classic Rosiclare Sandstone Member of Ulrich and Smith (1905, p. 24, 39-40), Pinsak (1957, p. 22) considered through subsurface study that the Rosiclare of the Indiana outcrop lies below the classic Rosiclare and correlates with some of the type Fredonia of Ulrich and Smith. Swann (1963, p. 27, 49, 51, 80) agreed; he considered that the name Rosiclare of Ulrich and Smith and many others is nearly synonymous with the term Aux Vases of the Illinois standard section and that the Rosiclare of Malott and the Indiana outcrop correlates with the Spar Mountain Sandstone Member, below the Aux Vases, of the Ste. Genevieve of southern Illinois. Following these correlations, the name Rosiclare is poorly used in Indiana.

Ste. Genevieve Limestone, Blue River Group, NMS
Mississippian System

Type locality and use of name in Indiana: The Ste. Genevieve Limestone was named by Shumard (1860, p. 406; 1873, p. 293-294) for exposures in the Mississippi River bluff south of Ste. Genevieve in Ste. Genevieve County, Mo., but the name remained mostly suppressed in favor of the term St. Louis Limestone. The name was revived by Ulrich and Smith (1905), and although Beede and others (1915, p. 207), had suggested that rocks of Ste. Genevieve age are present in Indiana, it remained for Cumings (1922, p. 507) to use the name directly in Indiana. Prior to that time, Ste. Genevieve rocks had been assigned variously to the Mitchell Limestone (see under “Blue River Group”) and to the Paoli and St. Louis Limestones. As proposed by Cumings, the Ste. Genevieve extended no lower than the Lost River Chert Bed. Its present lower boundary, as much as 37 feet below the Lost River, established by Malott (1932, p. 291, 315). (See also Bates, 1932, p 268, and McGrain, 1943, p. 158-159.) Gray, Jenkins, and Weidman (1960, p. 48) assigned the Ste. Genevieve to the middle part of the River Group.

Description: The Ste. Genevieve Limestone in Indiana is a carbonate sequence that is 60 to 170 feet thick and that thickens southward and
southwestward. Its constituent beds are composed largely of microcrystalline calcite, fossil debris, oolites, pellets of limestone, and scattered grains of quartz. Zones of nodular chert also are present as are subordinate beds of dolomitic limestone, dolomite, argillaceous limestone, sandy limestone to calcareous sandstone, conglomerate, breccia, shale, and silicified limestone. The Ste. Genevieve of Indiana outcrop has been divided into three parts called, in ascending order, the Fredonia, Rosiclare, and Levias Members. The Lost River Chert Bed is a prominent marker in the Fredonia, and the Bryantsville Breccia Bed marks the top of the Levias throughout the outcrop of the formation in Indiana.

The Ste. Genevieve Limestone crops out in a northward-narrowing belt from the Ohio River in Harrison and Crawford Counties to west-central Putnam County. It is present throughout the Indiana subsurface south of the central parts of Parke and Vermillion Counties and west of its outcrop belt (Pinsak, 1957, p. 18), but in the subsurface its upper equivalents are assigned to the Renault and Aux Vases Formations. The Ste. Genevieve-Chesterian boundary is an unconformity, and in places in Owen County the Bethel Formation rests on the Levias Member. (See Perry and Smith, 1958, for evidence and references.) North from central Putnam County the Ste. Genevieve is overlapped by Pennsylvanian rocks. Opinion on the St. Louis-Ste. Genevieve boundary in Indiana, partly for different points of observation, ranges from one of unconformity (Bates, 1932, p. 268) to one of transition (Perry, Smith, and Wayne, 1954, p. 30).

**Correlation:** The Ste. Genevieve, conventionally considered as the uppermost formation of the Meramecian and Valmeyeran Series, generally is correlated with the type Meramecian rocks in Missouri by means of the crinoid *Platycrinites penicillus* and, less so, by means of the brachiopod *Pugnoides otturnwa* and the coral *Lithostrotion harmodites*. These species, however, are not restricted to the Ste. Genevieve as the formation is now everywhere defined, and at times the independent application of either paleontologic or lithologic criteria has resulted in inconsistent recognition and correlation of the Ste. Genevieve and associated formations. (See Weller, 1920b, p. 96;
The lower part of the Ste. Genevieve of Indiana outcrop is thought to correlate in a general way with the Ste. Genevieve deeper in the Illinois Basin, and the upper part corresponds to the Aux Vases Formation of the basin. (See also the named members herein.)

Much of the stated Ste. Genevieve correlation is based on observed coextension of rock units; presuming that the rock units are well defined, the time relations remain more in doubt, and time transgression of the Ste. Genevieve and its members is a distinct possibility. For example, the St. Louis-Ste. Genevieve boundary in the Mississippi Valley corresponds to the boundary between the conodont-based *Apatognathus? geminus-Cavusgnathus* and *Gnathodus bilineatus-Cavusgnathus characta* Assemblage Zones (Collinson, Scott, and Rexroad, 1962, p. 17, 24-25), but in the Springville Quarry, Lawrence County, this zonal boundary lies above the Fredonia as designated by Perry, Smith, and Wayne (1954, p. 25-30). (See Rexroad and Collinson, 1963, p. 7.) In the Bloomington Crushed Stone Co. quarry, Monroe County, this zonal boundary is 71 feet above the base of the conventional St. Louis-Ste. Genevieve contact (Burger and others, 1966, p. 38-39).

**St. Louis Limestone**, Valmeyeran Series, Mississippian System

*Type area and use of name in Indiana:* The name St. Louis Limestone was first used broadly by George Engelmann (1847, p. 119-120) with reference to the uppermost beds of Carboniferous limestone exposed in eastern Missouri and southern Illinois. For some time, later use was mostly in a group sense for limestone exposed at St. Louis, Mo. Present-day use stems from Ulrich's (1904, p. 103) restriction of the name, based on exposures near St. Louis, to the limestone between the Spergen Limestone (now called the Salem) below and the Ste. Genevieve Limestone above.
Early applications, or correlations, of the name in Indiana also included parts of what is now the Salem Limestone (Hopkins and Siebenthal, 1897, p. 299) and the Ste. Genevieve Limestone (Cumings, 1922, p. 507). The Mitchell Limestone as proposed by Elrod (1899, p. 258-267) was nearly coincident with the St. Louis of Cumings (1922, p. 506-508). Beede and others (1915, p. 207), noting that certain Indiana rocks have affinities with those of the St. Louis area, nevertheless assigned rocks now included in the St. Louis, Ste. Genevieve, and Paoli to the Mitchell (see under “Blue River Group”). Present restriction of the name in Indiana to rocks between the Salem and the Ste. Genevieve as defined here apparently stems from Malott (1932, p. 291, 315, fig. 7), although the criteria remained to be set forth by Bates (1932, p. 268) and McGrain (1943, p. 158-159). Few vertically extensive exposures and no reference sections exist in the state.

Description: From criteria developed in subsurface studies by Pinsak (1957, p. 23-24), the St. Louis Limestone of Indiana is divisible into two parts. The lower part generally is drab-gay, tan, and brown microcrystalline thin-bedded dolomitic limestone that contains silt-to sand-size quartz grains and clay. Black, gray, and greenish shales commonly are intercalated. Apart from isolated lenticular concentrations of algae and other fossils, the lower part has extensive deposits of gypsum and anhydrite (McGregor, 1954a, pl. 2); in places northward from Owen County to Montgomery County, the lower 10 to 40 feet contains many discontinuous beds and thick lenses of breccia that consists of fragments of gray limestone in a matrix of greenish-gray shaly and sandy carbonate rock.

The upper part of the St. Louis Limestone is coarser grained and contains fewer and thinner shales than the lower part but has the same drab-gray, tan, and light-brown colors and thin bedding. Much light-gray or bluish-gray brittle chert in nodules, small lenses, and thin beds is characteristic. Pelletoid limestone, often described as oolitic, is common and resembles oolitic limestone in the overlying Ste. Genevieve Limestone, which adds to the difficulty of distinguishing the two formations.
The St. Louis is underlain conformably by the Salem and overlain by the Ste. Genevieve disconformably, according to some opinion (Bates, 1932, p. 268; McGrain, 1943, p. 162), and transitionally according to other (Perry, Smith, and Wayne, 1954, p. 30). It crops out in a broad belt corresponding to the Mitchell Plain that extends from the Ohio River to northeastern Parke County, where it is overlapped by Pennsylvanian rocks. Eighty-five feet thick in Putnam County, it thins southward to about 60 feet in Owen County (Gates and Melhorn, in preparation) and from there thickens to about 150 feet in Washington County (Sunderman, 1968) and to 205 to 275 feet in Harrison County (McGrain, 1943, fig. 2). Its maximum subsurface thickness is about 400 feet in western Posey County. Most of the thickening and thinning appears to take place in the lower part of the formation (Pinsak, 1957, p. 23).

**Correlation:** By means of the corals (*Lithostrotion proliferum, Lithostrotionella castelnaui, and L. hemisphaerica*), the St. Louis of Indiana is correlated with the type St. Louis and with many other middle Mississippian rocks in the continent. The upper part belongs in the *Apatognathus? geminus-Cavusgnathus* Assemblage Zone, which also is found in the upper part of the type St. Louis (Rexroad and Collinson, 1963).

**St. Meinrad Coal Bed, Mansfield Formation, HCH**

Pennsylvanian System

**Type locality:** Franklin and Wanless (1944, p. 87-88) used the name St. Meinrad Coal for the coal mined near St. Meinrad, Spencer County, but cited no specific type section or other exposure. This coal lies stratigraphically 160 to 180 feet below the top of the Mansfield formation and 25 to 50 feet below the Pinnick Coal Member. It is considered here to have the rank of member in the Mansfield Formation.

**Description:** The St. Meinrad Coal Bed consists of moderately bright exceptionally clean semiblocky coal that ranges from less than 0.1 foot to more than 5.0 feet in thickness and that averages about 4.0
feet in thickness where mined. The roof of the coal is dark-gray fissile carbonaceous shale or tan to gray massive medium-grained sandstone. The floor is gray sandy carbonaceous underclay or shale. The coal contains an inorganic parting throughout much of its extent in Perry County (Hutchison, in preparation, b), and in places the upper few inches of the seam is a bone coal.

**Correlation:** Franklin and Wanless (1944) thought that the St. Meinrad corresponds to coals that have been called the Upper Cannelton and Upper Troy Coals along the Ohio River bluff in Perry County, and Ashley (1899, p. 1301) referred to the coal mined along Anderson River in Spencer and Perry Counties south of St. Meinrad as Coal II. Hutchison (1959) mapped the St. Meinrad in a few square miles of northeastern Spencer County and found that the coal appeared to be cut out by sandstone both north and south of this small area. In Perry County, however, Hutchison (in preparation, b) traced the St. Meinrad coal to the Ohio River and found that it is a probable correlative of the Lower Cannelton Coal of Franklin.

**St. Peter Sandstone, Champlainian Series, HHG**

Type area: The St. Peter Sandstone was named by Owen (1847, p. 169) for exposures along the Minnesota River (then called the St. Peter River) in southern Minnesota. For long the name was widely misapplied to many different sandstones. A type section, where the sandstone is 163 feet thick, was established by Stauffer (1934).

Description: This formation is known only from the subsurface in Indiana except for fragmented outcrops in the Kentland structure in Newton County (Wayne, Johnson, and Keller, 1966). In the northwestern part of the state the St. Peter is 135 feet thick; it thins southeastward and is less than 25 feet thick over much of the state (Gutstadt, 1958a, p. 53-56). The St. Peter overlies the Knox Dolomite (Canadian and St. Croixan) and is overlain by the Black River Limestone (Champlainian) in northwestern Indiana and by the Joachim Dolomite (Champlainian) in the remainder of the state.
Correlation: The St. Peter Sandstone has been widely recognized under its own name and is one of the best keys to rock-unit correlation from Michigan to Missouri to Minnesota. It has been established, however, that the unit is time transgressive, and therefore rocks partially time equivalent to the St. Peter of Indiana subsurface are found under other names even in areas where the St. Peter itself is recognized. Thus Gutstadt (1958a, p. 54) equated the Joachim Limestone, Dutchtown Limestone, St. Peter Sandstone, and Everton Formation of southeastern Missouri with the St. Peter of the northwestern Indiana subsurface. Buschbach (1964, p. 23), however, following Grohskopf (1955) and Knight and Koenig (1957) dropped the Dutchtown from his classification, found the Everton to be somewhat older than the St. Peter, and equated the St. Peter (of Indiana) with only the Joachim and St. Peter of Missouri. Illinois equivalents are assigned to the Ancell Group, which includes the St. Peter Sandstone and the overlying Glenwood Formation (Buschbach, 1964, p. 23).

*St. Wendel Sandstone Member, Bond Formation, CEW
Pennsylvanian System

Type section: The name St. Wendells was first published as a formation name in a columnar section by Logan (1932), who apparently followed the terminology and spelling used in C. A. Malott’s field notes and later published (Malott, 1948, p. 132), and who also used the term Bufkin Formation for probably equivalent rocks. The name, defined by Wier (in preparation) as the St. Wendel Sandstone Member of the Bond Formation, was taken from St. Wendel in Posey County near the Vanderburgh county line. Wier designated a type section in the NW¼NW¼SE¼ sec. 19, T. 5 S., R. 11 W.

Description: The St. Wendel Sandstone Member of the Bond Formation is a medium-grained micaceous massive sandstone ranging from 1 to 55 feet in thickness. In some places it directly overlies the Shoal Creek Limestone Member, and in other places it is separated from the Shoal Creek by shale. It is well exposed in bluffs in northern Gibson County and in Knox County. Northward in Sullivan County the
stratigraphic position of the St. Wendel is occupied by shale or thin beds of sandstone and shale.

Salamonie Dolomite, Niagaran Series, Silurian System

Type and reference sections: The Salamonie Dolomite was named for exposures of dolomite in the headwaters area of the Salamonie River near Portland, Jay County, east-central Indiana (Pinsak and Shaver, 1964, p. 24). The type section is the exposure in the Rockledge Products, Inc., quarry and the rocks penetrated by Indiana Geological Survey drill hole 44, cored from the floor of that quarry in the NW¼NW¼ sec. 30, T. 23 N., R. 14 E.; two principal reference sections are the exposures in the H and R Stone Co. quarry near Ridgeville, Randolph County (SE¼SE¼ sec. 12, T. 21 N., R. 13 E.), and the rocks cored in the Northern Indiana Public Service Co. Carl Wyneken No. 1 well near Wallen, Allen County (SE¼SW¼SE¼ sec. 11, T. 31 N., R. 12 E.). The two cores mentioned are in the core library of the Indiana Geological Survey.

Description: In northern Indiana the Salamonie is underlain by the Brassfield Limestone and overlain in most of the area by the Waldron Formation; in the northern two to three tiers of counties it is overlain by the Salina Formation. In northern parts of the state the formation consists characteristically of three parts; in ascending order they are: (1) dolomite and dolomitic limestone that is light gray to tan, dense to fine grained, argillaceous, and commonly cherty; (2) dolomite that is light gray to white, granular, vuggy, very porous, nearly pure, and commonly referred to as reef or reef-detrital dolomite even though reported reef structures at that level are rare or unproven in Indiana (see, however, French, 1967); and (3) limestone and dolomite that is gray, tan, and brown, granular, vuggy, and fairly pure. Some western sections have more limestone than generally is found in eastern sections.

In southeastern Indiana the Salamonie comprises, in its lower part, argillaceous dolomitic limestone and shale as much as 30 feet thick that is assigned to the Osgood Member and, in its upper part, light-
colored commonly cherty dolomitic limestone and dolomite as much is 55 feet thick that is called the Laurel Member. In that part of the state, the formation is underlain by the Brassfield Limestone and Cincinnatian rocks; it is overlain by the Waldron Shale and by Devonian rocks.

The Salamonie is 135 feet thick at the type section, from which the upper part is absent, 90 to 100 feet in places high on and southwest of the Cincinnati Arch in northern Indiana, 180 to more than 200 feet near the Illinois state line in Newton County and in the flanking portions of the Michigan Basin, and less than 100 feet in southeastern Indiana. As the formation was originally defined by Pinsak and Shaver (1964), its Indiana distribution was restricted to the area generally north of the latitude of Indianapolis but now is understood to extend into southern Indiana, where its distribution is that of the Osgood and Laurel Members (French, 1967). Much of the middle and upper parts have been removed by erosion from the area immediately north of Richmond, and the upper part wedges out southward in the central part of the state.

*Correlation:* In northern Indiana the Salamonie Dolomite includes the so-called Osgood-Laurel section of some reports, the type portion of Cumings and Shrock's (1928b, p. 588) New Corydon Limestone, and much of what has been called the Brassfield Limestone; in far northern Indiana it includes the upper part of the Cataract Formation of Cohee (1948). The middle and upper parts of the Salamonie correlate with much of the so-called White Niagaran and Brown Niagaran rocks and also with much or most of the Clinton and undifferentiated Niagaran rocks of the Michigan Basin. In northeastern Illinois the bottom of the Salamonie possibly corresponds to a level within the Kankakee Dolomite, and its top very likely is coextensive with the top of the Joliet Dolomite. The lower and middle parts of the Salamonie of northern Indiana are mostly dolomitic facies of the Osgood and Laurel Members of southern Indiana; in immediately adjacent parts of western Ohio, Salamonie-equivalent rocks are the Dayton Limestone, Osgood Formation, Laurel Limestone, and the Euphemia, Springfield, and Cedarville Dolomites.
The brachiopod *Pentamerus oblongus*, a Salamonie guide fossil, is common and shows, along with many other fossils, that the formation belongs in the lower part of the Niagaran Series, and, in British nomenclature, mostly to the Llandovery Series. In northwestern Indiana a zone of abundant ammodiscid foraminifers, the *Ammodiscus-Thurammina* Assemblage Zone, has been observed by Mound (1968) in places several feet above the base of the formation. In these places at least the lowest part is in Mound’s lowest zone, the *Turritellella* Assemblage Zone. Following common Midwestern and Midcontinent practices, the lowermost, preammodiscid part in that area thus is in an upper part of the Alexandrian Series.

(See Pinsak and Shaver, 1964; French, 1967; and Mound, 1968.)

