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1960

CLASSIFICATION OF THE PENNSYLVANIAN STRATA OF ILLINOIS

R. M. Kosanke
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H. B. Willman

REPORT OF INVESTIGATIONS 214

ILLINOIS STATE GEOLOGICAL SURVEY
JOHN C. FRYE, *Chief* URBANA, ILLINOIS

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Illinois State Geological Survey Report of Investigations 214
Urbana, Illinois 1960

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*The McLeansboro and Carbondale Groups were subdivided into cyclothems, and the Caseyville and Tradewater Groups in southern Illinois were subdivided into seven formations. In several reports from 1940 to 1950 the base of the McLeansboro was put at the top of No. 6 Coal.

**Cyclothems are retained in a separate cyclical classification.

†Bounding units of groups and formations indicated by italics.

Fig. 1.—Chart showing history of stratigraphic classification of Pennsylvanian rocks used by the Illinois State Geological Survey.

CLASSIFICATION OF THE PENNSYLVANIAN STRATA OF ILLINOIS

R. M. Kosanke, J. A. Simon, H. R. Wanless, and H. B. Willman

ABSTRACT

A new rock-stratigraphic classification of Pennsylvanian strata of Illinois is presented in conformity with the multiple stratigraphic classification system recently adopted by the Illinois State Geological Survey. The nearly 3000 feet of Pennsylvanian strata have been classified into formations based on gross variations in average composition or in relative abundance of distinctive lithologic types. The following three groups and seven formations are recognized.

	Maximum thickness (ft.)
McLeansboro Group	
Mattoon Formation	600+
Bond Formation	300+
Modesto Formation	400
Kewanee Group	
Carbondale Formation	400
Spoon Formation	350
McCormick Group	
Abbott Formation	350
Caseyville Formation	500

The Pennsylvanian sequence consists of several hundred individual lithologic units—sandstone, shale, clay, limestone, and coal — few of which are thick enough to be considered formations. About 130 of the individual units have been named and are recognized as members.

The gross characteristics used to differentiate the formations generally cannot be determined from individual exposures. Consequently, identification of a formation depends on recognition of a characteristic member within the exposure, or on determination of the relation of the exposure to selected widespread members that are the bounding units of the formations.

The revised classification replaces one that did not recognize formations. In the previous classification four groups were divided into about 50 cyclothems based on the cyclical repetition of the various rock types. Because the cyclical units have not proved useful in economic studies and have not been widely used in mapping, they have not made satisfactory units for rock-stratigraphic classification. However, as they are particularly useful in geologic interpretation they are retained in a separate cyclical classification.

The practice of applying the same geographic name to several closely associated members is eliminated and new names have been presented where necessary. Although an effort has been made to extend one name to all equivalent strata in various parts of the state, local names are retained in some areas. A chart shows a composite section of the Pennsylvanian strata in Illinois, all the names accepted in Illinois for the rock units and cyclothems, and correlations with units in Indiana, western Kentucky, and Missouri. Descriptions of the type sections of the formations, a table of type localities of all named members, and a list of type localities of named cyclothems are included.

PART I

THE PROBLEM OF CLASSIFICATION

INTRODUCTION

Pennsylvanian strata constitute the bedrock surface throughout approximately four-fifths of Illinois and have a maximum thickness of about 3000 feet. Because an important segment of geological research in the state is concerned with Pennsylvanian rocks, the design of an effective stratigraphic classification of these strata has long been of major interest to the Illinois State Geological Survey.

The last extensive study of the classification of the Pennsylvanian rocks of Illinois established the cyclothem as the fundamental unit of rock classification (Weller, Wanless, 1927-1932). Although cyclothems were considered a special type of formational unit, the earlier formations, each including many cyclothems, were retained until 1940, at which time they were elevated to the rank of groups. Prior to the present study, no further changes had been made in classification units.

The relation of the new classification (pl. 1) of Pennsylvanian rocks to the previous classifications used by the Illinois Geological Survey is shown in figure 1. The development of earlier classifications has been discussed in a 1956 publication by Wanless. The same publication contains a chart compiled by Raymond Siever showing the classification and nomenclature in effect at the beginning of the present study.

Recognition of the cyclical sequence as a unit of stratigraphic classification has been instrumental in promoting advances in Pennsylvanian stratigraphy, and the unit has been accepted in many quarters. However, it has not been used extensively in economic studies, particularly coal and oil studies primarily concerned with subsurface data.

Furthermore, the Pennsylvanian classification has developed along lines diverging from the standard practice used for other systems of rocks. This divergence reflects the major differences in the character of the stratigraphic sequences. In the pre-Pennsylvanian rocks of Illinois, thick units of limestone, dolomite, sandstone, and shale are differentiated into formational units characterized by gross lithologic features. In contrast, the Pennsylvanian units that may be identified by similar lithologic characteristics are for the most part too thin to be accepted as formational units. Many of these thin units have a greater contrast in lithology than formations in pre-Pennsylvanian rocks. Both field and subsurface stratigraphy of Pennsylvanian rocks are based largely on identification and correlation of these units, many of which are useful key beds.

Consideration of these factors prompted the restudy of Pennsylvanian classification by a Survey committee consisting of the authors of this report. John C. Frye, Chief of the Survey, took part in the discussions and was particularly helpful in the consideration of the theoretical aspects of stratigraphic classification. Raymond Siever served on the committee until he left the Survey. David L. Reinertsen assisted in field studies of the type sections and was primarily responsible for assembling data and for compilation of tables of stratigraphic names. He also assisted in compiling the type and reference sections in the appendix. Other members of the Survey staff were consulted on specific problems. The following gave helpful criticism of the manuscript: Elwood Atherton, A. H. Bell, K. E. Clegg, George E. Ekblaw, J. E. Lamar, G. B. Maxey, D. L. Reinertsen, D. H. Swann, W. H. Smith, M. L. Thompson, W. A. White, and G. M. Wilson.

Stratigraphic classifications are essentially philosophical, expressing as they do individual concepts of the nature and origin of the rocks and of the objectives and mode of operation of classification. Complete agreement on these factors is scarcely to be expected, even from a committee of four. However, this committee started with general agreement on the need for improvement of classification and nomenclature and belief that a completely new analysis of the problem would be worth while. The conclusions reached represent in major part a general agreement rather than a compromise of conflicting viewpoints.

The restudy consisted of the following stages:

1) Review of the nature of Pennsylvanian sediments based on consideration of specific sequences, generalizations, and types of variations.

2) Discussion of the origin of the sediments and the basic problems in sedimentation to provide a basis for recognizing natural units and evaluating their relative importance.

3) Discussion of principles of stratigraphic classification.

4) Critical review of the existing classification.

5) Evaluation of alternative classifications.

6) Definition of new stratigraphic units and revision of nomenclature.

NATURE OF PENNSYLVANIAN STRATA

Stratigraphic classifications are based on generalizations of the nature of the sequence and are effective to the degree that the generalizations accurately embrace the range of variations. Consideration therefore has been given to both the general nature of the sequence and the types of variations.

The lithologic sequence of Pennsylvanian rocks is well known throughout much of Illinois. Detailed studies have been made in many areas and inter-area correlations are well established (Wanless, 1956). The exact correlation of certain isolated exposures, however, is not yet definite, particularly in the lowest and highest parts of the column.

The nature of the sequence is shown in a composite section for the whole state (pl. 1). Details of typical sections may be obtained from published reports, particularly the following:

Western Illinois—Udden (1912), Hinds (1919), Cady (1921), Savage (1921), Culver (1925), Wanless (1929, 1931a, 1931b, 1931c, 1957).

Northern Illinois—Cady (1915, 1919), Culver (1922), Willman and Payne (1942).

Central Illinois — Shaw and Savage (1913), Kay (1915), Udden and Shaw (1915), Shaw (1921, 1923), Lee (1926), DuBois (1951), Ball (1952), Smith (1958).

Eastern Illinois—Campbell and Leverett (1900), Kay and White (1915), Rich (1916a, 1916b), Cady and others (1952), Potter (1956).

Southern Illinois — Shaw and Savage (1912), Cady (1916, 1917, 1919, 1925), Lamar (1925), Butts (1925), Weller (1940), Harrison (1951), Cady and others (1952, 1955), Wanless (1955), Smith (1957), Hopkins (1958).

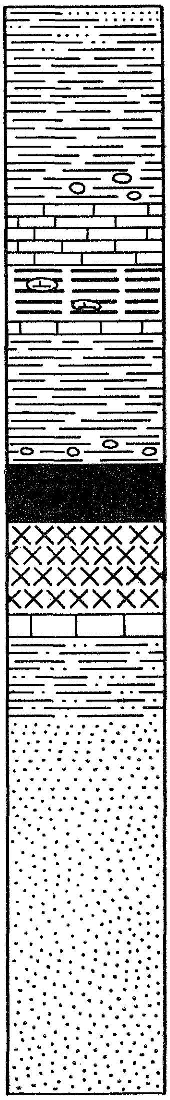
General Character

In general, 85 to 95 percent of the sediments of Pennsylvanian age in Illinois are siliceous clastics. About 50 percent are predominantly argillaceous rocks (47 percent gray, red, green, and black relatively soft shales, 2 percent underclays, and 1 percent black slaty shales), and about 40 percent are arenaceous rocks (sandstones and siltstones). About 5 percent of the sediments are predominantly calcareous rocks, largely limestone but including some dolomitic and ankeritic types. One to 2 percent are coal, and all other types, including siderite and chert, make up less than 1 percent of the total.

THICKNESS OF UNITS

The sequence is characterized vertically by frequent and commonly sharp changes in lithology. These changes differentiate units of uniform lithology, referred to as "individual units." Five hundred or more individual units are present, most of them from less than an inch to perhaps 30 feet thick. Only a few locally exceed 100 feet thick, and the average thickness is perhaps on the order of 3 to 5 feet.

The sandstones, many of which are interbedded with siltstone and grade laterally to siltstone, are the most variable in thickness. Thicknesses of 30 to 50 feet are common. A few sandstones are as much as 100 feet thick in some areas and rarely they are



Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.

Limestone; contains marine fossils.

Shale, black, hard, fissile, "slaty"; contains large black spheroidal concretions and marine fossils.

Limestone; contains marine fossils.

Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

Coal; locally contains clay or shale partings.

Underclay, mostly medium to light gray except dark gray at top; upper part noncalcareous, lower part calcareous.

Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

Shale, gray, sandy.

Sandstone, fine-grained, micaceous; and siltstone, argillaceous; variable from massive to thin-bedded; usually with an uneven lower surface.

Fig. 2.— Arrangement of lithologic units in a cyclothem.

300 or more feet thick. Some of the unusually thick occurrences probably represent two or more superimposed sandstones.

Uninterrupted sequences of shale in places exceed 100 feet thick, but thicknesses of 20 to 40 feet are more common. The shales are much more persistent than the sandstones and their variations in thickness generally are gradual, except where they are truncated by sandstones.

The underclays are commonly 2 to 5 feet thick, but greater thicknesses are not rare and locally they are as much as 30 feet thick.

The black slaty shales are commonly 1 to 5 feet thick but are thicker in some areas.

The limestones have a wide range of thickness. Many widely persistent beds are less than a foot thick, and thicknesses of 2 to 4 feet are common. A few limestones are persistently 10 to 20 feet thick; in limited areas some are as much as 30 feet thick, and one limestone has a maximum thickness of 50 feet.

Most coal beds are 6 inches to 3 feet thick, but they range from scarcely more than a thin carbonaceous streak to beds as much as 15 feet thick. A few coal beds average 3 to 7 feet thick over broad areas.

PERSISTENCE OF UNITS

Most of the Pennsylvanian sequence is characterized by great lateral persistence of almost all individual units except the sandstones, a few of which likewise have good continuity. Some of these lithologic units appear to be almost continuously present throughout Illinois. All gradations of persistence may be found, from beds that are erratic in occurrence to those that extend almost continuously over many counties with only slight variations in thickness. The latter include many thin beds, some only an inch or two thick.

CYCLICAL SEQUENCES

The individual units generally occur in orderly sequences that are repeated many times. The sequences are rarely complete, but exceptions to the order are not common. The most commonly present components of the sequence are a basal sandstone overlain by underclay, coal, black slaty shale, limestone, and gray shale. In addition, a limestone bed is locally present in or at the base of the underclay and another beneath the black slaty shale. Gray shale is locally present between the sandstone and underclay and between the coal and the black slaty shale. This sequence represents a cycle of sedimentation (Udden, 1912) and is currently called a cyclothem (fig. 2). About 50 cyclothems are named in Illinois.

Variations in Cyclothems

The lateral uniformity of the cyclothems and their vertical similarity both have been emphasized in many reports. In practice, correlation is based on persistent differences in cyclical sequences and on distinctive characteristics of individual beds.

DISTINCTIVE CHARACTERISTICS

The limestones have perhaps the greatest distinctiveness and some may be identified by characteristic texture, argillaceous content, bedding, color, weathering character, or faunal assemblage. However, because most of the limestone lithologies are repeated somewhere in the column, specific identification of many limestones must be based in part on knowledge of the sequence or of approximate position in the column.

Some of the black slaty shales are nearly as distinctive as the limestones and may be identified by variations in hardness, fissile character, and content of fossils and concretions.

Some shales are distinctive in color, texture, bedding, and content of fossils and concretions.

The sandstones locally have distinctive texture, degree of cementation, or weathering characteristics.

A few coals have distinctive clay or shale partings, and a uniform thickness of the coal may be characteristic throughout some regions.

Even the underclays vary in color and commonly have an upper noncalcareous zone that may have a distinctive thickness.

TYPES OF VARIATIONS

Variations in the sequence of beds are of two general types—those resulting from cutouts and unconformities and those resulting from varying conditions of sedimentation, mainly modifications of the usual cyclic pattern. The latter type includes 1) lateral changes or facies, 2) the components of the sequence, 3) the intercalation in the sequence of individual components out of the usual order, and 4) variations repeated in several cyclical sequences, thus producing different types of cycles.

Channel Sandstones

In many places variations in sequence result from truncation of underlying beds by channels filled with sandstone. Many channels cut through the upper units of the underlying cyclothem and over considerable areas rest directly on the coal. Some sandstone bodies cut through the coals and deep into the underlying strata. The generally massive and relatively coarse-grained sandstones of the channel facies have a sharp and undulating basal contact that appears to give the cyclical sequences an unconformable base. However, the frequency of channeling is relatively low. Drill records show that throughout much of Illinois only two or three of the sandstones are likely to occur in a prominent channel facies at one place. The number in any one drill hole generally will average less than one per 10 cycles.

Although the channels commonly are believed to be the result of subaerial erosion, the sequence between the channels appears to be entirely conformable. The physical evidence for unconformities appears to be present in less than 20 percent of the area for any cyclothem in Illinois, and no unconformities are known for some cyclothems. An exception is the limited area in extreme southern Illinois where the Caseyville sandstones may occur persistently in channel facies.

Lateral Changes or Facies

Lateral changes in texture of both the basal sandstone of one cyclical sequence and the adjacent shale that forms the uppermost unit of the underlying sequence make it difficult to interpret stratigraphic boundaries in many areas. Except where the sandstone is in channel facies, it is difficult to determine whether sandstones, siltstones, and sandy shales are interchannel facies of the sandstone or are sandy facies of the shales that are cut out along the channels. Many of the sandstones grade laterally to siltstone, and sandy shale locally replaces the sandstone, even in the channel facies.

Where outcrops are abundant it is commonly possible to see the channel margins and thus determine the relations of the sandy deposits. In the much larger area where Pennsylvanian stratigraphy is based entirely on subsurface studies — electric logs, sample cuttings, a few cores — recognition of the unconformity is much more difficult. Sandy beds may be arbitrarily assigned to the upper cyclothem, but the relations are clear only when the sandstones are in the most prominent channel facies.

Incompleteness of Cyclothems

The relative completeness of cyclothems in four quadrangles in western Illinois has been determined by Wanless (1957, p. 55). In 23 cyclothems present in that area, the average cyclothem has only 5 of the 10 most common units of the ideal cyclothem. Although one cyclothem has nine and four have eight units, many units are known from only a few localities. Including known occurrences elsewhere in the Illinois Basin, the average completeness is about 7.5 of the 10 units for these 23 cyclothems, and all 10 are known for four cyclothems. Because of the local distribution of many units, the completeness of the cyclothems decreases with restriction of area. In any one locality, such as a drill hole, the completeness commonly will be less than half of the standard units.

Out-of-Order Units

Variations in the sequence also result from the intercalation of units out of the standard order. An example is the presence of a local 4- to 6-inch coal in the Canton Shale of the St. David Cyclothem in northern Illinois. The Jake Creek Sandstone that locally underlies the Oak Grove Limestone Member of the Liverpool Cyclothem in western Illinois also is an out-of-order bed. In northern Illinois an underclay and coal are present between this sandstone and limestone and the sequence is differentiated as the Lowell Cyclothem. Thus, the Oak Grove Limestone and the overlying Purington Shale are in the Liverpool Cyclothem of western Illinois but are in the Lowell Cyclothem in northern Illinois.

These relations illustrate the potential variations in sequence resulting from lateral persistence of only one or two units of a cyclothem and suggest that a cycle can be interrupted at almost any point and started over again. This type of variation could produce a complete lack of orderly sequence, but it appears to be so uncommon that it can be recognized and treated as a local aberration of a cyclothem unless it is prominent enough to justify recognition as a separate cyclothem.

Repeated Variations

Some variations from the standard sequence are repeated through several cycles and provide a basis for recognizing types of cyclothems. Three major types of variations may be noted: 1) those characterized by excessive development of one of the standard members, such as a sandstone or limestone, 2) those characterized by the persistent dropping of a standard member, common cases being the persistent absence of the sandstone, limestone, or coal, and 3) those resulting from the presence of new units, such as red shale.

Some of these variations modify the complexion of the entire sequence, producing sections dominated by shale or sandstone, or in some areas permitting a vertical differentiation based on changes in types of cyclothems or on types of distinctive units.

ORIGIN OF PENNSYLVANIAN SEDIMENTS

Many aspects of the origin of Pennsylvanian sediments remain controversial. Although an understanding of the mode of deposition of the sediments is recognized to be a valuable aid in the differentiation of natural units, the formulation of rock-stratigraphic classification cannot wait for the solution of such problems. It has seemed imperative to proceed with refinement of the classification, anticipating that more effective field stratigraphy will further the understanding of sources of sediments, mode of transportation, and cause and environment of deposition. The major concepts of origin are briefly reviewed.

Classification of Pennsylvanian rocks was hampered for many years by the concept that the sediments were laid down irregularly and that, except for some of the coals and a few other beds, lenticular relations and facies changes so dominated the sediments that local sequences had little significance. Recognition of the widespread distribution of many units and the cyclical nature of the sedimentation was a major stimulus to studies of origin.

The variety of sediments found in the Pennsylvanian rocks suggests a wide range in conditions of sedimentation. Compared with the sediments of other Paleozoic systems, they indicate both a greater range in environment and more frequent changes in type of sediment.

Explanations for the cyclical character of the sedimentation hinge on the origin of the individual lithologic types, but only a few of these have a reasonably clear origin. The environment of deposition of the limestones and associated shales is clearly marine because they contain marine fossils. Variations in the fossil assemblages of the limestones are taken to reflect differences in water depth (Elias, 1937; Wanless, 1958).

It is generally accepted that the coals were formed from plant debris that accumulated essentially at place of growth in freshwater swamps. A few local coals represent accumulation of transported plant debris.

The remainder of the sediments are of less clear origin. Most of the sandstones are commonly accepted to be nonmarine, as suggested by the local presence of thin coals and the common occurrence of plant fossils. However, a few sandstones locally contain indigenous marine fossils. Also, the uniform texture, sorting, and bedding throughout considerable thicknesses of sandstone suggest marine sedimentation rather than stream deposition.

The origin of the channels which the sandstone fills likewise is uncertain. Some geologists see in them a dendritic pattern of subaerial erosion, in which case the filling with nonmarine deposits is a logical, although not essential, consequence. Other students of the problem consider the channels to be marine or tidal-flat scour features, in which case the sandstones could have been deposited in a marine or brackish water environment. As the general uniformity of the sandstones seems inconsistent with the steep-sided channels, it is not impossible that some are subaerial channels filled with marine sands.

The sands deposited in a nonmarine environment in some regions may grade through brackish water to marine deposits. Variations in relative subsidence of the basin could cause some of the sandstones in any region to be nonmarine and others to be marine. The principal source of the sandstones appears to be the Canadian Shield northeast of Illinois. Some additions probably came into southern Illinois from the east and into northern and western Illinois from the northwest (Siever and Potter, 1956; Potter and Siever, 1956a, 1956b).

The general absence of fossils favors a nonmarine or brackish water origin for the limestones associated with the underclays. Some of these limestones have a few fossils that are not typically marine. Marine fossils have been found locally in limestones at or near the positions of the underclay limestones.

It is widely accepted that the sandstone-underclay-coal sequence in each cyclothem is nonmarine, whereas the shale-limestone sequence above the coal is marine. However, most of the exceptions noted above indicate a trend toward accepting as marine some of the beds supposed to be nonmarine, and it is not impossible that more of the sequence is marine or brackish water than is now accepted. The freshwater origin of the coal beds limits the trend in that direction.

Several explanations have been suggested for the cyclical alternation of marine and nonmarine sediments. All accept the requirement of a sinking basin, but some envision essentially continuous or repeated sinking, and others postulate alternating sinking and uplift. Changes in the types of sediments of the individual units are attributed by some to repeated diastrophism in the positive areas. Others favor climatic cycles as the major control in erosion and transportion of clastic sediments. Eustatic changes in sea level have been proposed as the dominant factor in controlling the type of sediment. Some favor cycles of glaciation as the cause of eustatic changes. An evaluation of these concepts is beyond the scope of the present study.

The individual units of a cycle are considered to be essentially contemporaneous throughout the areas in which they can be traced. In general, lateral variations in lithology of the members are within a limited range that does not overlap the range of variations of adjacent units. The widespread continuity of many of the lithologic units without recognized lateral transition zones opposes a concept of facies relationships between members.

Because each cycle contains both marine and freshwater deposits, marine invasion and withdrawal is required for each cycle. If the regional continuity of individual cycles is accepted, the amount of time transgression of individual units cannot exceed the duration of each marine invasion or, similarly, of each nonmarine sequence. Minor overlapping time equivalence between different lithologies is required to explain the irregular distribution of some units. For practical purposes, however, the bedding contacts between lithologic units appear to be isochronous surfaces.

This interpretation applies only to areas such as the Illinois Basin where alternating marine and nonmarine sequences are widely traced. It may not apply to areas where the sequence is almost entirely marine or nonmarine. In areas where the sequence is dominantly nonmarine sandstone, conditions probably favored sand accumulation during most of the cycle, rather than periods of nondeposition (equivalent to the marine sequence elsewhere) between the intervals of sand accumulation. Similarly, in the marine sequences, sedimentation probably was nearly continuous rather than interrupted by diastems equivalent to the intervals of nonmarine deposition of other areas.

PRINCIPLES OF CLASSIFICATION

One object of the present restudy of Pennsylvanian classification was to modify the existing classification to conform to the recent statement of policy of the Illinois State Geological Survey regarding stratigraphic nomenclature (Willman, Swann and Frye, 1958). That policy statement introduced several concepts that had not been accepted when the last major review of Pennsylvanian classification was made, particularly the following:

1) The use of multiple classification to develop stratigraphic classifications for special needs and to restrict the range of criteria employed in a single classification. Under this policy, cyclical sedimentation can be accepted as a basis for stratigraphic classification independent of rock-stratigraphic classification, although the policy allows the use of cyclical sequences as rock-stratigraphic units where more desirable units are not present. Rock-stratigraphic units are based on lithologic differences between adjoining units; cyclical units are based on similarities between units. Therefore, cyclical classification is retained for its special merits, unencumbered by the requirements of rock-stratigraphic classification.

2) The acceptance of rock-stratigraphic classification as the major working classification used by the field and subsurface stratigrapher. Such acceptance requires that rock-stratigraphic classification be designed to meet practical needs. However, a classification that does not recognize genetic units is not likely to be the most effective. In most sequences, and particularly in the Pennsylvanian, several possible units may qualify as formations, and practical considerations such as the need for fine or coarse subdivision, ease of differentiation, and mappability must weigh heavily in making the choice.

3) The adoption of uniform use of standard units of rock-stratigraphic classification throughout the stratigraphic column. A major problem in the formulation of policy was whether different classification names should be devised to emphasize differences in character of units in different systems or parts of systems, a notable example being the cyclothems of the Pennsylvanian System. It was decided that such practice had no stopping point and that it violated a major objective of classification —the design of a uniform framework for evaluation of units. This decision removes the name "cyclothem" from the rock-stratigraphic classification of the Illinois Geological Survey, although it does not eliminate the cyclical unit from possible recognition as a group, formation, or member.

4) The acceptance of the formation as the fundamental unit of rock-stratigraphic classification. For some years the Illinois classification has included groups, cyclothems, and members, but no formations. The fundamental unit is interpreted in the new policy to be the first unit to be differentiated, the one unit that most clearly meets, or most effectively compromises, the requirements of distinctive lithology, continuity, and practical needs, and the one unit of which a complete sequence is required. Other rock-stratigraphic units are assemblages or subdivisions of formations, used only as needed. This interpretation establishes a definite method of approach to classification, primarily aimed at more consistent differentiation of units.

5) The clarification of policy concerning priority. The accepted rules eliminate duplicate use of names, a practice widely used in the Pennsylvanian to show close association and to conserve names — for example, Curlew Limestone, Curlew Coal, Curlew Sandstone. Some attempt has been made to correct conflicts resulting from the discovery of prior use of a name, but the new policy accepts the premise that in cases of long established use a change in names may cause confusion where no confusion has ex-

isted and none is likely to develop. This premise reduces the number of names which need to be changed.

6) The definition of rock-stratigraphic units should include gross lithology, stratigraphic position in relation to overlying and underlying beds, type section, and derivation of name. Many of the named stratigraphic units in the Pennsylvanian of Illinois do not have adequate definitions. Some names that were introduced on maps or in tables have been widely used. In some cases, although not generally so stated, the impression is given that the names are introduced informally, and therefore neither standard practices of definition nor regard for priority need be followed. The new policy calls for introduction of names only in places where adequate definition can be given. If a change in previous classification is involved, a statement of reasons for the change must be given.

ADVANTAGES AND DISADVANTAGES OF THE CYCLICAL CLASSIFICATION

Since the cyclothem was introduced as a unit of classification in the Pennsylvanian rocks of Illinois, many advantages in its use have become evident, among them the following:

1) Recognition of the cyclical nature of the sediments has been valuable in solving field problems, particularly in deciphering poorly exposed sections, in directing the search for important coal and limestone key beds, and in providing a framework for systematic field description.

2) Cyclothems have been shown to be mappable on the scale of a mile to the inch (Willman and Payne, 1942; Wanless, 1957), providing that some thin or partial cyclothems may be combined in a map unit. This practice does not differ from that commonly used where certain formations thin to unmappable size, but it may be required more frequently in mapping cyclothems. A few persistently thin cyclothems are not known to be of mappable thickness. Mapping cyclothems is essentially mapping the base of the sandstones. This has advantages locally in outlining cutouts and in indicating the degree and area of truncation of underlying strata.

3) Cyclothems can be differentiated in cores, and even in some descriptions of cores made before the cyclical arrangement was recognized. Under the most favorable conditions they also may be differentiated in samples of cuttings from churn and rotary drill holes, in some cases with an accuracy as great as that for most formations in other systems. However, they are differentiated in subsurface with much less accuracy in areas of thin cyclothems and in areas where the sandstones are not well developed. In much of Illinois they are recognized readily from subsurface data in parts of the section, scarcely at all in other parts.