**Salem Limestone**, Valmeyeran Series, Mississippian System

*Type locality and principal reference section:* A type section was not specifically designated by Cumings (1901, p. 232-233) when he proposed the name Salem Limestone, although a section described by Gorby (1886, p. 143) was quoted and served essentially as a type section. Gorby’s section has been quarried away, but a section at nearly the same place in the Hoosier Lime and Stone Co. quarry (Perry, Smith, and Wayne, 1954, p. 47-49), 0.8 mile west of Salem in the NE¼ sec. 24, T. 2 N., R. 3 E., Washington County, is here designated as the principal reference section. Its contact with the underlying Harrodsburg Limestone is at the base of unit 6 of Perry, Smith, and Wayne (1954), and its top is the top of unit 13, that is, the base of the St. Louis Limestone. These contacts as specified here are slightly different from those of the cited source, which is in error.

*History of nomenclature:* The nomenclatural history of the unit called the Salem embodies one of the more enduring disputes among an earlier generation of foremost American geologists, and the reader should refer to Cumings (1922, p. 499-505). Interest was heightened through the famous Salem, or Spergen Hill, fauna, which is in collect-
tions and museums throughout the world, and the Spergen Hill locality still is on the collecting itinerary of visiting geologists from around the world. Time has permitted the name Salem to become dominant, and with adoption of that term by the U.S. Geological Survey as recommended by Helen Duncan (memorandum, February 12, 1957) and as published by Kottlowski (1954) and by Wilson, Keroher, and Hansen (1959, p. 466), the term Spergen Limestone and its variations became only a landmark of the great era of descriptive stratigraphy.

The terms Spergen fossil bed (Hall, 1858) (capitalization of this and other obsolete or trade terms as in original sources), Spergen’s till Bed (Lyon, 1869, p. 619), and their variations, although older than the name Salem, have in effect been assigned to collectors’ jargon for the renown collecting site at Spergen, Sperge’s, or Spurgeon’s Hill near Salem, in the S½ sec. 24, T. 2 N., R. 4 E., Washington County. This disposition rests upon the early assignment in a geologic sense of the pertinent rocks, not to a Spergen formation, but rather to the Warsaw formation (limestone), through Hall’s (1858, 1883) correlations; also to the St. Louis group, following Worthen (1866, p. 83); and later to the Bedford limestone (from Bedford, Lawrence County), a name proposed formally by Hopkins and Siebenthal (1897, p. 298) and used earlier in variant form by Elrod and McIntire (1876, p. 209) and Richard Owen (1862). The name Bedford came into considerable provincial use and appeared in U.S. Geological Survey reports. The term Bedford already was preempted, however, for the Bedford Shale of Ohio (Newberry, 1871, p. 22), so that Cumings (1901, p. 232-233) proposed replacement by the name Salem Limestone. Nevertheless, Ulrich (1904, p. 90) adopted the term Spergen Hill limestone, which evolved to the Spergen limestone (Wilmarth, 1938, p. 2039). During the next 50 years dozens of reports followed varying practices, including stratigraphic use of many quarry and trade names, which include the Bastard stone, Bedford rock (stone, oolitic limestone), Bloomington stone, Indiana limestone (oolite, oolitic limestone, oolitic stone), oolitic limestone, Salem stone, and White River limestone. (See Cumings, 1922, p. 499, 503-504.)
Description: The Salem Limestone has three characteristic lithologies: (1) massive calcarenite, from which the nationally known dimension stone is quarried, that is gray to light gray, well sorted, medium or coarse grained, and porous; (2) calcarenites, not used for dimensional stone purposes, that range widely in grain size, sorting, porosity, and bedding; and (3) impure carbonate rock containing varying quantities of quartz and other noncarbonate grains, carbonaceous material, and fossil debris. These differing calcarenites constitute lithofacies that as rock bodies are a township and more in areal extent (Pinsak, 1957, pls. 1, 3, 5).

Most of the Salem contains whole specimens of fossils, demonstrated (Smith, 1962) to be sorted and in places beautifully preserved in great variety (Cumings and others, 1906). The calcarenite grains include, in decreasing order of abundance, fragments of fossils, whole microfossils, and pellets of carbonate containing minute fragments of fossils. The Salem commonly has been called an oolitic limestone, partly because mechanically rounded fossil debris imparts an oolitic aspect in places. True oolites are rare, however, and are outnumbered by also rare structureless pellets. The calcarenite grains commonly are covered by a calcitic coating that generally is not thick enough to show either the radiating or concentric habit of calcite in true oolites. Some geologists have considered only the quarry beds as the Salem, but the massive quarry beds in fact are intercalated with bedded rocks of otherwise similar lithologic aspects.

The Salem Limestone is everywhere present in Indiana from the Ohio River in Harrison County to near the Montgomery-Parke county boundary and southwestward into the Illinois Basin. On outcrop between the Ohio River and Monroe County, it thickens and thins between 60 to 100 feet, and in central Putnam County it is 50 feet thick, from where it thins northward and is overlapped, in northern Parke County, by Pennsylvanian rocks. Basinward, the Salem generally is 100 to 200 feet thick but increases in thickness southwestward to 360 feet in Posey County (Pinsak, 1957, pl. 3).

Correlation: The Salem of Indiana, by means of the fauna of the
Spergen fossil bed, was correlated by Hall (1858, 1883) with his (1857) Warsaw Formation of western Illinois, but beginning with Butts (1915; 1922, p. 119-120) the Salem has been correlated with a Mississippi Valley position above the Warsaw Limestone, or it has been considered to be an upper member of the Warsaw. The name Salem, however, is now used in western Illinois, where its age relationships are not necessarily identical to those of Indiana. Assignment to a lower middle part of the Meramecian Series, which has a Missouri type area, dates from Ulrich (1904, p. 110), but the series of assignment here is the Valmeyeran.

*Endothyra baileyi* (Hall) is considered to be a Salem guide fossil. It has been used to correlate, at least approximately, Midcontinent rocks of middle Mississippian age with the Salem, and although their paleoecologic relationships are not well understood, the Salem endothyrids were thought to be distinct in the Mississippian endothyrid zonation by Zeller (1950, p. 15, pl. 6). Other Salem guide fossils that have been used for at least approximate interregional correlation and that have some understanding in a vertical zonation are blastoids of the *Pentremites conoideus* group (Galloway and Kaska, 1957). Certain ostracod species of the genera *Amphissites* and *Glyptopleura* Geis, 1932; Brayer, 1952) also appear to be diagnostic.

**Salina Formation**, Cayugan and Niagaran? Series, RHS

*Type area and use of name in Indiana:* The term Salina was first used by J. D. Dana in 1863 in the combination Salina Period, during which time the Guelph limestones and marls and limestones and salt of the so-called Saliferous Epoch were deposited in central New York. That is, it included rocks then assigned to the Onondaga Salt Group (Dana, 1880, p. 232-233), which by 1863 did mean Silurian rocks rather than both Silurian and Devonian. Since 1863 the term has undergone much evolution in New York, where it now excludes Guelph and uppermost Cayugan rocks and has group rank in the Cayugan Series (Fisher, 1960). The type area borders Syracuse, N. Y., on the north. (See Wilmarth, 1938, p. 1551, 1890-1892.)
The name Salina has been used in the Michigan Basin both as a formation (Landes, 1945) and as a group (Ells, 1962, p. 45) for thick evaporite-bearing carbonate rocks that make up the bulk of the Silurian section in the deeper parts of the basin and that conventionally have been assigned to the Cayugan Series. From this understanding, Pinsak and Shaver (1964, p. 47) extended the Salina concept as a formation to northern Indiana, where it includes the Kokomo Limestone Member, the overlying Kenneth Limestone Member, and rocks unnamed to member. The rocks unnamed to member collectively are older and younger than and the same age as the named members.

**Description:** The Salina Formation in Indiana consists of several spatially intergrading rock types that have been interpreted to represent marginal facies of sediments deposited in a hypersaline basin. Especially characteristic are dolomite and dolomitic limestone that are tan, brown, and gray banded, dense to fine grained, and thinly laminated (the poker chip lithology of driller’s terms); light-colored crystalline vuggy rather pure dolomite (especially in areas northward); and gray to pink coarse-grained evidently fossil-fragmental dolomitic limestone (especially in Tipton, Carroll, and Starke Counties). Sandy rocks, shale, and, in Howard and Cass Counties, cherty limestone and white and pink coarse-grained limestone of reefy aspect and bearing the brachiopod *Conchidium* also are present. Little or no bedded Salina evaporitic rocks are present in Indiana.

The Salina ranges in thickness from about 500 feet in far northeastern Indiana to nothing along apparently both eroded and depositional edges in north-central Indiana. Thus the formation thins southward, probably in part by progressive loss of its lower parts, and it has a southern limit whose fingerlike configuration is partly determined by the position of the Logansport and Jasper Sags across the Cincinnati Arch. Original thicknesses also seem to have been related to the structural sags, where they have a complementary relationship with thickness of the underlying Wabash Formation. (See Pinsak and Shaver, 1964, p. 47, 50-54, Appendix.)

**Correlation:** The brachiopod *Conchidium*, found in Salina rocks in
Marshall County cores and above so-called poker-chip rocks in Cass County, indicates a 
Ludlow age in the British standard, but the brachiopods *Coelospira congregata* and others 
in the Kenneth member indicate simply a Silurian age.

The formation generally lacks fossils, however, and it is overlain by middle Devonian 
rocks and underlain by Niagaran rocks ranging from Salamonie Dolomite in the Michigan 
Basin to the upper part of Wabash Formation in the sag areas. Thus the Salina has been 
assigned several speculative ages, even a Devonian age. Much of the Salina, especially 
where it thins southward most abruptly, faces the bank facies (Fort Wayne Bank) of the 
Wabash Formation in uncertain relationship, possibly one of partial contemporaneity of 
deposition when considered regionally. Further, the Salina contact with the underlying 
Salamonie Dolomite in the south flank of the Michigan in is difficult to recognize, placed, 
as it is, rather arbitrarily in the midst of somewhat similar carbonate rocks; thus one 
concept of the Salina, of Ells (1958, p. 33) for example, includes rocks that extend 
southward beneath the Waldron Formation and that were assigned to Salamonie by Pinsak 
and Shaver (1964, p. 28). For all these reasons, parts of the Salina possibly are Niagaran 
in age, as well as Cayugan, as that epoch is conventionally inferred in the Midwest.

Considered as a rock unit, much of the Salina of Indiana merges with A unit of 
Michigan, in an A-to-G system (Landes, 1945), although rocks having an age as late as 
that of the G unit may be present in the state's northeast corner (Ells, 1958, fig. 6). The 
formation in Indiana also corresponds, in a general way at least, to the Greenfield Dolomite 
J possibly to part of the Tymochtee Shale of Ohio. (See Berry and Boucot, in preparation, 
and Pinsak and Shaver, 1964.)

**Saluda Formation**, Cincinnatian Series, Ordovician System

*Type locality:* The name Saluda Bed was first used by Foerste (1902, 369) in 
describing a gray silty dolomitic limestone exposed along Saluda Creek 6 miles 
south of Hanover, Jefferson County. Foerste stated that the name replaced the 
preoccupied name *Madison Beds*
(of Borden, 1874, and others) given to typical exposures at Madison, Jefferson County. Now recognized as the Saluda Formation (Brown and Lineback, 1966, p. 1021), this unit has been known as a member of the Whitewater Formation (Shideler, 1914; Fox, 1962) and as the Saluda Limestone (Patton, Perry, and Wayne, 1953). The Saluda was formerly assigned to the Richmond Group, but the Richmond no longer is considered here to have group status in Indiana, although its use in an age or stage sense is not precluded. (See Brown and Lineback, 1966, p. 1020.)

**Description and correlation:**

The Saluda Formation, a unit of dolomitic mudstone and dolomite, contains in its lower part a zone rich in corals, *Columnaria* and *Tetradium*, that is traceable from Clark County to Wayne County and that has been referred to as the *Tetradium Reef*, *Columnaria Reef*, *Madison Reef*, and *Tetradium Zone*. The base of this zone marks the base of the Saluda north of Jefferson County, but a dolomitic mudstone, characteristically about 25 feet thick, underlies the coral beds in Clark and Jefferson Counties and marks the lower part of the Saluda there. Together, the coralline and dolomitic beds of the Saluda Formation contrast well with the interbedded limestones and shales of the underlying Dillsboro Formation and make the contact between these two formations quite distinct. The Saluda in most places is overlain by the limestones and calcareous shales of the Whitewater Formation, and the contact of the two is placed at the top of the highest dolomitic bed. (See Brown and Lineback, 1966, p. 1021-1022.) In Jefferson and Clark Counties, however, the Whitewater Formation is absent, and the Saluda is overlain disconformably by the Brassfield Limestone or the Osgood Member of the Salamonie Dolomite. (See "Whitewater Formation" for discussion.) The Saluda thins from 60 feet at the Ohio River near Madison to 14 feet in Decatur County and to 9 feet in Wayne County (Brown and Lineback, 1966), for the most part complementing a corresponding thickening of the Whitewater Formation. Despite the prominence of the Saluda, Foerste (1905) found it indistinguishable from beds above and below it outside the Madison area and proposed the name Versailles Bed for rocks unassigned to the upper part of the Dillsboro Formation and to the Saluda and Whitewater Formations.
The Saluda Formation is not recognized in Ohio, where equivalent rocks are considered to be part of the Whitewater Formation or where it is recognized as a thin member between Lower and Upper Whitewater Members. Because it changes in facies southward, the unit is not recognized generally in Kentucky but has been described in the Louisville area and in Oldham County (Conkin, 1952; Browne, 1958, p. 41-45). (See also the discussion on Cincinnati faunal zones under “Dillsboro Formation” and Hatfield, 1964.)

Sample Formation, West Baden Group, Mississippian System

Type locality and Indiana reference section: The Sample Formation was originally named the Sample Sandstone Member of the Gasper Oolite by Butts (1917, p. 70-73), who designated the type locality at Sample Station, Breckinridge County, Ky. As exposed in this area, the formation consists of 20 to 40 feet of massive thick-bedded and crossbedded sandstone, flaggy sandstone, and shale. A standard reference section in Indiana for the Sample Formation is in a railroad cut near Huron, Lawrence County (Indiana Geological Survey, 1957, p. 11; Malott, 1952, p. 104).

History of name in Indiana: Malott (1919, p. 10) originally proposed the name Brandy Run Sandstone for these rocks in Indiana. This name was abandoned when equivalence to the Sample was recognized (Cumings, 1922, p. 515). Gray and Perry (1956, p. 1005) changed the name to Sample Formation in recognition of the mixed lithologic character of the unit.

Description: The Sample Formation in Indiana is 24 to 42 feet thick and consists of varicolored shales and thin-bedded and crossbedded sandstones (Indiana Geological Survey, 1957, pl. 2). Shales dominate in the northern part of the outcrop area from Putnam County southward through Orange County, but sandstones become more conspicuous southward to the Ohio River (Malott, 1952, p. 13). The Sample Formation is recognized in the subsurface from Parke County southwestward. It conformably overlies the Beaver Bend Limestone and is overlain conformably by the Reelsville
Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian). In many places the Reelsville is absent, apparently by nondeposition (Gray and Perry, 1956), so that the Elwren Formation directly overlies the Sample. The contact in this circumstance is generally transitional and difficult or impossible to place with certainty, but at a few places a local disconformity separates the two formations (Malott, 1919, p. 11).

**Correlation:** The Sample Formation has been considered equivalent to part of the Paint Creek Formation of southwestern Illinois (Swann and Atherton, 1948, p. 270). Currently, however, the name Paint Creek has been replaced in the Illinois standard section by the name Ridenhower Formation, and the Sample is designated as a member in the middle of that formation (Swann, 1963).

**Sanders Group, Valmeyean Series, Mississippian System**

**Type locality and reference sections:** The term Sanders Group was proposed by Smith (1965) to include all rocks that he assigned to the Harrodsburg and Salem Limestones. The type locality is near Sanders in Monroe County. Reference sections in this area that expose the bottom and top parts of the group are in tributaries of Ramp Creek within half a mile east and northeast of Sanders and in an abandoned quarry in the center of the E1/2NW1/4SE1/4 sec. 33, T. 8 N., R. 1 W. (Smith, 1965, p. 9). A type section has not been designated.

**Description:** The Sanders comprises middle Mississippian rocks having close internal lithologic similarities and forming a natural unit between silty and shaly rocks of the Borden Group (below) and hard thick-bedded limestones of the Blue River Group (above). Thus the group includes at its bottom only the upper part of the Lower Harrodsburg Limestone of Stockdale (1931), and it includes at its top, in the Salem, impure limestones that are mostly above the dimension-stone quarry beds (known as the Indiana Limestone and by many other trade and quarry terms) and below the St. Louis Limestone. In characteristic exposures the group consists (in ascending order) of (1) as much as 11 feet of thick-bedded biofragmental limestone, the Leesville
Member of the Harrodsburg; (2) as much as 10 feet of shaly siliceous geodiferous limestone, the Guthrie Creek Member of the Harrodsburg; (3) about 35 feet of biofragmental thick-bedded limestone, the upper part of the Harrodsburg; and (4) 50 to 100 feet of massive calcarenites, commonly consisting of whole, calcite-coated fossils, and making up the dimension stone of the Salem, and impure quartz-bearing argillaceous carbonate rocks, which are found in the quarry belt, mostly in the top part of the Salem. Subsurface sections, however, show that these lithologies, particularly in the Salem, are complexly interbedded and interlensed even though the formational parts of the group maintain separate identities.

Rocks of the Sanders Group crop out in many places in the Mitchell Plain. In exposed and near-exposed sections the group ranges in thickness from 0 feet at both pre-Pennsylvanian erosional and possibly nondepositional wedge edges in and north of Putnam County to nearly 150 feet at the Ohio River. Thickness generally, but not uniformly, increases southeastward along the outcrop and southwestward into the Illinois Basin, in which Indiana thicknesses as great as 450 feet in Posey County have been recorded. (See Pinsak, 1957, pls. 1 and 3, and Smith, 1965, p. 9 and 11.)

**Correlation:** The Sanders Group formerly was assigned to the basal part of the Meramecian Series but is here assigned to an upper part of the Valmeyeran Series. In this time-rock sense, however, the named Sanders formations of Indiana, and thus the group itself, do not necessarily correlate exactly with the identically named formations as they are recognized in different parts of Illinois. (See discussions under “Harrodsburg Limestone” and “Salem Limestone, Correlation.”)

**Seelyville Coal Member (III), Staunton Formation, HCH**

**Pennsylvanian System**

*Type locality:* The name Seelyville was applied casually by Ashley (1909, p. 31, chart opposite p. 97) to the thick coalbed mined underground at Seelyville in Vigo County. No specific type section was
designated. It has also been known as Coal III, which Ashley (1909, p. 57) designated as the thick bed mined around Seelyville, Staunton, Turner, Fontanet, Coal Bluff, Rosedale, and Coxville and the lower bed worked at Clinton and Lyford, all in Indiana. Wier (in preparation) proposed that the name Seelyville Coal Member (of the Staunton Formation) replace the term Coal III for stratigraphic purposes in Indiana.

Description: The Seelyville Coal Member (III) has been reported to be as much as 11 feet thick and averages 6 feet in thickness in the northern part of the coalfield. It is bright banded, highly pyritiferous, and split into three benches of approximately equal thickness by two thin pyritiferous shale partings (Hutchison, 1960). The roof of the coal is either gray silty carbonaceous shale or brown to gray massive friable fine-grained carbonaceous micaceous sandstone. The floor generally is gray plastic underclay that in places is quite shaly.

Correlation, nomenclature, and distribution: The Seelyville (III) is near the top of the Staunton Formation and is known by a number of local names along its outcrop area, which extends the length of the Indiana coalfield. Beginning at the north, it has been called the Lower Hanging Rock Coal in Vermillion County, where it was mined in conjunction with the Colchester Coal Member (IIIa) along the Big Vermillion River northwest of Eugene. In Clay and Vigo Counties, it has been called the Staunton Coal and the Seelyville Coal from exposures around Staunton and Seelyville. In the decade from 1899 to 1909, it was known in the Brazil area and northward as Coal VI rather than Coal III because of a miscorrelation (Ashley, 1899). The error was corrected in Ashley’s 1909 report. To the south, in Dubois and Pike Counties, the Seelyville has been called the Rock Creek Coal (Fuller and Ashley, 1902, p. 2). Along the outcrop in the latter counties, it is only 2 to 3 feet thick and has a nondescript shale or sandstone roof.

In western Illinois the thin Lower Liverpool Coal, or a coaly horizon, lies a few feet below the Colchester (No. 2) Coal and may correspond to the Seelyville (III) (Wanless, 1939, p. 27). Alexander
(1943) correlated the Seelyville with a part of the Abingdon Cyclothem of western Illinois. Kosanke and others (1960, p. 33, pl. 1) adopted the name Seelyville Coal Member for a comparable coalbed in the upper part of the Spoon Formation of Illinois.

**Selmier Member**, New Albany Shale, Devonian System

*Type section and description:* The Selmier Member of the New Albany Shale was named by Lineback (1968 and in preparation) for a greenish-gray mudstone exposed in its type section on the south wall of the Berry Materials Co. quarry in the NW¼NW¼NE¼ sec. 34, T. 7 N., R. 8 E., Jennings County. The name was taken from the Selmier State Forest 1 mile northeast of the type exposure.

The mudstone has very little organic matter in it, which distinguishes the Selmier member from other parts of the New Albany, and it contains dolomite, dolomitic sandstone, thin beds of brownish fissile shale, and a fauna of conodonts and a few pelecypods and gastropods. The Selmier is absent from places in southern Clark County but otherwise is present in the southeastern Indiana outcrop belt. It reaches its maximum exposed thickness of 22 feet at the type section, although a thickness of 50 feet has been reported in the subsurface in Jackson County. The Selmier lies stratigraphically between the Blocher and Morgan Trail Members of the New Albany Shale.

*Correlation:* The Selmier Member correlates with the upper part of Zone to1 in the German standard and corresponds to the *Spathiocaris* Zone of Campbell (1946). It is correlated with the Sweetland Creek Shale of Illinois and is stratigraphically equivalent to part of the Antrim Shale of Michigan and northern Indiana, to the Olentangy Shale of Ohio, and to the upper part of the Dowelltown Member of the Chattanooga Shale of Tennessee. (See Lineback, in preparation.)

**Shady Lane Coal Member**, Mansfield Formation, Pennsylvanian System

*Type section:* The name Shady Lane was given by Hutchison (1960,
p. 12) to the coal that lies 30 to 40 feet below the top of the Mansfield Formation and some 10 feet above what is probably the Ferdinand Limestone Member. This coal is exposed in the stream valley in the SE1/4 sec. 23, T. 13 N., R. 6 W., near Shady Lane, a small community on U.S. Highway 40, Clay County. The Shady Lane is considered here to have the rank of member.

Description: Shady Lane coal is shiny and pyritiferous, ranges from 0.5 to 3.0 feet in thickness, breaks into small regular cubes when mined, and is iridescent on fractured surfaces. Its iridescence has led to the trade name Peacock coal. The roof is generally tan to yellow ferruginous carbonaceous sandstone, but in places it is gray soft carbonaceous slightly sandy shale. The floor of the coal is gray to light-gray shaly somewhat plastic carbonaceous underclay. The Shady Lane Coal Member can be traced only with difficulty a few miles from the type locality, although a coalbed at about the same stratigraphic position is present over much of the northern part of the coalfield. The Shady Lane is one of the several coalbeds identified in different places as Coal I (Ashley, 1909, p. 60-61).

Shelburn Formation, McLeansboro Group, AMB & CEW
Pennsylvanian System

Type locality and redefinition: The name Shelburn Formation was used by Cumings (1922, p. 525, 529) for the rocks included in the “interval between the disconformity above Coal VII and the base of the Merom Sandstone.” The name was taken from Shelburn, Sullivan County, although no type section was designated by Cumings.

Miscorrelation by Shrock and Malott (1929) of the West Franklin Limestone Member, which is at the top of the Shelburn Formation of present definition, resulted in misuse of the name Shelburn. The name was used by Logan (1932) in southern Indiana as a group name for rocks extending to the top of his Ditney Formation, but in Sullivan County the name was used for rocks extending to the top of the Livingston Limestone Member (Bond Formation) (Malott, 1948, p. 125-141; Wier and Esarey, 1951, pl. 4). Wier and Gray (1961) and
ROCK-UNIT NAMES

Wier (in preparation) have defined the Shelburn Formation to include rocks from the top of the Danville Coal Member (VII) of the Dugger Formation to the top of the West Franklin Limestone Member. The term Shelburn as thus defined includes only the lower part of the rocks originally called the Shelburn Formation by Cumings in Sullivan County but is the same as the Shelburn Formation that he recognized in Gibson and Vanderburgh Counties to the south.

*Description:* The Shelburn Formation includes the Busseron Sandstone, Pirtle Coal, and West Franklin Limestone Members, unnamed beds of shale, siltstone, and sandstone, and thin discontinuous beds of coal clay and limestone. The formation ranges from 50 to 250 feet in thickness and is mainly composed of shale and siltstone and sandstone (Wier, in preparation).

The Shelburn Formation crops out from along the Ohio River in Vanderburgh and Posey Counties northward to Vigo and Vermillion Counties.

**Shoal Creek Limestone Member,** Bond Formation, CEW

*Pennsylvanian System*

*Type locality and synonyms:* Henry Englemann (1868, p. 175) used the name Shoal Creek Limestone for exposures along Shoal Creek, T. 3 N., R. 4 W., in Clinton County, Ill. The unit was given member status in the Bond Formation by Kosanke and others (1960, p. 38-39) and was recognized with similar rank in Indiana by Wier (in preparation).

The Shoal Creek probably is equivalent to the Hayden Branch Formation in Sullivan County as described by Malott (1937, p. 279), and various authors have referred to the Shoal Creek as the Parkers Limestone near Parkers Settlement and as the New Haven Limestone near Solitude, both places in Posey County.

*Description:* In Indiana the Shoal Creek Limestone Member of the Bond Formation is a bluish- to brownish-gray finely crystalline fossiliferous limestone that generally is a single bed. It overlies a
black fissile shale and the Parker Coal Member (Patoka Formation) and is 75 to 100 feet above the Vigo Limestone Member (Patoka Formation) in Vanderburgh and Posey Counties. In Sullivan County the limestone is thin but in most places lies about 30 to 50 feet above the Vigo Limestone Member.

**Siberia Limestone Member**, Menard Formation, AMB
Mississippian System

*Type section and use of name:* Malott and Thompson (1920) introduced the name Siberia Limestone by simply listing it as a member of the Buffalo Wallow Formation, a name no longer used in Indiana. Later Malott (1925) properly defined the Siberia and designated the J. Schilling Quarry, 2½ miles southeast of Siberia, Perry County (sec. 36, T. 3 S., R. 3 W.), as the type section. The equivalence of this unit to at least part of the Menard Limestone of Illinois was recognized by Malott (1931), and Weller and Sutton (1940) stated that the type Menard might be represented by the Siberia Limestone and its overlying and underlying shale units. The term Menard was adopted for use in Indiana (Malott and Esarey, 1940; Malott, Esarey, and Bieberman, 1948), but Rexroad and Nicoll (1965) revived the name Siberia Limestone as a member in the middle part of the Menard Formation.

*Description:* Typically a sparry laminated or crossbedded massive generally fossiliferous limestone, the Siberia Limestone Member, which attains a maximum thickness of 15 feet, is a widespread and persistent unit that has been recognized from Schnellville in Dubois County to the southern border of Indiana. (See Malott, 1925; Rexroad and Nicoll, 1965.)

**Silver Creek Member, North** Vernon Limestone, AMB & JBP
Devonian System

*Type locality and reference section:* The Silver Creek Member of the North Vernon Limestone was named as a formation (Silver Creek Hydraulic Limestone) by Siebenthal (1901, p. 345-346) for exposures
of a drab-gray massive homogeneous fine-grained argillaceous magnesian limestone along Silver Creek, Clark County. Stratigraphically it was considered to be directly above the Jeffersonville Limestone, but rocks of Hamilton age are now known to lie between these so-called “cement beds” and the Jeffersonville Limestone. (See “Speed Member.”) The term Silver Creek later was reduced to the rank of member by Butts (1915). Approximately 14 feet of the Silver Creek in typical lithology can be seen at the Louisville Cement Co. quarry at Speed, Clark County, in lots 131 and 132 of Clark’s Grant.

**Description:** Descriptive terms, such as “Hydraulic limestone,” “Cement Beds,” and “Waterlime,” have been used for the Silver Creek because of its properties for use as hydraulic cement. Geographically it does not extend much farther south than Louisville, Ky. (Savage, 1931), and is not recognizable north of southern Scott County in Indiana (Dawson, 1941). In outcrop it ranges from 0 to 26 feet in thickness; the maximum thickness known is in Clark County. Northward thinning is complemented by thickening of the Speed Member, a time equivalent of the Silver Creek Member (Patton and Dawson, 1955). Tongues with Speed lithology are found in the Silver Creek Member, which in places contains chert and silicified fossils. At the Falls of the Ohio, the Silver Creek rests on the Jeffersonville Limestone.

**Correlation:** As a member of the North Vernon Limestone, the Silver Creek Member is equivalent to rocks in New York of the Hamilton Group, and it was assigned a Skaneateles age by Cooper and Warthin (1936). The unit correlates with the Silica Shale of Ohio and with parts of the Lingle Limestone of Illinois and of the Traverse Formation (Group) of northern Indiana and of Michigan. (See Stumm, 1964; Meents and Swann, 1965; and Thornbury and Deane, 1955.) In an earlier period of geologic study in Indiana, the Silver Creek commonly was both referred to as “water lime” or “waterlime” in the Helderberg Group and was correlated with rocks so named in New York. (See, for example, Hall, 1842, and Siebenthal, 1901, p. 335.)
Silverwood Limestone Member, Staunton Formation, HCH

Pennsylvanian System

_Type section:_ The name Silverwood was applied by Alexander (1943, p. 143) to a well-developed cyclothem exposed on the east side of Coal Creek about a quarter of a mile north of Indiana Highway 234 in the NE ¼ SW ¼ sec. 36, T. 18 N., R. 8 W., near Silverwood, Fountain County. The limestone in the cyclothemic sequence also was referred to as the Silverwood, and that usage, with member rank in the Staunton Formation, is followed here.

_Description:_ The Silverwood Limestone Member consists of three benches. The upper bench is dark-blue fossiliferous limestone, which is 0.2 foot thick and has distinctive cone-in-cone structure. The middle bench is limy fossiliferous shale, 0.75 foot thick, and the lower and more persistent bench is dark-gray fossiliferous limestone, 0.3 foot thick (Alexander, 1943).

_Correlation and distribution:_ The Silverwood Cyclothem of Alexander, according to Alexander (1943), extends as far north as Fall Creek in north-central Warren County and includes Coal II of Parke and Clay Counties as defined by Ashley (1909). In Fountain County, however, the Silverwood Limestone Member lies some 50 feet above Coal II, and it correlates with one or more of a group of marine zones in the middle part of the Staunton Formation (Hutchison, 1961). This zone can be traced along the outcrop and in the subsurface from Warren County to the Ohio River.

Speed Member, North Vernon Limestone, AMB & JBP

Devonian System

_Type section:_ The Speed Member of the North Vernon Limestone was named by Sutton and Sutton (1937, p. 326) for an 18-inch fossiliferous shaly limestone exposed beneath the natural cement rock (Silver Creek Member) and above the Jeffersonville Limestone at Speed's Quarry near Sellersburg, Clark County, in lots 131 and 132, Clark's Grant. Previous descriptions of the section had considered this zone, where present, as part of the underlying Jeffersonville,
although Whitlatch and Huddle (1932) recognized the possibility that because of the presence of the brachiopod *Stropheodonta demissal* the zone is Hamilton in age.

**Description:** The Speed Member is typically a blue-gray crystalline fossiliferous limestone containing thin beds in part which weather to a platy appearance because of flat-lying brachiopod shells and other fossil debris. It is not recognizable as a unit at the Falls of the Ohio but thickens northward from its type area at the expense of the overlying Silver Creek Member. The contact with the Silver Creek is transitional, and the contact with the underlying Jeffersonville is disconformable. In the area north of southern Scott County, the Speed Member makes up all the North Vernon Limestone below the Beechwood Member. (See Patton and Dawson, 1955.)

**Correlation:** The Speed Member is correlated with part of the Hamilton Group and probably the Skaneateles Formation of the New York standard. It correlates with the Delaware Limestone of Ohio and with parts of the Lingle Limestone of Illinois and the Traverse Formation (Group) of northern Indiana and of Michigan. (See Cooper and Warthin, 1941; Stumm, 1964; Meents and Swann, 1965; and Thornbury and Deane, 1955.)

**Springfield Coal Member** (V), Petersburg Formation, AMB & CEW Pennsylvanian System

*Type locality:* The name Springfield was first applied by Worthen (1883, p. 6) to a coal mined near Springfield, Sangamon County, Ill. Wanless (1956, p. 10) designated sec. 16, T. 16 N., R. 4 W., as a type locality. Wier (in preparation) extended use of this name to Indiana, calling the Indiana coal that is correlative with the Illinois type the Springfield Coal Member (V) of the Petersburg Formation. This coal had previously been called the Main Newburg Coal (Owen, 1839, p. 11) and Coal V (Ashley, 1899, p. 90, 843; 1909, p. 56) and had been erroneously called Coal VII (Ashley, 1899, p. 90, 843). This unit had also been listed as the Petersburg Coal and the coal at Alum Cave (Cumings, 1922, fig. 2).
Description and correlation: The Springfield Coal Member extends almost continuously from the Ohio River in Warrick County to west-central Vermillion County, but in a few places sandstone-filled Pennsylvanian channels partially or completely cut out the coal. This coal is generally about 5 feet thick but is more than 7 feet thick in southwestern Pike County and is reported to be as much as 13 feet thick in east-central Sullivan County. Its thickness and continuity make the Springfield an economically important coalbed. In general it has no shale partings, although in northeastern Warrick County it has a medial shale parting 1 to 10 feet thick. The Springfield Coal Member contains a diagnostic spore population made up mostly of the genera *Lycospora* and *Laevigatosporites* (Guennel, 1952, p. 28, fig. 6), especially the species *Laevigatosporites pseudothiessenii* (now *Verrucosporites pseudo thiessenii*).

The coal is generally underlain by silty clay or, in some places, by shale or sandstone; it is overlain either by a black fissile shale, which ranges from 1 to 6 feet in thickness and commonly contains iron-rich concretions in the basal beds, or by as much as 30 feet of gray shale or shaly sandstone, which intervenes in a few places between the coal and the black shale (Wier, in preparation).

Because of its continuity the Springfield coal is well known in Indiana, Illinois, and Kentucky. It also has been called the Harrisburg (No. 5) Coal in Illinois and correlates with Coal No. 9 in Kentucky.

**Staunton Formation, Alleghanian Series, HCH**

Pennsylvanian System

Type area: The Staunton Formation was named by Cumings (1922, p. 525) for rocks exposed near Staunton, Clay County. As defined by Cumings, this formation included the interval from the disconformity above Coal II to the disconformity above Coal IV, thus also including the Seelyville Coal Member (III) and the Colchester Coal Member (IIa). Wier (1950) restricted the Staunton Formation to include those rocks in the interval between the disconformity above Coal II and the disconformity above the Seelyville Coal Member. Wier and
Gray (1961) and Wier (in preparation) changed the upper boundary of the Staunton to the top of the Seelyville coal. Hutchison (in preparation, c) changed the lower boundary of the Staunton Formation to the top of the Minshall Coal Member and thus reassigned the Perth Limestone Member, which formerly belonged to the underlying Brazil Formation, to the Staunton Formation. In the same report Hutchison abandoned the poorly defined and miscorrelated Coal II as a stratigraphic name.