4) Cyclothems have great lateral continuity and thus are valuable for correlation. The cyclothem unit extends and can be recognized more widely than an individual member. In view, however, of the great continuity of many distinctive members, this advantage is only locally significant.

5) Lateral variations in dominant composition within cyclothems and vertical differences in sequence and lithology between cyclothems provide a valuable approach to studies of environment, sedimentation, source of sediments, and other aspects of genesis.

Difficulties encountered in the use of the cyclothem as the fundamental unit of rock-stratigraphic classification include the following:

1) Differentiation of the Pennsylvanian sequence based entirely on the base of the sandstones, or on the position of the sandstones where they are absent, has proved difficult in many areas. Although the base of the sandstones is sharply defined where the sandstone is in channel facies, the contact is gradational in the areas between the channels. Because the upper shale of the underlying cyclothem generally becomes sandy upward, the contact is difficult to place. It is impossible to be certain that sandy beds between the channels are continuous with the sandstone in the channel facies. In many cases sandstone is absent.

Channel facies have proved to be much less extensive than originally believed and the advantages in mapping them, therefore, are very limited areally. As a whole, the base of the sandstones is the most difficult contact in the entire sequence to pick consistently.

2) In mapping, the bases of the sandstones have the disadvantage of being the least useful horizons for showing structure. This disadvantage is partially offset by the usefulness of the contact in outlining cutouts, as previously noted. In field work, mapping the base of the sandstones is relatively difficult and time-consuming. The contact is also perhaps the least economically significant, and except on very large scale maps its mapping is generally impractical if one or more of the commercially important coals, limestones, shales, and underclays is shown. Although not all of these can always be mapped, mapping either the underclay, coal, or limestone of a cyclothem provides adequate location for the other units of the cyclothem, because they are close in the sequence. As location of mineral resources is a major objective of geologic mapping, it has become increasingly important to map the economic beds, if necessary at the expense of mapping formation or other boundaries.

3) A similar problem arises in the differentiation of cyclothems in subsurface — in cores, cuttings, and electric logs. In the analysis of the large amount of data available from drilling for coal, oil and gas, and water in the Pennsylvanian, the differentiation of cyclothems requires recognition of the base of the sandstones, the contact most difficult to pick. As other contacts may be readily identified, cyclothems usually have not been differentiated, even where the data were adequate to permit their recognition. In general, cyclothems have not proved to be of sufficient value in economic studies to justify the additional work of differentiating them.

4) Other difficulties with the cyclical classification arise from changes in stratigraphic policy, including the following:

a) The requirement that units of rock-stratigraphic classification should be used uniformly throughout the rock column eliminates the use of the name cyclothem. It requires recognition of a complete sequence of formations, and, to date, it has not been practical to differentiate a complete sequence of cyclothems in the lower and upper parts of the column.

b) The general principle that formations are differentiated by differences in lithology is not consistent with the recognition of cyclothems as formations, because cyclothems are similar. Although cyclothems are lithologic units, the emphasis in their recognition is on sedimentation and genesis rather than lithology, and in some ways they are more closely related to time-stratigraphic than to rock-stratigraphic units.

c) Cyclothems have been considered exempt from rules of nomenclature. The common disregard of rules of priority and definition makes necessary a complete re-evaluation of their classification and nomenclature.

Consideration of the advantages and disadvantages of the cyclical classification has led us to conclude that the cyclical sequence has important uses and should be retained in a cyclical classification independent of the rock-stratigraphic classification.

REVIEW OF ALTERNATIVE CLASSIFICATIONS

The major and long-standing problem of rock-stratigraphic classification in the Pennsylvanian succession is the recognition of a formational unit. The principal alternatives for formational units that have been considered in this restudy are summarized in figure 3. There are a few possibilities intermediate to those illustrated, and some boundaries could be moved without significantly changing the degree of subdivision or the principle involved.

ALTERNATIVE 1 — INDIVIDUAL UNITS

The many individual rock units that compose the Pennsylvanian sequence have been called members, beds, or units. They are, in general, the 10 lithologic units of

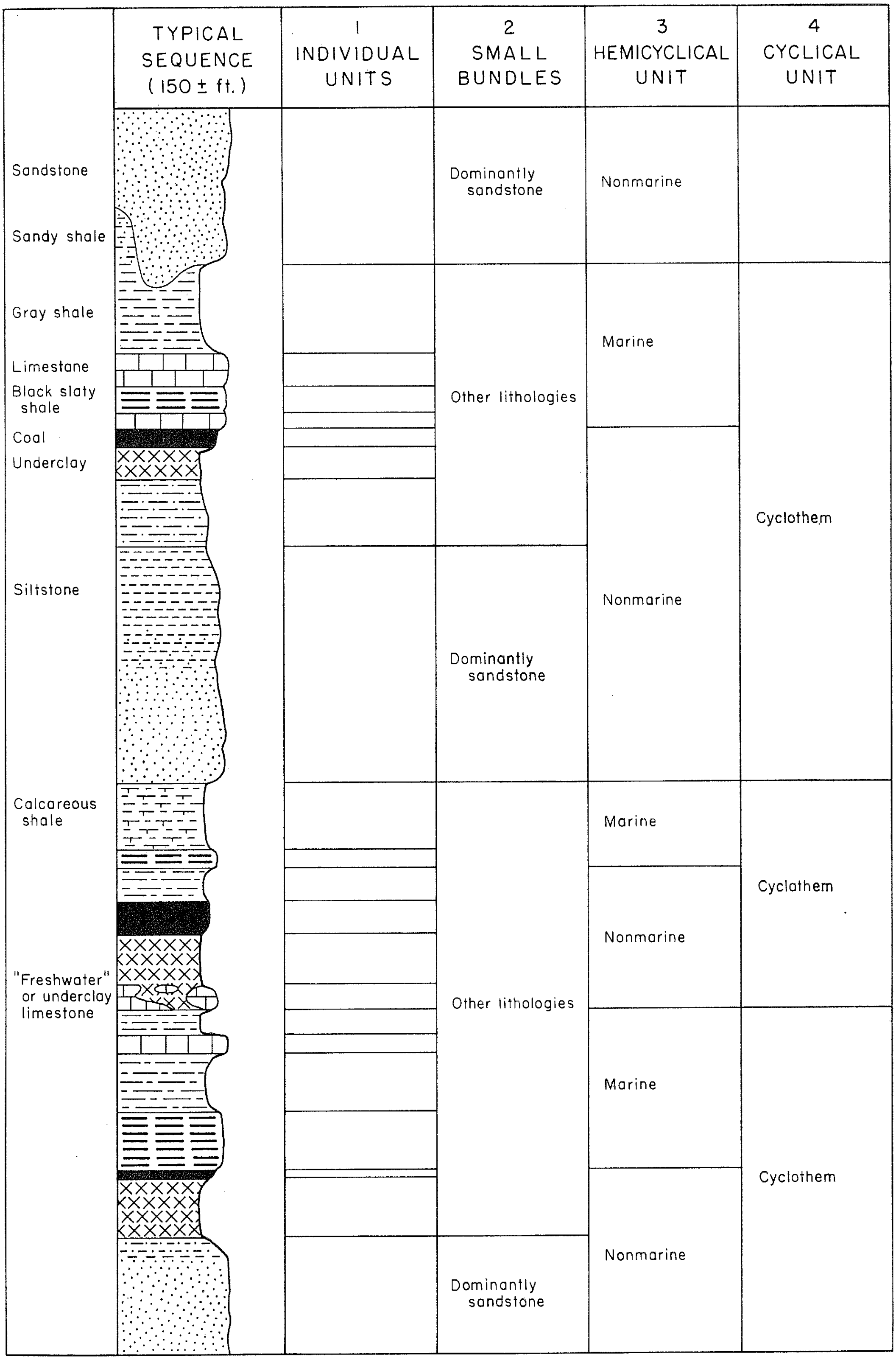
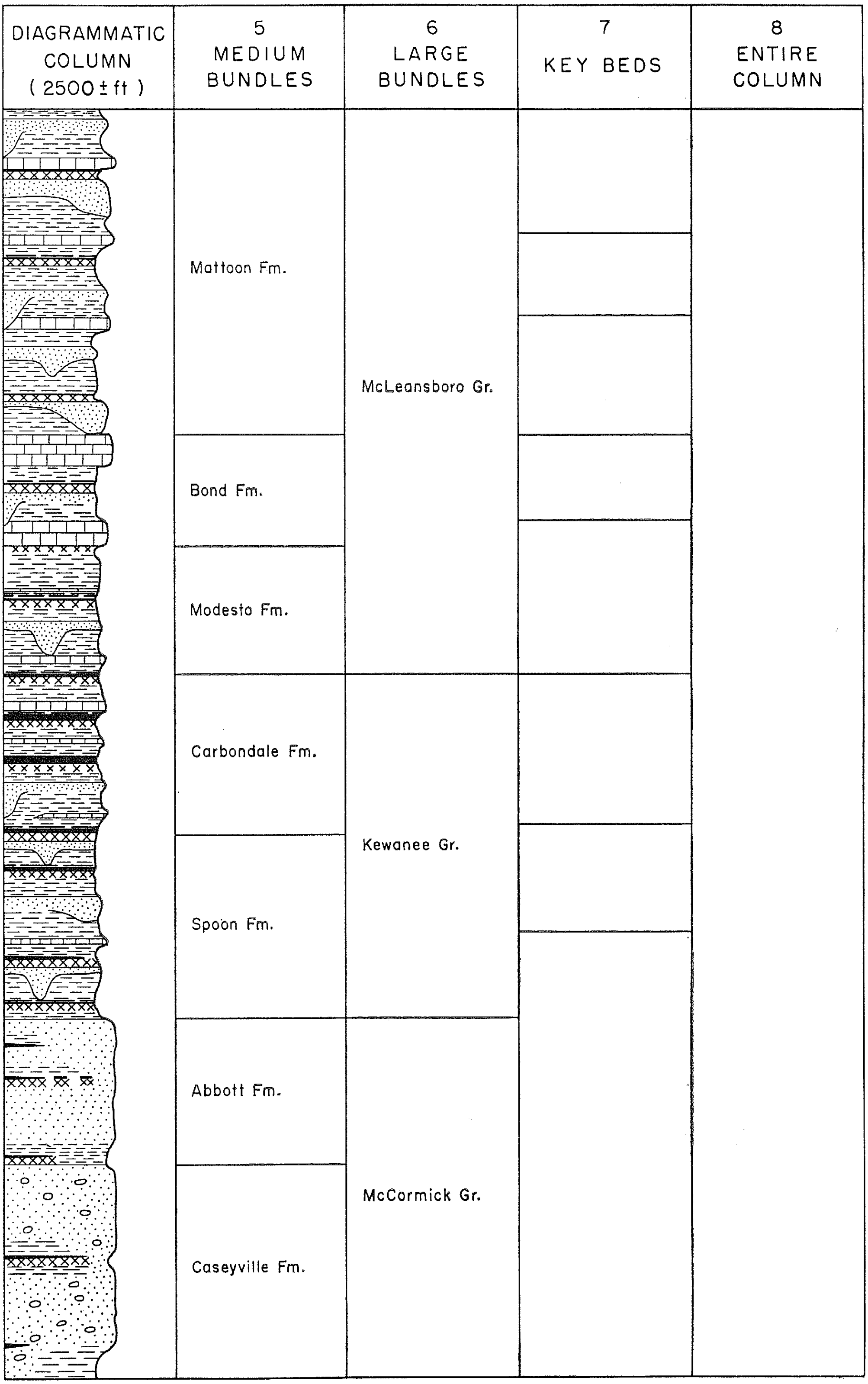


Fig. 3. — Principal alternatives for formations



in the Pennsylvanian rocks of Illinois.

the typical cyclothem, but twice as many or more may be identified in some cyclothems depending on the degree of splitting. These individual units have the lithologic distinctiveness and continuity desired in formations to a degree generally exceeding that found in other Paleozoic systems in this region. Many of them are key beds on which local stratigraphic work and regional tracing in the Pennsylvanian is based.

In spite of the factors that favor recognition of the individual units as formations, we have found no published support for this position. The major objection to alternative 1 is that it would create such a large number of formations. Even granting some lumping of closely related beds and of interbedded units, at least 300 formations, and perhaps several hundred more, could be differentiated in Illinois. Perhaps only a tenth of these units, mostly shales and sandstones, would meet the recommended minimum size for formations — 10 feet thick for an extent of 50 miles. Even this size limit is too small if it results in recognition of several thin formations in sequence, a condition that would occur many times in the Pennsylvanian.

Recognition of the formation as the fundamental unit of rock-stratigraphic classification requires a complete sequence of formations. A prohibitive number would be required if individual units were accepted as formations. At present there is no demonstrated need for such a fine subdivision, and most of the names would have slight use. It is conceivable that, as the need for greater detail in stratigraphic studies develops, such a classification will be accepted. Many of these units will be named as their value becomes apparent, and their upgrading to formational status will be less difficult than at present.

ALTERNATIVE 2 — SMALL BUNDLES

Small bundles (fig. 3) are based on lithologic grouping by major rock types. Beds of different rock type that are too thin to merit differentiation are arbitrarily included in the bundles. This approach recognizes as formations the major sandstones separated by dominantly shale formations that contain the coals, limestones, and thin sandstones. Alternative 2 recognizes the dominance of shale and sandstone in the Pennsylvanian sequence.

In certain areas of Illinois and in certain parts of the column, this method of classification proves workable. Applied to the entire column it would recognize a minimum of 25 formations or perhaps as many as 100 formations.

In principle and in degree of subdivision, the small bundles offer one of the most attractive means of differentiating formational units. It is used extensively in the Midcontinent region. In practice it has many disadvantages for use in Illinois, as follows:

1) It results almost entirely in differentiating formations on the top and bottom of the sandstones, the two most difficult contacts in the entire sequence to trace laterally. Specific identification of sandstones is therefore based largely on relation to beds more easily identified.

2) The sandstone units are thick and well defined only in the limited areas of the channel facies. Although these sandstones could continue to be recognized as formations in the areas between channels where they are thin, other unnamed sandstones in the same sequence that are not ranked as formations might be more prominent. Thus the ranking of units in one sequence would soon be entirely out of proportion in an adjoining area. Much of the usefulness of the classification would be lost, and many unwieldy combinations, hyphenated names, or new names, would be required.

3) The shale formations would contain the important key beds and the economically important members, but their boundaries would have no significant relations to these important members. The formations, then, would have no particular value for descriptive purposes in economic studies.

4) In parts of the column the formations would be roughly equivalent to hemicycles in size, but in others they would combine several cycles. In general these units would be sufficiently near the cyclothem in size that their only advantage would be in eliminating the restrictions imposed by rigid

adherence to cyclical differentiation. A subdivision at about this level would be more effectively served by cycles or hemicycles, which furnish a more systematic basis for differentiation.

The small bundles appear to be too heterogeneous to provide a useful system of classification in Illinois.

ALTERNATIVE 3 — HEMICYCLOTHEMS

The marine and nonmarine parts of the cyclothem may be treated as separate units called hemicyclothems (fig. 3). The use of hemicyclothems as formations presents the same general difficulties as those previously noted for cyclothems. Although adjacent formations would differ in composition, each would embody such varied rock types that the basis for differentiation would clearly be genetic rather than rock stratigraphic. They would provide twice as many formations as the cyclothems, many of which are already too small for convenient use.

ALTERNATIVE 4 — CYCLOTHEMS

The advantages and disadvantages of using cyclothems as formations have been discussed. The effectiveness of cyclothems as formations would have been improved if a more generous lumping of thin and partial cyclothems had been practiced. Some of the practical objections to cyclothems would be removed if the break were made at the coals rather than at the base of the sandstones. However, even if the base were changed to this or other positions, the cyclothem still would not fill either the theoretical or the practical requirements for a rock-stratigraphic unit. As the cyclothem is useful in its present form for cyclical classification and has long been established in an extensive literature in Illinois, modification does not seem desirable.

ALTERNATIVE 5 — MEDIUM BUNDLES

The units next larger than cyclothems are medium-sized bundles (fig. 3) differentiated on the basis of gross lithology. They are based in part on dominant lithology and in part on differing characteristics of the minor constituents, particularly on number and thickness of distinctive beds such as limestones and coals. The advantages in using these units as formations are as follows:

1) Successive units differ in gross lithologic characteristics.

2) The units extend over much of Illinois.

3) They are desirable map units.

4) The contacts are based on widely traced key beds.

5) The number of units differentiated (seven) is not excessive. In the Pennsylvanian rocks of Illinois, a relatively large formation has many merits. As previously emphasized, stratigraphic work will continue to be based essentially on individual lithologic units regardless of how they are classified or whatever other units are differentiated.

6) The medium bundle is the smallest unit, larger than the individual unit, that is needed for most uses of classification. When complete description of the sequence within the medium bundles is needed, cyclothems or other units also may be differentiated.

ALTERNATIVE 6 — LARGE BUNDLES

The large bundles (fig. 3) are similar to the medium bundles but are based on even more gross lithologic characteristics. They are much larger than desired for formational units; only three are recognized in the entire column. Acceptance of the medium bundles as formational units would make these larger units logical groups.

ALTERNATIVE 7 — KEY BEDS

By differentiating formations strictly on the basis of key beds, it is possible to select formations of almost any size desired. However, failure of this alternative to recognize internal characteristics of the units produces essentially artificial groupings useful only as "pigeon holes" in classification. It, therefore, falls short of many of the objectives of rock-stratigraphic classification.

ALTERNATIVE 8 — ENTIRE SEQUENCE

An extreme method of classification, based on the general uniformity in sequence, or uniformity in heterogeneity, would justify classification of the entire Pennsylvanian column as one formation.

CONCLUSION

For rock-stratigraphic classification the medium-sized bundles are accepted as formations, the individual units as members, and the large bundles as groups.

Cyclothems are retained for cyclical classification.

NOMENCLATURE OF ROCK-STRATIGRAPHIC UNITS

The differentiation and naming of members and beds requires special consideration. In the Pennsylvanian, *members* generally are distinguished by the fact that the overlying and underlying units are of different lithology, for example, underclay, coal, and black shale members in sequence. *Beds,* as stratigraphic units, are subdivisions of members and therefore usually have similar material above and below, for example, a persistent clay bed in a coal member.

MEMBERS

Members are the primary subdivisions of formations. In Illinois they consist of 1) distinct lithologic units such as sandstones, shales, coals, slates, underclays, limestones, and 2) alternations of two (rarely more) distinct lithologic types, such as interbedded limestone and shale. Previously in this report members have been referred to as individual units.

Only those members that are referred to frequently should be named. Additional names may be added as the need is demonstrated. Members that can be identified easily by reference to another member, as underclay of No. 5 Coal, black shale above No. 5 Coal, underclay limestone below No. 5 Coal, need not be named. Unusual relations will require exceptions. For example, where the underclay of No. 2 Coal is actually a composite of several underclays, it may be called the Cheltenham Clay Member. Thin units representing the feather edge of coals, limestones, or sandstones in the clay will be classified as beds in the area where the Cheltenham Clay is recognized as a member, even though they may be specifically identified as members in another area.

The expression "underclay of No. 5 Coal" should be treated as a descriptive term and as neither a formal nor informal name. The word "underclay" therefore should not be capitalized. Informal names, such as "blue band," "septarian limestone," "*Cardiomorpha* limestone," should be enclosed in quotation marks, but the use of such names is discouraged. In general, an informal name should be used only when needed for local or temporary identification. If it must be used more extensively, the unit qualifies for formal naming. Geographic names are not assigned to informal units.

The recognition of a complete sequence of members may be desirable when a detailed description of an area is made (Willman and Payne, 1942; Wanless, 1957). The members can be numbered instead of named, but the numbers should be used in only the one report. In reports describing Pennsylvanian sequences in less detail, perhaps indicating only important coals or limestones, it is not necessary to recognize a complete sequence of members or even all the named members.

Excessive splitting of members based on alternating units of similar lithology (interbedded limestone and shale) or on minor lithologic differences should be avoided. Transitional zones should not be differentiated as members but should be included in the member above or below.

Minor variations in sand, shale, or calcareous content, of limestone or ironstone concretions, of lenses of sandstone, or of other inclusions present in part of a member do not justify differentiation of that part as a separate member. These variations may be described as a characteristic of part of the member.

Even though they are in sequence, shales of radically different character (such as black, gray, and red shales, and some very calcareous shales) may be differentiated as members provided they are well defined, have the general relationship of members, and have wide distribution.

The full name of a member, such as Canton Shale Member, should be used at the beginning of a discussion, but thereafter "Member" may be dropped.

BEDS

Only beds of special significance and of wide distribution should be named. Beds may be named even though the member of which they are a part is not named.

A bed in one area may be classified as a member in another area. However, in the description of a local area, such as a quadrangle or county, this practice should generally be avoided.

Classification as a member or bed should be based primarily on relations mentioned above and not on distinctiveness of lithology or on thickness. For example, less than one inch of No. 5 Coal below black shale and above underclay is recognized as a member, although a 6-inch coal in the Canton Shale Member is called a bed. A unit should be recognized as a member rather than a bed if the relations permit.

NOMENCLATURE OF CYCLOTHEMS

Cyclothems have geographic names. They may be given the same name as a prominent member or bed in the cyclothem, or they may be given another name. As the word "cyclothem" will always be used when the unit is referred to, use of a geographic name already adopted for some other form of stratigraphic classification does not cause confusion and is permitted. However, names used for other Pennsylvanian stratigraphic units or for other stratigraphic units in Illinois or bordering states should not be applied to a cyclothem in Illinois. The term "cyclothem" will be capitalized when used with a geographic name, as in St. David Cyclothem.

A sequence of three or more of the ten units of the ideal cyclothem will normally be differentiated as a cyclothem and named. One or two units not in the normal order of the cyclical sequence but interfingered within a cyclothem should be treated as part of the cyclothem. One or two units may be differentiated as a cyclothem if they occur at a cyclothem boundary, and they should be differentiated if a cyclothem is recognized at this position elsewhere.

In an area where the intercalation of several units within a cyclothem requires the recognition of two cyclothems, both should have new names. This will avoid the confusion of a cyclothem's having variable definitions in different areas. Member names are independent of cyclical classification and will be unaffected by changes in cyclothem names.

Names such as Upper, Middle, and Lower are not acceptable in cyclothem names.

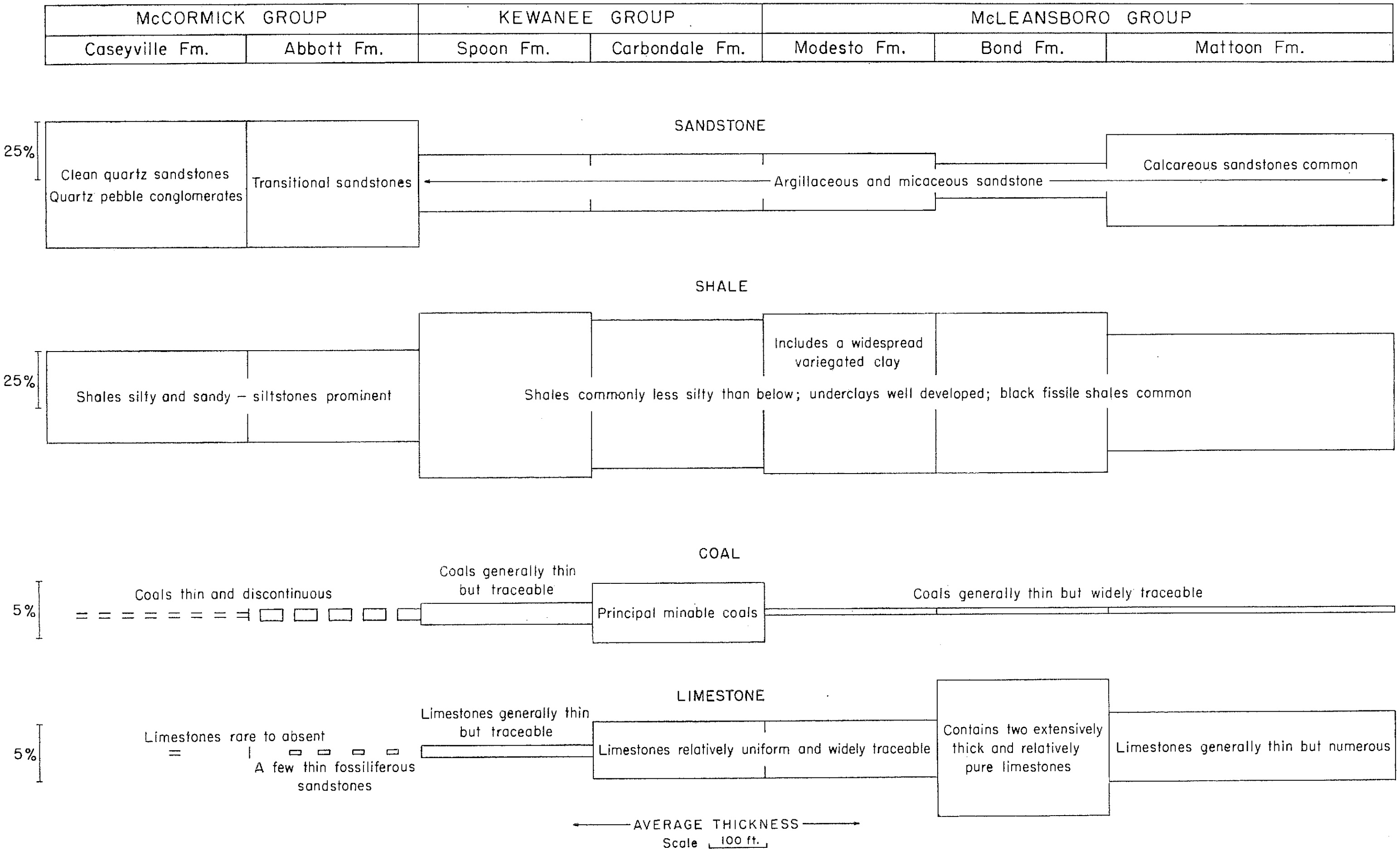


Fig. 4.—Distribution of the four principal lithologies in Pennsylvanian strata of Illinois.

PART II

ROCK-STRATIGRAPHIC CLASSIFICATION

GENERAL STATEMENT

Strata of Pennsylvanian age in Illinois are separated from older Paleozoic rocks by a major unconformity. In places they overlap the entire Mississippian, Devonian, and Silurian Systems and rest on Ordovician rocks as old as the St. Peter Sandstone (Weller et al., 1945; Wanless, 1955, p. 1760). Throughout most of the extensive area they cover in Illinois, Pennsylvanian rocks are overlain by deposits of Pleistocene age. Although neither the youngest nor the oldest Pennsylvanian rocks of the Appalachian and Midcontinent regions are recognized in the Illinois Basin, Pennsylvanian rocks in Illinois include beds equivalent to most of the major subdivisions recognized in other areas.

The Pennsylvanian strata are named for the state of Pennsylvania (Williams, 1891), and the name has been used in Illinois with system rank since 1906 (S. Weller, 1906, fig. 1). Neither series nor stage subdivisions of the time-stratigraphic classification of Pennsylvanian rocks have as yet been adopted by the Illinois Geological Survey, but the relation of the sequence to units recognized in adjacent states is shown on plate 1 and relation to units of other regions is to be found in the Pennsylvanian correlation chart (Moore et al., 1944).

In rock-stratigraphic classification, groups, formations, and members are recognized, as previously discussed. The abundance of relatively thin but distinctive lithologic units has made it desirable to recognize sequences or bundles of these units as formations. The formations differ in the relative abundance and gross lithologic characteristics of sandstones, shales, siltstones, limestones, and coals (fig. 4). Larger units based on lithologic similarities between the formational units are recognized as groups, and the relatively thin lithologic units are recognized as members.

This rock-stratigraphic classification replaces one in which cyclical sequences, or cyclothems, were treated as formational units, although not formally so designated. The reason for applying the name "cyclothem" was to emphasize the differences between the cyclical sequences and normal formational units. Rejection of the cyclothem as a term or a unit of rock-stratigraphic classification requires the introduction of a nearly complete new sequence of formation and group units and names.

Seven formations are recognized and placed in three groups, as follows:

- McLeansboro Group
  - Mattoon Formation
  - Bond Formation
  - Modesto Formation
- Kewanee Group
  - Carbondale Formation
  - Spoon Formation
- McCormick Group
  - Abbott Formation
  - Caseyville Formation

In general, names of members are the same as in the previous classification, except for names introduced to replace such duplications as Curlew Limestone, Curlew Coal, and Curlew Sandstone. The geographic name is retained for only one of such units after a consideration of priority, extent of use, and relative prominence of the unit. A few names of minor units are abandoned as unnecessary, particularly in cases of duplication. Compound names and informal descriptive names for unusual rock types are changed to the standard format for formal usage.

Where different member names have been applied to the same unit in various parts of the state, the name having priority and widest use is chosen. However, no attempt is made to eliminate all such synonyms, even where correlations are reasonably well established. In some cases the continued use of local names seems preferable to a choice between long established and widely used names.

The revised classification and a composite column of the Pennsylvanian rocks of Illinois are shown on plate 1. The column is a compilation of representative sections, mostly those typical of the sequence in the type areas of the formations. Because of considerable variation in thickness and lithology throughout the state, the section is generalized and does not include all members recognized, particularly in parts of the section where lateral variations are most prominent. Although the composite section shows a total of only about 2300 feet of strata, a composite of maximum thicknesses of the formations would be more than 3000 feet.

In the following description of the revised classification, all accepted names are listed. Only names that are new, redefined, or otherwise different from those shown on the correlation chart compiled by Siever (*in* Wanless, 1956) are discussed. Type localities and original references of all named formations and members are listed in table 1.

McCORMICK GROUP

The McCormick Group, which contains the Caseyville and Abbott Formations, is the lowest group in the Pennsylvanian of Illinois. The group is here named for the village of McCormick in northwestern Pope County, which is located in an area where strata of the two formations are prominently exposed. It includes strata formerly included in the Caseyville Group and the lower part of the Tradewater Group.

The McCormick Group is characterized by the prominence of thick, commonly massive, relatively pure quartz sandstones that constitute 50 to 60 percent of the strata. Sandy shale and siltstone normally make up 40 percent or more of the section. Coals are characteristically thin and of very limited continuity. Limestones are uncommon to rare, although fossiliferous sandy beds or sandy limestones have been reported locally.

Although a number of named members in the group have been rather extensively traced in outcrop, they are more difficult to trace in subsurface. The upper boundary of the group, the top of the Murray Bluff Sandstone, is difficult to recognize in some areas because of the variability of the sequence.

Cyclothems in the McCormick Group, in contrast to those of the Kewanee Group, rarely are composed of more than four or five different lithologic units. Limestones are generally absent and more than one coal usually is present in each cyclothem.

CASEYVILLE FORMATION

The Caseyville Formation as here defined includes strata from the base of the Pennsylvanian to the top of the Pounds Sandstone. It corresponds to the Caseyville Formation as defined by Lee (1916) and probably to strata referred to as Caseyville Conglomerate by Owen (1856, p. 48). The Caseyville as previously used in Illinois (Weller, 1940) is thus redefined to exclude 40 to 60 feet of strata (including the Reynoldsburg Coal) above the Pounds Sandstone and below the Grindstaff Sandstone that are now defined as part of the overlying Abbott Formation.

The type area defined by Lee (1916, p. 15-16) after Owen (1856) was "measured from outcrops on the Illinois shore of the Ohio River between the mouth of the Saline River and Gentry's Landing below Battery Rock" in Hardin County (geologic section 1, appendix). A supplementary section for this formation consists of exposures along the Illinois Central Railroad cut from the Mississippian-Pennsylvanian contact about 1½ miles north of Robbs to the area over the railroad tunnel near Zion Church in Pope County (geologic section 2).

The Caseyville is, in general, restricted to the southern part of the coal basin in southern Illinois.

LITHOLOGY

The Caseyville Formation is characterized by dominance of sandstone and prominent development of sandy shale and siltstone (fig. 4). Sandstone members are not uncommonly of the order of 100 feet thick, and the two sandstone members that have been named, Pounds and Battery Rock, form prominent bluffs along the Pennsylvanian escarpment of southern Illinois.

The Caseyville sandstones are composed of clean quartz sands and have little clay or mica. The sandstones contain well rounded white quartz pebbles, commonly about 1/4 to 1/2 inch in diameter, although pebbles about 1 1/2 inches in diameter have been reported. In some areas the quartz pebbles are distributed throughout the sandstone bodies, but more commonly they are concentrated along bedding planes or in conglomeratic lenses. In many exposures the quartz pebbles are scarce and are found only by careful search. Secondary enlargement of quartz grains is common and gives sparkle to the rock. The character of these sandstones has been described by Glass et al. (1956), Lamar (1925), Potter and Olson (1954), Potter and Glass (1958), Potter and Siever (1955, 1956a, 1956b), Rich (1916a, 1916b), Siever (1951), Siever and Potter (1956), Wanless (1939, 1955), Weller (1940). The character of the sandstones is the most useful feature for distinguishing the Caseyville from overlying formations.

The shaly and silty strata below the principal sandstones are characteristically sandy. Sandstone benches up to at least 25 feet and similar to the principal sandstone members occur in the Lusk Shale, the lowest member.

Two or more coal beds have been recognized within each of the more shaly parts of the Caseyville Formation throughout much of the southern Illinois outcrop belt. The coals, however, generally are very thin and not widely traceable. Only one coal, the Gentry Coal Member, has been widely correlated, but even this is not continuously traceable.

In general, limestones have not been observed in Caseyville strata, but fossiliferous sandy beds occur in a few places. Some of the fossils are reworked from Mississippian and older rocks. The notable exception is the Sellers Limestone Member, which is exposed near Sellers Landing in Hardin County near the Ohio River. It is dark, iron rich, relatively dense marine limestone about 2 feet thick. Although the exact stratigraphic position of the Sellers Limestone is not established, Wanless (1939, p. 64) indicated its position between the Gentry Coal (formerly called the Battery Rock Coal) and the Battery Rock Sandstone. The description of the type section of the Caseyville (geologic section 1) shows limestone between the Pounds Sandstone and the Gentry Coal.

THICKNESS

The Caseyville Formation is highly variable in thickness because the pre-Pennsylvanian surface is irregular and because the formation thins westward toward the western shelf area and northward from the area of maximum development in southern Illinois. Although thicknesses in excess of 500 feet have been reported, a maximum thickness of 350 feet is more common.

MEMBERS OF THE CASEYVILLE FORMATION

Southeastern Illinois

In southeastern Illinois the following members are named:

Pounds Sandstone
Gentry Coal
Sellers Limestone
Battery Rock Sandstone
Lusk Shale

The Gentry Coal Member is named here for exposures in Hardin County, near Gentry Landing (geologic section 1). Owen (1856) termed this the Battery Rock Coal, but the name Battery Rock has been more widely used for the sandstone and is here restricted to the sandstone.

Southwestern Illinois

In southwestern Illinois the following named members are recognized:

Pounds Sandstone
Drury Shale
Battery Rock Sandstone
Wayside Sandstone

Like the Lusk Shale Member to the east, the Wayside Sandstone Member is a complex unit consisting of several beds of massive sandstone separated by silty shale. It probably includes strata equivalent to the Lusk Shale. The sandstones generally are lenticular and not widely traceable. Two or more thin, erratic coals or coaly streaks are recognized within this complex member, one of which was termed Wayside Coal (Kosanke, 1950). The name now is restricted to the sandstone, and at present no name is needed for the coal.

The name Battery Rock is extended from southeastern Illinois to southwestern Illinois for the sandstone previously named Lick Creek. The name Lick Creek is preempted.

The Drury Shale Member contains all strata between the Battery Rock and Pounds Sandstone Members. This unit is dominantly shale but includes some sandstone and two or more thin, discontinuous coals. The name Drury Shale is not used in southeastern Illinois, where the Gentry Coal and the Sellers Limestone are differentiated in this interval.

The Lusk and Drury Shale Members are composite units, but until they are subdivided the names are useful and are retained.

The name Pounds Sandstone Member is extended to this area to include strata formerly considered to be the lower part of the Makanda Sandstone, which has been subdivided. The name Makanda is discontinued.

Abbott Formation

The name Abbott Formation is proposed here for strata from the top of the Pounds Sandstone Member to the top of the Bernadotte Sandstone Member of western Illinois. The latter is believed to be equivalent to the Murray Bluff Sandstone Member of southern Illinois. The formation is named for Abbott Station, which is located about the midpoint of the type exposures of the formation along the Illinois Central Railroad cut in Pope County (geologic section 3). The Abbott Formation overlaps the Caseyville Formation and throughout most of central, northern, and western Illinois is the basal formation of the Pennsylvanian System. However, it in turn is overlapped by the younger Spoon Formation on some of the more prominent anticlinal structures.

The Abbott Formation consists of strata that were included in the lower part of the sequence formerly called the Tradewater Group.

LITHOLOGY

Like the Caseyville Formation, the Abbott Formation is characterized by the dominance of sandstone, sandy shale, and siltstone. The massive sandstone members generally do not attain a maximum thickness as great as do those of the Caseyville. The sandstones of this formation may be considered transitional from the relatively pure quartz sandstones of the Caseyville Formation to the argillaceous and micaceous sandstones of higher Pennsylvanian formations. The lowermost sandstone is a relatively clean quartz sandstone, and the highest sandstone member is more argillaceous and micaceous.

Sandstones of the Caseyville and Abbott Formations can best be differentiated by the general absence of quartz pebbles and the greater prominence of clay matrix in the Abbott sandstones. A few quartz pebbles have been reported in sandstone members of the Abbott Formation, but they are rare.

Sandstones and siltstones constitute more than 50 percent of the Abbott Formation (fig. 4).

Although the shales of the Abbott are commonly sandy and silty, like those in the underlying Caseyville, there are more nonsandy, clayey shales than in underlying strata.

Coals in the Abbott Formation generally are thicker and much more widely traceable than coals of the Caseyville. However, the coals are rarely more than 24 inches thick and have much less continuity than the higher coals.

Limestones are generally absent in this formation but relatively thin, discontinuous, sandy limestones or fossiliferous sandstones are associated with at least two of the sandstone members. In Indiana Ferdinand and Fulda Limestones occur in strata equivalent to the Abbott Formation.

THICKNESS

The Abbott Formation has a maximum thickness of 300 to 350 feet in southern

Illinois, but it thins westward and northward. The Abbott probably is never more than 100 feet thick in western Illinois and is generally much thinner.

MEMBERS OF THE ABBOTT FORMATION

Southern Illinois

In the southern part of Illinois, six members of the Abbott Formation are recognized:

Murray Bluff Sandstone
Delwood Coal
Finnie Sandstone
Willis Coal
Grindstaff Sandstone
Reynoldsburg Coal

The name Boskydell Sandstone used on the chart compiled by Siever (*in* Wanless, 1956) was applied to the unit called Boskydell Marine Zone by Wanless in the same report. The name has been used (Wanless, 1939, 1956; Weller, 1940; Weller et al., 1942; Desborough, 1959) for a bed or an ill-defined zone of fossiliferous calcareous sandstone or sandy limestone interbedded with sandstone. Because the name Boskydell has been used for material of this lithologic character now believed to occur at more than one horizon, and because the unit generally lacks the distinctiveness and continuity of units recognized as members elsewhere in the Pennsylvanian sequence, the name is dropped from formal usage.

The sandstone formerly called Delwood is now named Finnie, the name used for this sandstone in Kentucky (Owen, 1856; Lee, 1916). This change was made to retain the name Delwood for the coal.

Western Illinois

The following members of the Abbott Formation are recognized in western Illinois:

Bernadotte Sandstone
Pope Creek Coal
Tarter Coal
Manley Coal
Babylon Sandstone

The Babylon Sandstone is provisionally correlated with the Grindstaff Sandstone Member of southern Illinois (Wanless, 1957), but pending further studies both names are retained.

The name Manley Coal Member is proposed here for the coal formerly called Babylon Coal. This name is taken from the small settlement of Manley four miles west of the type outcrop. The type locality remains unchanged (table 1).

The name Tarter Sandstone, previously applied to the sandstone below the Tarter Coal, is discontinued in order to retain the name for the coal. As the sandstone is thin and only locally present, no name is needed.

Similarly, the name Pope Creek is retained for the coal and dropped for the thin, local sandstone, for which a name is not deemed necessary.

KEWANEE GROUP

The Kewanee Group includes the Spoon and Carbondale Formations. The group is named for the city of Kewanee in Henry County, which lies within the outcrop belt of the formations that constitute this group.

This middle group of Pennsylvanian formations is characterized by the widespread development of minable coals. Approximately 99.9 percent of the mapped minable coal reserves of Illinois occur in the Kewanee Group (Cady and others, 1952).

Sandstones generally compose 25 percent of the Kewanee Group, compared with 60 percent of the underlying McCormick Group. The Kewanee sandstones are characteristically argillaceous and highly micaceous.

The Kewanee Group is marked by the earliest occurrence of widespread limestones of relatively uniform thickness. The limestones are commonly 1 to 5 feet thick, although some locally are more than 10 feet.

Cyclic sedimentation is well defined and the cyclothems show perhaps the maximum variety of rock types. This character is in marked contrast to that of the underlying McCormick Group but is similar to the cyclic character of at least the lower part of the overlying McLeansboro Group.

SPOON FORMATION

Spoon Formation is the name proposed here for strata from the top of the Bernadotte Sandstone Member to the base of the Colchester (No. 2) Coal Member. The formation derives its name from exposures in a roadcut and railroad cut of the T.P. and W. Railroad about ¼ mile west of Spoon River in Fulton County (geologic section 4). The Spoon Formation consists of strata previously included in the upper part of the sequence formerly called the Tradewater Group.

LITHOLOGY

The Spoon Formation contains much less sandstone and correspondingly more shale than the underlying formation (fig. 4). The sandstones are generally more argillaceous and micaceous than sandstones of the Abbott Formation, although this change is a gradational one. They do not differ markedly from sandstones of overlying formations.

The shales of the Spoon Formation are commonly less sandy than those in underlying strata, and underclays beneath the coals and black shales above the coals are generally better developed.

Coal members, for the most part, are thicker and much more widely traceable than coals encountered in lower formations. They lack the uniform thickness, and most of them lack the very wide continuity, of coals in the overlying Carbondale Formation.

Although limestones are relatively minor in the Spoon Formation, several limestones of appreciable continuity occur and have been correlated widely. The limestones are not as continuous as those in the overlying Carbondale Formation.

THICKNESS

The Spoon Formation has a maximum thickness of about 350 feet in southern Illinois but is thinner in most places. It ranges from a few feet to nearly 100 feet thick in western Illinois.

MEMBERS OF THE SPOON FORMATION

Southeastern Illinois

Although not all are recognized throughout southeastern Illinois, the following members of the Spoon Formation are named:

Palzo Sandstone
DeKoven Coal
Davis Coal
Stonefort Limestone
Wise Ridge Coal
Mt. Rorah Coal
Creal Springs Limestone
Granger Sandstone
O'Nan Coal
Curlew Limestone
New Burnside Coal
Bidwell Coal

The name Bidwell Coal Member is herein proposed for a previously unnamed coal exposed about ¾ mile northeast of the Bidwell School in Johnson County (geologic section 5D).

The name New Burnside Coal Member is applied here to the upper of two coals mined in the vicinity of the village of New Burnside in Johnson County (geologic section 5D).

The name O'Nan Coal Member is proposed here to replace the Curlew Coal in order to retain the name Curlew for the limestone. The name is derived from Dennis O'Nan Ditch, which flows across the north tip of Indian Hill (DeKoven 7½ minute quadrangle), Union County, Kentucky. Although the name is changed, the type area remains the same.

The name Granger Sandstone Member is proposed here to replace Curlew Sandstone in order to retain the name Curlew for the limestone. The name is derived from the village of Grangertown about five miles southeast of Indian Hill in Union County, Kentucky, which is the original type locality of the sandstone.

The name Creal Springs Limestone Member is proposed here for a limestone exposed just above the top of the sandstone quarried east of Creal Springs in Williamson County (geologic section 5C). This limestone previously was correlated with the Curlew Limestone but is now considered to be younger (Thompson et al., 1959).

The name Mt. Rorah Coal Member is proposed here to replace Bald Hill Coal because of prior use of the name Bald Hill. The type locality of this unit is unchanged (table 1), and the name is derived from Mt. Rorah Church, about two miles northwest of the type outcrop.

The name Wise Ridge Coal Member is proposed here for the coal formerly called Stonefort in order to restrict that name to the Stonefort Limestone. The type locality is unchanged (table 1) and the unit is named for Wise Ridge, about 3 miles west of the town of Stonefort.

The type outcrops of the Stonefort Limestone Member are in a road cut and in ravines east of the road in NE1/4 SE1/4 sec. 25, T. 10 S., R. 4 E., Williamson County. This is a correction of the location cited by Wanless (1956, p. 9).

Southwestern Illinois

The following named members of the Spoon Formation are recognized in southwestern Illinois although not all are recognized in the same area:

Cheltenham Clay
DeKoven Coal
Davis Coal
Seahorne Limestone
Vergennes Sandstone
Murphysboro, Litchfield,
and Assumption Coals

The Litchfield Coal Member and the Assumption Coal Member have been recognized only in the vicinity of mines near Litchfield in Montgomery County and Assumption in Christian County (table 1). These coals are tentatively correlated with the Murphysboro (No. 1) and Rock Island (No. 1) Coals, but until their correlation can be established with greater certainty, the names are retained for local use.

The name Cheltenham Clay Member is applied locally to a dominantly clay unit that is a composite of several underclay members. It has a stratigraphic range that varies from place to place.

Western Illinois

The named members of the Spoon Formation in western Illinois are as follows:

Cheltenham Clay
Browning Sandstone
Abingdon Coal
Isabel Sandstone
Greenbush Coal
Wiley Coal
Seahorne Limestone
DeLong Coal
Brush Coal
Hermon Coal
Seville Limestone
Rock Island (No. 1) Coal

The coals formerly called Lower DeLong, Middle DeLong, and Upper DeLong are herein named, respectively, the Hermon Coal Member, the Brush Coal Member, and the DeLong Coal Member. The Hermon Coal is named for the village of Hermon, about 2½ miles south of the type exposure; the Brush Coal is named for Brush Creek, in the vicinity of the type outcrop; and the DeLong Coal is named for the village of DeLong about 1½ miles northeast of the type outcrop. The type section is the same for all three coals and remains unchanged (table 1).

The Abingdon Coal Member (table 1), not shown on the chart by Siever (*in* Wanless, 1956), was named by Culver (1925).

Northern Illinois

The names "Goose Lake" Clay, "Ottawa" Clay, and "Utica" Clay are trade names and are not recognized as part of the stratigraphic nomenclature. The name Cheltenham Clay Member is extended to this area from western and southwestern Illinois.

Eastern Illinois

Although a substantial number of widely traceable members occurs in the Spoon Formation in eastern Illinois, the only member that has been named is the Indiana III Coal. This coal has been informally called the Seeleyville Coal in Indiana, and the name Seeleyville Coal Member is here accepted for this coal in Illinois (table 1).

CARBONDALE FORMATION

The Carbondale Formation is here redefined to include strata between the base of the Colchester (No. 2) Coal and the top of the Danville (No. 7) Coal. The Carbondale Formation was originally named by Shaw and Savage (1912) for the town of Carbondale, which is in the outcrop belt of strata of this formation. As originally defined, the Carbondale included strata from the bottom of the Murphysboro Coal to the top of the Herrin (No. 6) Coal. The Murphysboro Coal was then considered equivalent to the No. 2 Coal of western Illinois. The intent was to use the No. 2 Coal as the base of the Carbondale and, except at Murphysboro, it was so used. Later the Carbondale was redefined as a group (Weller, 1940, p. 36) and the boundaries moved to include strata from the base of the Palzo Sandstone to the base of the Anvil Rock Sandstone (Willman and Payne, 1942, p. 87, 95). The present redefinition shifts the boundaries again, but the major part of the unit remains the same.

No type locality other than the vicinity of Carbondale was proposed. To define the formation in an area where No. 2 Coal is well developed and the formation more completely exposed, a type section is here designated for this unit in Fulton County, Illinois (geologic section 6).

LITHOLOGY

The Carbondale Formation is dominantly gray shale (fig. 4), but sandstones are prominent locally and have a maximum thickness of about 100 feet. The sand bodies are generally linear in their maximum development and are interpreted as filled channels. The formation is characterized by wide distribution of coals and limestones. Many of the coals are relatively thick, commonly ranging from 2 to 7 feet and in some areas up to 15 feet. The formation includes the principal coals that have been most extensively mined in Illinois. Several limestone members are nearly as extensive as some of the coals. The limestones are usually about 1 to 5 feet thick, but some are locally thicker. They usually are relatively argillaceous. A few are locally highly dolomitic. Black fissile shales are particularly well developed over most of the coals, and underclays are uniformly present. Cyclic sequences have a wider variety of lithologic units than occur in lower formations.

THICKNESS

The Carbondale Formation is commonly 225 to 300 feet thick, but in parts of northern, western, and southwestern Illinois the formation thins to about 125 feet, locally even less. In part of southeastern Illinois, the formation is nearly 400 feet thick.

MEMBERS OF THE CARBONDALE FORMATION

Southern Illinois

The named members in the Carbondale Formation in southern Illinois are as follows:

Danville (No. 7) Coal
Galum Limestone
Allenby Coal
Bankston Fork Limestone
Anvil Rock Sandstone
Conant Limestone
Jamestown Coal
Brereton Limestone
Herrin (No. 6) Coal
Vermilionville Sandstone
Briar Hill (No. 5A) Coal
St. David Limestone
Harrisburg (No. 5) Coal
Hanover Limestone
Summum (No. 4) Coal
Roodhouse Coal
Shawneetown Coal
Colchester (No. 2) Coal

The name Colchester (No. 2) Coal Member is now extended to the No. 2 Coal throughout Illinois.

The name Shawneetown Coal Member is herein proposed for the coal believed to be the lower of two coals formerly called No. 2A (Harrison, 1951). Some reports have referred to the two coals noted between No. 2 Coal and No. 4 Coal as the No. 2A Coal, but this name is now discarded. The Shawneetown Coal has not been recognized in outcrops in Illinois but was encountered at a depth of 543 feet 10 inches in Union Colliery Company drill hole 28, located in sec. 23, T. 9 S., R. 9 E., Gallatin County, Illinois. A coal horizon at a depth of 504 feet 11 inches in this drill hole may be the position of the upper coal but is not formally named. Representative samples of this diamond drill core, including the Shawneetown Coal, are in the core file of the Illinois Geological Survey (core 2639).

The Roodhouse Coal Member is recognized only in the vicinity of Roodhouse in Greene County.

The name Summum (No. 4) Coal Member is here extended to No. 4 Coal throughout Illinois.

The name Vermilionville Sandstone Member is extended from northern Illinois to the equivalent sandstone in southern Illinois for which the name Cuba Sandstone has been used. The name Cuba was preempted.

The name Brereton Limestone Member is extended to the caprock limestone of No. 6 Coal in southern Illinois to replace the name Herrin, now restricted to the Herrin (No. 6) Coal Member.

Conant Limestone Member is the name here proposed for the limestone formerly called Jamestown. The name Jamestown will be used for the coal beneath the limestone. The name is derived from the village of Conant in Perry County, Illinois, about 2 miles east of the type outcrop which is unchanged (table 1).

The name Allenby Coal Member is proposed here for the coal formerly called Bankston, so that the name may be restricted to the Bankston Fork Limestone. The new name is derived from the village of Allenby in Saline County, about half a mile southwest of the type outcrop, which is not changed (table 1).

The name Danville (No. 7) Coal Member is extended to No. 7 Coal throughout Illinois. In southern Illinois it replaces the name Cutler (No. 7) Coal.

Western and Northern Illinois

The following members of the Carbondale Formation are recognized in western and northern Illinois:

Danville (No. 7) Coal
Copperas Creek Sandstone
Pokeberry Limestone
Lawson Shale
Brereton Limestone
Herrin (No. 6) Coal
Big Creek Shale
Vermilionville Sandstone
Canton Shale
St. David Limestone
Springfield (No. 5) Coal
Covel Conglomerate
Hanover Limestone
Summum (No. 4) Coal
Kerton Creek Coal
Pleasantview Sandstone
Purington Shale
Oak Grove Limestone
Lowell Coal
Jake Creek Sandstone
Francis Creek Shale
Colchester (No. 2) Coal

The name Colchester (No. 2) Coal Member is extended from western to northern Illinois to replace the name LaSalle (No. 2) Coal so that the name LaSalle can be retained for the LaSalle Limestone.

The name Oak Grove Limestone Member replaces the name Oak Grove Beds. Although it is a complex unit consisting of interbedded limestone and shale, it is designated as a limestone because its most distinctive elements are limestone and it occurs at a position in the cyclical sequence normal for a limestone.

The name Vermilionville Sandstone Member is extended from northern to western Illinois to replace the name Cuba Sandstone. The name Cuba was preempted.

The name Lawson Shale Member is proposed here for the shale above the Brereton Limestone Member in western Illinois, formerly called Sheffield Shale. The name Sheffield was preempted. The name Lawson is derived from Lawson Creek, about a mile west of the type exposure, which has not been changed (table 1).

The name Danville (No. 7) Coal Member is extended from eastern Illinois to the equivalent unit in northern and western Illinois, replacing the name Sparland (No. 7) Coal.

Eastern Illinois

The following named members of the Carbondale Formation are recognized in eastern Illinois:

Danville (No. 7) Coal
Herrin (No. 6) Coal
Harrisburg (No. 5) Coal
Summum (No. 4) Coal
Shawneetown Coal
Colchester (No. 2) Coal

The name Colchester (No. 2) Coal is extended to the No. 2 Coal throughout Illinois.

The name Shawneetown Coal is extended to this area from southeastern Illinois. It is applied to the lower of two coals commonly encountered between No. 2 Coal and No. 4 Coal near the Illinois-Indiana boundary in eastern Illinois. Siever (*in* Wanless, 1956) referred to both coals as No. 2a Coal.

The name Herrin (No. 6) Coal is extended to eastern Illinois and replaces the name Grape Creek Coal.

McLEANSBORO GROUP

The McLeansboro Group includes the Modesto, Bond, and Mattoon Formations. McLeansboro Formation was the name originally applied to all Pennsylvanian strata above the No. 6 Coal as described from cores of two diamond drill holes near McLeansboro in Hamilton County (DeWolf, 1910). The McLeansboro later was elevated to a group (Weller, 1940, p. 36), and the base of the Copperas Creek (Anvil Rock) Sandstone (Willman and Payne, 1942, p. 87, 135) was made the base of the group. As herein redefined the McLeansboro Group includes all strata above the top of the Danville (No. 7) Coal.

The McLeansboro Group differs from the Kewanee Group below in that its limestones are more abundant and thicker and its coals thinner (fig. 4). Most of the cyclothems show a proportionately greater development of the marine units than do the lower cyclothems. The coals commonly are less than one foot thick, but locally are as much as 36 inches thick.

The McLeansboro Group has a maximum thickness of about 1200 feet in Jasper County, but more than 1600 feet of McLeansboro strata recently have been reported from a test hole in western Kentucky within a few miles of Illinois.