**Description:** The Staunton Formation consists of 75 to 125 feet of sandstone and shale and as many as eight coalbeds. These coalbeds are generally of little areal extent and variable in quality and thickness. Three lithologies characterize the roof of the coals: (1) black fissile shale overlain by limestone, (2) gray soft silty or sandy shale and interbedded fossiliferous shale or limestone, and (3) gray massive to shaly hard to friable sandstone. The floor of the coals is underclay, clay shale, or sandy shale. The four named members of the formation are the Perth, the Silverwood, and the Holland Limestone Members and the Seelyville Coal Member (III). The Perth limestone lies at or near the base of the Staunton. The Silverwood and Holland limestones are in the middle part of the formation. The Seelyville Coal Member (III), a commercially mined coalbed, is at the top of the Staunton Formation.

**Correlation:** The Staunton Formation is considered to include the basal rocks of the Alleghenian Series in Indiana and is recognizable throughout the Indiana coalfield. Probable equivalents of the Staunton Formation include the uppermost part of the Tradewater Formation and the lowermost part of the Carbondale Formation of western Kentucky, the upper part of the Spoon Formation of Illinois, and the lower part of the Cabaniss Subgroup, of the Cherokee Group, of Missouri (Kosanke and others, 1960, pl. 1; Wanless, 1962, p. 12).

The Staunton includes limestones that at times have been mistakenly called the Minshall Limestone, as at Minshall, Parke County, and near West Lebanon, Warren County. At least some of the Minshall-
confused limestones, as well as other Staunton limestones, contain the fusulinid *Wedekindellina*, and they are in the ostracod zone characterized by *Amphissites centronotus*, *A. giryi*, and *Roundyella cf. R. simplicissima*: a Desmoinesian age is indicated in the Midcontinent classification. The lowest Staunton limestones, that is, the Perth Limestone Member of west-central Indiana and the limestone next above the Buffaloville Coal Member (Brazil Formation) in southern Indiana, contain pre-*Wedekindellina* (a Desmoinesian fusulinid) microfaunas characterized by *Fusulinella* and the ostracod *Amphissites centronotus*. This fauna is markedly different from that of lower fossil zones that are early Pennsylvanian in age. Although lack of adequate knowledge of type or near-type Atokan faunas of Oklahoma make the Atokan-Desmoinesian boundary problematical, *Fusulinella* bearing rocks in Indiana may be assigned to the Desmoinesian Series in accord with one of the Midcontinent practices (Thompson and Shaver, 1964, and oral communication, 1965).

*Stendal Limestone Member*, Petersburg Formation, AMB & CEW

**Pennsylvanian System**

*Type and reference sections:* The name Stendal Limestone Member (of the Petersburg Formation) was proposed by Wier (in preparation) for the limestone previously known as the Houchin Creek cap (Weller, Henbest, and Dunbar, 1942, p. 32) or Houchin Creek Limestone (Cooper, 1946, p. 16) and exposed near Stendal, Pike County. Wier designated the type section in the SE¼NE¼SW¼ sec. 3, T. 3 S., R. 7 W., and a reference section in the NE¼SW¼sec. 12, T. 3 S., R. 7 W.

*Description:* The Stendal Limestone Member is a black dense argillaceous locally fossiliferous limestone, ranging from I to 3 feet in thickness. It overlies a black shale, 1 to 3 feet thick, which separates this limestone from the underlying Houchin Creek Coal Member (Wier, in preparation).

*Correlation:* The Stendal is probably correlative with the Hanover Limestone Member of western Illinois and with the black limestone overlying Coal No. 8b in western Kentucky.
Stephensport Group, Chesterian Series, Mississippian System

**Type area and description:** The name Stephensport was originally suggested in 1920 by Cumings in a letter to Stuart Weller (Cumings, 1922, p. 514). The name was not formally proposed, however, until 1960 when Gray, Jenkins, and Weidman (p. 37) introduced it, in a sense somewhat modified from Cumings’ original suggestion, as a group name to include, in descending order, the Glen Dean Limestone, Hardinsburg Formation, Golconda Limestone, Big Clifty Formation, and Beech Creek Limestone. The group, which includes about equal parts of gray limestones, gray shales, and thin-bedded sandstones that are prominent cliff formers, was named for Stephensport, Breckinridge County, Ky. The total thickness of this unit is 130 to 160 feet (Gray, Jenkins, and Weidman, 1960, p. 37-38). It conformably overlies the West Baden Group (Chesterian Series) and is overlain conformably by the Tar Springs Formation (Chesterian Series) or disconformably by the Mansfield Formation (lower Pennsylvanian).

(See the discussion of “Naming of groups in upper Mississippian of Indiana” under “West Baden Group.”)

Sunbury Shale, Kinderhookian Series, Mississippian System

**Type locality:** Originally described as the Sunbury Black Slate (Hicks, 1878, p. 216, 220), the Sunbury Shale was named for Sunbury, Delaware County, Ohio, where 10 to 15 feet of black carbonaceous shale overlies the Berea Sandstone and underlies what was called the Raccoon Shales (now part of the Cuyahoga Group).

**Description:** In the Michigan Basin portion of northernmost Indiana, the Sunbury is a black shale, less than 10 feet thick, that separates the lighter colored Ellsworth Shale (below) from the Coldwater Shale. The unit is recognized by Lineback (1968 and in preparation) in Steuben, Lagrange, LaPorte, and Porter Counties, but it is absent from central northernmost Indiana.

**Correlation:** The Sunbury is laterally equivalent to the uppermost part of the Ellsworth Shale of Michigan and northern Indiana and
probably is in part equivalent to the Henryville Bed near the top of the New Albany Shale (Lineback, 1968 and in preparation).

**Survant Coal Member** (IV), Linton Formation

**Pennsylvanian System**

_Type section:_ Fuller and Ashley (1902, p. 2) used the name Survant Coal in describing exposures near the abandoned town of Survant in Pike County. Originally designated by Ashley (1899, p. 108-113) as Coal IV in Sullivan and Greene Counties, the coal is now known as the Survant Coal Member (IV) of the Linton Formation (Wier, in preparation), and its type section is in the SW 1/4 NE 1/4 sec. 2, T. 2 S., R. 7 W., at the south edge of Survant along the Patoka River.

_Description and correlation:_ The Survant Coal Member is a bright-banded coal that ranges from 0.2 to 8 feet in thickness. Local facies changes of the upper part of this coal to either a canneloid coal or a black bituminous shale are found north of Linton, Greene County. The Survant coal has a shale parting that is commonly less than a few feet thick but that reaches a thickness of 20 feet in southwestern Greene County and southeastern Clay County and 30 feet in northwestern Vigo County. The top of the Survant coal, which is also the top of the Linton Formation, is marked by a sandstone or gray shale in the base of the Petersburg Formation.

The Survant is thin in Illinois (Wier, in preparation) and is correlative with Coal No. 8 in the Henderson area of Kentucky (Walker, Puryear, and Cathey, 1951, p. 12).

**Tar Springs Formation,** Chesterian Series

**Mississippian System**

_Type locality:_ The original name, Tar Springs Sandstone, is generally attributed to D. D. Owen (1857, p. 85-87), although it is certain that he did not intend application of the name in the modern formational sense. The name is taken from a natural feature in Breckinridge County, Ky., called Tar Spring, near which the unit is 100 to 150
ROCK-UNIT NAMES

feet thick and consists of massive cliff-forming sandstone, shaly sandstone, and shale as redescribed by Butts (1917, p. 103-105).

Description: The name Tar Springs Sandstone was first applied in Indiana only to a crossbedded cliff-forming sandstone that is as much as 90 feet thick in some places but is absent from others (Malott, 1925, p. 107). The same name was later applied to a rather indeterminate unit that includes other rocks as well as the prominent sandstone (Malott, Esarey, and Bieberman, 1948). Although the position of the upper boundary remains vague, the lower boundary is now established in Indiana as the top of the so-called massive or main Glen Dean Limestone, and the unit is designated the Tar Springs Formation (Indiana Geological Survey, 1957; Gray, Jenkins, and Weidman, 1960, p. 38). The unit thus contains much shale, but the lithologic constitution and the thickness are nowhere clearly stated. The Tar Springs Formation is recognized at the surface from southwestern Orange County to the Ohio River and is known in the subsurface from central Martin County southwestward. The base of the massive sandstone member is uneven, but in most places the formation overlies the Glen Dean Limestone conformably and is overlain conformably by the Vienna Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

Correlation: Horowitz and Perry (1961, p. 866) have concluded on the basis of crinoid faunas that the basal part of the Tar Springs Formation, which includes limestones and shales assigned by them to the Glen Dean Limestone, is late Visean or early Namurian in age in European chronology.

Boundary problems and concept of naming formations in upper part of Chesterian Series: The exact position of most of the boundaries between formations in the upper part of the Chesterian Series in Indiana is not well understood. In large part this uncertainty results from the fact that no detailed work has been done on these rocks since Malott's (1925) pioneering study. In this paper Malott seems not to have recognized the need for including all the rocks in his
scheme of formational nomenclature, for he (Malott, 1925, p. 106) stated:
The shale masses count but little in the stratigraphic expression of the upper Chester, and may not be used in the study of the structural details which the region of their occurrence expresses. They are mere fillers or intervals between the outstanding limestone and sandstone units which alone are given names and definite status.

Later, Malott and Esarey (1940, p. 7) in describing the section at Sulphur (sec. 36, T. 3 S., R. 1 W.) stated that “the sandstone above the Vienna ... is not the Waltersburg,” the interval between them being only 10 feet rather than the more common 50 to 60 feet, and “...the Tar Springs is poorly represented as a sandstone.” Still later, however, Malott, Esarey, and Bieberman (1948, stops 2-5, pl. 2) seem to have recognized the necessity of extending formational names to embrace the entire section; some of the so-called “shale fillers” are added to the limestone formations, however, and some to the sandstones, and it is difficult to determine what philosophy has governed the choice.

No recent study has considered the problem of the nomenclature of these rocks in Indiana; as a result, formational boundaries are placed differently, especially in subsurface and surface usage (Indiana Geological Survey, 1957, pl. 3).

**Trafalgar Formation, Wisconsinan Stage, Pleistocene Series**

*Type section:* The type section of the Trafalgar Formation is a cut bank along Buckhart Creek about 2 miles east of Trafalgar in southcentral Johnson County (SE¼NW¼sec. 8, T. 11 N., R. 4 E., Franklin Quadrangle) (Wayne, 1963, p. 45).

*Description:* The Trafalgar Formation consists dominantly of calcareous till that is compact but unconsolidated. Thin beds or lenses of silt, sand, and gravel are included in the formation, which, as originally defined, consists of two members. The lower member is called the Center Grove Till Member and the upper the Cartersburg Till Member. The Morton Loess Tongue, which corresponds with the upper *Hendersonia occulta* bed, underlies the Center Grove Till Member; another thin silt, the *Vertigo alpestris oughtoni* bed, separates the two members.
of the formation. The soil profile in the upper part of the formation is generally thin (carbonates removed to a depth of 2½ to 5 feet) and exhibits a brown B horizon. The Trafalgar Formation unconformably overlies the Jessup Formation, but in some places it lies on the Atherton Formation or on any of several Paleozoic rock units. Throughout central Indiana, where the Trafalgar is the principal surficial unit, the formation is overlain by lenses of Atherton gravels, sands, and silts and by both alluvial and paludal sediments of the Martinsville Formation. In the northern part of the state, it is overlain by the Lagro Formation.

Correlation: Sediments of the Trafalgar are principally glacially deposited and are Wisconsinan in age. Radiocarbon dates for Trafalgar wood samples indicate that the part of the formation in central Indiana was deposited between 17,000 and 23,000 years ago. The *Vertigo alpestris ough toni* bed has been dated at 20,000 years (Wayne, 1965, p. 9).

Gooding, working in the Whitewater basin in southeastern Indiana, has proposed names for advances and retreats of the Wisconsinan glacial margin that he has interpreted from the sedimentary record there. Following Gooding’s (1963, p. 665) abstract, these units are here referred to uniformly as stades and interstades, although his primary designations were collectively as drifts, glacial stades, stadials, and interstadials. Gooding’s (1963, p. 674) Whitewater Stade was proposed for a glacial advance that left a till containing inclusions of reddish-brown till and overlying Sangamonian sediments and soil. The glacial retreat represented by an overlying fossiliferous silt was named the New Paris Interstade. Discrepancies in radiocarbon dates for wood associated with these deposits make it difficult to use these dates confidently, and the lack of weathering makes it difficult to correlate these deposits with older Wisconsinan (Altonian) deposition in Illinois. Their correlation with other deposits is thus uncertain.

Drift representing Gooding’s Fayette Stade lies directly on a Sangamonian soil profile in some places and is overlain by a fossiliferous bed, representing the *Connersville Interstade*, that has been dated
as 20,000 years B.P., as has the *Vertigo alpestris aughtoni* bed that lies between the Center Grove and Cartersburg Till Members of the Trafalgar Formation. Gooding (1963, p. 678) called the drifts that overlie his Connersville deposits the Tazewell Stade.

**Traverse Formation**, Erian Series, Devonian System

*Type area:* A sequence of thick-beded buff granular magnesian limestones exposed around Little Traverse Bay in the northwestern part of the Lower Peninsula of Michigan was named the Little Traverse Group by N. H. Winchell in 1871 (p. 26-33). Lane (1893) shortened the name to the Traverse Group, and this terminology is now used in the type area. The Traverse is recognized as a formation in Indiana consisting of Limestones that are coextensive with a part of the Traverse Group of Michigan and that are found generally north of the Cincinnati Arch in northern Indiana (Schneider and Keller, in preparation).

*Description and correlation:* Overlain by the Antrim Shale, the Traverse Formation in Indiana consists of limestone and dolomitic limestones that are variably brown, tan, and gray and very fine grained to coarse grained and biofragmental. Sandy, argillaceous, brecciated, very fossiliferous, and cherty facies are present in the unit, which has carbonaceous wavy shaly partings in some beds. The top of the formation is commonly marked by a light-colored to tan fine-grained oolitic dolomitic limestone. It thickens to more than 100 feet in Steuben County and thins southward toward the arch. In northwestern Indiana, especially in Jasper and Lake Counties, there is evidence, although it is somewhat destroyed by erosion, that the Traverse Formation lies directly on rocks of Silurian age and thus overlaps the underlying Detroit River Formation in this area (Pinsak and Shaver, 1964; Schneider and Keller, in preparation).

The exact spatial relationships between the Traverse Formation and the North Vernon Limestone in northern Indiana are not known. They may be equivalent units and thus exist in a facies relationship; the evidence has been all but destroyed by erosion, however, along
the crestal area of the Cincinnati Arch, and the relationships are not clear. The Traverse is at least partly correlative with the Hamilton Group of New York. (See Thornbury and Deane, 1955; Pinsak and Shaver, 1964, and Schneider and Keller, in preparation.)

**Frenton Limestone**, Champlainian Series, Ordovician System

*Type locality and description:* The Trenton Limestone was named by Vanuxem (1838, p. 257) for Trenton Falls in Oneida County, N. Y., where it is a light-gray limestone about 100 feet thick. In the type area the Trenton is now generally given group status and is subdivided into several formations. In the Cincinnati region the name was first used by Miller (1881), who recognized a Trenton Group including units that had formerly been called the Point Pleasant Beds in the River Quarry Beds (of Orton, 1873). Rocks equivalent to the Point Pleasant and River Quarry Beds crop out in Indiana along the Ohio River between Norths Landing and Florence in Switzerland County. The Indiana Geological Survey now refers these exposed rocks to the Lexington Limestone.

The name Trenton has also been used in Indiana as an oilfield term to include not only those rocks properly called Trenton, but the underlying Black River Limestone and Joachim Dolomite as well. Following the usage of Gutstadt (1958a, p. 62-64), however, the Indiana Geological Survey restricts the name Trenton in the subsurface of Indiana to the upper part of this series of limestones. In northern Indiana the Trenton is 225 feet thick and consists of tan fossiliferous dolomitic limestone and dolomite; the formation becomes less dolomitic and thins southward and is very thin in or absent from the southeastern part of the state.

The Trenton Limestone overlies the Black River Limestone (Champlainian) and underlies the Kope Formation (Cincinnatian) in eastern Indiana (Brown and Lineback, 1966) and the Maquoketa Shale in the western part of the state. According to Rooney (1966) the upper contact of the Trenton Limestone is a disconformity.

*Correlation:* The Trenton Limestone is directly equivalent to the
Galena Group of northern Illinois and to the Kimmswick Limestone and the underlying Decorah Shale of Missouri (Buschbach, 1964, p. 23). Under its own name the Trenton Limestone is also recognized in the subsurface of Michigan and Ohio and eastward to the type area.

**Underwood Bed, Clegg Creek Member, Mississippian System** AMB

*Type section and description:* The Underwood Bed, originally named as a formation by Campbell (1946), is a greenish-gray fossiliferous shale in its type section in the SE¼ sec. 21, T. 2 N., R. 8 E., 2 miles east of Underwood. It is now recognized as a bed (Lineback, in preparation) in the upper part of the Clegg Creek Member of the New Albany Shale. The unit, overlain by the Henryville Bed and underlain by the Falling Run Bed, is of extremely limited extent and cannot be recognized away from its type section.

*Correlation:* Containing a Kinderhookian conodont and scolecodont fauna, the Underwood is the lowest bed of proven Mississippian age in the New Albany Shale. It is correlated with the lower part of the Hannibal Shale of the upper Mississippi Valley (on the basis of the conodont fauna of the *Siphonodella sulcata* Zone) and with the European biostratigraphic Zone cuI. (See Lineback, in preparation, and “Clegg Creek Member, Correlation.”)

**Universal Limestone Member, Dugger Formation,** AMB & CEW  
Pennsylvanian System

*Type locality and description:* The name Universal Limestone Member (of the Dugger Formation) was first used by Wier (1951) for a mottled gray and brown fine-grained argillaceous fossiliferous limestone exposed in its type locality in the SW¼ sec. 31, T. 14 N., R. 9 W., south of Universal, Vermillion County. Ranging from 0.1 to 11.9 feet in thickness, this unit can be recognized beneath the Danville Coal Member (VII) near the top of the Dugger Formation throughout most of the Indiana outcrop. The limestone is thickest and most persistent in Vermillion and Vigo Counties but can be seen in some abandoned strip mines in *War r i c k C o u n t y a s a t a n a n d d a r k - g r a y*
mottled dense nonfossiliferous limestone. In Sullivan and Knox Counties its stratigraphic position is generally marked by a calcareous shale or calcareous siltstone. The unit is entirely absent from a few places.