MODESTO FORMATION

The Modesto Formation includes all strata from the top of the Danville (No. 7) Coal Member to the base of the Shoal Creek Limestone Member. It is named here for the town of Modesto in northern Macoupin County where there are prominent outcrops of the formation. The formation is nearly completely exposed in Macoupin County in four sections described previously by Payne (1942) and Ball (1952) (geologic section 7) that are here designated type exposures.

LITHOLOGY

The Modesto Formation is dominated by gray shales (fig. 4), but sandstones are locally prominent. The formation differs from the Carbondale Formation below in having thinner coals, thicker limestones, and by a greater abundance of red shales. It differs from the Bond Formation above in having thinner limestones and more prominent sandstone members. Coals of the Modesto are rarely more than a foot thick, but most of them are widely distributed. Sandstones locally may be as much as 75 feet thick in filled channels. Most of the limestones are thin and very argillaceous, with the exception of the Piasa and Lonsdale Limestones of western and southwestern Illinois and the West Franklin Limestone in southeastern Illinois. Cyclic sequences are well developed, and some cyclothems contain nearly the maximum number of lithologic types.

THICKNESS

The Modesto Formation is commonly about 300 feet thick, but it has a maximum thickness of more than 400 feet in southeastern Illinois. The formation is only about 200 feet thick in its local occurrences in northern Illinois.

MEMBERS OF THE MODESTO FORMATION

Southeastern Illinois

The following named members are recognized in the Modesto Formation of southeastern Illinois:

New Haven Coal
Chapel (No. 8) Coal
Trivoli Sandstone
West Franklin Limestone
Lake Creek Coal
Pond Creek Coal
DeGraff Coal
Piasa Limestone

The name Piasa Limestone Member is extended to southeastern and southern Illinois from the type area in Jersey County (table 1). The name replaces that of Cutler Limestone, which has been discontinued because the name is preempted.

The Piasa Limestone and DeGraff, Pond Creek, and Lake Creek Coals may be included in the complex West Franklin Limestone Member in the eastern part of the area.

The name DeGraff Coal Member (Cady, 1950, unpublished manuscript) is accepted here for a coal exposed along Galum Creek in the SE cor. NE¼ sec. 21, T. 5 S., R. 4 W., Perry County, Illinois. The name is derived from the DeGraff School about one mile northeast of the exposure. This coal has been called informally the "1st Cutler Rider Coal" (Kosanke, 1950; Wanless, 1956).

Pond Creek Coal Member is the name proposed here for a coal reported at a depth of 125 feet in Consolidated Coal Company drill hole 91 in SW¼ NE¼ NE¼ sec. 21, T. 8 S., R. 3 E., Williamson County. The coal is named for the creek that flows through the northern part of the township. This coal has been called informally the "2nd Cutler Rider Coal" (Kosanke, 1950; Wanless, 1956).

The name Lake Creek Coal Member (Cady, 1950, unpublished manuscript) is accepted here for a coal encountered at a depth of 86 feet 7 inches in the drill hole described above. The name is derived from Lake Creek Township in which the drill hole is located. This coal has been called informally the "3rd Cutler Rider Coal" (Kosanke, 1950; Wanless, 1956).

Although the Pond Creek and Lake Creek Coal Members may have surface exposure, no outcrops have been recognized with certainty. These and the DeGraff Coal have been encountered in several drill holes in the general area. The Survey has on file cores of all three coals from a drill hole in NE¼ SW¼ SE¼ sec. 18, T. 7 S., R. 4 E., Franklin County (core 3732).

The name Chapel (No. 8) Coal Member is extended from the type area in western Illinois to the coal formerly called No. 8 Coal in southern Illinois.

Southwestern Illinois

The largest number of named members of the Modesto Formation is in southwestern Illinois where the following members have been named:

New Haven Coal
Macoupin Limestone
Womac Coal
Burroughs Limestone
Carlinville Limestone
Chapel (No. 8) Coal
Trivoli Sandstone
Scottville Limestone
Athensville Coal
Rock Branch Coal
Piasa Limestone

The name Rock Branch Coal Member is here applied to the coal previously called Scottville so that the latter name can be restricted to the Scottville Limestone. The coal is named for Rock Branch, in northwest Macoupin County, along which it is exposed. The type locality is unchanged (table 1).

The name Athensville Coal Member is here introduced for the coal formerly called Upper Scottsville. The name is from the village of Athensville in Greene County about 4½ miles to the southwest of the type locality, which is the same as that of the Rock Branch Coal.

The name Chapel (No. 8) Coal, extended from the type area in western Illinois, replaces the name Trivoli (No. 8) Coal formerly used in this area.

The name Burroughs Limestone Member is here restricted to the middle sandy limestone unit of the strata formerly called Burroughs Beds (Ball, 1952, p. 38). The type outcrop remains unchanged (table 1).

The name Womac Coal Member is proposed here for the coal formerly called Macoupin Coal. The coal is named for the village of Womac, Macoupin County, approximately three miles northeast of the type exposure, which is unchanged. The name Macoupin is restricted to the Macoupin Limestone.

The name New Haven Coal Member is extended from southeastern Illinois to the equivalent coal below the Shoal Creek Limestone Member.

Western and Northern Illinois

The named members of the Modesto Formation in western and northern Illinois are as follows:

Cramer Limestone
Chapel (No. 8) Coal
Trivoli Sandstone
Exline Limestone
Lonsdale Limestone
Gimlet Sandstone
Farmington Shale

The name Chapel (No. 8) Coal Member replaces the name Trivoli (No. 8) Coal so that the name Trivoli can be retained for the Trivoli Sandstone. The name is derived from Graham Chapel, about two miles north of the type locality, which is unchanged (table 1).

The name Cramer Limestone Member is proposed for the unit formerly called Trivoli Limestone and is named for the village of Cramer, Peoria County, about 1 1/3 miles southwest of the type locality, which remains unchanged (table 1).

The name Turner Limestone, informally used in northern Illinois, is discontinued. The limestone is believed to be equivalent to the Cramer Limestone.

The name Hicks Limestone is discontinued because it is preempted. It is not considered desirable to propose a new name for this unit at this time.

Eastern Illinois

Only the Chapel (No. 8) Coal and West Franklin Limestone Members are named in the Modesto Formation in eastern Illinois. The name Chapel (No. 8) Coal is extended to the eastern part of the state from the type area in western Illinois.

BOND FORMATION

The name Bond Formation is here proposed for strata extending from the base of the Shoal Creek Limestone Member to the top of the Millersville Limestone Member. This formation is named for Bond County where exposures of the formation are prominent. The type section is a composite of seven exposures (geologic section 8).

A reference section for the Bond Formation is a core from a diamond drill hole in southeastern Christian County (geologic section 9). Twenty-eight representative samples of the formation from this core are in the core file of the Illinois Geological Survey (core C-2409).

LITHOLOGY

The Bond Formation is characterized in the area of its typical development by thick limestones, in particular its bounding units (fig. 4). Throughout much of the area of its occurrence, the Shoal Creek Limestone commonly ranges from 5 to 15 feet thick. The Millersville Limestone Member attains a maximum thickness of nearly 50 feet in Christian County, although thicknesses of 20 to 30 feet are more common. The strata between these limestones are predominantly shale, although sandstones are prominently developed in some areas. In southeastern Illinois, the upper part of the formation is dominantly shale and the position of the Millersville Limestone is determined with some difficulty. Coal members are generally less than a foot thick, but several appear to be widely traceable. Limestones between the bounding members are usually very argillaceous and similar in lithology to comparable limestones in the underlying Modesto Formation. In northern Illinois the formation is comparatively thin, lacks sandstones, and has a relatively high proportion of limestones and calcareous shales. Cyclic sequences are well developed in this formation.

THICKNESS

In the type area, the Bond Formation is nearly 300 feet thick, and it probably is thicker in southeastern Illinois. East of the LaSalle Anticline in east-central Illinois and also in northern Illinois the formation is 75 feet or less thick.

MEMBERS OF THE BOND FORMATION

Central and Southwestern Illinois

Eight members have been named in the Bond Formation of the central and southwestern part of Illinois:

Millersville Limestone
Coffeen Limestone
Witt Coal
Flat Creek Coal
Bunje Limestone
Sorento Limestone
McWain Sandstone
Shoal Creek Limestone

The name Sorento Limestone Member (Simon, 1946, unpublished manuscript) is accepted here for a limestone exposed just west of the village of Sorento in Bond County (geologic section 8F).

The name Bunje Limestone Member (Simon, 1946, unpublished manuscript) is accepted here for a limestone exposed about one mile due south of the village of Bunje in Bond County (geologic section 8E).

The name Flat Creek Coal Member (Simon, 1946, unpublished manuscript) is accepted here for an outcrop of the coal along Flat Creek in northwestern Bond County (geologic section 8D).

The name Witt Coal Member (Gluskoter, 1958, unpublished manuscript) is accepted here for a coal exposed about 6½ miles due south of the town of Witt in southeastern Montgomery County (geologic section 8C).

The name Coffeen Limestone Member (Gluskoter, 1958, unpublished manuscript) is accepted here for the limestone overlying the Witt Coal. The name is taken from the village of Coffeen, which is located about 5 miles southwest of the type exposure. The type locality is the same as that for the Witt Coal (geologic section 8C).

Southeastern and Eastern Illinois

The following named members of the Bond Formation in southeastern and eastern Illinois are not all recognized in the same area:

Livingston and Millersville Limestones
Reel Limestone
Flannigan Coal
Mt. Carmel Sandstone
Shoal Creek Limestone

All named members retain previously established usage (table 1). The Livingston Limestone Member is recognized east of the LaSalle Anticline and the equivalent Millersville Limestone Member (geologic section 8B) is recognized west of the anticline.

The Livingston Limestone Member in some areas has two benches that have been referred to as Upper and Lower Livingston (Siever, *in* Wanless, 1956). The terms "upper" and "lower" will be used only in the informal sense and not capitalized.

Northern Illinois

In northern Illinois, only the Hall Limestone Member and the LaSalle Limestone Member are formally named.

MATTOON FORMATION

The Mattoon Formation is proposed for all Pennsylvanian strata above the top of the Millersville Limestone Member. The formation is named for the city of Mattoon, which lies in the general outcrop belt of the unit.

Compared to those of lower formations, outcrops of the Mattoon are relatively discontinuous and widely scattered. In the area underlain by Mattoon strata the principal minable coals lie at their greatest depths, and consequently there has been little diamond drill exploration. Electric log data also are lacking because logging of oil test holes generally starts below 100 feet and many logs do not record the upper 150 to 300 feet of strata. As a result less information is available about the Mattoon Formation than about the underlying formations.

It is therefore not possible to compile a complete sequence for a type section. The best reference section that can be given at present consists of an oil test hole (Survey control well 191, geologic section 11) and outcrops of named members and associated strata (geologic section 10) positioned relative to the Millersville Limestone, as shown on the generalized column (pl. 1). The rotary drilled oil test hole is one from which Survey crews collected 5-foot samples and one-foot drilling time in the field. Samples (sample set 11257) and electric log for this test hole are on file at the Illinois Geological Survey.

LITHOLOGY

The Mattoon Formation is characteristically dominated by shale and sandstone (fig. 4); local development of thick sandstone is common. Sandstone is more characteristic of the Mattoon than of any other formation above the McCormick Group. Coal beds generally are thin but locally may be about 3 feet thick. Coals are less uniform and have been less widely traced than in other formations of the Kewanee and McLeansboro Groups. Limestones may be fairly widespread, but, with the exception of the Omega Limestone, generally are thin and commonly are very argillaceous.

THICKNESS

The Mattoon Formation is confined largely to the area of the deeper part of the Illinois Basin where it has a maximum thickness of 500 to 600 feet. In an area in Union County, western Kentucky, 750 feet or more of Mattoon strata are present.

MEMBERS OF THE MATTOON FORMATION

Central and Southeastern Illinois

The Mattoon Formation is thickest in central and southeastern Illinois where the following members have been named:

Reisner Limestone
Woodbury Limestone
Gila Limestone
Greenup Limestone
Bogota Limestone
Effingham Limestone
Shumway Limestone
Omega Limestone
Bonpas Limestone
Calhoun Coal
Trowbridge Coal
Opdyke Coal
Shelbyville Coal
McCleary's Bluff Coal
Friendsville Coal

Many of these units are recognized only in the vicinity of their type exposure, and the stratigraphic order of some of them is uncertain. The order listed above, which differs from that previously used, is partially based on an unpublished manuscript by Van Den Berg (1956) in which the interval between the named member and the Millersville Limestone was determined on electric logs of wells near each type exposure. The relative position of some of the named coal members is uncertain. In general, each is recognized only in local areas where it has been mined.

The name McCleary's Bluff Coal (geologic section 10J) is applied to a 3-inch coal bed that lies an estimated 50 feet above the Friendsville Coal at McCleary's Bluff in Wabash County (table 1). It was erroneously shown below the Friendsville Coal on the 1956 (Siever, *in* Wanless, 1956) correlation chart.

The name Calhoun Coal Member (geologic section 10I), informally used by Noé (1934, p. 103), is accepted here for the coal immediately below the Bonpas Limestone. The name is derived from the village of Calhoun, Richland County, two miles northwest of the type exposure, which is the same as that for the limestone (table 1). At the type exposure, the Calhoun Coal and the Bonpas Limestone lie about 525 feet above the Shoal Creek Limestone.

The name Bonpas Limestone Member (geologic section 10I) is here proposed to replace the name Calhoun Limestone in order to restrict the name Calhoun to the underlying coal. The limestone is named for Bonpas Creek, about 1½ miles to the east of the type outcrop (table 1).

The name Effingham Limestone Member (geologic section 10F) is here proposed for the marine limestone exposed in a tributary to Salt Creek half a mile south of Effingham (table 1). The informal name "Effingham" Beds used earlier (Wanless, 1956) is discontinued.

The names Bogota Limestone Member (geologic section 10E), Greenup Limestone Member (geologic section 10D), Gila Limestone Member (geologic section 10C), and Woodbury Limestone Member (geologic section 10B) are here formally proposed for limestone units (generally marine) in their respective cyclothems, described by Newton and Weller (1937). The name Reisner Limestone Member is proposed here to replace the name Newton Limestone because the name Newton is preempted. The limestone is named for Reisner School 1½ miles southwest of the type outcrop (geologic section 10A). The Newton Cyclothem name is unchanged. Type outcrops (table 1) have been designated within type areas described by Newton and Weller for each cyclothem.

Eastern Illinois

In eastern Illinois the only named members of the Mattoon Formation are the Cohn Coal Member and the Merom Sandstone Member. The Cohn Coal Member (geologic section 10K) is here named for an outcrop described by Newton and Weller (1937) two miles southeast of Cohn, now called Livingston, in Clark County (table 1).

Northern Illinois

Only the lowermost strata of the Mattoon Formation are exposed in northern Illinois. The Little Vermilion Limestone Member is the only named unit of the Mattoon Formation in this area.

PART III
CYCLICAL CLASSIFICATION

GENERAL STATEMENT

The cyclical classification is retained but is entirely independent of rock-stratigraphic classification, as previously noted. It is, however, modified to conform to standard stratigraphic practice. A few new cyclothem names are introduced, duplicate names are replaced, and the previously accepted order changed in a few places. No attempt is made to complete the sequence of cyclothems in parts of the section or in areas where cyclothems have not been formally differentiated. Some complex sequences are treated as individual cyclothems.

Accepted cyclothem names are shown on plate 1 and in tables 2 and 3. The references listed include the principal reports that describe the cyclic sequences, variously called "formations," "cycles," or "cyclothems" in the publications.

NAME CHANGES

Northern and Western Illinois

The name Hermon Cyclothem is herein applied to the cyclothem formerly called Lower DeLong (Wanless, 1931a). The village of Hermon is about 2½ miles south of the type locality, which is unchanged. The type locality is the same as that for the Hermon Coal (table 1).

The name Brush Cyclothem is herein applied to the cyclothem formerly called the Middle DeLong (Wanless, 1931a). It is named for Brush Creek in the vicinity of the type locality of the cyclothem, which is the same as the type locality of the Brush Coal (table 1).

The name DeLong Cyclothem is herein applied to the cyclothem formerly called the Upper DeLong (Wanless, 1931a). The type outcrop is unchanged and is the same as that for the type locality of the DeLong Coal (table 1).

The name Tonica Cyclothem is proposed here for the strata in northern Illinois previously referred to the Liverpool Cyclothem (Willman and Payne, 1942, p. 95-102). The Liverpool Cyclothem in that region consisted of only the lower members of the type Liverpool. The Oak Grove Limestone and the Purington Shale Members, which are the upper part of the Liverpool Cyclothem in the type area in western Illinois, were included in the Lowell Cyclothem, because of the interfingering of a coal, underclay, and sandstone in the base of the Oak Grove Limestone. Adoption of the name Tonica Cyclothem for the lower Liverpool strata wherever the Lowell Cyclothem is well enough developed to be named should lessen the confusion.

The name Tonica is derived from the town of Tonica, LaSalle County, 3 miles southeast of the type section. The type locality is the same as that of the Lowell Cyclothem and occurs along the Vermilion River half a mile west of Lowell in LaSalle County (Willman and Payne, 1942, geol. sec. 33, p. 299-300).

The location of the type outcrops of the Summum Cyclothem was incorrectly given in the 1956 report by Wanless (p. 10). The type exposure is in T. 3 N., at the same site as the type outcrop of the Summum (No. 4) Coal Member (table 1).

Southern Illinois

The location of the type locality of the Stonefort Cyclothem reported by Wanless (1956, p. 9) was incorrect. The correct location is NE¼ SE¼ sec. 25, T. 10 S., R. 4 E., Williamson County.

The name Liverpool Cyclothem, extended to southern Illinois by Siever (*in* Wanless, 1956) is discontinued for that area because it included strata not in the Liverpool Cyclothem in the type area. Until further detailed work is done to delineate cyclothemic units in southern Illinois, no replacement name will be proposed.

The name Crab Orchard Cyclothem, indicated by Siever (*in* Wanless, 1956), is dropped because of prior use of the name. Briar Hill Cyclothem is proposed for this unit, which contains the Briar Hill (No. 5A) Coal Member. The name is derived from Briar Hill near the village of DeKoven, Union County, Kentucky.

The name Cutler Cyclothem was introduced by Siever (*in* Wanless, 1956) in southern Illinois. Strata of this cycle have been referred to the Sparland Cyclothem, but strata included in the cycle in southern and southwestern Illinois do not include all of the strata included in the Sparland Cyclothem. The type locality in sections 2 and 3, T. 6 S., R. 4 W., Perry County, was formerly the type outcrop of the Cutler Limestone, a name now discontinued because of extension of the name Piasa Limestone Member to this area.

The Sorento, Bunje, and Flat Creek Cyclothems, originally described by Simon (1946, unpublished manuscript) and informally introduced by Wanless (1955, 1956), are herein formally recognized. The Sorento Cyclothem is named for the village of Sorento, Bond County, which lies just east of the type outcrop (geologic section 8F). The Bunje Cyclothem is named for the village of Bunje, Bond County, one mile north of the type outcrop (geologic section 8E). Flat Creek Cyclothem is named for Flat Creek, southwestern Bond County, where strata of the cyclothem are exposed. The type outcrop is described in geologic section 8D.

The Witt Cyclothem, originally named and described by Gluskoter (1958, unpublished manuscript) is formally proposed. It is named for the village of Witt, Montgomery County, about 6 miles north of the type outcrop (geologic section 8C).

Table 1.—Type Localities of Accepted Pennsylvanian Rock-Stratigraphic Units in Stratigraphic Order

Group, formation, and member	County	Quadrangle	T.	R.	Sec.	Part	Original references to (a) name (b) type locality
McCormick Group	Pope	Harrisburg-Brownfield	Vicinity of McCormick, NW part of county				a, b) Present report
Caseyville Formation	Hardin	Shawneetown	11S	10E	Along the Ohio River between Saline River and Gentry Landing		a) Owen, 1856, p. 48 b) Lee, 1916, p. 15–16
Lusk Shale Member	Pope	Harrisburg-Brownfield	12–13S	6E	Along Lusk Creek		a, b) Weller, 1940, p. 36
Wayside Sandstone Member	Jackson	Carbondale	11S	2E	30	N½	a) Lamar, 1925, p. 84–85 b) Wanless, 1956, p. 9
Battery Rock Sandstone Member	Hardin	Shawneetown	11S	10E	26	Along the Ohio River bluff	a, b) Cox, 1875, p. 204
Drury Shale Member	Jackson	Carbondale	10S	1W	33, 34	Along Drury Creek	a, b) Lamar, 1925, p. 91–95
Sellers Limestone Member	Hardin	Shawneetown	11S	10E	21	SE	a) Wanless, 1939, p. 36, 101 b) Wanless, 1956, p. 9
Gentry Coal Member	Hardin	Shawneetown	11S	10E	26	SW	a) Present report. Previous name, Battery Rock Coal (Owen, 1856, No. 1 vertical section; Worthen and Engelmann, 1866, p. 360–361) b) Present report
Pounds Sandstone Member	Gallatin	Equality	10S	8E	35, 36	Along Pounds Hollow	a, b) Weller, 1940, p. 38
Abbott Formation	Pope	Harrisburg	11S	5E	5–7, 18–19	NW (5) to SE SW (19)	a, b) Present report
Reynoldsburg Coal Member	Johnson	Marion	11S	4E	32	W½ north of Cedar Creek	a, b) Weller, 1940, p. 39
Grindstaff Sandstone Member	Gallatin	Equality	10S	8E	28	NE corner	a, b) Butts, 1925, p. 44
Babylon Sandstone Member	Fulton	Avon	7N	1E	14	NE NE, W bank of Spoon River	a) Wanless, 1931a, p. 189–190, 192–193 b) Wanless, 1956, p. 9; 1957, p. 65 and geol. sec. 41, p. 205
Manley Coal Member	Fulton	Avon	7N	1E	14	NE NE, W bank of Spoon River	a) Present report. Previous name, Babylon Coal (Wanless, 1931a, p. 189–190, 192–193) b) Wanless, 1957, p. 66, geol. sec. 41, p. 205
Willis Coal Member	Gallatin	Equality	10S	9E	30	SE SW	a, b) Butts, 1925, p. 62–63 and pl. III
Tarter Coal Member	Fulton	Vermont	5N	1E	2	SE	a) Wanless, 1939, p. 15, 103 b) Wanless, 1956, p. 9; 1957, p. 67, geol. sec. 34, p. 202
Finnie Sandstone Member	Union, Ky.	Shawneetown	Along road for less than 2 miles N of Mulfordtown				a) Owen, 1856, No. 1 vertical section b) Glenn, 1912b, p. 14
Delwood Coal Member	Pope	Harrisburg	11S	6E	3	NW NW	a) Weller, 1940, p. 40 b) Wanless, 1956, p. 9; Wanless field note

Pope Creek Coal Member	Mercer	Alexis	14N	2W	33	Center	a) Wanless, 1931a, p. 189–190, 192 b) Wanless, 1929, p. 52, geol. sec. 4, "Suite I"; Wanless, 1956, p. 9
Murray Bluff Sandstone Member	Saline	Harrisburg	10S	5E	35	NE	a, b) Weller, 1940, p. 40
Bernadotte Sandstone Member	Fulton	Vermont	5N	2E	19	SW	a) Savage, 1927, p. 307–316 b) Wanless, 1956, p. 9; 1957, p. 70–72, geol. sec. 37, p. 103
Kewanee Group	Henry		Vicinity of Kewanee				a, b) Present report
Spoon Formation	Fulton	Vermont	6N	1E	22	NE SE	a, b) Present report
Bidwell Coal Member	Johnson	Marion	11S	4E	5	NE SE SW	a, b) Present report
Rock Island (No. 1) Coal Member	Rock Island	Vermont	6N	1E	23	SW SW, SW bank Spoon River	a) Worthen, 1868, p. 6; Bement, 1910, p. 197, table 9 b) Wanless, 1957, p. 72 and geol. sec. 33, p. 201
Murphysboro Coal Member	Jackson	Murphysboro-Alto Pass	9S	2W	9	SE	a) Worthen, 1868, p. 11–12 b) Wanless, 1956, p. 9
Litchfield Coal Member	Montgomery	Mt. Olive	9N	5W	32	SE NE NE; mine	a, b) Kay, 1915, table 9 and footnote, p. 139
Assumption Coal Member	Christian	Assumption	12N	1E	2	NE NW SE; mine	a, b) Cady, 1935, p. 53
New Burnside Coal Member	Johnson	Marion	11S	4E	5	SE SE SW	a) Weller, 1940, p. 42 b) Present report
Seville Limestone Member	Fulton	Vermont	6N	1E	23	SW SW	a) Wanless, 1931a, p. 189–192 b) Wanless, 1956, p. 9; 1957, p. 72–73 and geol. sec. 33, p. 201
Curlew Limestone Member	Union, Ky.	Shawneetown	South side of Indian Hill, near Curlew				a) Owen, 1856, vertical diagram 1 b) Glenn, 1912b, p. 24
O'Nan Coal Member	Union, Ky.	Shawneetown	Indian Hill, near Curlew				a) Present report. Previous name, Curlew Coal (Owen, 1856, p. 47) b) Glenn, 1912b, p. 25
Hermon Coal Member	Knox	Galesburg	9N	2E	6, 8	Along Brush Creek	a) Present report. Previous name, Lower DeLong Coal (Wanless, 1931a, p. 188–192) b) Wanless, 1956, p. 9; 1957, p. 73–74
Granger Sandstone Member	Union, Ky.	Shawneetown	Indian Hill, near Curlew				a) Present report. Previous name, Curlew Sandstone (Owen, 1856, vertical diagram 1) b) Glenn, 1912b, p. 24–26
Brush Coal Member	Knox	Galesburg	9N	2E	6, 8	Along Brush Creek	a) Present report. Previous name, Middle DeLong Coal (Wanless, 1931a, p. 188–192) b) Wanless, 1956, p. 9; 1957, p. 74–75
Creal Springs Limestone Member	Williamson	Marion	10S	3E	25	NE SE SE	a, b) Present report
Mt. Rorah Coal Member	Williamson	Harrisburg	10S	4E	35	SE	a) Present report. Previous name, Bald Hill Coal (Cady, 1926, p. 260) b) Cady, 1926, p. 260
DeLong Coal Member	Knox	Galesburg	9N	2E	6, 8	Along Brush Creek	a) Present report. Previous name, Upper DeLong Coal (Wanless, 1931a, p. 188–192) b) Wanless, 1956, p. 9; 1957, p. 73–76

TABLE 1.—Continued

Group, formation, and member	County	Quadrangle	T.	R.	Sec.	Part	Original references to (a) name (b) type locality
Wise Ridge Coal Member	Williamson	Harrisburg	10S	4E	25	NE SE	a) Present report. Previous name, Stonefort Coal (Wanless, 1939, p. 30, 103) b) Present report
Stonefort Limestone Member	Williamson	Harrisburg	10S	4E	25	NE SE	a) Henbest, 1928, p. 70–71 b) Present report
Vergennes Sandstone Member	Jackson	Murphysboro	7S	3W	11	N½	a, b) Shaw and Savage, 1912, p. 7
Seahorne Limestone Member	Fulton	Havana	3N	3E	5	S½ SE	a) Wanless, 1931a, p. 191 b) Wanless, 1956, p. 9; 1957, p. 76 and geol. sec. 30, p. 200
Wiley Coal Member	Fulton	Avon	7N	2E	16	SW NW	a) Wanless, 1931a, p. 191 b) Wanless, 1956, p. 9; 1957, p. 79 and geol. sec. 42, p. 206
Davis Coal Member	Union, Ky.	Shawneetown	Davis Mine, ½ mile E of DeKoven				a) Old ref. to Owen, 1856, incorrect; present usage from Lee, 1916, p. 19, 30 b) Wanless, 1956, p. 10
Greenbush Coal Member	Warren	Avon	8N	1W	24	E½	a) Wanless, 1931a, p. 191 b) Wanless, 1956, p. 10; 1957, p. 81 and geol. sec. 40, p. 205
DeKoven Coal Member	Union, Ky.	Shawneetown	Near DeKoven Station				a, b) Lee, 1916, p. 30
Isabel Sandstone Member	Fulton	Havana	4N	3E	16	NW NE	a) Wanless, 1931a, p. 192 b) Wanless, 1956, p. 10; 1957, p. 83 and geol. sec. 28, p. 199
Palzo Sandstone Member	Williamson	Marion	10S	4E	16	SE	a) Cady, 1942, p. 9; Weller et al., 1942, p. 10, footnote b) Wanless, 1956, p. 10
Cheltenham Clay Member	St. Louis, Mo.		Cheltenham district, St. Louis				a, b) White, 1909, p. 293
Abingdon Coal Member	Knox	Galesburg	9N	2E	6	Center	a) Culver, 1925, p. 75 b) Weller et al., 1942, p. 1589
Seeleyville Coal Member	Vigo, Ind.		12N	7–8W	Mines in vicinity of Seeleyville, Ind.		a, b) Present report. Previous name Coal III (Ashley, 1898, p. 105-107)
Browning Sandstone Member	Schuyler	Beardstown	2N	1E	18		a) Searight ms., 1929; Wanless, 1939, p. 14, 78 b) Wanless, 1956, p. 10; 1957, p. 86
Carbondale Formation	Jackson		Vicinity of Carbondale, Illinois				a) Shaw and Savage, 1912, p. 6
	Fulton	Glasford	7N	4E	1	SE NE	b) Present report
		Canton	8N	3E	20	NW NE NW	
		Canton	8N	3E	21	SW cor.	
Colchester (No. 2) Coal Member	McDonough	Colchester	5N	4W	12, 13		a) Worthen, 1868, p. 11 b) Wanless, 1956, p. 10
Francis Creek Shale Member	Fulton	Vermont	5N	1E	22	NE SW, along Francis Creek	a) Savage, 1927, p. 309; restricted by Wanless, 1929, p. 49, 89 b) Wanless, 1929, p. 89; 1956, p. 10; 1957, geol. sec. 36, p. 203

Jake Creek Sandstone Member	Fulton	Vermont	4N	1E	13	NE, along Jake Creek	a, b) Wanless, 1957, p. 85, 89 and geol. sec. 38, p. 204
Lowell Coal Member	LaSalle	LaSalle	32N	2E	8	SE SW	a, b) Willman and Payne, 1942, p. 102–105, geol. sec. 33, p. 300
Oak Grove Limestone Member	Fulton	Havana	5N	3E	6	SW SE	a) Wanless, 1931a, p. 184, 187, 192; present report b) Wanless, 1956, p. 10; 1957, p. 91 and geol. sec. 22, p. 197
Purington Shale Member	Knox	Galesburg	11N	2E	17	SW	a) Wanless, 1931a, p. 184, 188, 192—from Poor ms., 1930 b) Wanless, 1956, p. 10
Shawneetown Coal Member	Gallatin	Shawneetown	9S	9E	23	NW SW NW	a) Present report. Previous name, No. 2A Coal (Harrison, 1951) b) Present report (coal at 544 feet in Union Colliery diamond drill hole 28)
Pleasantview Sandstone Member	Schuyler	Beardstown	2N	1E	31	Along Mill Creek	a) Wanless, 1929, p. 90, attributes it to Searight ms., 1929 b) Wanless, 1929, p. 90; 1956, p. 10; 1957, geol. sec. 5, p. 190
Kerton Creek Coal Member	Fulton	Beardstown	3N	2E	15	NE NE	a) Ekblaw, 1930, p. 391; Wanless, 1957, p. 98, attributes it to Searight ms., 1929 b) Wanless, 1956, p. 10; 1957, p. 98 and geol. sec. 1, p. 189
Roodhouse Coal Member	Greene	Roodhouse	12N	11W	21	NW	a) Siever, chart *in* Wanless, 1956 b) Present report
Summum (No. 4) Coal Member	Fulton	Vermont	3N	2E	3	NE	a) Wanless, 1931a, p. 82, 192 b) Wanless, 1956, p. 10; 1957, geol. sec. 39, p. 204
Hanover Limestone Member	Greene	Roodhouse	10N	11W	27	NE SW	a) Wanless, *in* Lamar et al., 1934, p. 84; Wanless, 1957, p. 101, attributes name to Van Pelt field notes b) Wanless, 1956, p. 10; 1957, p. 101
Covel Conglomerate Member	LaSalle	Ottawa	33N	3E	26	SE SW	a) Willman, 1939, p. 174–176 b) Willman and Payne, 1942, p. 116, footnote; Wanless, 1956, p. 10
Springfield (No. 5) Coal Member	Sangamon	Springfield	16N	4W	16		a) Worthen, 1883, p. 6. Named from subsurface exposures in coal mines b) Wanless, 1956, p. 10
Harrisburg (No. 5) Coal Member	Saline	Harrisburg	In coal mines in the vicinity of Harrisburg				a, b) Shaw and Savage, 1912, p. 7
St. David Limestone Member	Fulton	Havana	6N	4E	17	SE SE	a) Savage, 1927, p. 309, 313; Wanless, 1931a, p. 182–192 b) Wanless, 1956, p. 10; 1957, geol. sec. 21, p. 197
Canton Shale Member	Fulton	Canton	6N	4E	9	Center	a, b) Savage, 1921, p. 240–241, and geol. sec., p. 241
Briar Hill (No. 5A) Coal Member	Union, Ky. Saline	Shawneetown Eldorado Equality	In mines at DeKoven 9S	7E			a) Glenn, 1912b, p. 38; Cady, 1919, p. 20; 1926, p. 255 b) Wanless, 1956, p. 10

TABLE 1.—Continued

Group, formation, and member	County	Quadrangle	T.	R.	Sec.	Part	Original references to (a) name (b) type locality
Vermilionville Sandstone Member	LaSalle	Ottawa	32N	2E	9	SE	a) Cady, 1915, p. 29 b) Wanless, 1956, p. 10
Big Creek Shale Member	Fulton	Canton	7N	4E	Along Big Creek		a) Savage, 1927, p. 309, 313, 315 b) Wanless, 1957, p. 108
Herrin (No. 6) Coal Member	Williamson	Herrin	In mines in the vicinity of Herrin				a) Worthen, 1870, p. 93, referred to No. 6 Coal; Shaw and Savage, 1912, p. 6 b) Shaw and Savage, 1912, p. 6
Brereton Limestone Member	Fulton	Glasford	7N	4E	1	SE NE, east bank of Middle Copperas Creek	a) Savage, 1927, p. 309, 313–315 b) Wanless, 1956, p. 10; 1957, p. 107, 111, 112, and geol. sec. 16, p. 195
Lawson Shale Member	Bureau	Annawan	16N	6E	24	Center	a) Present report. Previous name, Sheffield Shale (Wanless, 1939, p. 102; 1956, p. 10; 1957, p. 112) b) Wanless, 1956, p. 10; 1957, p. 112
Jamestown Coal Member	Perry	Coulterville	5S	4W	34	NW NE	a) Bell et al., 1931, p. 3 b) Wanless, 1939, p. 17, 19, 88; 1956, p. 10
Conant Limestone Member	Perry	Coulterville	5S	4W	34	NW NE	a) Present report. Previous name, Jamestown Limestone (Bell et al., 1931, p. 3) b) Wanless, 1939, p. 17, 88; 1956, p. 10
Pokeberry Limestone Member	Schuyler	Beardstown	2N	1W	26	NW	a) Wanless, 1939, p. 17, 98 b) Wanless, 1956, p. 11; 1957, p. 113 and geol. sec. 3, p. 188
Copperas Creek Sandstone Member	Fulton	Glasford	Along Copperas Creek				a) Savage, 1927, p. 309 b) Wanless, 1957, p. 114
Anvil Rock Sandstone Member	Union, Ky.	Shawneetown	1½ miles NW of DeKoven				a, b) Owen, 1856, p. 45
Bankston Fork Limestone Member	Saline	Harrisburg	9S	5E	19	NE NW	a, b) Cady, 1926, p. 261–262 (location incorrect) b) Present report
Allenby Coal Member	Williamson	Harrisburg	9S	4E	24	NE NW in roadside east of R. R. crossing	a) Present report. Previous name, Bankston Coal (Wanless, 1939, p. 14, 76) b) Present report. Kosanke, 1950, p. 79
Galum Limestone Member	Perry	Pinckneyville	6S	4W	13	Near center of N line	a) Bell et al., 1931, p. 3 b) Wanless, 1956, p. 11
Danville (No. 7) Coal Member	Vermilion	Danville	19N	11W	7	E½	a) Bradley, 1870, p. 250–252 b) Wanless, 1956, p. 11
McLeansboro Group	Hamilton	McLeansboro	4S	5E	25	SE SW SW NE	a, b) DeWolf, 1910, p. 181; Weller, 1940, p. 36, footnote 13
Modesto Formation	Macoupin	Greenfield	12N	9W	16 to 17	NE SW SW to NE	a, b) Present report
		Carlinville	10N	7W	35	SW SE; W½ NE NW	
		Carlinville	9N	7W	2	NE NW	
Piasa Limestone Member	Jersey	Brighton	8N	10W	25	E½	a) Culver, 1925, p. 20 b) Wanless, 1956, p. 11

Farmington Shale Member	Fulton	Canton-Glasford	8N	4E	Outcrops in Farmington Township		a) Savage, 1927, p. 309 b) Wanless, 1956, p. 11
DeGraff Coal Member	Perry	Coulterville	5S	4W	21	SE cor. NE SW	a) Present report—from Cady ms., 1950. Previous name, 1st Cutler Rider Coal (Kosanke, 1950, p. 82–84) b) Present report—from Cady ms., 1950
Rock Branch Coal Member	Macoupin	Greenfield	12N	9W	16	SW SW NW	a, b) Present report. Previous name, Scottville Coal (Payne, 1942, p. 4)
Pond Creek Coal Member	Williamson	West Frankfort	8S	3E	21	SW SW NE NE	a) Present report. Previous name, 2nd Cutler Rider Coal (Kosanke, 1950, p. 82–84) b) Present report—from Cady ms., 1950
Gimlet Sandstone Member	Marshall	Lacon	12N	9E	16	N½ SE, along Gimlet Creek	a) Wanless, 1931a, p. 182, 183, 190, 192 b) Wanless, 1956, p. 11; 1957, p. 116
Athensville Coal Member	Macoupin	Greenfield	12N	9W	16	SE NW SW	a, b) Present report. Previous name, Upper Scottville Coal (Kosanke, 1950, p. 85)
Lake Creek Coal Member	Williamson	West Frankfort	8S	3E	21	SW SW NE NE	a) Present report—from Cady ms., 1950. Previous name, 3rd Cutler Rider Coal (Kosanke, 1950, p. 82–84) b) Present report—from Cady ms., 1950
Lonsdale Limestone Member	Peoria	Peoria	8N	7E	14		a, b) Worthen, 1873, p. 238 b) Wanless, 1957, geol. sec. 15, p. 194 (near type)
West Franklin Limestone Member	Posey, Ind.	Henderson, Ky.-Ind.	7S	12W	24	South-central	a, b) Collett, 1884, p. 61–62 b) Wanless, 1956, p. 11
Scottville Limestone Member	Macoupin	Greenfield	12N	9W	16	W½ SW	a) Payne, 1942, p. 4 b) Wanless, 1956, p. 11
Exline Limestone Member	Appanoose, Ia.	Centerville	67N	17W	6	SE	a, b) Cline, 1941, p. 65–66
Trivoli Sandstone Member	Peoria	Glasford	8N	5E	3	SW	a) Wanless, 1931a, p. 182, 183, 190, 192 b) Wanless, 1956, p. 11; 1957, p. 121 and geol. sec. 8, p. 193
Chapel (No. 8) Coal Member	Peoria	Glasford	8N	5E	3	SW	a) Present report. Previous name, Trivoli (No. 8) Coal (Wanless, 1931a, p. 181–182, 190, 192) b) Wanless, 1956, p. 11; 1957, p. 121 and geol. sec. 8, p. 193
Cramer Limestone Member	Peoria	Glasford	8N	5E	3	SW	a) Present report. Previous name, Trivoli Limestone (Wanless, 1931a, p. 182, 190, 192) b) Wanless, 1956, p. 11; 1957, p. 121 and geol. sec. 8, p. 193
Carlinville Limestone Member	Macoupin	Carlinville	10N	7W	35	SW SW	a) Worthen, 1873, p. 290–301 b) Wanless, 1956, p. 11
Burroughs Limestone Member	Macoupin	Carlinville	10N	7W	27	NW SW	a) Weller, *in* Cooper, 1946, p. 12, attributes this to Ball b) Wanless, 1956, p. 11; Ball, 1952, geol. sec. 17, p. 85
Womac Coal Member	Macoupin	Carlinville	9N	7W	2	NE NW	a) Present report. Previous name, Macoupin Coal (Wanless, 1931b, p. 810–811) b) Wanless, 1956, p. 11; Ball, 1952, geol. sec. 19, p. 85–86

TABLE 1.—Concluded

Group, formation, and member	County	Quadrangle	T.	R.	Sec.	Part	Original references to (a) name (b) type locality
Macoupin Limestone Member	Macoupin	Carlinville	9N	7W	2	NE NW	a) Wanless, 1931b, p. 810-811 b) Wanless, 1956, p. 11; Ball, 1952, geol. sec. 19, p. 85–86
New Haven Coal Member	Gallatin	New Haven	7S	10E	19	NW	a, b) Kosanke, 1950, p. 88–89
Bond Formation	Bond	Mt. Olive	7N	4W	29	SW NW	a, b) Present report
	Bond	New Douglas	6N	4W	6, 7	Creek along east edge	
	Bond	New Douglas	6N	4W	7	Cen. S½, along Dry Fork	
	Bond	New Douglas	6N	5W	24	East central along Flat Creek	
	Montgomery	Hillsboro	8N	2W	7	NE NW SE	
	Christian	Pana	12N	1W	28	SE NE	
	Montgomery	Nokomis	10N	2W	3	NE NE NE	
Shoal Creek Limestone Member	Clinton	Breese-Carlyle	3N	4W	Along Shoal Creek and vicinity		a, b) Engelmann, 1868, p. 175, 177–183
Hall Limestone Member	Bureau	LaSalle	16N	11E	33	NW SW	a) Weller, *in* Cooper, 1946, p. 12, attributes this to Willman ms., 1931 b) Wanless, 1956, p. 12—from Willman ms., 1931
McWain Sandstone Member	Macoupin	Carlinville	10N	7W	25	SE	a, b) Ball, 1952, p. 44 and geol. secs. 29, 33, 34, p. 89, 90, 91
Mt. Carmel Sandstone Member	Wabash	Mt. Carmel	1S	12W	21	W½	a, b) Worthen, 1875b, p. 52, 55
Sorento Limestone Member	Bond	New Douglas	6N	4W	6	NE NE fractional sec.	a) Present report. Wanless, 1955—from Simon ms., 1946 b) Present report—from Simon ms., 1946
Bunje Limestone Member	Bond	New Douglas	6N	4W	7	SE SW	a) Present report. Wanless, 1955—from Simon ms., 1946 b) Present report—from Simon ms., 1946
Flannigan Coal Member	Hamilton		6S	5E	Flannigan Township		a, b) Newton and Weller, 1937, p. 9
Flat Creek Coal Member	Bond	New Douglas	6N	5W	24	NE SE	a) Present report. Wanless, 1955—from Simon ms., 1946 b) Present report—from Simon ms., 1946
Reel Limestone Member	Wabash	Mt. Carmel	1S	12W	8	NE (?)	a, b) Worthen, 1875b, p. 55
Witt Coal Member	Montgomery	Hillsboro	8N	2W	7	NE NW SE	a, b) Present report—from Gluskoter ms., 1958
Coffeen Limestone Member	Montgomery	Hillsboro	8N	2W	7	NE NW SE	a, b) Present report—from Gluskoter ms., 1958
Millersville Limestone Member	Christian	Pana	12N	1W	28	SE NE	a) Taylor and Cady, 1944, p. 22
					34	NW NW	b) Payne and Cady, 1944, p. 12-13
Livingston Limestone Member	Clark	Marshall	11N	11W	6	SE NW	a) Worthen, 1875b, p. 11–19 b) Wanless, 1956, p. 12
LaSalle Limestone Member	LaSalle	LaSalle	33N	1E	14		a) Cady, 1908, p. 128–134 b) Wanless, 1956, p. 12

Mattoon Formation	Outcrops in counties of deeper Illinois Basin area of southeastern Illinois						a, b) Present report
Little Vermilion Limestone Member	LaSalle	LaSalle	33N	1E	11	SW SW	a) Weller, *in* Cooper, 1946, p. 14—from Willman ms., 1931 b) Wanless, 1956, p. 12—from Willman ms., 1931
Friendsville Coal Member	Wabash	Sumner	1N	13W	13, 24		a) Fuller and Clapp, 1904, p. 2 b) Kosanke, 1950, p. 89; Wanless, 1956, p. 12
McCleary's Bluff Coal Member	Wabash	Mt. Carmel	2S	13W	29	NW SW SE	a, b) Present report; Kosanke, 1950, p. 89
Cohn Coal Member	Clark	Marshall	11N	12W	1	NE	a, b) Newton and Weller, 1937, p. 18
Shelbyville Coal Member	Shelby	Shelbyville	11N	3-4E	Outcrops and mines in the vicinity of Shelbyville		a) Broadhead, 1875, p. 169-171 b) Kay, 1915, p. 215, 216
Merom Sandstone Member	Sullivan, Ind.	Hutsonville	7N	10W	7		a, b) Collett, 1871, p. 199 b) Wanless, 1956, p. 12
Opdyke Coal Member	Jefferson		3S	4E	Coal in vicinity of village of Belle Rive (and Opdyke)		a, b) Cady and others, 1952, p. 90-91
Trowbridge Coal Member	Shelby	Mattoon	10N	6E	11	About cen. of S line	a, b) Cady, 1948, p. 5, footnote 4
Calhoun Coal Member	Richland	Olney	2N	14W	6	NE NE NE	a) Noé, 1934, p. 103, refers to this coal as "Calhoun" (from old strip pit at Calhoun) b) Present report
Bonpas Limestone Member	Richland	Olney	2N	14W	6	NE NE NE	a) Present report. Previous name, "Calhoun" Limestone (Weller, *in* Dunbar and Henbest, 1942, p. 27) b) Present report
Omega Limestone Member	Marion	Salem	3N	4E	30	NW NW NE	a) Weller and Wanless, *in* Lamar et al., 1934, p. 128 b) Weller and Bell, 1936, p. 29-32; Wanless, 1956, p. 12; present report
Shumway Limestone Member	Effingham	Effingham	9N	5E	26	SE SE SW	a) Weller, *in* Dunbar and Henbest, 1942, p. 28; Wanless, 1956, p. 12 b) Present report
Effingham Limestone Member	Effingham	Effingham	8N	6E	33	Creek along south line of NW¼	a, b) Wanless, 1956, p. 7, 12 b) Present report
Bogota Limestone Member	Jasper	Sailor Springs	5N	8E	17	NE NE	a, b) Newton and Weller, 1937, p. 9 b) Present report
Greenup Limestone Member	Cumberland	Toledo	9N	9E	3	Cen. W½ NE	a) Newton and Weller, 1937, p. 9, 26 b) Present report
Gila Limestone Member	Jasper	Teutopolis	8N	9E	31	NE SW	a) Newton and Weller, 1937, p. 27 b) Present report
Woodbury Limestone Member	Cumberland	Teutopolis	9N	8E	32	S½ SE	a, b) Newton and Weller, 1937, p. 9, 28-30
Reisner Limestone Member	Jasper	Greenup	7N	10E	16	NE NE	a, b) Present report. Previous name Newton Ls. (Newton and Weller, 1937, p. 9, 24-25)

Table 2.—Alphabetic List of Named Cyclothems in Illinois Showing Formation, Distribution, and Principal References

Named Cyclothem	Formation	Area of state	References
Abingdon	Spoon	Western	Weller, Wanless, et al., 1942
Babylon	Abbott	Western	Wanless, 1931a, p. 189–190, 192–193; 1957, geol. sec. 41, p. 189
Bankston	Carbondale	Southwestern and southeastern	Weller, *in* Dunbar and Henbest, 1942, p. 16–18; Wanless, 1956, p. 11
Battery Rock	Caseyville	Southwestern and southeastern	Weller, 1940, p. 37; Wanless ms., 1938
Bogota	Mattoon	Southeastern	Newton and Weller, 1937, p. 9, 19–24; Wanless, 1956, p. 12
Brereton	Carbondale	All	Wanless, 1931a, p. 180, 182–183, 190, 192
Briar Hill	Carbondale	Southwestern and southeastern	Present report. Previous name, Crab Orchard Cyclothem, Wanless ms., 1938; Weller et al., 1942, p. 16.
Brush	Spoon	Western	Present report. Previous name, Middle DeLong Cyclothem, Wanless, 1931a, p. 188, 192; 1956, p. 9
Bunje	Bond	Southwestern	Present report. Wanless, 1955, p. 1764—from Simon ms., 1946
Carlinville	Macoupin	Southwestern	Ball, 1952, p. 34-37
Cohn	Mattoon	Eastern	Newton and Weller, 1937, p. 9, 18–19
Colbert	Spoon	Southeastern	Wanless, 1956, p. 5, 9
Cutler	Carbondale-Modesto	Southwestern, southeastern, and eastern	Present report. Siever, *in* Wanless, 1956
DeKoven	Spoon	Southeastern	Weller, *in* Dunbar and Henbest, 1942, p. 16; Wanless, 1956, p. 10
DeLong	Spoon	Western	Present report. Previous name, Upper DeLong Cyclothem, Wanless, 1931a, p. 188, 192; 1956, p. 9
Delwood	Abbott	Southeastern	Weller, 1940, p. 39; Wanless, 1956, p. 9
Flannigan	Bond	Southeastern	Newton and Weller, 1937, p. 9–10
Flat Creek	Bond	Southwestern	Present report. Wanless, 1955, p. 1764—from Simon ms., 1946
Gila	Mattoon	Southeastern	Newton and Weller, 1937, p. 9, 27–28
Gimlet	Modesto	Western, northern, southeastern, and eastern	Wanless, 1931a, p. 182, 192
Greenbush	Spoon	Western	Wanless, 1931a, p. 188, 192; 1956, p. 10
Greenup	Mattoon	Southeastern	Newton and Weller, 1937, p. 9, 26–27
Grindstaff	Abbott	Southwestern and southeastern	Butts, 1925, p. 44; Weller, 1940, p. 39
Hall	Modesto-Bond	Northern	Weller, *in* Cooper, 1946, p. 12—from Willman ms., 1931
Hermon	Spoon	Western	Present report. Previous name, Lower DeLong Cyclothem, Wanless, 1931a, p. 188, 192; 1957, p. 73
Hicks	Modesto	Northern	Weller, *in* Cooper, 1946, p. 12—from Willman ms., 1931
Jamestown	Carbondale	Southeastern	Bell et al., 1931, p. 3; Wanless and Weller, 1932, p. 1007; Wanless, 1956, p. 10
LaSalle	Bond-Mattoon	Northern	Weller and Bell, 1936, p. 26—from Willman ms., 1931
Little Vermilion	Mattoon	Northern	Weller, *in* Cooper, 1946, p. 14; Cooper, 1946, p. 16—from Willman ms., 1931
Liverpool	Spoon-Carbondale	Western	Wanless, 1931a, p. 188, 192; 1956, p. 10; 1957, p. 25, and geol. secs. 24, 25, p. 198
Lowell	Carbondale	Northern	Willman and Payne, 1942, p. 87, 102–103 and geol. sec. 33, p. 300
Lusk	Caseyville	Southeastern	Weller, 1940, p. 36–37
Macedonia	Abbott-Spoon	Southeastern	Weller, 1940, p. 39, 40; Wanless, 1956, p. 9
Macoupin	Modesto	Southwestern	Wanless, 1931b, p. 804, 811–812; Ball, 1952, geol. sec. 19, p. 85–86
Newton	Mattoon	Southeastern	Newton and Weller, 1937, p. 9, 24–25
Pope Creek	Abbott	Western	Wanless, 1931a, p. 189–190, 192

TABLE 2.—Concluded

Named Cyclothem	Formation	Area of state	References
Pounds	Caseyville-Abbott	Southwestern and southeastern	Wanless, 1929, geol. sec. 4, p. 52, "Suite I"; 1957, p. 67–70; Weller, 1940, p. 38–39
St. David	Carbondale	All	Wanless, 1931a, p. 182, 192; 1957, p. 102 and geol. sec. 21, p. 197
Seahorne	Spoon	Western and southwestern	Wanless, 1931a, p. 188, 192; 1957, p. 76 and geol. sec. 30, p. 200
Seville	Abbott-Spoon	Western	Wanless, 1931a, p. 189, 192; 1957, p. 70 and geol. sec. 33, p. 201
Shoal Creek	Modesto-Bond	Southwestern, southeastern, and eastern	Wanless, 1931b, p. 804, 812
Shumway	Mattoon	Southeastern	Weller, *in* Dunbar and Henbest, 1942, p. 28; Wanless, 1956, p. 12
Sorento	Bond	Southwestern	Present report. Wanless, 1955, p. 1764—from Simon ms., 1946
Sparland	Carbondale-Modesto	Western and northern	Wanless, 1931a, p. 182, 192
Stonefort	Spoon	Southeastern	Present report. Weller, 1940, p. 39; Wanless, 1956, p. 9 (location in error)
Summum	Carbondale	All	Wanless, 1931a, p. 182, 192; 1957, p. 94 and geol. sec. 39, p. 204
Tarter	Abbott	Western	Wanless, 1956, p. 9; 1957, p. 66 and geol. sec. 34, p. 202
Tonica	Spoon-Carbondale	Northern	Present report. Previously called Liverpool Cyclothem in northern Illinois (Willman and Payne, 1942)
Trivoli	Modesto	All	Wanless, 1931a, p. 182, 192; 1956, p. 11; 1957, p. 121 and geol. sec. 8, p. 193
Wiley	Spoon	Western	Wanless, 1931a, p. 188, 192; 1956, p. 9; 1957, p. 79 and geol. sec. 42, p. 206
Witt	Bond	Southwestern	Present report—from Gluskoter ms., 1958
Woodbury	Mattoon	Southeastern	Newton and Weller, 1937, p. 9, 28–30

TABLE 3.—ALPHABETICAL LIST OF NAMES ACCEPTED AND NAMES RESTRICTED OR ABANDONED IN THIS REPORT
(Fm. = Formation; M. = Member; Ls. = Limestone; Ss. = Sandstone; Sh. = Shale)