Correlation: Wier (in preparation) stated that the Universal Limestone Member is probably equivalent to the Brankston Fork Limestone Member of Illinois and western Kentucky, although the Galum Limestone Member of southwestern Illinois (Kosanke and others, 1960, pl. 1) occupies approximately the same stratigraphic position.

Upper Block Coal Member, Brazil Formation, HCH
Pennsylvanian System

Type area: The name Upper Block Coal, originally a trade name, was first used formally by Ashley (1909, p. 57-58) for the upper of the two block coals mined near Brazil, Clay County. Although no definite type exposure was named, Ashley apparently referred to an area about 2 or 3 miles northeast of Brazil. Many earlier descriptions of this block coal were made, including those by Ashley (1899) from the mines and outcrops in Clay County. Although of nongeographic derivation, the name is given member rank in the Brazil Formation by the Indiana Geological Survey because of long commercial and geologic application.

Description: In northern Clay County (Hutchison, 1960, p. 17-18), the Upper Block Coal Member consists of moderately dull banded hard semisplint coal that in mining comes up in blocks measuring 0.5 foot to more than 3.0 feet on a side. This characteristic, as in Lower Block coal, results from two well-developed sets of vertical joints, which trend approximately N. 20° W. and N. 70° E. In this area the Upper Block coal ranges from 1.5 to 5.0 feet in thickness and averages slightly more than 3 feet in thickness where mined. About 1.5 feet above the base of the coalbed is a zone of soft flaky coal (fusain) 0.01 to 0.03 foot thick, known in the mining terms as the “bearing-in-band,” which divides the coal into two benches of somewhat unequal thickness. The lower bench tends to breakup into small
cubes, but the upper bench breaks into larger blocks. In places the top few inches of the bed is a bone coal.

The roof of the coal is generally gray hard silty thick-bedded shale, but in places it is a few inches of gray soft flaky shale overlain by brown or gray hard medium-grained massive sandstone. In some small areas the sandstone forms the roof of the coal. The floor is gray hard slightly sandy carbonaceous underclay that becomes quite plastic when moistened.

The Upper Block Coal Member, lying near the middle of the Brazil Formation, about 25 feet above the Lower Block and 20 to 25 feet below the Minshall Coal Member, has been recognized from northern Fountain County (Hutchison, 1961) through Parke and Clay Counties (Hutchison, 1956, 1960), western Owen County, and eastern Greene County (Kottlowski, 1959, 1960). A coalbed of different physical characteristics, but here considered to be Upper Block coal, is present in the same stratigraphic position in Daviess, Dubois, and Spencer Counties (Logan, 1922, p. 624). In these southern counties the coal is much less blocky and, as a rule, much thinner than in Clay and Owen Counties and southern Parke County.

*Correlation and floral zones:* Wanless (1939, p. 105) tentatively correlated the Upper Block Coal Member of Indiana with the Pope Creek Coal of western Illinois' and the Ice House Coal and Elm Lick Coal of western Kentucky. Kosanke and others (1960, pl. 1) correlated it with the Delwood Coal of southeastern Illinois and the Dry Wood Coal of Missouri.

Guennel (1958, p. 27-30), on the basis of miospore analysis, assigned known exposures of Upper Block coal to three floral zones. These zones, from the top down, are referred to as Upper Block c Zone, Upper Block b Zone, and Upper Block a Zone.

**Velpen Limestone Member**, Linton Formation, AMB & CEW
Pennsylvanian System

*Type section:* The name Velpen Coal was used by Fuller and Ashley
(1902) for the coal in Pike County now known as the Colchester Coal Member (IIIa) of the Linton Formation. The name Velpen was later used by Weller, Henbest, and Dunbar (1942, p. 32) for the cap rock of this coal and by Cooper (1946, p. 16) and Zangerl and Richardson (1963, p. 28) for the limestone above the coal. Wier (in preparation) adopted the name Velpen Limestone Member (Linton Formation) and designated its type section in the NE¼SE¼NE¼ sec. 8, T. 2 S., R. 6 W., half a mile northeast of Velpen in Pike County.

**Description:** The Velpen Limestone Member is a variable unit, generally tan to black, dense, and argillaceous, containing small crinoid columnals and ranging from 0.1 to 1.5 feet in thickness. The Velpen consists in some places of black dense sparsely fossiliferous limestone, or brownish-gray finely crystalline limestone containing abundant brachiopods and crinoid fragments, or calcareous fossiliferous shale, or nonfossiliferous argillaceous siderite. It generally rests on a black shale, which separates it from the underlying Colchester Coal Member (IIIa), and underlies a gray or black shale. The Velpen is recognizable in the outcrop wherever the Colchester can be identified.

**Correlation:** The stratigraphic position of the Velpen is identified in Illinois as the so-called “Oak Grove Marine Limestone and shale bands” (Wanless, 1939, p. 24), a zone of limestones and calcareous shales.

**Vienna Limestone,** Chesterian Series, Mississippian System

**Type locality:** The Vienna Limestone was named by Stuart Weller (1920a, p. 396-398) for exposures in and near Vienna, Johnson County, Ill. As originally described, the lower part of the formation is a cherty limestone, and the upper part is a black fissile shale. Swann (1963, p. 38, 84-85), however, restricted the name to the limestone unit, which is commonly 5 to 10 feet thick.

**Description:** The Vienna Limestone in Indiana is an olive-green shale containing thin beds of yellow argillaceous micritic limestone. Its stated thickness of 40 to 60 feet (Malott, Esarey, and Bieberman, 1948, p. 25) is questionable because the formation is ambiguously defined and its boundaries are unclear. (See discussion of boundary
problems under “Tar Springs Formation.”) In subsurface usage, the Vienna is restricted to a thinner, basically limestone unit. Known in surface exposures from northern Crawford County to the southern border of the state, the unit overlies the Tar Springs Formation conformably and is overlain with apparent conformity by the Waltersburg Sandstone or disconformably by the Mansfield Formation (lower Pennsylvanian).

Use of name in Indiana: The first Indiana reference to the term Vienna Limestone is in a guidebook by Malott and Esarey (1940). When names were first assigned to upper Chesterian rocks in the state (Malott and Thompson, 1920), all Mississippian rocks above the Tar Springs Formation were assigned to the Buffalo Wallow Formation, which was said to include the Siberia Limestone at its base. In all probability, however, this basal limestone is the Vienna, for a few years later (Malott, 1925) the Siberia was properly assigned to a higher position and is now considered to be a member of the Menard Formation.

**Vigo Limestone Member, Patoka Formation, CEW**

**Pennsylvanian System**

*Type locality:* The Vigo Limestone Member was named as a part of the Shelburn Formation by Waddell (1954) for exposures along Prairie Creek near Vigo in Vigo County (W½NW¼ sec. 28, T. 10 N., R. 10 W.). Wier (in preparation), in redefining the Shelburn Formation, placed the Vigo Limestone Member in the Patoka Formation.

*Description:* The Vigo is a light- to dark-gray fossiliferous limestone with a few streaks of black carbonaceous limestone. It is thickest (2.5 feet) in sec. 35, T. 9 N., R. 10 W., in southern Vigo County and also is fairly thick throughout much of its outcrop area in Sullivan County. It extends on outcrop and in the subsurface from northern Vigo County southward to the Ohio River.

**Wabash Formation, Niagaran Series, Silurian System RHS**

*Type area and reference sections:* The Wabash Formation was named by Pinsak and Shaver (1964, p. 34-47) for all Niagaran rocks lying
above the Louisville Limestone, exclusive of rocks of the Salina Formation (which commonly is assigned to the Cayugan Series), in the upper Wabash Valley, Carroll, Cass, Miami, Wabash, and Huntington Counties, northern Indiana. Five principal reference sections were designated; the most complete is the rocks cored in the Northern Indiana Public Service Co. Gale M. and Glada Skinner No. 1 well near Royal Center, Cass County (NW¼NW¼ sec. 10, T. 28 N., R. 1 W), and others consist of some of the classic exposures of the reef section of northern Indiana.

Description: The Wabash Formation consists of rocks of three principal types that intergrade and replace one another spatially: (1) dolomitic siltstone to silty dolomite that is gray, dense to fine grained, argillaceous, and thick bedded to massive and that is characteristic of, but not confined to, the Mississinewa Shale Member in the lower part of the formation; (2) limestone and dolomitic limestone that is light colored, granular, fossil fragmental, cherty, and slabby bedded in weathered exposures and that is characteristic of, but not confined to, the Liston Creek Limestone Member in the upper part of the formation in and near its type area; and (3) light-colored granular vuggy massive nearly pure dolomite that is present as biothermal, bank, reef, and reef-detrital facies throughout the formation and that Pinsak and Shaver (1964, p. 39-40) referred to the Huntington Lithofacies as a replacement for the term Huntington Dolomite (Limestone, Stone) of older reports. The middle and upper parts of the formation are unassigned to member in western and northwestern Indiana, where regionally homogeneous divisions are lacking or poorly understood.

The formation is nearly 300 feet thick in west-central Indiana and as thick as 250 feet in places along its northern sinuous limit, between Fort Wayne and Lake Michigan, where it apparently terminates in a bank facies (Fort Wayne Bank) against the Salina Formation in not clearly understood relationship. Thicknesses are as much as 100 feet less in places southward where the overlying Salina Formation is near its southern limit and is complementary in thickness. Devonian rocks progressively overlap older parts of the eroded edge of the
formation southeastward and overlap it completely in southern Indiana, although
the formation is present in the subsurface immediately down the structural dip
from exposures of the Louisville Limestone. The formation is absent from east­
central Indiana because of erosion. (See Pinsak and Shaver, 1964.)

Correlation: The Wabash Formation is the highest unit among the rocks
conventionally assigned to the Niagaran Series in Indiana, but it possibly is much
younger than the undifferentiated Niagara rocks lying below the Salina Group
in deeper parts of the Michigan Basin. The formation correlates with the middle
and upper parts of the Racine Dolomite of northeastern Illinois (of Willman,
1943) and with much of the upper part of the Thorn Group, a name applied by
Lowenstam (1949, p. 18), in Illinois and in Indiana. And southward in Illinois,
in its lower part at least, it probably correlates with a part of the Moccasin Springs
Formation of the Bainbridge Group. Much of the nontypical New Corydon
Limestone of Cumings and Shrock (1928a) of east-central northern Indiana is
included in the Wabash, as is the Noblesville Dolomite of Kindle and Breger
(1904).

The well-known Mississinewa graptolites, characterized by Monograptus
falciformis (=M. bohemicus) (Cumings and Shrock, 1928a), indicate a Ludlow
age in the British standard and have some equivalency with a similar fauna in the
upper part of the Moccasin Springs Formation of Illinois. (See C. A. Ross, 1962.)
Other guide fossils are abundant species of the brachiopod Conchidium
throughout and rare examples of the pelecypod Megalomus canadensis high in
the formation, which indicate an age comparable to that of the Guelph Dolomite
of the Great Lakes area and of the Ludlow Series of Britain. (See also the “Salina
Formation,” Berry and Boucot, in preparation, and Pinsak and Shaver, 1964.)

Waldron Shale, Formation, Niagaran Series, Silurian System RHS

Type section: The name Waldron Shale was used by N. M. Elrod (1883, p.
111), replacing the earlier designations Waldron Bed and Waldron fossil bed, for
the thinly interbedded clay, shale, and lime-
stone overlying the quarry stone (Laurel Limestone) near Waldron, Shelby County. The term Waldron, at Waldron, referred to the exposure on Conns Creek in the NE¼ sec. 6, T. 11 N., R. 8 E., which was one of the locations yielding the renowned fauna of more than 200 species described by James Hall of New York and others. (See Cumings, 1922, p. 453, 454.) During recent years, excellent type exposures have been opened in the Standard Materials Corp. quarry at the Conns Creek location stated above.

The term Waldron Formation was adopted by Pinsak and Shaver (1964, p. 29) for the more dolomitic facies of this unit in northern Indiana.

**Description:** Underlain by the Laurel Member of the Salamonie Dolomite in southern Indiana and by the Salamonie Dolomite in northern Indiana and overlain by the Louisville Limestone (both with apparent conformity), Waldron shale and dark to mottled sublithographic to fine-grained limestone and dolomitic limestone, which commonly is nodular, constitute a marked stratigraphic break of a few feet within scores of feet of otherwise fairly pure carbonate rocks. Fossils are extremely abundant in places, commonly in small biohermal masses or mats, but they are absent from many sections.

In southern Indiana the Waldron tends to be thinner, as much as 10 feet thick, and more shaly, but northward in the subsurface it consists almost wholly of argillaceous carbonate rocks as much as 30 feet thick.

The Waldron area of subdrift exposure extends south and north of Shelby County, crosses the structural crest in north-central Indiana, turns eastward, and crosses from Adams County into Ohio. It is absent east and south of the outcrop area and from the northern two to three tiers of Indiana counties. (See Pinsak and Shaver, 1964.)

**Correlation:** Following Hall (1882, p. 219-220), a middle Niagaran age for the Waldron, comparable to that of the Rochester Shale of New York, is favored here and, in the British standard, a Wenlock age (Berry and Boucot, in preparation). The Waldron very likely is
Waltersburg Sandstone, Chesterian Series, HHG
Mississippian System

Type locality: The Waltersburg Sandstone was named by Stuart Weller (1920a, p. 398) for exposures of a massive cliff-forming sandstone near Waltersburg, Pope County, Ill. There the unit is as much as 70 feet thick but is absent from some places or is not recognizable.

Former name in Indiana: This unit was first named the Wickliffe Sandstone by Malott (1925, p. 108). Later a correlation with the Waltersburg was suggested but without presentation of supporting evidence (Malott, 1931, p. 222), and gradually the name Waltersburg supplanted the term Wickliffe (Malott and Esarey, 1940; Malott, Esarey, and Bieberman, 1948). Originally, Malott (1925, p. 109) had reservations about naming the sandstone because of its discontinuity, but evidently he decided to use the separate name because a sandstone at an apparently equivalent position in Illinois had also been recognized by Weller (1920a, p. 398).

Description: The Waltersburg Sandstone in Indiana is a hard resistant sandstone that forms ledges and waterfalls. The thickness is variously stated, although 35 feet seems to be the maximum expectable. If the name is restricted to sandstone, as intended by Weller (1920a), Malott (1925), and Malott, Esarey, and Bieberman (1948, p. 25), the unit is present only from northwestern Crawford County southward to north-central Perry County and is absent from most of the southern two-thirds of Perry County, where shale occupies the equivalent stratigraphic interval (Malott, 1925, p. 108-109). (See also discussion of boundary problems under “Tar Springs Formation.”) In the subsurface, a thicker unit that includes shale as well as sandstone is recognized from southern Daviess County southwestward. The Walters-
burg conformably overlies the Vienna Limestone and is overlain conformably by the Menard Limestone or disconformably by the Mansfield Formation (lower Pennsylvanian).

**West Baden Group**, Chesterian Series, Mississippian System HHG

*Type locality and description:* The name West Baden was originally proposed as a group name in 1920 by E. R. Cumings in a letter to Stuart Weller (Cumings, 1922, p. 514). The term received no subsequent use, however, until revived in a modified sense by Gray, Jenkins, and Weidman (1960, p. 44). The group, named for West Baden, Orange County, includes, in descending order, the Elwren Formation, Reelsville Limestone, Sample Formation, Beaver Bend Limestone, and Bethel Formation. It consists of gray and varicolored shales, thin-bedded and crossbedded sandstones, and beds of limestone of variable thickness. The total thickness at the outcrop ranges from 100 to 140 feet (Gray, Jenkins, and Weidman, 1960, p. 44). Known on the surface from Putnam County southward to the Ohio River, the West Baden Group can also be recognized in the subsurface. The maximum reported subsurface thickness is 260 feet, in Gibson County (Sullivan, in preparation). A major feature of the West Baden Group in the subsurface is a southwestward-trending belt about 10 miles wide across which the limestone units were not deposited and in which sandstones dominate the entire thickness of the group (Sullivan, in preparation). The West Baden conformably overlies the Blue River Group (Valmeyeran and Chesterian Series) and is overlain conformably by the Stephensport Group (Chesterian Series) or disconformably by the Mansfield Formation (lower Pennsylvanian).

**Naming of groups in upper Mississippian of Indiana:** Rocks that are now considered to belong in the Chesterian Series in Indiana previously went by a variety of names, most of which originated elsewhere. Among these names are Ferruginous Sandstone, Kaskaskia Limestone, *Archimedes* Limestone, Pentremital Limestone, and Chester Limestone, all of which were originally used in early reports on the geology of southwestern Illinois. Hopkins (1904) first applied an indigenous name to these rocks in Indiana. He included all rocks
from the top of the Mitchell Limestone (discussion under “Blue River Group”) to the base of the Mansfield Formation in his Huron Group, named for Huron, Lawrence County. This name was used for a time, but it was preoccupied, and when equivalence to the Chester Group of southern Illinois became clearer, Greene (1911, p. 269) suggested that the name Chester be substituted and then casually and without explanation used the name Solsberry Formation for these rocks (Greene, 1911, p. 275, 281). The term Chester came into common use, however, and as formational names became accepted, subdivision of the series into groups became possible. These subdivisions were called lower Chester, middle Chester, and upper Chester (Cumings, 1922, p. 408, 515), and were used as groups but commonly were not expressly so called. “Chesterian” is now regarded by the Indiana Geological Survey as a time and time-rock name and in Indiana is appropriately designated as an epoch or a series but not as a group. Gray, Jenkins, and Weidman (1960, p. 44) therefore revived Cumings’ suggested names West Baden and Stephensport. Group names for rocks in the upper part of the Chesterian Series in Indiana have not yet been proposed. (See also discussions by Cumings, 1922, p. 508-515, and Malott, 1952, p. 4-7.)

**West Franklin Limestone Member, Shelburn Formation, CEW**

Pennsylvanian System

**Type locality and synonyms:** The limestone exposed in the high banks of the Ohio River at West Franklin, Posey County, was first mentioned in the literature by Owen (1839, p. 8) and later by Lesquereux (1862, p. 296-297), who described the units exposed along the river and referred to them informally as the lower bank of the West Franklin Limestone. Wilmarth (1938, p. 2307), however, gave credit for first use of the name to Collett (1884, p. 61-62), who also used the term West Franklin Limestone. Wier and Gray (1961) and Wier (in preparation) reduced the rank of this limestone to that of member, uppermost in the Shelburn Formation, and Wier (in preparation) designated the above-mentioned exposure at West Franklin in the SE¼SE¼ sec. 24, T. 7 S., R. 12 W., as the type locality.
Synonyms of the West Franklin are the terms Somerville Formation, used in Gibson County by Fuller and Clapp (1904, p. 2), and Maria Creek Limestone, used in Sullivan County by Malott (1948, p. 125).

**Description and correlation:** The West Franklin Limestone Member generally consists of limestone beds separated by shale. In Gibson County three beds of limestone are found, but northward only the upper two are present and in places only one limestone is observed. The lowest limestone bed is sparsely fossiliferous, ranges from 1 to 4 feet in thickness, and is overlain by 1 to 25 feet of tan, blue-gray, or variegated nonfossiliferous shale that in some places has an intercalated shale. The middle limestone is a massive light-gray to tan argillaceous fossiliferous limestone ranging from 4 to 10 feet in thickness at the south end of the outcrop and thinning northward to 0.5 to 3.8 feet of flaggy nodular limestone in Sullivan County. In Posey County it contains large colonies of the coral *Chaetetes*. (See Wier, in preparation.) Gray shale, 0.1 to 3 feet thick, separates the middle limestone from the upper, more cherty limestone, which is gray to brown, dense, crystalline, argillaceous, and fossiliferous. The upper limestone is 1 to 6 feet thick in Gibson, Vanderburgh, and Posey Counties and attains a maximum thickness of 10 feet in Sullivan County.

The West Franklin Limestone Member is recognized in Illinois and is correlated with the Madisonville Limestone of western Kentucky.

**Whitewater Formation,** Cincinnatian Series, AMB

Ordovician System

**Type locality:** The Whitewater Formation was named by Nickles (1903, p. 208) for exposures of bluish-gray rubbly argillaceous limestone interbedded with calcareous shale along the Whitewater River at Richmond, Wayne County. The Whitewater was formerly assigned to the Richmond Group, but the Richmond no longer is considered here to have group status in Indiana, though its use in an age or stage sense is not precluded. (See Brown and Lineback, 1966, p. 1020.)

**Description:** As now recognized, the Whitewater Formation includes
the rocks formerly placed in the Elkhorn Formation (Utgaard and Perry, 1964). Limestone and calcareous shale make up the formation, which contains a higher proportion of limestone than do other Cincinnatian units below the Saluda Formation (Brown and Lineback, 1966, p. 1022). At the base of the Whitewater near Madison, Ind., and Louisville, Ky., is a thin gastropod-rich limestone bed that has been called the Hitz Bed, Hitz Limestone Member, or *Lophospira hammell* Bed (Foerste, 1903, p. 347), and a part of the formation was once included in the Versailles Bed (Foerste, 1905). The Whitewater conformably overlies the Saluda Formation and is overlain by the Brassfield Limestone (Silurian) except in a few places in Jefferson, Ripley, and Decatur Counties, where the Osgood Member of the Salamonie Dolomite directly overlies the formation (Brown and Lineback, 1966, p. 1022). The upper contact of this uppermost unit in the Cincinnatian Series is thought to be disconformable because the basal Brassfield contact is irregular and because there are reworked Ordovician fossils in the Brassfield itself. The Whitewater Formation thins southward from about 80 feet at Richmond to 64 feet at New Point, and to virtually nothing near Madison, but this thinning is to some extent accompanied by a corresponding thickening of the underlying Saluda Formation and therefore is probably not entirely ascribable to disconformity. The Whitewater Formation is not recognized outside the Ohio-Kentucky-Indiana area of Ordovician outcrop. (See the discussion on Cincinnatian faunal zones under “Dillsboro Formation.”)

**Literature Cited**

Alexander, J. W.


American Commission on Stratigraphic Nomenclature

Ashley, G. H.
Ashley, G. H., and Kindle, E. M.
Bassler, R. S.
Bates, R. E.
Becker, L. E.
Beede, J. W., and others
Berry, W. B. N., and Boucot, A. J.
Bhattacharya, Nityananda
Blatchley, W. S.
Blatchley, W. S., and Ashley, G. H.

Bradley, F. H.

Brayer, R. C.

Brokaw, A. D.

Brown, G. D., Jr., and Lineback, J. A.

Browne, R. G.
1958 - The geology of Bernheim Forest: Kentucky Naturalist, v. 12, p. 27-53, pls. 1-6, 5 figs.

Browne, R. G., and Schott, V. J.

Burger, A. M., and others
1966 - Excursions in Indiana geology: Indiana Geol. Survey Guidebook 12, 71 p., 16 figs., 2 maps, 1 diagram.

Buschbach, T. C.

Butts, Charles
1922 - The Mississippian Series of eastern Kentucky: Kentucky Geol. Survey, ser. 6, v. 7, 188 P., 82 pls., 7 figs.
LITERATURE CITED

Campbell, Guy
Campbell, M. R.
Caster, K. E., Dalve, E. A., and Pope, J. K.
Chamberlin, T. C., and Salisbury, R. D.
Cohee, G. V.
1948 - Thickness and lithology of upper Ordovician and lower and middle Silurian rocks in the Michigan Basin: U.S. Geol. Survey Oil and Gas Inv. (Prelim.) Chart 33, 2 sheets, 10 figs.

Collett, John
Collinson, Charles, Scott, A. J., and Rexroad, C. B.
1962 - Six charts showing biostratigraphic zones, and correlations based on conodonts from Devonian and Mississippian rocks of the upper Mississippi Valley: Illinois Geol. Survey Circ. 328, 32 p., 6 charts.
Conant, L. C., and Swanson, V. E.
Conkin, J. E.
Conkin, J. E.


Cooper, G. A., and Phelan, Thomas

Cooper, G. A., and Warthin, A. S.


Cox, E. T.

1876 Seventh annual report of the Geological Survey of Indiana, made during the year 1875: 601 p., 2 pls., 1 fig., 4 maps.

Crider, A. F.

Culbertson, J. A.

Cumings, E. R.


LITERATURE CITED

Cumings, E. R.

Cumings, E. R., and Galloway, J. J.

Cumings, E. R., and Shrock, R. R.

Cumings, E. R., and others

Dana, J. D.

Daniels, R. B., and Handy, R. L.

Dawson, T. A.

DeWolf, F. W.

Dunn, P. H.

Ells, G. D.
Elrod, M. N.
Elrod, M. N., and McIntire, E. S.
Emmons, Ebenezer
Engelmann, George
Engelmann, Henry
Esarey, R. E., and Bieberman, D. F.
Evans, C. S.
Fisher, D. W.
Foerste, A. F.
1898 - A report on the Niagara limestone quarries of Decatur, Franklin, and Fayette Counties, with remarks on the geology of the middle and upper Silurian rocks of these and neighboring (Ripley, Jennings, Bartholomew, and Shelby) counties: Indiana Dept. Geology and Nat. Resources, Ann. Rept. 22, p. 195-256, 5 pls.
Foerste, A. F.
1903 The Richmond Group along the western side of the Cincinnati Anticline in Indiana and Kentucky: Am. Geologist, v. 31, p. 333-361, 3 pls., 1 fig.
1905 - The classification of the Ordovician rocks of Ohio and Indiana: Science, new ser., v. 22, p. 149-152.
1906 - The Silurian, Devonian, and Irvine formations of east-central Kentucky, with an account of their clays and limestones: Kentucky Geol. Survey Bull. 7, 369 p., 8 pls., 10 figs., 7 maps.

Ford, J. P.

Fox, W. T.
1962 - Stratigraphy and paleoecology of the Richmond Group in southeastern Indiana: Geol. Soc. America Bull., v. 73, p. 621-642, 10 figs., 1 table.

Franklin, D. W.
Franklin, D. W., and Wanless, H. R.

French, R. R.

Friedman, S. A.

Frye, J. C., and Willman, H. B.

Fuller, M. L., and Ashley, G. H.

Galloway, J. J., and Kaska, H. V.

Gates, G. R., and Melhorn, W. N.
- Geology and mineral resources of Monroe County, Indiana: Indiana Geol. Survey Bull. - [in preparation].

Geis, H. L.
1932 - Some ostracodes from the Salem Limestone, Mississippian, of Indiana: Jour. Paleontology, v. 6, p. 149-188, pls. 22-26, 1 fig.

Geologic Names Committee, Indiana Geological Survey

Glenn, L. C.
1922 - The geology and coals of Webster County, Kentucky: Kentucky Geol. Survey, ser. 6, v. 5, 249 p., 31 figs.
Gooding, A. M.
1963 - Illinoian and Wisconsin glaciations in the Whitewater basin, southeastern Indiana, and adjacent areas: Jour. Geology, v. 71, p. 665-682, 3 figs., 6 tables.

Gorby, S. S.

Gordon, Mackenzie, Jr.

Gray, H. H.
Gray, H. H., Brown, G. D., Jr., and Lineback, J. A.
Gray, H. H., Jenkins, R. D., and Weidman, R. M.
Gray, H. H., and Perry, T. G.

Greene, F. C.

Grohskopf, J. G.

Guennel, G. K.
Gutstadt, A. M.
1958a - Cambrian and Ordovician stratigraphy and oil and gas possibilities in Indiana: Indiana Geol. Survey Bull. 14, 103 p., 1 pl., 17 figs., 8 tables.

Hall, James
1858 - Geology of Iowa: general reconnoissance: Des Moines, Charles van Benthuysen, Report of the Geological Survey of the State of Iowa, p. 45-146, figs. 4-11, 1 map.
1879a - Footnote [Correlation of the Pendleton Sandstone]: Indiana Geol. Survey, Ann. Repts. 8, 9, and 10, p. 60.

Harrison, J. A.

Hilgard, E. W.
LITERATURE CITED

Hopkins, T. C.
1896 - The Carboniferous sandstones of western Indiana; an economic report on the sandstones of a portion of western Indiana, accompanied by two atlas sheets showing the outcrops and distribution of the sandstone: Indiana Dept. Geology and Nat. Resources, Ann. Rept. 20, p. 186-327, 9 pls., 7 figs., 2 maps.
1904 - A short description of the topography of Indiana, and of the rocks of the different geological periods; to accompany the geological map of the state: Indiana Dept. Geology and Nat. Resources, Ann. Rept. 18, p. 15-78.

Hopkins, T. C., and Siebenthal, C. E.

Horowitz, A. S.
1965 - Crinoids from the Glen Dean Limestone (middle Chester) of southern Indiana and Kentucky: Indiana Geol. Survey Bull. 34, 52 p., 5 pls., 3 figs., 10 tables.

Horowitz, A. S., and Perry, T. G.

Huddle, J. W.

Hutchison, H. C.
Hutchison, H. C.
- Distribution, structure, and mined areas of coals in Daviess County, Indiana: Indiana Geol. Survey Prelim. Coal Map - [in preparation, a].
- Distribution, structure, and mined areas of coals in Perry County, Indiana: Indiana Geol. Survey Prelim. Coal Map 14 [in preparation, b].

Indiana Geological Survey

Indiana University Sedimentation Seminar
- Bethel Sandstone (Mississippian) of western Kentucky and south-central Indiana, a submarine channel fill: p., 1 pl., 17 figs., 3 tables [in preparation].

Jenkins, R. D.

Johnson, G. H., and Keller, S. J.
- Geologic map of the 1° X 2° Fort Wayne Quadrangle, Indiana, Michigan, and Ohio, showing bedrock and unconsolidated deposits: Indiana Geol. Survey Regional Geol. Map - [in preparation].

Keyes, C. R.

Kindle, E. M.
1899 The Devonian and Lower Carboniferous faunas of southern Indiana and central Kentucky: Bull. Am. Paleontology, no. 12 (v. 3), III P.
Kindle, E. M.

Kindle, E. M., and Breger, C. L.
1904 - The stratigraphy and paleontology of the Niagara of northern Indiana:

KjHeesvig-Waering, E. N.

Knight, R. D., and Koenig, J. W.

Kosanke, R. M., and others

Kottlowski, F. E.

Landes, K. K.

Lane, A. C.
Lane, A. C., and others

Leighton, M. M.

Leighton, M. M., and Brophy, J. A.

Leighton, M. M., and Willman, H. B.

Lesley, Joseph

Lesquereux, Leo

Leverett, Frank
1898 - The Peorian soil and weathered zone: Jour. Geology, v. 6, p. 244-249.
1929 - The Pleistocene of northern Kentucky: Kentucky Geol. Survey, ser. 6, v. 31, 80 p., 15 figs.

Liebe, R. M.
LITERATURE CITED

Lineback, J. A.
1963 Age of the Rockford cephalopod fauna (Mississippian) of southern Indiana: Jour. Paleontology, v. 37, p. 939-942, 1 fig.

Logan, W. N.
1930 The mineral fuel resources of Indiana: Indiana Year Book for 1929, p. 161-171, 2 figs., 1 table.

Lowenstam, H. A.

Lyon, S. S.
1860 - Remarks on the stratigraphical arrangement of the rocks of Kentucky, from the Catenipora escharoides horizon of the Upper Silurian Period, in Jefferson County, to the base of the productive Coal Measures in the eastern edge of Hancock County: Acad. Sci. St. Louis Trans., v. 1, p. 612-621, 1 fig.

McEwan, E. D.

McFarlan, A. C., and White, W. H.

McFarlan, A. C., and others
McGrain, Preston

McGregor, D. J.
1954a - Gypsum and anhydrite deposits in southwestern Indiana: Indiana Geol. Survey Rept. Prog. 8, 24 p., 2 pls., 2 figs.

Malott, C. A.
1919 - The “American Bottoms” region of eastern Greene County, Indiana-a type unit in southern Indiana physiography: Indiana Univ. Studies, v. 6, no. 40, 61 p., 2 pls., 10 figs.
1921 - Some special physiographic features of the Knobstone cuesta region of southern Indiana; an example of explanatory physiography: Indiana Acad. Sci. Proc. for 1919, p. 361-383, 7 figs., 2 maps.
1946 - The geology of Cataract Falls, Owen County, Indiana: Jour. Geology, v. 54, p. 322-326, 2 figs.
LITERATURE CITED

Malott, C. A.

Malott, C. A., and Esarey, R. E.
1940 - Outcrop of the Chester Series of southern Indiana [mimeo.]: Indiana-Kentucky Geol. Soc., May 18, 1940, 1 pl., route map.

Malott, C. A., Esarey, R. E., and Bieberman, D. F.
1948 - Upper and middle Mississippian formations of southern Indiana:

Malott, C. A., and Thompson, J. D., Jr.
1920 - The stratigraphy of the Chester Series of southern Indiana [abs.]

Mather, W. W.

Meek, F. B., and Worthen, A. H.

Meents, W. F., and Swann, D. H.

Melhorn, W. N.

Melhorn, W. N., and Smith, N. M.

Miller, A. K., and Collinson, Charles
Miller, S. A.

Mound, M. C.

Newberry, J. S.

Newcombe, R. B.

Newsom, J. F.

Newton, W. A., and Weller, J. M.

Nickles, J. M.
1902 - The geology of Cincinnati: Cincinnati Soc. Nat. History Jour., v. 20, no. 2, p. 49-100, 1 fig.

Nicoll, R. S., and Rexroad, C. B.
1968 - Stratigraphy and conodont paleontology of the Salamonie Dolomite and Lee Creek Member of the Brassfield Limestone (Silurian) in southeastern Indiana and adjacent Kentucky: Indiana Geol. Survey Bull. 40, 73 p., 7 pls., 4 figs., 2 tables.
Norwood, C. J.  

Orton, Edward  

Owen, D. D.  

Owen, D. D., and Norwood, J. G.  
1847 - Researches among the Protozoic and Carboniferous rocks of central Kentucky made during the summer of 1846: St. Louis, Keemle and Fields, 12 p., 2 pls.

Owen, Richard  

Patton, J. B.  
Patton, J. B.
Patton, J. B., and Dawson, T. A.
Patton, J. B., Perry, T. G., and Wayne, W. J.
Perkins, R. D.
Perry, T. G., and Horowitz, A. S.
  1963 - Bryozoans from the Glen Dean Limestone (middle Chester) of southern Indiana and Kentucky: Indiana Geol. Survey Bull. 26, 51 p., 9 pls., 1 fig., 15 tables.
Perry, T. G., and Smith, N. M.
  1958 - The Meramec-Chester and intra-Chester boundaries and associated strata in Indiana: Indiana Geol. Survey Bull. 12, 110 p., 6 pls., 1 fig.
Perry, T. G., Smith, N. M., and Wayne, W. J.
Pinsak, A. P.
  1957 - Subsurface stratigraphy of the Salem Limestone and associated formations in Indiana: Indiana Geol. Survey Bull. 11, 62 p., 5 pls., 8 figs., 2 tables.
Pinsak, A. P., and Shaver, R. H.
Potter, P. E.
Puscas, George

1946 - Fort Knox and vicinity, geology: Army Map Service, map and text.

Read, C. B.

Rexroad, C. B.
1967 - Stratigraphy and conodont paleontology of the Brassfield (Silurian) in the Cincinnati Arch area: Indiana Geol. Survey Bull. 36, 64 p., 4 pls., 4 figs.


Rexroad, C. B., and Collinson, Charles


Rexroad, C. B., and Scott, A. J.
1964 - Conodont zones in the Rockford Limestone and the lower part of the New Providence Shale (Mississippian) in Indiana: Indiana Geol. Survey Bull. 30, 54 p., 3 pls., 1 fig., 2 tables.

Rexroad, C. B., and others

Rickard, L. V.
Rodriguez, Joaquin

Rooney, L. F.

Ross, C. A.

Ross, T. W.

Safford, J. M.
1869 - Geology of Tennessee: Nashville, Tenn., S. C. Mercer, Printer of the State, 550 p., illus., pls., map.

St. Jean, Joseph, Jr.

Sangree, J. B.

Savage, T. E.

Schneider, A. F., and Keller, S. J.

Shaver, R. H., and others
Shaw, E. W., and Savage, T. E.

Shideler, W. H.

Shimek, Bohumil

Shimer, H. W., and Shrock, R. R.

Shrock, R. R., and Malott, C. A.

Shumard, B. F.