Unit name	Formation or remarks
Abbott Fm.	
Abingdon Coal M.	Spoon
Abingdon Cyclothem	Spoon
Absher Ls.	Replaced by St. David Ls. M.
Allenby Coal M.	Carbondale
Anvil Rock Ss. M.	Carbondale
Assumption Coal M.	Spoon
Athensville Coal M.	Modesto
Ava Shale	Discontinued
Babylon Coal	Replaced by Manley Coal M.
Babylon Cyclothem	Abbott
Babylon Ss. M.	Abbott
Bald Hill Coal	Replaced by Mt. Rorah Coal M.
Bankston Coal	Replaced by Allenby Coal M.
Bankston Cyclothem	Carbondale
Bankston Fork Ls. M.	Carbondale
Battery Rock Coal	Replaced by Gentry Coal M.
Battery Rock Cyclothem	Caseyville
Battery Rock Ss. M.	Caseyville
Bernadotte Ss. M.	Abbott
Bidwell Coal M.	Spoon
Big Creek Sh. M.	Carbondale
Bogota Cyclothem	Mattoon
Bogota Ls. M.	Mattoon
Bond Fm.	
Bonpas Ls. M.	Mattoon
Boskydell Ss.	Discontinued
Brereton Cyclothem	Carbondale
Brereton Ls. M.	Carbondale
Briar Hill (No. 5A) Coal M.	Carbondale
Briar Hill Cyclothem	Carbondale
Browning Ss. M.	Spoon
Brush Coal M.	Spoon
Brush Cyclothem	Spoon
Bunje Cyclothem	Bond
Bunje Ls. M.	Bond
Burroughs Beds	Replaced by Burroughs Ls. M.
Burroughs Ls. M.	Modesto
Calhoun Coal M.	Mattoon
"Calhoun" Ls.	Replaced by Bonpas Ls. M.
Canton Sh. M.	Carbondale
Carbondale Fm.	
Carbondale Group	Discontinued
Carlinville Coal	Discontinued
Carlinville Cyclothem	Modesto
Carlinville Ls. M.	Modesto
Caseyville Fm.	
Caseyville Group	Discontinued
Chapel (No. 8) Coal M.	Modesto
Cheltenham Clay M.	Spoon
Cheltenham Fire Clay	Replaced by Cheltenham Clay M.
Coffeen Ls. M.	Bond
Cohn Coal M.	Mattoon
Cohn Cyclothem	Mattoon
Colbert Cyclothem	Spoon
Colchester (No. 2) Coal M.	Carbondale
Conant Ls. M.	Carbondale
Copperas Creek Ss. M.	Carbondale
Covel Conglomerate M.	Carbondale
Crab Orchard Cyclothem	Replaced by Briar Hill Cyclothem
Cramer Ls. M.	Modesto
Creal Springs Ls. M.	Spoon
Cuba Ss.	Replaced by Vermilionville Ss. M.
Curlew Coal	Replaced by O'Nan Coal M.
Curlew Ls. M.	Spoon
Curlew Ss.	Replaced by Granger Ss. M.
Cutler Coal	Replaced by Danville (No. 7) Coal M.
Cutler Cyclothem	Carbondale—Modesto
Cutler Ls.	Replaced by Piasa Ls. M.
Cutler Rider Coals	
First	Replaced by DeGraff Coal M.
Second	Replaced by Pond Creek Coal M.
Third	Replaced by Lake Creek Coal M.
Cutler Ss.	Discontinued
Danville (No. 7) Coal M.	Carbondale
Davis Coal M.	Spoon
DeGraff Coal M.	Modesto
DeKoven Coal M.	Spoon
DeKoven Cyclothem	Spoon
DeLong Coal M.	Spoon
DeLong Cyclothem	Spoon
Delwood Coal M.	Abbott
Delwood Cyclothem	Abbott
Delwood Ss.	Replaced by Finnie Ss. M.
Drury Sh. M.	Caseyville
"Effingham" Beds	Replaced by Effingham Ls. M.
Effingham Ls. M.	Mattoon
Exline Cyclothem	Discontinued
Exline Ls. M.	Modesto
Farmington Sh. M.	Modesto
Finnie Ss. M.	Abbott
First Cutler Rider Coal	Replaced by DeGraff Coal M.
Flannigan Coal M.	Bond
Flannigan Cyclothem	Bond
Flat Creek Coal M.	Bond

Table 3.—Continued

Unit name	Formation or remarks
Flat Creek Cyclothem	Bond
Francis Creek Sh. M.	Carbondale
Friendsville Coal M.	Mattoon
Galum Ls. M.	Carbondale
Gentry Coal M.	Caseyville
Gila Cyclothem	Mattoon
Gila Ls. M.	Mattoon
Gimlet Cyclothem	Modesto
Gimlet Ss. M.	Modesto
"Goose Lake" Clay	Discontinued
Granger Ss. M.	Spoon
Grape Creek Coal	Replaced by Herrin (No. 6) Coal M.
Greenbush Coal M.	Spoon
Greenbush Cyclothem	Spoon
Greenup Cyclothem	Mattoon
Greenup Ls. M.	Mattoon
Grindstaff Cyclothem	Abbott
Grindstaff Ss. M.	Abbott
Hall Cyclothem	Modesto-Bond
Hall Ls. M.	Bond
Hanover Ls. M.	Carbondale
Harrisburg (No. 5) Coal M.	Carbondale
Hermon Coal M.	Spoon
Hermon Cyclothem	Spoon
Herrin Ls.	Replaced by Brereton Ls. M.
Herrin (No. 6) Coal M.	Carbondale
Hicks Cyclothem	Modesto
Hicks Ls.	Discontinued
Indiana Coal No. III	Replaced by Seeleyville Coal M.
Isabel Ss. M.	Spoon
Jake Creek Ss. M.	Carbondale
Jake Creek Sh.	Discontinued
Jamestown Coal M.	Carbondale
Jamestown Cyclothem	Carbondale
Jamestown Ls.	Replaced by Conant Ls. M.
Kerton Creek Coal M.	Carbondale
Kewanee Group	
Lake Creek Coal M.	Modesto
LaSalle (No. 2) Coal	Replaced by Colchester (No. 2) Coal M.
LaSalle Cyclothem	Bond-Mattoon
LaSalle Ls. M.	Bond
Lawson Sh. M.	Carbondale
"Liberty" Ss.	Discontinued
Lick Creek Ss.	Replaced by Battery Rock Ss. M.
Litchfield Coal M.	Spoon
Little Vermilion Cyclothem	Mattoon
Little Vermilion Ls. M.	Mattoon
Liverpool Cyclothem	Spoon-Carbondale
Livingston Ls. M.	Bond
Lonsdale Ls. M.	Modesto
Lowell Coal M.	Carbondale
Lowell Cyclothem	Carbondale
Lower DeLong Coal	Replaced by Hermon Coal M.
Lower DeLong Cyclothem	Replaced by Hermon Cyclothem
Lower Livingston Ls.	Replaced by Livingston Ls. M.
Lusk Cyclothem	Caseyville
Lusk Sh. M.	Caseyville
McCleary's Bluff Coal	Mattoon
McCormick Group	
Macedonia Cyclothem	Abbott-Spoon
McLeansboro Group	
Macoupin Cyclothem	Modesto
Macoupin Ls. M.	Modesto
McWain Ss. M.	Bond
Makanda Fm.	Discontinued
Makanda Ss. (Lower)	Replaced by Pounds Ss. M.
Manley Coal M.	Abbott
Mattoon Fm.	
Merom Ss. M.	Mattoon
Middle DeLong Coal	Replaced by Brush Coal M.
Middle DeLong Cyclothem	Replaced by Brush Cyclothem
Millersville Ls. M.	Bond
Modesto Fm.	
Mt. Carmel Ss. M.	Bond
Mt. Rorah Coal M.	Spoon
Murphysboro Coal M.	Spoon
Murray Bluff Ss. M.	Abbott
New Burnside Coal M.	Spoon
New Haven Coal M.	Modesto
New Haven Ls.	Replaced by Shoal Creek Ls. M.
Newton Cyclothem	Mattoon
Newton Ls.	Replaced by Reisner Ls. M.
No. 8 Coal	Replaced by Chapel (No. 8) Coal M.
No. 7 Coal	Replaced by Danville (No. 7) Coal M.
No. 6 Coal	Replaced by Herrin (No. 6) Coal M.
No. 5 Coal	Replaced by Springfield (No. 5) Coal M. or Harrisburg (No. 5) Coal M.
No. 5A Coal	Carbondale
No. 4 Coal	Replaced by Summum (No. 4) Coal M.
No. 2 Coal	Replaced by Colchester (No. 2) Coal M.
No. 2A Coal	Replaced by Shawneetown Coal M.
No. 1 Coal	Replaced by Rock Island (No. 1) Coal M.
Oak Grove Beds	Replaced by Oak Grove Ls. M.
Oak Grove Ls. M.	Carbondale
Omega Ls. M.	Mattoon
O'Nan Coal M.	Spoon

TABLE 3.—Continued

Unit name	Formation or remarks
Opdyke Coal M.	Mattoon
"Ottawa" Clay	Discontinued
Palzo Ss. M.	Spoon
Piasa Ls. M.	Modesto
Pleasantview Ss. M.	Carbondale
Pokeberry Cyclothem	Replaced by Jamestown Cyclothem
Pokeberry Ls. M.	Carbondale
Pond Creek Coal M.	Modesto
Pope Creek Coal M.	Abbott
Pope Creek Cyclothem	Abbott
Pope Creek Ss.	Discontinued
Pounds Cyclothem	Caseyville-Abbott
Pounds Ss. M.	Caseyville
Purington Sh. M.	Carbondale
Reel Ls. M.	Bond
Reisner Ls. M.	Mattoon
Reynoldsburg Coal M.	Abbott
Rock Branch Coal M.	Modesto
Rock Island (No. 1) Coal M.	Spoon
Roodhouse Coal M.	Carbondale
St. David Cyclothem	Carbondale
St. David Ls. M.	Carbondale
Scottville Coal	Replaced by Rock Branch Coal M.
Scottville Ls. M.	Modesto
Seahorne Cyclothem	Spoon
Seahorne Ls. M.	Spoon
Second Cutler Rider Coal	Replaced by Pond Creek Coal M.
Seeleyville Coal M.	Spoon
Sellers Ls. M.	Caseyville
Seville Cyclothem	Abbott-Spoon
Seville Ls. M.	Spoon
Shawneetown Coal M.	Carbondale
Sheffield Sh.	Replaced by Lawson Sh. M.
Shelbyville Coal M.	Mattoon
Shoal Creek Cyclothem	Modesto-Bond
Shoal Creek Ls. M.	Bond
Shumway Cyclothem	Mattoon
Shumway Ls. M.	Mattoon
Sorento Cyclothem	Bond
Sorento Ls. M.	Bond
Sparland (No. 7) Coal	Replaced by Danville (No. 7) Coal M.
Sparland Cyclothem	Carbondale-Modesto
Spoon Fm.	
Springfield (No. 5) Coal M.	Carbondale
Stonefort Coal	Replaced by Wise Ridge Coal M.
Stonefort Cyclothem	Spoon
Stonefort Ls. M.	Spoon
"Sub-Babylon" Coal	Discontinued
Summum (No. 4) Coal M.	Carbondale
Summum Cyclothem	Carbondale
Tarter Coal M.	Abbott
Tarter Cyclothem	Abbott
Tarter Ss.	Discontinued
Third Cutler Rider Coal	Replaced by Lake Creek Coal M.
Tonica Cyclothem	Spoon-Carbondale
Tradewater Group	Discontinued
Trivoli (No. 8) Coal	Replaced by Chapel (No. 8) Coal M.
Trivoli Cyclothem	Modesto
Trivoli Ls.	Replaced by Cramer Ls. M.
Trivoli Ss. M.	Modesto
Trowbridge Coal M.	Mattoon
Turner Cyclothem	Replaced by Trivoli Cyclothem
Turner Ls.	Replaced by Cramer Ls. M.
Upper DeLong Coal	Replaced by DeLong Coal M.
Upper DeLong Cyclothem	Replaced by DeLong Cyclothem
Upper Livingston Ls.	Replaced by Livingston Ls. M.
Upper Macoupin Cycle	Discontinued
Upper Scottville Coal	Replaced by Athensville Coal M.
"Utica" Clay	Discontinued
Vergennes Ss. M.	Spoon
Vermilionville Ss. M.	Carbondale
Wayside Coal	Discontinued
Wayside Ss. M.	Caseyville
West Franklin Ls. M.	Modesto
Wiley Coal M.	Spoon
Wiley Cyclothem	Spoon
Willis Coal M.	Abbott
Wise Ridge Coal M.	Spoon
Witt Coal M.	Bond
Witt Cyclothem	Bond
Womac Coal M.	Modesto
Woodbury Cyclothem	Mattoon
Woodbury Ls. M.	Mattoon

REFERENCES

ASHLEY, G. H., 1898, The coal deposits of Indiana: *in* Indiana Department of Geology and Natural Resources 23rd Annual Report, p. 1-1573.

BALL, J. R., 1952, Geology and mineral resources of the Carlinville quadrangle: Illinois Geol. Survey Bull. 77, 110 p.

BELL, A. H., BALL, C. G., and MCCABE, L. C., 1931, Geology of the Pinckneyville and Jamestown areas, Perry County, Illinois: Illinois Geol. Survey Ill. Pet. 19, 22 p.

BEMENT, A., 1910, The Illinois coal fields: *in* Year book for 1909: Illinois Geol. Survey Bull. 16, p. 182-202.

BRADLEY, F. H., 1870, Geology of Vermilion County: *in* Geology and paleontology, vol. IV, p. 241-265, Geol. Survey of Illinois.

BROADHEAD, G. C., 1875, Geology of Shelby County: *in* Geology and paleontology, vol. IV, p. 163-174, Geol. Survey of Illinois.

BUTTS, CHARLES, 1925, Geology and mineral resources of the Equality-Shawneetown area: Illinois Geol. Survey Bull. 47, 76 p.

CADY, G. H., 1908, Cement-making materials in the vicinity of LaSalle: *in* Illinois Geol. Survey Bull. 8, p. 127-134.

CADY, G. H., 1915, Coal resources of District I (Longwall): Illinois Geol. Survey Min. Inv. 10, 149 p.

CADY, G. H., 1916, Coal resources of District VI: Illinois Geol. Survey Min. Inv. 15, 94 p.

CADY, G. H., 1917, Coal resources of District II (Jackson County): Illinois Geol. Survey Min. Inv. 16, 55 p.

CADY, G. H., 1919, Coal resources of District V (Saline and Gallatin counties): Illinois Geol. Survey Min. Inv. 19, 135 p.

CADY, G. H., 1921, Coal resources of District IV: Illinois Geol. Survey Min. Inv. 26, 247 p.

CADY, G. H., 1925, Structure of parts of northeastern Williamson and western Saline counties: Illinois Geol. Survey Rept. Inv. 2, 20 p. (In cooperation with U. S. Geol. Survey.)

CADY, G. H., 1926, The areal geology of Saline county: Illinois Acad. Sci. Trans., v. 19, p. 250-272.

CADY, G. H., 1935, Classification and selection of Illinois coals: Illinois Geol. Survey Bull. 62, 354 p.

CADY, G. H., 1942, Analysis of Illinois coals: U. S. Bureau of Mines Tech. Paper 641, p. 1-23.

CADY, G. H., 1948, Analysis of Illinois coals: Illinois Geol. Survey Bull. 62, Supplement, 77 p.

CADY, G. H., 1950, McLeansboro group in southern Illinois: Illinois Geol. Survey, unpublished manuscript.

CADY, G. H., and others, 1952, Minable coal reserves of Illinois: Illinois Geol. Survey Bull. 78, 138 p.

CADY, G. H., et al., 1955, Subsurface geology and coal resources of the Pennsylvanian system in Wabash County, Illinois: Illinois Geol. Survey Rept. Inv. 183, 24 p.

CAMPBELL, M. R., and LEVERETT, FRANK, 1900, Danville, Illinois-Indiana: U. S. Geol. Survey Geol. Atlas, Folio 67, 10 p.

CLINE, L. M., 1941, Traverse of upper Des Moines and lower Missouri series from Jackson County, Missouri, to Appanoose County, Iowa: Bull. Am. Assoc. Petroleum Geologists, v. 25, no. 1, p. 23-72.

COLLETT, JOHN, 1871, Second Annual Report: Indiana Geol. Survey, p. 190-240.

COLLETT, JOHN, 1884, 13th Annual Report, Indiana Dept. of Geology and Natural History, p. 45-70.

COOPER, C. L., 1946, Pennsylvanian ostracodes of Illinois: Illinois Geol. Survey Bull. 70, 177 p.

COX, E. T., 1875, Geology of Gallatin County: *in* Geology and paleontology, vol. VI, p. 197-219, Geol. Survey of Illinois.

CULVER, H. E., 1922, Note on the occurrence of fusulinas in the Pennsylvanian rocks of Illinois: Illinois Acad. Sci. Trans., v. 15, p. 421-425.

CULVER, H. E., 1925, Coal resources of District III (Western Illinois): Illinois Geol. Survey Min. Inv. 29, 128 p.

DESBOROUGH, G. A., 1959, Correlation of the Boskydell Sandstone in southwestern Illinois: Bull. Am. Assoc. Petroleum Geologists, v. 43, no. 11, p. 2720-2724.

DEWOLF, F. W., 1910, Studies of Illinois coal—Introduction: *in* Year book for 1909, Illinois Geol. Survey Bull. 16, p. 178-181.

DUBOIS, E. P., 1951, Geology and coal resources of a part of the Pennsylvanian system in Shelby, Moultrie, and portions of Effingham and Fayette counties: Illinois Geol. Survey Rept. Inv. 156, 32 p.

DUNBAR, C. O., and HENBEST, L. G., 1942, Pennsylvanian Fusulinidae of Illinois: Illinois Geol. Survey Bull. 67, 218 p.

EKBLAW, S. E., 1930, Channel deposits of the Pleasantview sandstone in Western Illinois: Illinois Acad. Sci. Trans., v. 23, no. 3, p. 391-399.

ELIAS, M. K., 1937, Depth of deposition of the Big Blue (Late Paleozoic) sediments in Kansas: Geol. Soc. America Bull., v. 48, p. 403-432.

ENGELMANN, HENRY, 1868, Geology of Clinton and Washington counties: *in* Geology and paleontology, vol. III, p. 145-191, Geol. Survey of Illinois.

FULLER, M. L., and CLAPP, F. G., 1904, Patoka, Indiana-Illinois: U. S. Geol. Survey Geol. Atlas, Folio 105, 12 p.

GLASS, H. D., POTTER, P. E., and SIEVER, RAYMOND, 1956, Clay mineralogy of some basal Pennsylvanian sandstones, clays, and shales: Bull. Am. Assoc. Petroleum Geologists, v. 40, no. 4, p. 750-754.

GLENN, L. C., 1912a, The geology of Webster County: *in* Norwood, C. J., 1912, Report on the progress of the Survey for the years 1910 and 1911: Kentucky Geol. Survey Bull., ser. 3, p. 25-35.

GLENN, L. C., 1912b, A geological reconnaissance of the Tradewater River region, with special reference to the coal beds: Kentucky Geol. Survey Bull. 17, 75 p.

GLUSKOTER, H. J., 1958, A stratigraphic study of the Shoal Creek–Millersville Interval in south-central Illinois: State University of Iowa, unpublished master's thesis, 97 p.

HARRISON, J. A., 1951, Subsurface geology and coal resources of the Pennsylvanian system in White County, Illinois: Illinois Geol. Survey Rept. Inv. 153, 40 p.

HENBEST, L. G., 1928, Fusulinellas from the Stonefort limestone member of the Tradewater formation: Jour. Paleontology, v. 2, no. 1, p. 70-71.

HINDS, HENRY, 1919, Colchester–Macomb, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 208, 14 p.

HOPKINS, M. E., 1958, Geology and petrology of the Anvil Rock sandstone of Southern Illinois: Illinois Geol. Survey Circ. 256, 49 p.

KAY, F. H., 1915, Coal resources of District VII (Coal No. 6 west of Duquoin anticline): Illinois Geol. Survey Min. Inv. 11, 233 p.

KAY, F. H., and WHITE, K. D., 1915, Coal resources of District VIII (Danville): Illinois Geol. Survey Min. Inv. 14, 68 p.

KOSANKE, R. M., 1950, Pennsylvanian spores of Illinois and their use in correlation: Illinois Geol. Survey Bull. 74, 128 p.

LAMAR, J. E., 1925, Geology and mineral resources of the Carbondale quadrangle: Illinois Geol. Survey Bull. 48, 172 p.

LAMAR, J. E., WILLMAN, H. B., FRYLING, C. F., and VOSKUIL, W. H., 1934, Rock wool from Illinois mineral resources: Illinois Geol. Survey Bull. 61, 262 p.

LEE, WALLACE, 1916, Geology of the Kentucky part of the Shawneetown quadrangle: Kentucky Geol. Survey Bull., ser. 4, v. 2, pt. 2, 73 p.

LEE, WALLACE, 1926, Gillespie–Mt. Olive, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 220, 14 p.

LINES, E. F., 1912, Stratigraphy of Illinois with reference to Portland-cement materials: *in* Portland-cement resources of Illinois, Illinois Geol. Survey Bull. 17, p. 59-76.

MOORE, R. C., et al., 1944, Correlation of Pennsylvanian formations of North America: Geol. Soc. America Bull., v. 55, no. 6, p. 657-706.

NEWTON, W. A., and WELLER, J. M., 1937, Stratigraphic studies of Pennsylvanian outcrops in part of Southeastern Illinois: Illinois Geol. Survey Rept. Inv. 45, 31 p.

NOÉ, A. C., 1934, Our present knowledge of American coal ball plants: Illinois Acad. Sci. Trans., v. 26, no. 3, p. 103.

OWEN, D. D., 1856, Report of the geological survey in Kentucky made during the years 1854 and 1855: Kentucky Geol. Survey Bull., v. I, ser. 1, 416 p.

PAYNE, J. N., 1942, Structure of Herrin (No. 6) coal bed in Macoupin County, eastern Jersey and Greene, southeastern Scott, and southern Morgan and Sangamon counties: Illinois Geol. Survey Circ. 88, 46 p.

PAYNE, J. N., and CADY, G. H., 1944, Structure of Herrin (No. 6) coal bed in Christian and Montgomery counties and adjacent parts of Fayette, Macon, Sangamon, and Shelby counties: Illinois Geol. Survey Circ. 105, 57 p.

POOR, R. S., 1930, Geology and mineral resources of the Galesburg and Monmouth quadrangles: Illinois Geol. Survey unpublished manuscript RSP-4, 108 p. (Revised 1935.)

POTTER, P. E., 1956, Subsurface geology and coal resources of the Pennsylvanian system in Crawford and Lawrence Counties, Illinois: Illinois Geol. Survey Rept. Inv. 193, 17 p.

POTTER, P. E., and GLASS, H. D., 1958, Petrology and sedimentation of Pennsylvanian sediments in Southern Illinois — A vertical profile: Illinois Geol. Survey Rept. Inv. 204, 60 p.

POTTER, P. E., and OLSON, J. S., 1954, Variance components of cross-bedding direction in some basal Pennsylvanian sandstones of the Eastern Interior Basin — Geological application: Jour. Geology, v. 62, no. 1, p. 50-73.

POTTER, P. E., and SIEVER, RAYMOND, 1955, A comparative study of upper Chester and lower Pennsylvanian stratigraphic variability: Jour. Geology, v. 63, no. 5, p. 429-451.

POTTER, P. E., and SIEVER, RAYMOND, 1956a, Sources of basal Pennsylvanian sediments in the Eastern Interior Basin — 1. Cross-bedding: Jour. Geology, v. 64, no. 3, p. 225-244.

POTTER, P. E., and SIEVER, RAYMOND, 1956b, Sources of basal Pennsylvanian sediments in the Eastern Interior Basin — 3. Some methodological implications: Jour. Geology, v. 64, no. 5, p. 447-455.

POTTER, P. E., and others, 1959, Pennsylvanian geology and coal resources of Williamson County: Illinois Geol. Survey unpublished manuscript.

RICH, J. L., 1916a, Oil and gas in the Birds quadrangle: *in* Year book for 1915: Illinois Geol. Survey Bull. 33, p. 105-145.

RICH, J. L., 1916b, Oil and gas in the Vincennes quadrangle: *in* Year book for 1915: Illinois Geol. Survey Bull. 33, p. 147-175.

SAVAGE, T. E., 1921, Geology and mineral resources of the Avon and Canton quadrangles: *in* Year book for 1917 and 1918: Illinois Geol. Survey Bull. 38, p. 209-271.

SAVAGE, T. E., 1927, Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour. Sci., 5th ser., v. 14, no. 82, p. 307-316.

SEARIGHT, W. V., 1929, Geology and mineral resources of the Beardstown quadrangle: Illinois Geol. Survey unpublished manuscript WVS-1, 296 p.

Shaw, E. W., 1921, New Athens–Okawville, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 213, 12 p. (published 1922).

Shaw, E. W., 1923, Carlyle–Centralia, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 216, 10 p.

Shaw, E. W., and Savage, T. E., 1912, Murphysboro–Herrin, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 185, 15 p. (published 1913).

Shaw, E. W., and Savage, T. E., 1913, Tallula–Springfield, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 188, 12 p.

Siever, Raymond, 1951, The Mississippian–Pennsylvanian unconformity in Southern Illinois: Bull. Am. Assoc. Petroleum Geologists, v. 35, p. 542-581.

Siever, Raymond, 1956, Correlation chart of classification of the Pennsylvanian rocks of Illinois as of 1956: *in* Illinois Geol. Survey Circ. 217, pl. 1.

Siever, Raymond, and Potter, P. E., 1956, Sources of basal Pennsylvanian sediments in the Eastern Interior Basin — 2. Sedimentary petrology: Jour. Geology, v. 64, no. 4, p. 317-335.

Simon, J. A., 1946, Correlation studies of upper Pennsylvanian rocks in southwest-central Illinois: Univ. Illinois unpublished master's thesis, 36 p.

Smith, W. H., 1957, Strippable coal reserves of Illinois. Part 1. — Gallatin, Hardin, Johnson, Pope, Saline, and Williamson counties: Illinois Geol. Survey Circ. 228, 39 p.

Smith, W. H., 1958, Strippable coal reserves of Illinois. Part 2. — Jackson, Monroe, Perry, Randolph, and St. Clair counties: Illinois Geol. Survey Circ. 260, 35 p.

Stevenson, W. L., 1955, Pennsylvanian conodonts of Illinois: Univ. Illinois unpublished master's thesis, 56 p.

Taylor, E. F., and Cady, G. H., 1944, Structure of the Millersville limestone in the north part of the Illinois Basin: *in* Progress reports on subsurface studies of the Pennsylvanian System in the Illinois Basin: Illinois Geol. Survey Rept. Inv. 93, p. 22-26.

Thompson, M. L., Shaver, R. H., and Riggs, E. A., 1959, Early Pennsylvanian fusulinids and ostracods of the Illinois Basin: Jour. Paleontology, v. 33, no. 5, p. 772.

Udden, J. A., 1912, Geology and mineral resources of the Peoria quadrangle, Illinois: U. S. Geol. Survey Bull. 506, 103 p.

Udden, J. A., and Shaw, E. W., 1915, Belleville–Breese, Illinois: U. S. Geol. Survey Geol. Atlas, Folio 195, 14 p.

Van Den Berg, Jacob, 1956, Pennsylvanian stratigraphy above the Shoal Creek limestone in Illinois: Univ. Illinois unpublished master's thesis, 65 p.

Wanless, H. R., 1927, Stratigraphy and paleontology of the Pennsylvanian of northwestern Illinois (abst.): Geol. Soc. America Bull., v. 38, p. 133-134.

Wanless, H. R., 1929, Geology and mineral resources of the Alexis quadrangle: Illinois Geol. Survey Bull. 57, 230 p.

Wanless, H. R., 1931a, Pennsylvanian cycles in Western Illinois: *in* Papers presented at the quarter centennial celebration of the Illinois State Geological Survey: Illinois Geol. Survey Bull. 60, p. 179-193.

Wanless, H. R., 1931b, Pennsylvanian section in Western Illinois: Geol. Soc. America Bull., v. 42, p. 801-812.

Wanless, H. R., 1931c, The question of Pennsylvanian overlap in the Rock Island region: Illinois Acad. Sci. Trans., v. 24, no. 2, p. 331-340.

Wanless, H. R., 1932, Depositional basin of the Springfield (No. 5) coal in Northern Illinois (abst.): Illinois Acad. Sci. Trans., v. 25, no. 4, p. 153.