Siebenthal, C. E.

Siever, Raymond

Smith, N. M.
1965 - The Sanders Group and subjacent Muldraugh Formation (Mississippian) in Indiana: Indiana Geol. Survey Rept. Prog. 29, 20 p., 2 figs., 1 table.

Stauffer, C. R.
1934 - Type Paleozoic sections in the Minnesota valley: Jour. Geology, v. 42, p. 337-357.

Stockdale, P. B.
1929a - Facies of the Borden rocks of southern Indiana [abs.]: Ohio Jour. Sci., v. 29, p. 170.
Stockdale, P. B.

Stumm, E. C.
1964 - Silurian and Devonian corals of the Falls of the Ohio: Geol. Soc. America Mem. 93, 184 p., 80 pls., 2 figs., 1 table.

Sullivan, D. M.

Sunderman, J. A.
1931 A reconnaissance survey of the geology of northern Hardin County: Kentucky Geol. Survey, ser. 6, v. 37, p. 267-299, 3 pls., 10 figs.

Sutton, A. H., and Weller, J. M.

Sutton, D. G., and Sutton, A. H.
1937 - Middle Devonian of southern Indiana: Jour. Geology, v. 45, p. 320331, 1 fig.

Swadley, W. C.

Swann, D. H.

Templeton, J. S., and Willman, H. B.
Thompson, Maurice
Thompson, M. L., and Riggs, A. E.
Thompson, M. L., and Shaver, R. H.
Thornbury, W. D., and Deane, H. L.
1955 - The geology of Miami County, Indiana: Indiana Geol. Survey Bull. 8, 49 p., 8 pls., 1 fig.
Trowbridge, A. C., and Atwater, G. L.
Ulrich, E. O.
1904 - Determination and correlation of formations [of northern Arkansas]
Ulrich, E. O., and Smith, W. S. T.
Utgaard, John, and Perry T. G.
1960 Fenestrate bryozoans from the Glen Dean Limestone (middle Chester) of southern Indiana: Indiana Geol. Survey Bull. 19, 32 p., 6 pls., 12 figs.
1964 Trepostomatous bryozoan fauna of the upper part of the Whitewater Formation (Cincinnatian) of eastern Indiana and western Ohio: Indiana Geol. Survey Bull. 33, 111 p., 23 pls., 1 fig., 62 tables.
Van Sant, J. F., and Lane, N. G.
Vanuxem, Lardner
Waddell, Courtney

Walcott, C. D.

Walker, F. H., Puryear, R. E., and Cathey, J. B.

Walliser, O. H.

Wanless, H. R.

Wascher, H. L., Humbert, R. P., and Cady, J. G.

Wayne, W. J.
Wayne, W. J.
Wayne, W. J., Johnson, G. H., and Keller, S. J.
1966 - Geologic map of the 1° X 2° Danville Quadrangle, Indiana and Illinois, showing bedrock and unconsolidated deposits: Indiana Geol. Survey Regional Geol. Map 2.
Wayne, W. J., and Zumberge, J. H.
Weiss, M. P.
Weiss, M. P., and Sweet, W. C.
Weller, J. M., and Sutton, A. H.
Weller, J. M., and others
Weller, Stuart
1920b - The geology of Hardin County and the adjoining part of Pope County: Illinois Geol. Survey Bull. 41, 416 p.,11 pls., 30 figs., 4 tables.
White, C. A.
1870 - Report on the geological survey of the State of Iowa: Des Moines, Mills and Co., v. 1, 391 p., illus., tables.
Whitlatch, G. I., and Huddle, J. W.

Wier, C. E.
1952 - Geology and mineral deposits of the Jasonville Quadrangle, Indiana: Indiana Geol. Survey Bull. 6, 34 p., 6 pls., 6 figs.

Wier, C. E., and Esarey, R. E.

Wier, C. E., and Gray, H. H.
1961 - Geologic map of the Indianapolis 1° X 2° Quadrangle, Indiana and Illinois, showing bedrock and unconsolidated deposits: Indiana Geol. Survey Regional Geol. Map, Indianapolis Sheet.

Wier, C. E., and Stanley, J. T.
1953 - Distribution, structure, and mined areas of coals in Pike County, Indiana: Indiana Geol. Survey Prelim. Coal Map 3.

Willman, H. B.

Wilmarth, M. G.
Wilson, Druid, Keroher, G. C., and Hansen, B. E.

Winchell, N. H.

Winchell, N. H., and Ulrich, E. O.

Winslow, Arthur
1894 - Lead and zinc deposits: Missouri Geol. Survey, v. 6, 387 p., illus., tables.

Wooster, L. C.

Worthen, A. H.

Zangerl, Richard, and Richardson, E. S., Jr.
1963 - The paleoecological history of two Pennsylvanian black shales: Fieldiana, Geology Mem., v. 4, 352 p., 56 pls., 51 figs., 12 tables.

Zeller, E. J.

Ziegler, Willi
# Index

Rock-unit names in boldface type have been approved for use by the Indiana Geological Survey and are discussed in detail in the text.

<table>
<thead>
<tr>
<th>Page</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
</tr>
<tr>
<td>Abington Interglacial</td>
<td>80</td>
</tr>
<tr>
<td>Allens Creek Facies</td>
<td>51</td>
</tr>
<tr>
<td>Alpine Stade</td>
<td>80</td>
</tr>
<tr>
<td><strong>Alum Cave Limestone Member</strong></td>
<td>4</td>
</tr>
<tr>
<td>Ammonoid-Thurammina Assemblage Zone</td>
<td>152</td>
</tr>
<tr>
<td><em>amorphognathoides</em> Zone</td>
<td>124</td>
</tr>
<tr>
<td>Amphipora beds</td>
<td>77</td>
</tr>
<tr>
<td>Amphissites</td>
<td></td>
</tr>
<tr>
<td><em>centronotus</em></td>
<td>29, 73, 132, 172</td>
</tr>
<tr>
<td><em>A mphissites girtyi</em></td>
<td>29, 132, 172</td>
</tr>
<tr>
<td>Amphissites rothi, Zone of</td>
<td>57, 61, 73, 105, 132</td>
</tr>
<tr>
<td><em>A mphissites weaveri</em></td>
<td>61</td>
</tr>
<tr>
<td><strong>Antioch Limestone Member</strong></td>
<td>5</td>
</tr>
<tr>
<td>Antrim Shale</td>
<td>5</td>
</tr>
<tr>
<td><em>Apatognathus? geminus-Cavusognathus</em> Assemblage Zone</td>
<td>22, 120</td>
</tr>
<tr>
<td>Archimedes, Limestone</td>
<td>65, 66, 189</td>
</tr>
<tr>
<td>Amherst Formation</td>
<td>47, 48</td>
</tr>
<tr>
<td>Arthur Limestone</td>
<td>4</td>
</tr>
<tr>
<td><strong>Atherton Formation</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Aux Vases Formation</strong></td>
<td>8</td>
</tr>
<tr>
<td>Aux Vases Sandstone, Formation</td>
<td>8, 126</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td><strong>B</strong></td>
</tr>
<tr>
<td><em>Bactrognathus-Polygnathus communis</em> Assemblage Zone</td>
<td>22, 120</td>
</tr>
<tr>
<td><em>Bactrognathus</em>-<em>Taphrognathus</em> Assemblage Zone</td>
<td>22</td>
</tr>
<tr>
<td><strong>Barlow Lime</strong></td>
<td>10, 15</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

223
<table>
<thead>
<tr>
<th>Rock Unit</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffaloville Coal Member</td>
<td>28</td>
</tr>
<tr>
<td>Buffalo Wallow Formation</td>
<td>166,184</td>
</tr>
<tr>
<td>Bufkin Formation</td>
<td>149</td>
</tr>
<tr>
<td>Buhrstone, burrstone</td>
<td>78</td>
</tr>
<tr>
<td>Busseron Sandstone Member</td>
<td>29</td>
</tr>
<tr>
<td>Buterville Till Member</td>
<td>30</td>
</tr>
<tr>
<td>Button Mold Knob Member</td>
<td>118</td>
</tr>
<tr>
<td>Cagle loess Member</td>
<td>31</td>
</tr>
<tr>
<td>Callixylon</td>
<td>113</td>
</tr>
<tr>
<td>Camp Run Member</td>
<td>31</td>
</tr>
<tr>
<td>Cannelton Coal, Sandstone</td>
<td>104</td>
</tr>
<tr>
<td>Cannelton Lithofacies</td>
<td>103</td>
</tr>
<tr>
<td>Carbondale Group</td>
<td>32</td>
</tr>
<tr>
<td>Cartersburg Till Member</td>
<td>33</td>
</tr>
<tr>
<td>Carwood Formation</td>
<td>34</td>
</tr>
<tr>
<td>Cataract Formation</td>
<td>151</td>
</tr>
<tr>
<td>Cavefinella casei</td>
<td>105</td>
</tr>
<tr>
<td>cement rock, beds</td>
<td>121,167,168</td>
</tr>
<tr>
<td>Center Grove Till Member</td>
<td>34</td>
</tr>
<tr>
<td>Centerville Stade</td>
<td>80</td>
</tr>
<tr>
<td>Cheeletes</td>
<td>135,191</td>
</tr>
<tr>
<td>Chester Limestone, Group, lower Chester</td>
<td>189,190</td>
</tr>
<tr>
<td>upper Chester</td>
<td>189,190</td>
</tr>
<tr>
<td>Chonites coronatus</td>
<td>11</td>
</tr>
<tr>
<td>Cisco Branch Facies</td>
<td>58</td>
</tr>
<tr>
<td>Clarksville Division</td>
<td>47</td>
</tr>
<tr>
<td>Clegg Creek Member</td>
<td>35</td>
</tr>
<tr>
<td>Clinton Limestone</td>
<td>22,88,151</td>
</tr>
<tr>
<td>Clore Limestone</td>
<td>36</td>
</tr>
<tr>
<td>Cloverdale Till Member</td>
<td>37</td>
</tr>
<tr>
<td>coal at Alum Cave</td>
<td>169</td>
</tr>
<tr>
<td>Coal I</td>
<td>60,103,164</td>
</tr>
<tr>
<td>Coal II</td>
<td>24,148,168,170,171</td>
</tr>
<tr>
<td>Coal III</td>
<td>132,162,170,171</td>
</tr>
<tr>
<td>Coal Illa</td>
<td>38,183</td>
</tr>
<tr>
<td>Coal IV</td>
<td>132,162,170,174</td>
</tr>
<tr>
<td>Coal IVa</td>
<td>74</td>
</tr>
<tr>
<td>Coal V</td>
<td>27,28,169</td>
</tr>
<tr>
<td>Coal Va</td>
<td>27</td>
</tr>
<tr>
<td>Coal Vb</td>
<td>27</td>
</tr>
<tr>
<td>Coal VI</td>
<td>27,42,74,162</td>
</tr>
<tr>
<td>Coal VII</td>
<td>29,41,42,164,165,169</td>
</tr>
<tr>
<td>Coal VIIa</td>
<td>134</td>
</tr>
<tr>
<td>Coal VIIb</td>
<td>27</td>
</tr>
<tr>
<td>Coal VIIc</td>
<td>27</td>
</tr>
<tr>
<td>Coal VIId</td>
<td>27</td>
</tr>
<tr>
<td>Coal VIIe</td>
<td>27</td>
</tr>
<tr>
<td>Coal VIIf</td>
<td>27</td>
</tr>
<tr>
<td>Coal VIIg</td>
<td>27</td>
</tr>
<tr>
<td>Cnelosira congesta</td>
<td>81,157</td>
</tr>
<tr>
<td>Cohn Coal Member</td>
<td>38</td>
</tr>
<tr>
<td>Colchester Coal Member (Illa)</td>
<td>38</td>
</tr>
<tr>
<td>Coldwater Red Rock</td>
<td>39</td>
</tr>
<tr>
<td>Coldwater Shale</td>
<td>39</td>
</tr>
<tr>
<td>Columbia Stade</td>
<td>80</td>
</tr>
<tr>
<td>Colunnaria Reef</td>
<td>158</td>
</tr>
<tr>
<td>Conchidium</td>
<td>94, 99,112,156,186</td>
</tr>
<tr>
<td>Connersville Interstade</td>
<td>8,177</td>
</tr>
<tr>
<td>Coral Ridge Member</td>
<td>118</td>
</tr>
<tr>
<td>Coral Zone</td>
<td>77</td>
</tr>
<tr>
<td>Corniferous Limestone</td>
<td>77,120</td>
</tr>
<tr>
<td>Coryvile Formation</td>
<td>47,48</td>
</tr>
<tr>
<td>Coxville Sandstone Member</td>
<td>40</td>
</tr>
<tr>
<td>crnoid beds</td>
<td>51</td>
</tr>
<tr>
<td>Crinoidal Limestone</td>
<td>11,121</td>
</tr>
<tr>
<td>Cutright Sandstone Member</td>
<td>51</td>
</tr>
<tr>
<td>Cynthia Formation</td>
<td>47,91</td>
</tr>
<tr>
<td>Cypress Formation</td>
<td>41</td>
</tr>
<tr>
<td>Cypress Sandstone</td>
<td>14, 15,41,53</td>
</tr>
<tr>
<td>Dalmanella meeki Zone</td>
<td>46</td>
</tr>
<tr>
<td>Dalmanella multisecta Zone</td>
<td>46</td>
</tr>
<tr>
<td>Danville Coal Member (VII)</td>
<td>41</td>
</tr>
<tr>
<td>Degania Sandstone</td>
<td>42</td>
</tr>
<tr>
<td>Delanays Creek Facies</td>
<td>34</td>
</tr>
<tr>
<td>Deputy Formation</td>
<td>122</td>
</tr>
<tr>
<td>Detroit River Formation</td>
<td>43</td>
</tr>
<tr>
<td>Dicksburg Hills Sandstone Member</td>
<td>44</td>
</tr>
<tr>
<td>Dillsboro Formation</td>
<td>45</td>
</tr>
<tr>
<td>Ditney Coal Member</td>
<td>48</td>
</tr>
<tr>
<td>Dowell Hill Facies</td>
<td>118</td>
</tr>
<tr>
<td>Dry Creek Sandstone Member</td>
<td>51</td>
</tr>
<tr>
<td>Dugger Formation</td>
<td>49</td>
</tr>
</tbody>
</table>
INDEX

<table>
<thead>
<tr>
<th>E</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eau Claire Formation</td>
<td>50</td>
</tr>
<tr>
<td>Economy Formation</td>
<td>47, 48, 86</td>
</tr>
<tr>
<td>Eden Group, Eden as a stage</td>
<td>46, 47, 48, 86</td>
</tr>
<tr>
<td>Edwardsville Member</td>
<td>50</td>
</tr>
<tr>
<td>Elkhorn Formation</td>
<td>47, 48, 192</td>
</tr>
<tr>
<td>Ellsworth Shale, Ellsworth Member</td>
<td>52</td>
</tr>
<tr>
<td>Elwren Formation</td>
<td>53</td>
</tr>
<tr>
<td>Encrinial Limestone</td>
<td>11</td>
</tr>
<tr>
<td>Endothyra baileyi</td>
<td>155</td>
</tr>
<tr>
<td>Estheria</td>
<td>136</td>
</tr>
<tr>
<td>Evans Landing Facies</td>
<td>34</td>
</tr>
<tr>
<td>F</td>
<td>Page</td>
</tr>
<tr>
<td>Fairbanks Coal Member</td>
<td>54</td>
</tr>
<tr>
<td>Fairmount Formation</td>
<td>47, 48</td>
</tr>
<tr>
<td>Fairview Formation</td>
<td>47</td>
</tr>
<tr>
<td>Failing Run Bed</td>
<td>55</td>
</tr>
<tr>
<td>Farmdale Loess Member</td>
<td>55</td>
</tr>
<tr>
<td>Fayette Stade</td>
<td>177</td>
</tr>
<tr>
<td>Ferdinand Limestone Member</td>
<td>56</td>
</tr>
<tr>
<td>Ferruginous Sandstone</td>
<td>189</td>
</tr>
<tr>
<td>Finley Knob Shale Member</td>
<td>34</td>
</tr>
<tr>
<td>Fleener Facies</td>
<td>34</td>
</tr>
<tr>
<td>Floyds Knob Member</td>
<td>57</td>
</tr>
<tr>
<td>Fordyce Knob Sandstone Facies</td>
<td>58</td>
</tr>
<tr>
<td>Fort Wayne Bank</td>
<td>112, 157, 185</td>
</tr>
<tr>
<td>Fredonia Member</td>
<td>58</td>
</tr>
<tr>
<td>French Lick Coal Member</td>
<td>59</td>
</tr>
<tr>
<td>Friendsville Coal Member</td>
<td>108</td>
</tr>
<tr>
<td>Fulda Limestone Member</td>
<td>60</td>
</tr>
<tr>
<td>Fulton Shale</td>
<td>47</td>
</tr>
<tr>
<td>Fusulina</td>
<td>73, 135</td>
</tr>
<tr>
<td>Fusulinella</td>
<td>135</td>
</tr>
<tr>
<td>Fusulinella</td>
<td>29, 74, 132, 172</td>
</tr>
<tr>
<td>G</td>
<td>Page</td>
</tr>
<tr>
<td>Galesville Sandstone</td>
<td>61</td>
</tr>
<tr>
<td>Garrison Creek Interstade</td>
<td>80</td>
</tr>
<tr>
<td>Gasper Oolite, Limestone</td>
<td>13, 125</td>
</tr>
</tbody>
</table>