Wanless, H. R., 1938, Stratigraphy of the Caseyville and Tradewater groups of Illinois: Illinois Geol. Survey unpublished manuscript HRW-12, 76 p.

Wanless, H. R., 1939, Pennsylvanian correlations in the Eastern Interior and Appalachian coal fields: Geol. Soc. America Spec. Paper 17, 130 p.

Wanless, H. R., 1955, Pennsylvanian rocks of Eastern Interior Basin: Am. Assoc. Petroleum Geologists Bull. v. 39, no. 9, p. 1753-1820.

Wanless, H. R., 1956, Classification of the Pennsylvanian rocks of Illinois as of 1956: Illinois Geol. Survey Circ. 217, 14 p.

Wanless, H. R., 1957, Geology and mineral resources of the Beardstown, Glasford, Havana, and Vermont quadrangles: Illinois Geol. Survey Bull. 82, 233 p.

Wanless, H. R., 1958, Pennsylvanian faunas of the Beardstown, Glasford, Havana, and Vermont quadrangles: Illinois Geol. Survey Rept. Inv. 205, 59 p.

Wanless, H. R., and Weller, J. M., 1932, Correlation and extent of Pennsylvanian cyclothems: Geol. Soc. America Bull., v. 43, (Dec.), p. 1003-1016.

Weller, J. M., 1930, Cyclical sedimentation of the Pennsylvanian period and its significance: Jour. Geology, v. 38, no. 2 p. 97-135.

Weller, J. M., 1931a, The conception of cyclical sedimentation during the Pennsylvanian period: *in* Papers presented at the quarter centennial celebration of the Illinois State Geological Survey: Illinois Geol. Survey Bull. 60, p. 163-179.

Weller, J. M., 1931b, Sedimentary cycles in the Pennsylvanian strata — A reply: Am. Jour. Sci., 5th ser., v. 21, no. 124, p. 311-329.

Weller, J. M., 1931c, Pennsylvanian overlap in United States (discussion): Bull. Am. Assoc. Petroleum Geologists, v. 15, no. 6, p. 704-707.

Weller, J. M., 1940, Geology and oil possibilities of extreme Southern Illinois — Union, Johnson, Pope, Hardin, Alexander, Pulaski, and Massac counties: Illinois Geol. Survey Rept. Inv. 71, 71 p.

Weller, J. M., 1946, Stratigraphic summary: *in* Cooper, C. L., 1946, Pennsylvanian ostracodes of Illinois: Illinois Geol. Survey Bull. 70, p. 11-14.

Weller, J. M., and Bell, A. H., 1936, The geology and oil and gas possibilities of parts of Marion and Clay counties, with a discussion of the central portion of the Illinois Basin: Illinois Geol. Survey Rept. Inv. 40, 54 p.

Weller, J. M., Henbest, L. G., and Dunbar, C. O., 1942, Stratigraphy of the fusuline-bearing beds of Illinois: *in* Pennsylvanian Fusulinidae of Illinois: Illinois Geol. Survey Bull. 67, p. 9-34.

Weller, J. M., Wanless, H. R., Cline, L. M., and Stookey, D. G., 1942, Interbasin Pennsylvanian correlations, Illinois and Iowa: Bull. Am. Assoc. Petroleum Geologists, v. 26, no. 10, p. 1585-1593.

Weller, J. M., et al., 1945, Geologic map of Illinois: Illinois Geol. Survey.

Weller, Stuart, 1906, The geological map of Illinois: Illinois Geol. Survey Bull. 1, 26 p.

White, David, 1907, Report on field work done in 1907: *in* Year book for 1907, Illinois Geol. Survey Bull. 8, p. 268-272.

White, David, 1909, Paleobotanical work in Illinois in 1908: *in* Year book for 1908, Illinois Geol. Survey Bull. 14, p. 293-295.

Williams, H. S., 1891, Geology of Washington County: Arkansas Geol. Survey Annual Report for 1888, v. 4, p. xiii.

Willman, H. B., 1931, General geology and mineral resources of the Illinois deep waterway from Chicago to Peoria: Illinois Geol. Survey unpublished manuscript HBW-4, 257 p.

William, H. B., 1939, The Covel conglomerate, a guide bed in the Pennsylvanian of Northern Illinois: Illinois Acad. Sci. Trans., v. 32, no. 2, p. 174-176.

Willman, H. B., and Payne, J. N., 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, 388 p.

Willman, H. B., Swann, D. H., and Frye, J. C., 1958, Stratigraphic policy of the Illinois State Geological Survey: Illinois Geol. Survey Circ. 249, 14 p.

Worthen, A. H., 1868, Coal Measures and Lower Carboniferous limestone: *in* Geology and paleontology, vol. III, p. 1-19, Geol. Survey of Illinois.

Worthen, A. H., 1870, Geology of Fulton County: *in* Geology and paleontology, vol. IV, p. 90-110, Geol. Survey of Illinois.

Worthen, A. H., 1873, Geology of Peoria County: *in* Geology and paleontology, vol. V, p. 235-252, Geol. Survey of Illinois.

Worthen, A. H., 1875a, Geology of Bond County: *in* Geology and paleontology, vol. VI, p. 128-134, Geol. Survey of Illinois.

Worthen, A. H., 1875b, Geology of Clark, Wabash, Edwards, Lawrence, and Richland counties: *in* Geology and paleontology, vol. VI, p. 9-21, 37-65, Geol. Survey of Illinois.

Worthen, A. H., 1883, Economical geology: *in* Geology and paleontology, vol. VII, p. 1-51, Geol. Survey of Illinois.

Worthen, A. H., and Engelmann, Henry, 1866, Geology of Hardin County: *in* Geology [of Illinois], vol. I, p. 350-375, Geol. Survey of Illinois.

APPENDIX

GEOLOGIC SECTIONS

Type and Reference Sections of Formations

Geologic section 1 (modified from Lee, 1916, p. 15-16).—Section measured from outcrops on the Illinois shore of the Ohio River between the mouth of the Saline River and Gentry Landing below Battery Rock, T. 11 S., R. 10 E., Shawneetown quadrangle, Hardin County.

Type section of the Caseyville Formation.

	Thickness: (*ft*)
Pennsylvanian System	
McCormick Group	
Caseyville Formation	
Pounds Sandstone Member	
Conglomerate, massive, coarse-bedded; pebbles subordinate	55
Conglomerate, pebbles very abundant	25
Clay shale, blue-gray to dark; increasingly argillaceous below	5+
Talus. Includes a thin coal near Caseyville	20
Sandstone, loose, dirty, ragged bedding	25
Clay shale, blue	7
Sandy shale and shaly sand	17
Clay shale	30
Clay shale with limestone bands 1 to 4 inches thick, 2 to 3 feet apart	26
Limy shale, blue, with four bands of dense limestone 2 to 4 inches thick resembling ironstone	8
Limestone, dense, hard, like ironstone when fresh, weathering platy and argillaceous	5
Shale, blue	13
Talus	5+
Sandstone, massive, contains coarse mica and fine black specks at base	22
Slate, black, sandy	1
Slaty sand in thin sheets, dark, carbonaceous	5
Shale, black, sandy	5
Not exposed	5+
Gentry Coal Member	2
Talus	10
Sandstone, loose, irregular in texture	2
Talus	20
Sandstone, slabby, dense, fine-grained, ripple-marked	20
Talus	10
Sandstone	3
Talus, probably shale	15
Shale	3
Battery Rock Sandstone Member	
Sandstone in thin beds probably alternating with shaly sandstone	23
Talus	10
Conglomerate	65
Lusk Shale Member	
Sandstone, dirty and slabby	5
Talus	22
Sandstone, massive	7
Slaty sand	3
Talus	12
Total	511+

Mississippian System

Geologic section 2.—Section exposed along the railroad cut of the Illinois Central Railroad from railroad tunnel, NW¼ SW¼ SE¼ sec. 31, T. 11 S., R. 5 E., southward to NE¼ SE¼ NE¼ sec. 18, T. 12 S., R. 5 E., Brownfield and Harrisburg quadrangles, Pope County.

Reference section of the Caseyville Formation.

	Thickness: (*ft*)	(*in*)
Pennsylvanian System		
McCormick Group		
Caseyville Formation		
Pounds Sandstone Member, light gray, hard, medium to coarse-grained; numerous white quartz pebbles; massive (75± feet exposed in cliff)	100±	
Shale, light gray, thinly laminated, with sandy ironstone nodules and bands; grades into	10±	
Shale, medium dark gray, similar to above except for color; thin sandstone lenses	15±	
Gentry Coal Member, shaly in lower 2 to 5 inches		8-19
Underclay, gray, silty, carbonaceous	3±	
Shale, gray and dark gray, poorly laminated, silty; sandy in part	2	
Battery Rock Sandstone Member, light gray, weathering buff, hard; quartz pebbles present; massive in upper part, less massive in lower part.	100±	
Coal, at one point 8 inches thick; unit commonly consists of 2 to 4 inches of coal, shale, and sandstone conglomerate at base of sandstone above or occurs as stringers in sandstone		4±
Lusk Shale Member		
Shale, sandy, interbedded with shaly sandstone and thin-bedded sandstone. Sandstone is fine grained; occasional quartz pebble	15±	
Carbonaceous, clayey "smut" band.		1
Sandstone and shale; sandstone, light gray, conglomeratic with quartz pebbles, interbedded with gray, sandy shale and shaly sandstone; some benches of sandstone massive, some benches more thinly bedded; quartz pebbles present as in sandstones above. Area of maximum known development	125±	
Clay, greenish gray, with brown iron-staining in part; soft and plastic when wet; occasional shale fragments and light gray, dense, hard, angular		

Thickness:	*(ft)*	*(in)*
masses of sandstone. Grades into small pockets of clay filling depressions in the top of the limestone	1	3
Total	372	9±
Mississippian System		
Chester Series		
Kinkaid Limestone, gray, argillaceous in part, fossiliferous, massive; in benches up to 18 inches thick with occasional thin shaly band up to 6 inches thick; irregular beds of chert 2 to 8 inches thick and occasional rounded chert masses	12±	

Geologic section 3.—Exposures in cuts along the Illinois Central Railroad, NW¼ sec. 5, T. 11 S., R. 5 E., to north end of railroad tunnel, SE¼ SW¼ sec. 19, T. 11 S., R. 5 E., Harrisburg quadrangle, Pope County.

Type section of the Abbott Formation.

Thickness:	*(ft)*	*(in)*
Pennsylvanian System		
McCormick Group		
Abbott Formation		
Murray Bluff Sandstone Member		
Sandstone, yellowish gray, micaceous, mealy, massive	50	
Conglomerate (ironstone and shale pebbles in sandy matrix), reddish brown to rusty with some coalified logs or wood	1	6
Sandy, shaly material at unconformable contact		2
Shale, bony or coaly		3
Delwood Coal Member, somewhat shaly and bony, but fairly bright	3	
Clay, blue-gray, hard, sandy, poorly bedded, with carbonaceous root remains; micaceous	1	6
Clay, light gray, sandy, with irregular fracture; some carbonaceous root remains	2	
Sandstone, fine-grained, poorly bedded, bluish gray, dense, hard	1	
Shale, light to medium bluish gray, sandy; sandstone layers and ironstone bands	40±	
Finnie Sandstone Member, brownish gray, thin-bedded, medium-grained	60±	
Shale, black, silty, hard.	3	
Shale, greenish gray, hard, silty with small ironstone nodules or concretions	3	6
Shale, black, hard, massive		3
Willis Coal Member, rather thin-bedded, bright luster		2–4
Shale, black with thin coaly lenses		2
Underclay, medium olive-gray, hard, sandy, with carbonaceous root remains and ironstone concretions; stained yellowish brown; well indurated	3	
Shale, medium to light olive-gray, silty	3	
Shale, dark gray, silty to sandy; slightly micaceous; ironstone concretions	25±	
Grindstaff Sandstone Member, light gray, massive, medium-grained, fairly clean quartz sand	50±	
Conglomerate of shale, siltstone, and some sandstone; contains some large blocks several feet across	30±	
Total	277	7±

Geologic section 4 (modified from Wanless, 1957, geologic section 32, p. 201).—Roadcut, railroad cut of T. P. and W. Railroad, and ravine, SE¼ sec. 22, T. 6 N., R. 1 E., Vermont quadrangle, Fulton County.

Type section of the Spoon Formation.

Thickness:	*(ft)*	*(in)*
Pennsylvanian System		
Kewanee Group		
Carbondale Formation		
Francis Creek Shale Member, gray to olive-gray	18	
Colchester (No. 2) Coal Member	1	11
Total	19	11
Spoon Formation		
Underclay, light gray, noncalcareous	2	2
Underclay, rust brown, calcareous; selenite crystals	2	
Browning Sandstone Member		
Sandstone position; shale, silty and sandy, gray; upper 8 inches gray to red	8	8
Shale, dark gray, thin-bedded	2	
Shale, rust brown		8
Shale, black, carbonaceous		3
Abingdon Coal Member, coaly streak		1
Underclay, dark brown		4
Underclay, sandy, light gray	3	
Limestone concretions, brown and rust brown, large; discontinuous		6
Isabel Sandstone Member, gray	2	
Shale, medium gray	3	
Shale, dark gray, locally coaly		3
Underclay, gray, mottled yellow and rust brown	3	
Wiley Coal Member, soft		10
Underclay, dark gray		4
Underclay, light gray	2	
Seahorne Limestone Member, light gray, in discontinuous band of large concretions		8
Concealed	2	

Thickness:	(*ft*)	(*in*)
Underclay, light gray	1	
Shale, carbonaceous		2½
DeLong Coal Member		
Shale; contains canneloid coal		½
Underclay, light brownish gray	1	6
Shale, dark blue-gray		6
Brush Coal Member		
Clay, coaly		1
Underclay, light gray	5	
Shale, light gray	4	
Sandstone, reddish brown		1
Shale, dark gray, thin-bedded; selenite crystals	3	
Hermon Coal Member, coaly streak		½
Underclay, medium to dark gray	1	6
Shale, dark gray; ironstone concretions	1	6
Seville Limestone Member, argillaceous, light blue-gray, unevenly bedded; weathers platy; fossiliferous; pinches out to south	3	4
Shale, carbonaceous, black, soft		3
Rock Island (No. 1) Coal Member	2½–3	
Clay, dark gray to black, very carbonaceous; some semblance of bedding near top; occasional vitrain streak up to 1/16 inch thick; grades into		3
Underclay, medium gray becoming lighter gray downward, yellowish gray in part, firm, noncalcareous; carbonaceous root remains; occasional slightly silty zone in bottom 8 inches; grades into	1	7
Clay, light to medium gray with abundant yellowish iron-staining on fracture surfaces, plastic when wet, noncalcareous, very finely silty; some zones very hard; where weathered the iron material covers the surface in small clay-ironstone plates and flakes up to 1/16 inch thick; grades into	4	2
Total	64	9½

McCormick Group		
Abbott Formation		
Bernadotte Sandstone Member		
Siltstone, light gray, weathering whitish; very fine-grained, noncalcareous; some finely disseminated carbonaceous debris; considerable yellowish to reddish brown iron-staining; very argillaceous; becomes somewhat coarser grained downward; base concealed	1	4+

Geologic section 5.—Compiled from exposures at the following localities:

Geologic section 5A—abandoned strip mine pit on south-facing highwall, about 500 feet north of the south edge of the NW¼ NE¼ sec. 21, T. 10 S., R. 5 E., Harrisburg quadrangle, Saline County.

Geologic section 5B—along small stream draining abandoned strip mine pit from north of east-west road to about ⅛ mile south of this road, E½ NW¼ sec. 21, T. 10 S., R. 5 E., Harrisburg quadrangle, Saline County.

Geologic section 5C—east face of Creal Springs quarry, NE¼ SE¼ SE¼ sec. 25, T. 10 S., R. 3 E., and ravine on north-facing slope south of Sugar Creek, NW¼ SW¼ SW¼ sec. 30, T. 10 S., R. 4 E., Marion quadrangle, Williamson County.

Geologic section 5D—abandoned hillside strip mine and ravine to the north of the mine, center SE¼ SW¼ sec. 5, T. 11 S., R. 4 E., Marion quadrangle, Johnson County.

Reference section of the Spoon Formation in Southern Illinois. Geologic section 5C includes type outcrop of Creal Springs Limestone Member. Geologic section 5D includes type outcrops of New Burnside and Bidwell Coal Members.

Geologic section 5A

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
Kewanee Group		
Spoon Formation		
Palzo Sandstone Member		
Covered interval with large sandstone blocks on surface. The Palzo reaches a maximum known thickness of about 40 feet in this area	30±	
Shale, greenish gray, thickness uncertain	5±	
Shale, black, slaty	1	6
Shale, dark gray to black, fissile in part; very carbonaceous in bottom 2 inches		9
Coal, soft, top 4 inches much weathered	1	1
Underclay, light gray, slip-fractured; numerous carbonaceous root remains; micaceous; relatively firm; grades into	1	
Clay increasingly sandy downward. May be weathered sandstone in lower part	2	
Sandstone, light-gray, weathering brown, medium-grained, micaceous, dirty, massive, in benches up to 1½ feet thick; thins to west	10	
Siltstone, gray to dark gray, well laminated, carbonaceous; contains thin, light gray sandstone lenses and laminae; tends to be massive in bottom 2 feet	5	6
Shale, gray to dark gray, slightly silty becoming less silty downward, well laminated	20	
Shale, dark gray to black, relatively soft and earthy		6
DeKoven Coal Member, normally bright-banded	3	

Thickness:	(*ft*)	(*in*)
Underclay, light gray (slightly darker gray in top 2 inches), silty, soft, friable; numerous carbonaceous root remains	1	9
Clay, light greenish gray, silty, friable	2	3
Sandstone, gray, weathering olive-green; dark gray shaly partings and bands. Sandstone is dirty, massive, cross-bedded, and varies in thickness from 6 to 9 inches		8
Shale, medium gray, becoming dark gray to black in the bottom 3 inches; iron-stained on partings, thinly laminated	4	
Shale, black, fissile	1	10
Davis Coal Member, normally bright-banded	3	6
Underclay	1±	
Total	95	4

(Geologic sections 5A and 5B overlap)

Geologic section 5B

Davis Coal Member, hard and fairly bright	3	3
Underclay, medium brownish gray		1
Underclay, light gray with purplish cast, not bedded, slickensided, silty; carbonaceous root remains	1	4
Underclay, light gray, stained light yellow-brown along joint surfaces, slightly silty; carbonaceous root remains.	3	6
Clay, light gray, permeated with iron oxides whose weathering forms hard bands extending out through the clay; grades into	1	6
Shale, light olive-gray, poorly bedded, silty to sandy; sandstone lenses	2	
Siltstone or sandy shale, poorly bedded, streaked with iron along joint surfaces, poorly consolidated	2	
Sandstone, light olive-gray, fine-grained, thin-bedded; contains minute mica flakes	1	
Sandstone, light gray, weathering brownish gray, rather fine- to medium-grained, massive. Base concealed	4	
Total	18	8

(Relationship of geologic sections 5B and 5C uncertain within a few feet)

Geologic section 5C

Thickness:	(*ft*)	(*in*)
Sandstone, gray on weathered surfaces, buff on fresh fractures, medium- to fine-grained, even-bedded with some beds up to 5 feet thick, minor shale and siltstone partings. Generally 8 to 11 feet well exposed in a series of abandoned small quarries. Lower 7 feet poorly exposed but mostly interbedded sand and shale	18±	
Shale, medium to dark gray, soft, weathered	1	6
Shale, black, fissile. Observed in place on east side of abandoned wagon road. Base concealed	2+	
Shale, gray to dark gray, mostly covered	14	6
Stonefort Limestone Member, weathers light tan to buff; bluish gray on fresh surfaces, dense, fossiliferous		8
Covered interval appears to be mainly gray shale, with some black shale (position uncertain)	2	8
Shale, gray, fairly well to poorly bedded, soft, iron-stained, poorly exposed	5	
Wise Ridge Coal Member, very badly weathered	1	
Underclay, light gray with conspicuous yellow mottling; slip-fractured, relatively firm; carbonaceous root remains, not well exposed	1	8
Siltstone, light gray with yellowish oxidation mottling, argillaceous and fine-grained, fairly well bedded	5	
Shale, black, carbonaceous, fairly soft, fissile in part		¼–1
Underclay, medium gray, shaly and silty, fairly hard, some carbonaceous root remains; grades into	1	2
Shale, gray, well bedded, fairly hard; contains some ironstone concretions up to 6 by 18 inches in lower 2 feet	16	9
Mt. Rorah Coal Member		
Coal, upper 4⅜ inches finely banded in units ⅛-inch thick; lower 10 inches blocky and bright	1	2⅜
Clay, light brownish gray weathering yellow, shaly, much oxidized, abundant plant debris; unit thins to north (11 inches to 1 inch)		5
Coal, blocky, shaly, and weathered		4¾
Underclay, gray becoming light gray downward with much iron stain, slip-fractured, numerous carbonaceous root remains; noncalcareous, soft, blocky	4	10
Shale, light gray with much yellow iron-stained weathering, silty, poorly laminated	1	
Shale, medium gray with brown iron-staining on numerous partings, silty, fairly well laminated, carbonaceous; grades into	4	
Shale, gray, thinly and fairly well laminated	4	
Interval not well exposed. Probably gray shale similar to above	1	

Thickness:	(*ft*)	(*in*)
Creal Springs Limestone Member, weathers reddish buff, dense, hard, and fossiliferous; thins to north (4 to 24 inches thick) . .	1	6
Shale, gray, very silty, fairly soft but well bedded; ironstone concretions up to 4 inches long in upper part; some fairly persistent fine-grained sandstone benches up to 6 inches thick marked by strong ferruginous iron-staining	5	
Granger Sandstone Member, light gray to buff, generally fine- to very fine-grained with a few shale partings; abundant small-scale cross-bedding; becomes coarser grained with thicker beds toward base; at creek level is a 5-foot massive bed. Estimated thickness of the sandstone in this area is 60 to 70 feet	40	
Total	133	4+

(May be overlap between geologic sections 5C and 5D)

Geologic section 5D

Granger Sandstone Member		
Sandstone, light gray, fine-grained; irregularly interbedded with 10 to 15 percent shale partings; partings more numerous in upper portion .	18	6
Conglomerate, gray, sandy, and ferruginous; contains ¼- to 1-inch well rounded sandstone and shale pebbles . .	1	6
Shale, gray, sandy, interbedded with carbonaceous shale . .	1	
New Burnside Coal Member, normally bright-banded (seen in abandoned strip mine) . . .	3	
Covered; with some sandstone float shown in lower 3 feet . .	6	6
Shale, gray, sandy	11	6
Conglomerate, very ferruginous and hard, red color conspicuous; sandstone, shale, and some chert pebbles up to 3 inches in diameter embedded in a sandy matrix; disconformable with coal below	2	
Bidwell Coal Member		
Coal, blocky, beds ⅛- to 1-inch thick interbedded with approximately 25 percent coaly shale	1	5
Coal, blocky, bright; varies from ¾ to 1½ inches . . .		1
Clay, gray		1
Coaly shale		1½
Coal, blocky, bright		1
Shale, coaly		2½
Shale, coaly and very fissile . .		8
Clay, light gray, sandy, badly weathered; base concealed . .	3+	
Total	49	8

Geologic section 6.—Compiled from exposures at the following localities:

Geologic section 6A—(modified from Wanless, 1957, geologic section 16, p. 195) high east bank of Middle Copperas Creek and roadcut a little to the north, SE¼ NE¼ sec. 1, T. 7 N., R. 4 E., Glasford quadrangle, Fulton County.

Geologic section 6B—ditch and bank on the south side of the gob road and east of the C. B. and Q. Railroad, SW corner sec. 21, T. 8 N., R. 3 E., Canton quadrangle, Fulton County.

Geologic section 6C—cutbank on south side of Coal Creek and ravine about 200 feet to the south, E½ NE¼ NW¼ sec. 20, T. 8 N., R. 3 E., Canton quadrangle, Fulton County.

Type section of the Carbondale Formation. Geologic section 6A includes type outcrop of Brereton Limestone Member.

Geologic section 6A

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Modesto Formation		
Farmington Shale Member, gray, soft; weathers buff	4	6
Shale, black, soft to hard . . .		3
Total	4	9
Kewanee Group		
Carbondale Formation		
Danville (No. 7) Coal Member .	1	7
Underclay, light to dark gray, plastic	1	
Underclay, light gray	8	
Underclay, slightly sandy, calcareous, with limestone concretions	1	
Copperas Creek Sandstone Member		
Sandstone, gray, argillaceous; weathers reddish brown, massive	1	
Sandstone, buff to gray, fine-grained, shaly in upper part and massive below. . . .	12	
Lawson Shale Member, gray, soft, with small ironstone concretions	7	4
Shale, yellow-gray, calcareous, fossiliferous (crinoid stems and brachiopods)	1	4
Brereton Limestone Member, gray, in 2 benches, the upper bench 2 feet 2 inches thick and more massive than the lower .	3	6
Shale, light gray; weathers buff; soft, with small black calcareous and pyritic concretions . .	4	
Shale, black to dark gray . . .	1	
Herrin (No. 6) Coal Member		
Coal, irregular masses of micaceous siltstone at top . . .		8
Coal		11½
Shale, medium gray, laminated .		⅛–⅜
Coal		11¼
Clay, medium blue-gray, "blue-band"		2¾

Thickness:	*(ft)*	*(in)*
Coal		3½
Pyrite		¾
Coal		5¾
Clay, dark gray		¾
Coal	1	½
Underclay, noncalcareous, dark blue-gray	1	
Underclay, light gray		6
Underclay, calcareous, light gray	2	6
Vermilionville Sandstone Member, greenish gray, mottled brown, hard, lower part calcareous	3	
Canton Shale Member		
Shale, medium gray, slightly sandy	4	
Shale, light greenish gray; contains small ironstone concretions and limestone joint-fillings; base concealed	8	
Total	65	6

(Probably up to 20 feet of shale between geologic sections 6A and 6B)

Geologic section 6B

Thickness:	*(ft)*	*(in)*
Canton Shale Member, gray, weathered, soft	5	
Shale, black, slaty	1	6
Shale, black, carbonaceous		3
Springfield (No. 5) Coal Member, normally bright-banded	5	2
Underclay, medium to dark gray; weathers light gray with yellow staining; grades into		8
Shale, medium to dark gray, some yellow and brown staining, occasional coaly streak.	1	8
Shale, gray, olive cast, plastic when wet		2½
Clay, weathering yellowish brown, with hard calcareous nodules	1	6
Limestone, very argillaceous, irregular nodules in clay matrix		6
Clay, gray, weathering olive-drab; large, dark, rounded concretions in lower part associated with Covel Conglomerate-like material; associated concretions up to 6 inches thick and up to 18 inches long containing marine fossils, pitted surfaces (algal?), and phosphatic nodules	4	
Shale, dark gray, mottled with medium gray; becomes lighter toward the top		9
Hanover Limestone Member, medium gray, dense, hard, with marine fossils; bottom 6 inches nodular but massive bench; upper 3 to 4 inches thin-bedded with thin, discontinuous interbeds of dark gray shale; thickness variable		10
Shale, medium to dark gray; thickness variable		1±
Summum (No. 4) Coal Member, weathered, thickness variable		2½
Underclay, light gray; base concealed		8+
Total	23+	

(Estimated 5 feet between geologic sections 6B and 6C)

Geologic section 6C

Thickness:	*(ft)*	*(in)*
Pleasantview Sandstone Member, brownish gray, badly weathered, very soft	18±	
Purington Shale Member, light to medium gray with olive cast in part, thin-bedded, smooth; contains numerous thin bands and lenses of sideritic material; top slumped and covered	15±	
Oak Grove Limestone Member		
Limestone, medium gray with yellowish brown to reddish brown oxidation coating, dense to finely crystalline, argillaceous, hard, very nodular in appearance, quite fossiliferous (mainly brachiopods), much weathered in part	2±	
Shale, light to medium gray becoming darker downward with an olive-gray to reddish brown cast in part; contains some iron-staining on vertical fractures and abundant small selenite crystals throughout; top thin-bedded and fissile, becoming well bedded and thicker bedded downward; bottom 1 foot much harder	4	2
Limestone, brownish gray, dense, very hard, fossiliferous (numerous brachiopods); thickness varies from 2 to 7 inches; appearing somewhat nodular in part		4
Shale, medium gray, very calcareous, fossiliferous; contains abundant limy nodules up to 1¼ inches in diameter; represents transition zone from the overlying limestone to the underlying shale		3
Shale, medium to dark gray, medium-grained, quite hard, fairly well bedded, calcareous, almost a very argillaceous limestone in some zones, fossiliferous (pelecypods, crinoid stems)	3	
Sideritic band, slightly calcareous in part		1
Shale, medium dark gray, very carbonaceous in part, smooth, fairly well and thinly bedded, rather weak and crumbly.	1	8

Thickness:	*(ft)*	*(in)*
Limestone, gray, argillaceous, dense, fossiliferous; thickness varies from 4 to 16 inches within a distance of 5 feet.		10
Shale, dark gray, thin-bedded, soft, somewhat weathered		4
Shale, black, hard, fissile; occasional phosphatic nodule; some signs of weathering on fractures; somewhat softer in upper part		11
Shale, black, hard, fissile; numerous phosphatic nodules up to 1½ inches across; pimply appearance in part; tends to be massive	1	7
Shale, very dark gray to black, hard; small phosphatic nodules up to ¾ inch across		2
Colchester (No. 2) Coal Member, blocky, hard; approximately 5 inches exposed above water level; bottom below water level; lenses out within 6 feet to the northeast		5+
Total	46	11+
Spoon Formation		
Underclay, light to medium gray with some yellowish staining in the top 1 foot, relatively hard and firm, plastic when wet; contains carbonaceous root remains; bottom concealed	2	6+

Geologic section 7.—Compiled from exposures at the following localities:

Geologic section 7A (modified from Ball, 1952, geologic section 19, p. 85)—outcrops along small tributary of Macoupin Creek in SW¼ SE¼ sec. 35, T. 10 N., R. 7 W., and NE¼ NW¼ sec. 2, T. 9 N., R. 7 W., Carlinville quadrangle, Macoupin County.