Genesee Shale | 5, 116 |
Govenica Dolomite | 62 |
Gent Facies | 34 |
Geo Bed | 138 |
Glen Dean Limestone | 64 |
Goniatite Limestone | 140 |
Goss Mill Limestone Facies | 58 |
Grandview Limestone | 57, 61, 104 |
Grayville Limestone Member | 108 |
Guelp Dolomite | 186 |
Guthrie Creek Member | 66 |
Hamilton Group | 122 |
Hardinsburg Formation | 67 |
Harmon Formation | 47 |
Hayden Branch Formation | 165 |
Hazelton Bridge Coal Member | 71 |
Heldberg Group | 167 |
Henryville Bed | 71 |
Herrin Coal Member | 72 |
Hindostan, Whetstone | 60, 103, 105, 133 |
Hitz Bed, Limestone | 60, 132, 192 |
Holland Coal | 72 |
Holland Limestone Member | 72 |
Houchin Creek cap, Limestone | 172 |
Houchin Creek Coal Member (Iv) | 74 |
Hudson River Group | 47 |
Huntington Dolomite, Lithofacies, Limestone, Stone | 93, 112, 185 |
Huron Group | 190 |
Hydraulic limestone | 120, 167 |
Hymeta Coal Member (VI) | 74 |
<table>
<thead>
<tr>
<th>Rock Unit</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiana limestone, oolite, oolitic limestone, oolitic stone</td>
<td>153, 160</td>
</tr>
<tr>
<td>Indian Springs Shale</td>
<td>14</td>
</tr>
<tr>
<td>Inglefield Sandstone Member</td>
<td>75</td>
</tr>
<tr>
<td>Jackson Sand</td>
<td>15</td>
</tr>
<tr>
<td>Jacobs Chapel Bed</td>
<td>76</td>
</tr>
<tr>
<td>Jeffersonville Limestone</td>
<td>77</td>
</tr>
<tr>
<td>Jessup Formation</td>
<td>79</td>
</tr>
<tr>
<td>Joachim Dolomite</td>
<td>80</td>
</tr>
<tr>
<td>Kaskaskia Limestone</td>
<td>189</td>
</tr>
<tr>
<td>Kelly Hill Facies</td>
<td>34</td>
</tr>
<tr>
<td>Kenneth Limestone Member</td>
<td>81</td>
</tr>
<tr>
<td>Kenwood Beds, Formation, Member, Sandstone</td>
<td>118, 119</td>
</tr>
<tr>
<td>Kinkaid Limestone</td>
<td>82</td>
</tr>
<tr>
<td>Kirkville Coal</td>
<td>104</td>
</tr>
<tr>
<td>Kludognathus-Cavusgnathus naviculae Assemblage Zone</td>
<td>109</td>
</tr>
<tr>
<td>Knob Creek Facies</td>
<td>34</td>
</tr>
<tr>
<td>Knob, Knobstone Group</td>
<td>20, 68</td>
</tr>
<tr>
<td>Knox Dolomite</td>
<td>83</td>
</tr>
<tr>
<td>Kokomo Limestone Member</td>
<td>84</td>
</tr>
<tr>
<td>Kope Formation</td>
<td>85</td>
</tr>
<tr>
<td>L</td>
<td>75, 170</td>
</tr>
<tr>
<td>Laevigatosporites</td>
<td>75, 170</td>
</tr>
<tr>
<td>Laevigatosporites pseudothiessenii</td>
<td>170</td>
</tr>
<tr>
<td>Lafayette Gravel</td>
<td>86</td>
</tr>
<tr>
<td>Lagro Formation</td>
<td>87</td>
</tr>
<tr>
<td>Lake Huron Shale</td>
<td>47</td>
</tr>
<tr>
<td>Lampkins Sandstone Member</td>
<td>34</td>
</tr>
<tr>
<td>Laughery Formation</td>
<td>47</td>
</tr>
<tr>
<td>Laurel Member</td>
<td>88</td>
</tr>
<tr>
<td>Levia tricosinata</td>
<td>28</td>
</tr>
<tr>
<td>Levisville Member</td>
<td>89</td>
</tr>
<tr>
<td>Levias Member</td>
<td>90</td>
</tr>
<tr>
<td>Library Limestone</td>
<td>41</td>
</tr>
<tr>
<td>Liberty Formation</td>
<td>46, 47, 48</td>
</tr>
<tr>
<td>Linton Formation</td>
<td>92</td>
</tr>
<tr>
<td>Little Rock Creek Limestone</td>
<td>122</td>
</tr>
<tr>
<td>Little Newburg Coal</td>
<td>42</td>
</tr>
<tr>
<td>Locust Point Formation</td>
<td>95</td>
</tr>
<tr>
<td>Logansport Limestone</td>
<td>122</td>
</tr>
<tr>
<td>Lophsopora hammei Bed</td>
<td>46, 192</td>
</tr>
<tr>
<td>Louisville-Delphi Black Slate</td>
<td>116</td>
</tr>
<tr>
<td>Louisville Limestone</td>
<td>97</td>
</tr>
<tr>
<td>Lower Block a, b, and c Zones</td>
<td>24, 25, 101</td>
</tr>
<tr>
<td>Lower Block Coal Member</td>
<td>109</td>
</tr>
<tr>
<td>Lower Cannelton Coal</td>
<td>103, 104, 148</td>
</tr>
<tr>
<td>Lower Hanging Rock Coal</td>
<td>162</td>
</tr>
<tr>
<td>Lower Harrodsburg Limestone, Division</td>
<td>51, 68, 69, 137, 160</td>
</tr>
<tr>
<td>Lower Huntingburg Coal</td>
<td>104, 106</td>
</tr>
<tr>
<td>Lower Kaskaskia Limestone</td>
<td>19</td>
</tr>
<tr>
<td>Lower Millersburg Coal</td>
<td>75</td>
</tr>
<tr>
<td>Lower Paint Creek Limestone</td>
<td>9</td>
</tr>
<tr>
<td>Lycozpora</td>
<td>75, 170</td>
</tr>
<tr>
<td>M</td>
<td>108</td>
</tr>
<tr>
<td>McCleary's Bluff Coal Member</td>
<td>108</td>
</tr>
<tr>
<td>McLeansboro Group</td>
<td>101</td>
</tr>
<tr>
<td>McMicken Formation</td>
<td>47, 48, 86</td>
</tr>
<tr>
<td>McMillian Formation</td>
<td>47</td>
</tr>
<tr>
<td>Madison Beds</td>
<td>47, 157</td>
</tr>
<tr>
<td>Madison Reef</td>
<td>158</td>
</tr>
<tr>
<td>Main Newburg Coal</td>
<td>169</td>
</tr>
<tr>
<td>M-Continued</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Main Newburg Limestone</td>
<td>135</td>
</tr>
<tr>
<td>Mansfield Formation</td>
<td>102</td>
</tr>
<tr>
<td>Maquoketa Shale</td>
<td>105</td>
</tr>
<tr>
<td>Marble Hill Bed</td>
<td>47</td>
</tr>
<tr>
<td>Maria Creek Limestone</td>
<td>191</td>
</tr>
<tr>
<td>Mariah Hill Coal Bed</td>
<td>106</td>
</tr>
<tr>
<td>Martinsville Formation</td>
<td>106</td>
</tr>
<tr>
<td>Mattoon Formation</td>
<td>107</td>
</tr>
<tr>
<td>Maysville Group, Maysville</td>
<td></td>
</tr>
<tr>
<td>as a stage</td>
<td>46,47,48</td>
</tr>
<tr>
<td>Mecca Quarry Shale Member</td>
<td>39</td>
</tr>
<tr>
<td>Medora. Knob Facies</td>
<td>51</td>
</tr>
<tr>
<td>Megalonus canadensis</td>
<td>94, 186</td>
</tr>
<tr>
<td>Menard Formation</td>
<td>108</td>
</tr>
<tr>
<td>Merom Group</td>
<td>128</td>
</tr>
<tr>
<td>Merom Sandstone Member</td>
<td>109</td>
</tr>
<tr>
<td>Miami Bend Formation</td>
<td>122</td>
</tr>
<tr>
<td>middle Hendersonia occulta bed</td>
<td>7</td>
</tr>
<tr>
<td>Millersburg Coal</td>
<td></td>
</tr>
<tr>
<td>Millersburg Formation</td>
<td>32</td>
</tr>
<tr>
<td>Minshall Limestone</td>
<td>110,131,171</td>
</tr>
<tr>
<td>Minshall Member</td>
<td>110</td>
</tr>
<tr>
<td>Mississinewa Shale Member</td>
<td>111</td>
</tr>
<tr>
<td>Mitchell Formation, Limestone,</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>19,97,143,146,190</td>
</tr>
<tr>
<td>Monograptus falciformis (=? Monograptus bohemicus)</td>
<td>112,186</td>
</tr>
<tr>
<td>Mooretown Sandstone</td>
<td>13</td>
</tr>
<tr>
<td>Morgan Trail Member</td>
<td>112</td>
</tr>
<tr>
<td>Morton Loess Tongue</td>
<td>113</td>
</tr>
<tr>
<td>Mount Auburn Formation</td>
<td>47,48</td>
</tr>
<tr>
<td>Mount Ebel Sandstone Member</td>
<td>51</td>
</tr>
<tr>
<td>Mount Hope Formation</td>
<td>47,48</td>
</tr>
<tr>
<td>Mount Pleasant Sandstone</td>
<td>42</td>
</tr>
<tr>
<td>Mount Simon Sandstone</td>
<td>114</td>
</tr>
<tr>
<td>Muldraugh Formation</td>
<td>114</td>
</tr>
<tr>
<td>Murphys Bluff Formation</td>
<td>45</td>
</tr>
<tr>
<td>Petersburg Coal</td>
<td>132,169</td>
</tr>
</tbody>
</table>
P-Continued

Pinnick Coal Member ............... 133
Pirtle Coal Member ............... 134
Platycrinites
   penicillus . . . . 9,27,59,91,126,127,144
Platystrophia, zones of ......... 45,46
Point Pleasant Beds .......... 91,179
Polytylites wasanuckensis ....... 61
Popcorn Sandstone Bed ......... 126
Profusulinella, P. kentuckyensis . . . . . . . 57,61,73,105,132
Prospect Formation ........... 134
Protocanites lyoni .......... .... 142
Providence Limestone Member .... 135
Pugnoides ottumwa ............... 144

R
Raben Branch Member ............... 135
Raccoon Creek Group .......... 136
Ramp Creek Limestone Member ... 137
Red Bridge Limestone Bed ....... 138
Red Clastics .................. 114
Reeville Limestone ............... 138
Renault Formation ............... 139
Rhipidium ....................... 99
Richmond Group,
   Richmond as a stage .......... 46,47,48,158,191
Richmond Stade ................ 80
River Quarry Beds ............... 91,179
Riverside Sandstone Facies .... 51
Riverview Limestone Member .... 140
Rock Creek Coal ............... 162
Rockford Limestone ............... 140
Rosiclare Member ............... 142
Roundyella cf. R. simplicissima .... 172

S
St. Genevieve Limestone ........... 143
St. Joseph Formation ........... 95
St. Louis Limestone ............... 145

St. Meinrad Coal Bed ............... 147
St. Peter Sandstone ............... 148
St. Wendel Sandstone Member .... 149
Salamonie Dolomite ............... 150
Salem Limestone ............... 152
Salina Formation ............... 155
Saluda Formation ............... 157
Sanderson Formation ............... 159
Schooner Hill Facies ............... 95
Sellersburg Limestone,
   Beds, Formation .......... 11,77,121
Selnier Member ............... 163
Shady Lane Coal Member ........... 163
Shelburn Formation ............... 164
Shelburn Group ............... 128
Shelby Bed ............... 62
Shoual Creek Limestone Member .... 165
Shouls Coal ............... 104
Shouls Lithofacies ............... 103
Siberia Limestone Member ....... 166
Silver Creek Member ............... 166
Silver Hills Facies ............... 118
Silverwood Cyclothern ............... 168
Silverwood Limestone Member .... 168
Siphonodella isosticha-S. cooperi
   Assemblage Zone ............... 76,141-142
Siphonodella sulcata Zone ....... 117, 180
Solsberry Formation ............... 190
Somerset Shale, Member ........... 70
Somerville Limestone,
   Formation ............... 48,191
Southgate Formation ............... 47,48,86
Sparksville Facies ............... 34
Spathiocaris Zone ............... 16,163
Speck Member ............... 168
Speeny Hill fauna, limestone ..... 152, 153
Spergen Limestone, limestone,
   fossil bed, formation ...... 145, 153, 155
<table>
<thead>
<tr>
<th>Term</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spergen's Hill Bed</td>
<td>153</td>
</tr>
<tr>
<td>Spickert Knob Facies</td>
<td>95</td>
</tr>
<tr>
<td>Springfield Coal Member (V)</td>
<td>169</td>
</tr>
<tr>
<td>Springler Knob Facies</td>
<td>51</td>
</tr>
<tr>
<td>Staunton Coal</td>
<td>162</td>
</tr>
<tr>
<td>Staunton Formation</td>
<td>170</td>
</tr>
<tr>
<td>Stendal Limestone Member</td>
<td>172</td>
</tr>
<tr>
<td>Stephensport Group</td>
<td>173</td>
</tr>
<tr>
<td>Stewarts Landing Facies</td>
<td>51</td>
</tr>
<tr>
<td>Stobo bioherm</td>
<td>22</td>
</tr>
<tr>
<td>Strophomena planulohome Bed</td>
<td>46</td>
</tr>
<tr>
<td>Sunbury Shale</td>
<td>173</td>
</tr>
<tr>
<td>Survant Coal Member (IV)</td>
<td>174</td>
</tr>
<tr>
<td>Swanville Formation</td>
<td>122</td>
</tr>
<tr>
<td>Syringothyris texta</td>
<td>34</td>
</tr>
<tr>
<td>Talarocrinus Range Zone</td>
<td>127</td>
</tr>
<tr>
<td>Tanners Creek Formation</td>
<td>47,48</td>
</tr>
<tr>
<td>Tar Springs Formation</td>
<td>174</td>
</tr>
<tr>
<td>Tazewell Stage</td>
<td>178</td>
</tr>
<tr>
<td>Tetradium Reef, Zone</td>
<td>158</td>
</tr>
<tr>
<td>Thorn Group</td>
<td>186</td>
</tr>
<tr>
<td>Tip Top Sand</td>
<td>13</td>
</tr>
<tr>
<td>Trafalgar Formation</td>
<td>176</td>
</tr>
<tr>
<td>Traverse Formation</td>
<td>178</td>
</tr>
<tr>
<td>Trenton Limestone</td>
<td>179</td>
</tr>
<tr>
<td>Tropidoleptus carinatus</td>
<td>11</td>
</tr>
<tr>
<td>Troy Coal</td>
<td>103</td>
</tr>
<tr>
<td>Turritellina Assemblage Zone</td>
<td>152</td>
</tr>
<tr>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Underwood Bed</td>
<td>180</td>
</tr>
<tr>
<td>Universal Limestone Member</td>
<td>180</td>
</tr>
<tr>
<td>Upper Alum Cave Limestone</td>
<td>5</td>
</tr>
<tr>
<td>Upper Block a, b, and c Zones 25, 182</td>
<td></td>
</tr>
<tr>
<td>Upper Block Coal Member</td>
<td>181</td>
</tr>
<tr>
<td>Upper Cannelton Coal</td>
<td>103, 104, 148</td>
</tr>
<tr>
<td>Upper Harrodsburg Limestone, Division</td>
<td>68,69</td>
</tr>
<tr>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Velpen Coal</td>
<td>38, 182</td>
</tr>
<tr>
<td>Velpen Limestone Member</td>
<td>182</td>
</tr>
<tr>
<td>Verucossporites</td>
<td></td>
</tr>
<tr>
<td>Velpen limestone Member</td>
<td></td>
</tr>
<tr>
<td>Vertigo alpestris oughtoni</td>
<td>7,35,176,177,178</td>
</tr>
<tr>
<td>Vienna Limestone</td>
<td>183</td>
</tr>
<tr>
<td>Vigo Limestone Member</td>
<td>184</td>
</tr>
<tr>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Waterlime, waterfall,</td>
<td>85,167</td>
</tr>
<tr>
<td>Wabash Formation</td>
<td>184</td>
</tr>
<tr>
<td>Waldron Shale, Formation</td>
<td>186</td>
</tr>
<tr>
<td>Waltersburg Sandstone</td>
<td>188</td>
</tr>
<tr>
<td>Warren Beds</td>
<td>47</td>
</tr>
<tr>
<td>Warsaw formation, limestone,</td>
<td></td>
</tr>
<tr>
<td>waterfall limestone</td>
<td>68</td>
</tr>
<tr>
<td>Waynesville Formation</td>
<td>46,47,48</td>
</tr>
<tr>
<td>Wedekindellina</td>
<td>73,132,172</td>
</tr>
<tr>
<td>Weed Patch Member</td>
<td>51</td>
</tr>
<tr>
<td>West Baden Group</td>
<td>189</td>
</tr>
<tr>
<td>West Franklin Limestone Member</td>
<td>190</td>
</tr>
<tr>
<td>White Niagaran</td>
<td>151</td>
</tr>
<tr>
<td>White River limestone</td>
<td>153</td>
</tr>
<tr>
<td>Whitewater Formation</td>
<td>191</td>
</tr>
<tr>
<td>Whitewater Stade</td>
<td>177</td>
</tr>
<tr>
<td>Wickliffe Sandstone</td>
<td>188</td>
</tr>
</tbody>
</table>
DEVONIAN AND SILURIAN ROCK-UNIT NAMES USED IN INDIANA
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>SERIES</th>
<th>STAGE</th>
<th>IN. ILLINOIS GROUP</th>
<th>GROUP</th>
<th>FORMATION, MEMBER, AND BED</th>
<th>ASSEMBLAGE ZONES (FOX, 1962; CASTER, DALVE, AND POPE, 1955)</th>
<th>BIONOMENCLATURE</th>
<th>MISCELLANEOUS UNOFFICIAL NAMES</th>
<th>CITED IN TEXT</th>
<th>OTHER NAMES CITED IN TEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORDOVICIAN</td>
<td>Cincinnati</td>
<td>Eolian</td>
<td>Mauryan</td>
<td>Meuseka</td>
<td>Manikin Sh.</td>
<td>Diloboro Fm.</td>
<td>Dalmatella meeki Zone</td>
<td>Resserella meeki</td>
<td>Kope Fm.</td>
<td>Cuivre Fm.</td>
</tr>
<tr>
<td>CHAMPAIGNIAN</td>
<td>Bicknerian</td>
<td>Ancliff</td>
<td>Prestville</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Everton</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAMBRIAN</td>
<td>Trempealeau</td>
<td>Frankfort</td>
<td>Driftless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Knox Dol.</td>
<td>Gatesville Ss.</td>
</tr>
</tbody>
</table>

ORDOVICIAN AND CAMBRIAN ROCK-UNIT NAMES USED IN INDIANA