Geologic section 7B (modified from Ball, 1952, geologic section 15, p. 84)—outcrop along west bank of Macoupin Creek, W½ NE¼ NW¼ sec. 35, T. 10 N., R. 7 W., Carlinville quadrangle, Macoupin County.

Geologic section 7C—along northwest-flowing tributary to Turner Creek from SW¼ SW¼ SE¼ sec. 7., T. 12 N., R. 8 W., to NE¼ SE¼ SW¼ sec. 1, T. 12 N., R. 9 W., Greenfield and Jacksonville quadrangles, Macoupin County.

Geologic section 7D—along Rock Branch from bridge in NE¼ SW¼ SW¼ sec. 16, downstream into NE¼ sec. 17, T. 12 N., R. 9 W., Greenfield quadrangle, Macoupin County.

Type section of the Modesto Formation. Geologic section 7A includes type outcrops of Macoupin Limestone Member and Womac Coal Member, Geologic 7D includes type outcrops of Scottville Limestone Member, Athensville Coal Member, and Rock Branch Coal Member.

Geologic section 7A

Thickness:	*(ft)*	*(in)*
Pennsylvanian System		
McLeansboro Group		
Bond Formation		
Shoal Creek Limestone Member		
Limestone, light gray, dense, poorly bedded, nodular, abundantly fossiliferous, grades into	7	
Limestone, green-gray, more massive in upper than in lower part	1	6
Shale, gray, calcareous, soft, fossiliferous	1	1
Total	9	7
Modesto Formation		
Shale, bituminous, locally calcareous, subcuboidal jointing; contains worm borings	1	6
Shale, black, somewhat calcareous, hard; contains condonts, fish scales and spines, and occasional flakes of gypsum	2	3
Shale, black, calcareous, hard, poorly bedded, fossiliferous		5–6
Shale, brownish gray, calcareous, fossiliferous		½
Shale, dark gray, clayey, calcareous, sparsely fossiliferous; limestone concretions up to 4 inches thick and 12 inches across containing pyritized fossils occur near the top	2	2
Shale, light gray, clayey, noncalcareous, iron-stained		2½
Clay, light to medium blue-gray, noncalcareous, poorly bedded, some suggestion of lamination		8½
Clay, medium gray, harder than the above, slightly calcareous		7
Limestone, medium gray, shaly, fossiliferous		¼
Shale, gray, slightly calcareous		2
Limestone, very fossiliferous		½
Shale, medium gray, slightly calcareous; contains marine fossils and carbonaceous plant material		9
Limestone, blue-gray, highly fossiliferous; contains *Murchisonia* or *Worthenia* (?)		1½–2
Shale, blue-gray, thin-bedded, fossiliferous; contains *Nuculana* and carbonaceous plant material		4
Limestone, medium to dark blue-gray; contains *Aviculopecten*, *Murchisonia*, *Bellerophon*		½–1
Shale, light blue-gray, thin-bedded		5
Limestone, medium to dark blue-gray, subcrystalline, moderately fossiliferous, with *Aviculopecten* and gastropods		1½
Shale, blue-gray, thin-bedded		1-1½

Thickness:	(ft)	(in)
Limestone, dark blue-gray, fossiliferous		1½
Shale, blue-gray		1½
Limestone		¼-½
Shale, medium gray		5½
Shale, dark gray to black, highly calcareous, soft, fossiliferous; contains *Aviculopecten*, *Nuculana*	1	10
Limestone, contains numerous thin-shelled pelecypods		½
Coal, bright, irregular discontinuous band		¼
Clay, brownish gray, noncalcareous, joints filled with secondary calcite		7
Clay, dark gray, calcareous		3
Clay, light gray streaked with brown grading down to medium gray; contains small, rounded or uneven limestone nodules; grades into	1	10
Clay, light greenish gray, calcareous, contains nodules up to 2 inches in diameter	1	6
Shale, greenish gray, calcareous, poorly laminated above, becoming well and thinly bedded below, with limestone concretions up to 6 or 8 inches in maximum diameter	1	10
Shale, greenish gray, calcareous, sandy, almost a sandstone or siltstone		3-4
Macoupin Limestone Member		
Limestone, reddish, dense, nodular, poorly bedded, fossiliferous		8
Shale, light bluish gray, calcareous, well bedded; contains flattened, oval, greenish gray limestone concretions up to 1½ inches thick near top	1	
Shale, greenish gray, calcareous, micaceous, with lens-like masses of calcareous sandstone, slightly fossiliferous and containing trail markings	1	
Limestone, bluish gray where fresh, weathers to streaky, rusty brown; densely crystalline, fossiliferous, nodular		5
Shale, greenish gray, calcareous, micaceous, with scattered discoidal ironstone concretions displacing the shale laminae by their growth; joints filled with calcite and limonite	4	
Limestone, greenish, brownish, and dark gray, crinoidal, granular, abundantly fossiliferous, with *Neospirifer cameratus*		8
Shale, greenish gray, lower part dark gray, calcareous, fossiliferous, with flattened oval nodules of crystalline limestone		6-8
Shale, dark gray, slightly calcareous, fairly hard, unevenly bedded; contains some brownish gray limestone concretions in lower part	1	
Shale, black, hard, laminated; contains conodonts	1	1½
Clay, dark gray, calcareous, soft, fossiliferous; contains productids		1½
Womac Coal Member, bright bands, dull on bony laminated planes, thin-bedded		8
Underclay, noncalcareous		½
Underclay, greenish gray, small calcareous concretions near base		9
Underclay, bluish to greenish gray, calcareous, starchy fracture; varies from nongritty to sandy; contains calcareous nodules up to ¼ inch in diameter and very small crystals of marcasite (?)	6	
Shale, bluish or greenish gray, calcareous, slightly silty, thin-bedded, platy; contains calcareous concretions	1	6
Sandstone and sandy shales, bluish gray, interbedded, micaceous, highly calcareous (top 2 inches especially calcareous), ripple-marked, thin- to medium-bedded	2-3	
Shale, light greenish gray, somewhat micaceous, thin-bedded; locally includes thin beds of siltstone, sandstone, and limestone	2	5
Burroughs Limestone Member, bluish gray, sandy, crystalline, irregularly bedded, very fossiliferous, with occasional pebbles of limestone material	3	
Sandstone, noncalcareous, fine-grained, interlaminated with greenish shale		1-9
Total	46	10±

(Overlap between geologic sections 7A and 7B)

Geologic section 7B

Shale, light greenish gray, slightly gritty, noncalcareous, micaceous, platy, fossiliferous horizon about 10 inches above base	1	10
Burroughs Limestone Member, purplish brown, coarsely crystalline, crinoidal, cross-bedded; interlaminated with greenish shales, somewhat arenaceous, occasionally marked by carbonaceous traces; carries large productid brachiopods; slumps down in large irregular blocks	1	10
Sandstone, gray, lenticular, mud-cracked and ripple-marked, in-		

Thickness:	(*ft*)	(*in*)
terlaminated with thin lenses of greenish gray, noncalcareous shales; at its base locally occurs what seems to be a decomposed limestone with many fossils, chiefly gastropods		10
Shale, olive-gray, slightly calcareous, evenly bedded	7	
Shale, blue-gray, better bedded than above; contains medium purplish gray concretions, pyrite concretions, and a few black, carbonaceous impressions, possibly plant remains (?); marked near the base by crescent-shaped fractures	8	8
Carlinville Limestone Member		
Limestone, very nodular, fossiliferous		1½
Shale, medium gray		½
Limestone	1	6
Total	21	10

(Probable overlap between geologic sections 7B and 7C)

Geologic section 7C

Thickness:	(*ft*)	(*in*)
Carlinville Limestone Member		
Limestone, light brownish gray, dense to subcrystalline, abundantly fossiliferous (*Osagia*, *Neospirifer*, *Composita*, etc.); loose blocks very nearly in place	2	
Shale, light gray, calcareous, with ironstone or ferruginous limestone nodules	2	
Limestone, brownish gray, platy, argillaceous, fossiliferous, in calcareous shale		7
Limestone, dark gray, weathering light gray, dense, deeply fissured by solution along joints	2	7
Shale, black to dark gray, soft (not fissile), with worm tubes and fossils (*Neospirifer*, *Composita*, etc.)		6
Limestone, medium brownish gray, rather dense, slightly fossiliferous, massive, poorly bedded; forms falls in stream		7
Shale, dark brownish gray, carbonaceous, soft; indistinct plant traces		5
Shale, light gray, slightly silty, with well preserved *Calamites* and other stem and leaf compressions	2	6
Shale, light gray, silty, becoming more sandy downward, slightly ripple-marked, without plant traces	2	
Siltstone or sandstone, light gray, massive, lenticular units in a generally shaly series; thickness varies from 4 to 5 feet; possible small unconformity at base	4	6
Shale, light gray; silty; shows spheroidal weathering	11	
Shale, light olive or brownish gray, soft, clayey; thickness varies from 6 to 7 feet	6	6
Shale, black, hard, not fissile, slightly canneloid		5
Chapel (No. 8) Coal Member, fairly soft and shaly		4
Underclay, light to medium gray, not bedded; some ironstone or freshwater limestone nodules	2	6
Trivoli Sandstone Member		
Sandstone, shaly, light brownish gray	1	
Sandstone, more massive than preceding, absent downstream (lenticular?); thickness varies from 1½ to 3 feet	2	3
Shale or clay, dark greenish gray		6
Shale, greenish gray, with nodules of freshwater limestone	4	
Shale, light bluish gray, silty, with some small ironstone concretions	10	
Siltstone band, brownish gray, hard		8
Siltstone, shaly, and sandy shale, light gray with reddish cast, minutely cross-bedded, with thin, discontinuous lenses of fine sandstone; some shale and sandy shale strongly cross-laminated	15	
Sandstone, olive-gray, fine-grained, medium-bedded	5	
Shale, light gray, silty, with carbonaceous matter, becomes clayey downward	22	
Scottville Limestone Member		
Limestone, dark bluish gray, dense, massive, well jointed; joints widened by solution	1	
Limestone or calcareous ironstone, brownish gray, fossiliferous		4
Limestone, medium bluish gray, dense, fossiliferous; forms pavement in creek for 300 feet	2	2
Shale, dark gray, calcareous, soft, slightly fossiliferous	1	
Total	103	4

(Overlap of part of Trivoli Sandstone Member between geologic sections 7C and 7D)

Geologic section 7D

	(*ft*)	(*in*)
Trivoli Sandstone Member, brownish gray, fairly coarse-grained, soft, friable, cross-bedded, thin to massive in 3- to 6-inch beds; massive beds are lenticular; large mica flakes and carbonaceous flakes on bedding planes	12	

Thickness:	(*ft*)	(*in*)
Scottville Limestone Member, brownish gray; weathers dull gray; hard, massive, somewhat rectangularly jointed, fossiliferous (crinoids, *Composita*); thickness varies from 2½ to 3 feet	2	9
Shale, bluish gray, thin-bedded, fairly hard, noncalcareous, fossiliferous (stem impressions, *Derbyia*, *Aviculopecten*)	5	6
Athensville Coal Member, lenticular		1–2
Clay, greenish gray, nonbedded, noncalcareous, nongritty		7
Shale, greenish gray, poorly bedded, noncalcareous, nongritty; grades into	1	3
Sandstone, light bluish gray, shaly at top, poorly bedded below, noncalcareous	2	3
Sandstone, brownish gray, hard, slabby, massive, spotted with brown noncalcareous knots		8
Shale, pale bluish gray, evenly bedded, finely micaceous, slightly sandy becoming more sandy in lower 2 feet; thickness varies from 6 to 8 feet	7	
Sandstone, bluish gray, hard, slabby, very calcareous, nonmicaceous; contains some greenish gray shale pebbles spotted with brown; thickness varies from 2 to 3 feet	2	6
Shale, blue-gray to olive-gray, nonsandy, evenly bedded, somewhat massive, conchoidal fracture; ⅛-inch smut streak 6 feet from top	12	
Shale, olive-gray, rusty on fracture surfaces, thinner bedded than above, fossiliferous (*Derbyia*)	1	2
Shale, bluish gray, blocky, conchoidal fracture, slickensided		6
Shale, black, hard, fissile; becomes increasingly fossiliferous downward (*Marginifera*, *Orbiculoidea*, *Lima*, *Aviculopecten*, gastropods, conodonts); some lenses of black fossiliferous limestone present	1	9
Shale, brownish gray, soft, poorly bedded, noncalcareous		4½
Rock Branch Coal Member		
Coal		5½
Clay, dark bluish gray, somewhat shaly		2
Coal		2¼
Clay, gray to dark gray, rusty on joint surfaces, very rusty at base	1	2
Clay, gray, calcareous, with small calcareous nodules	1	8
Covered interval	2	
Sandstone, olive-gray, micaceous, fine-grained, slabby, poorly bedded; massive beds up to 5 inches thick; somewhat nodular in upper part, noncalcareous but contains embedded gray calcareous nodules ¼ to ½ inch in diameter; thickness varies from 3 to 4 feet	3	6
Shale, olive-gray, nongritty, evenly bedded up to ¼-inch thick	3	9
Clay, shaly, reddish brown, slickensided		1
Clay, dark gray (coal horizon)		½
Clay, light gray mottled with dark gray, soft, slickensided, noncalcareous, with carbonaceous root remains		10½
Clay, dark gray, interlaminated with light gray clay		2
Clay, dark greenish gray, noncalcareous, slickensided		4
Clay, light greenish gray, noncalcareous, slickensided		5
Clay, olive-gray, calcareous, blocky, harder than above	4	
Piasa Limestone Member		
Limestone, gray; weathers yellowish brown, fine-grained; knobby upper surface; somewhat nodular structure but massive in beds 8 to 10 inches thick; no fossils noted in upper beds	1	6
Shale, gray, calcareous	1	6
Limestone, olive-gray, fine-grained, hard, massive, very fossiliferous (*Fusulina*, *Composita*, crinoids, etc.)	2	
Covered interval, very poor exposures showing red shale, a thin smut band (horizon Danville (No. 7) Coal), and a bluish gray, fine-grained, finely micaceous sandstone	5	
Total	79	3±

Geologic section 8.—Compiled from exposures at the following localities:

Geologic section 8A (from field notes of M. E. Ostrom)—Nokomis Stone Company quarry, NE¼ NE¼ NE¼ sec. 3, T. 10 N., R. 2 W., Nokomis quadrangle, Montgomery County

Geologic section 8B—exposures along south bank of stream, SE¼ NE¼ sec. 28, T. 12 N., R. 1 W., Pana quadrangle, Christian County.

Geologic section 8C (modified from Gluskoter, 1958, p. 37–39)—east bank of the East Fork Shoal Creek, NE¼ NW¼ SE¼ sec. 7, T. 8 N., R. 2 W., Hillsboro quadrangle, Montgomery County.

Geologic section 8D (modified from Simon, 1946, p. 28) —along Flat Creek in east central part of sec. 24, T. 6 N., R. 5 W., New Douglas quadrangle, Bond County.

Geologic section 8E (modified from Simon, 1946, p. 30) —along Dry Fork, cen. S½ sec. 7, T. 6 N., R. 4 W., New Douglas quadrangle, Bond County.

Geologic section 8F (modified from Simon, 1946, p. 30) —along north-flowing tributary of Dry Fork along east edge of secs. 6 and 7, T. 6 N., R. 4 W., New Douglas quadrangle, Bond County.

Geologic section 8G (modified from Simon, 1946, p. 32) —SW¼ NW¼ sec. 29, T. 7 N., R. 4 W., Mt. Olive quadrangle, Bond County.

Type section of the Bond Formation. Geologic section 8B includes type outcrop of the Millersville Limestone Member; geologic section 8C includes type outcrops of the Coffeen Limestone and Witt Coal Members; geologic section 8D includes type outcrop of Flat Creek Coal Member; geologic section 8E includes type outcrop of Bunje Limestone Member; geologic section 8F includes type outcrop of Sorento Limestone Member.

Geologic section 8A

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Bond Formation		
Millersville Limestone Member		
Limestone, light brown, dense, hard, in beds ranging from 1 to 10 inches thick, fossiliferous	6	
Shale, light greenish gray, moderately well bedded, with argillaceous limestone nodules, very fossiliferous		10
Limestone, light brown, dense, hard, in beds ranging from 1 to 10 inches thick, fossiliferous	5	
Limestone, mottled light and medium gray, fine-grained with scattered medium- and coarse-grained fossil fragments; calcite nests; in beds ranging from 6 to 18 inches thick	17	
Limestone, gray, fine-grained, argillaceous	1	6
Siltstone, light gray	—	—
Total	30	4

(Probable overlap between geologic sections 8A and 8B)

Geologic section 8B

McLeansboro Group		
Bond Formation		
Millersville Limestone Member		
Clay, gray, plastic, with limestone nodules and fragments loosely embedded in clay	2	
Limestone, white, very much weathered, "algal," very fossiliferous, fusulinids	2	
Siltstone, with sandy interbeds	7±	
Siltstone, increasingly sandy, with thin beds of sandstone interbedded with shale near base	5±	
Total	16±	

(There is an estimated 60 feet of strata between geologic sections 8B and 8C. Shale, sandy shale, and sandstone are included in this interval [see geologic section 9]. Only scattered outcrops are known that include parts of this interval.)

Geologic section 8C

Thickness:	(*ft*)	(*in*)
Shale, gray, weathers brown to tan; clayey in part, calcareous	1	6
Shale, light gray, weathers brown; generally fine-grained but silty in part; brown staining is more common in silty portions; finely carbonaceous, micaceous, calcareous, no fossils observed; grades into	1	9
Shale, gray, coarse, silty, very calcareous, much iron staining, fossiliferous, crinoids apparent; contains occasional round concretionary masses about 1 inch in diameter and up to 3 inches long; grades into		5
Coffeen Limestone Member		
Limestone, gray, much iron staining in part, very silty, argillaceous, fossiliferous (crinoids, brachiopods, bryozoans)		6
Shale, gray, weathering brown, calcareous, fossiliferous; becomes less silty downward		2
Limestone, gray to dark gray, weathers brown; dense, fine-grained; contains occasional shaly streaks, very fossiliferous (crinoids, brachiopods, bryozoans)		7–12

(Note: Locally, within the outcrop, the lower limestone bench appears to thicken to about 17 inches and the upper bench becomes a very argillaceous limestone about 11 inches thick.)

Shale, gray, soft, iron-stained, calcareous, fossiliferous		1
Shale, gray, soft, with much carbonaceous and coaly plant debris; occasional coaly streaks up to ¼-inch thick; grades into		6
Shale, gray, fairly well to well laminated; contains many carbonaceous fragments concentrated on bedding planes; iron-staining on partings increasing in intensity downward; less carbonaceous material in lower part; grades into	4	
Shale, medium dark gray, fine-grained, thinly laminated, earthy in part; contains plant fragments; much iron-oxide staining along partings; grades into	3	
Shale, gray to dark gray, thinly bedded (but not as thinly as above); occasional carbonaceous partings		6
Shale, gray, a few thin coaly streaks		1
Witt Coal Member		
Coal	1	
Shale, black, very thinly bedded, coaly		⅛

Thickness:	(*ft*)	(*in*)
Underclay, medium gray, has mottled appearance owing to abundant black carbonaceous material and iron-oxide staining; contains carbonaceous root remains; blocky, poorly bedded		8
Clay, light greenish gray, unconsolidated, very poorly laminated, calcareous; becomes more calcareous downward; abundant small sideritic concretions up to ¾-inch diameter; concretions more abundant at base	1	3
Clay, medium to light gray, poorly laminated, slightly calcareous, iron-oxide staining along bedding and partings; contains small sideritic concretions up to ⅛-inch diameter		6
Clay, medium to light gray, slightly calcareous, poorly laminated; contains very small spherical concretions (less than 1/16-inch diameter) and iron-oxide staining along bedding and partings		6
Total	17	3±

(There is an estimated 40 feet of strata between geologic sections 8C and 8D. Shale, sandy shale, and sandstone are included in this interval [see geologic section 9]. Only scattered outcrops are known that include parts of this interval.)

Geologic section 8D

Thickness:	(*ft*)	(*in*)
Limestone, weathers reddish brown; fossiliferous, local occurrence		2–3
Shale, yellowish gray, calcareous, fossiliferous, somewhat carbonaceous		4–6
Shale, dark gray to black, noncalcareous, carbonaceous; some yellowish clay partings . . .		4–5
Shale, dark gray to black, flaky, fine, thin-bedded, noncalcareous		4
Shale, black, hard, fissile; minimum thickness where underlain by limestone clod, maximum where underlain by coal .		6–18
Limestone, bluish gray, clod, relatively soft, very fossiliferous, dark gray to black fossiliferous shale parting 0 to 8 inches thick in middle; 1 to 2 inches at top of clod hard; quite variable in single exposure, local in occurrence	0–2	
Flat Creek Coal Member . . .		8–12
Underclay, light gray, noncalcareous; some carbonaceous material, but not typical carbonaceous root remains	2	3
Clay, gray, weathering yellowish brown; carbonaceous; some slip fractures, noncalcareous . .		8
Clay, similar to above, calcareous, contains small calcareous nodules and limy concretions up to 3 inches across		2
Shale, light gray, hard, compact, silty, noncalcareous	1	4
Shale, medium gray, well bedded, slightly calcareous at top, becoming more calcareous toward base, occasional calcareous concretion	4	
Bunje Limestone Member, olive-gray, fine "mud texture," uniform; cone-in-cone structure throughout; apparent mud cracks where surface is well exposed		0–2
Total	12	8±

(Overlap between geologic sections 8D and 8E)

Geologic section 8E

Thickness:	(*ft*)	(*in*)
Bunje Limestone Member, bluish gray, weathering reddish brown, very fossiliferous; large pelecypod fauna; in beds up to 3 inches thick; one prominent clay parting; top of bed locally shows cone-in-cone structure .		8–18
Sandstone, bluish gray, shaly, calcareous	1	4
Sandstone, bluish gray, calcareous, hard, massive; weathers shaly, changes laterally to soft, shaly sandstone	1	3
Shale, bluish gray, sandy, thinly and evenly bedded		6
Sandstone, tan to light gray, micaceous, massively bedded in benches up to 8 inches thick; cross-bedded; wavy concretionary beds contain irregularly shaped flattened sandstone concretions; massive beds ripple-marked; becomes shaly in lower part	15±	
Shale, bluish gray, smooth, thinly and evenly bedded, finely micaceous, noncalcareous . . .	20+	
Total	39	3±

(Geologic sections 8E and 8F nearly continuous)

Geologic section 8F

Sorento Limestone Member		
Limestone, dark bluish gray, weathering reddish brown; argillaceous, fine-grained, massive, fossiliferous; upper		

Thickness:	*(ft)*	*(in)*
surface has large fucoid markings up to ½ inch in diameter		3–4
Shale, medium to dark gray, fossiliferous		1–3
Limestone, bluish gray, weathering light gray; argillaceous, fine to medium crystalline, massive; weathers slabby, fossiliferous (bryozoans, spirifer, *Composita*, gastropods, crinoids, trilobites, and many large flat remains of pelecypod *Aviculopinna*) . . .		6–16
Shale, dark gray to black, calcareous, thin-bedded, fossiliferous, absent where coal is found		0–4
Coal, usually much weathered, absent locally		½–1½
Underclay, greenish gray, noncalcareous, hard, slip-fractured	1	2
Clay, gray, blocky, noncalcareous		3
Clay, gray, blocky; contains calcareous concretions	1	5
Shale, gray, weathering reddish brown; calcareous, fine-grained, poorly bedded	1	8
Shale, bluish gray, thin-bedded, calcareous; contains reddish brown limy concretions and fairly persistent horizontal concentrations of these concretions	8	
Shale, bluish gray, thin-bedded, calcareous, fossiliferous . . .	2	6
Limestone, gray, coarsely crystalline, very fossiliferous, massive, usually quite argillaceous . .		4–7
Shale, medium gray, thin-bedded, calcareous, fossiliferous . . .		2
Shale, medium gray, noncalcareous, thin-bedded, silty . . .	2	2
Shale, medium gray, silty, thin-bedded, finely micaceous, calcareous with some calcareous concretions	3	10
Total	23	3±

(Geologic sections 8F and 8G nearly continuous)

Geologic section 8G

Thickness:	*(ft)*	*(in)*
Shoal Creek Limestone Member, gray to bluish gray, somewhat darker toward base, fine, compact, hard, massive, fossiliferous	6–13±	
Modesto Formation		
Shale, dark gray, thin-bedded, smooth, fine, noncalcareous; contains *Aviculopecten* . . .		5½
Shale, black, fissile; contains concretions; fossiliferous (*Aviculopecten*, conodonts)	1	8
Shale, light gray grading down to medium gray, thin-bedded, noncalcareous	2–4	
Shale, black, thin-bedded, with coalified plant compressions .		10
New Haven Coal Member, quite variable in thickness . . .		1–15½
Underclay, gray to greenish gray, noncalcareous	2	
Clay, gray to greenish gray, noncalcareous, weathering yellowish brown	2	
Shale, gray, thin-bedded, noncalcareous, finely micaceous, weathering brown	6+	
Total	16±	

Geologic section 9.—From log of Peabody Coal Company diamond drill hole 59, NW¼ NE¼ NE¼ NW¼ sec. 33, T. 11 N., R. 1 E., Pana quadrangle, Christian County. Surface elevation, 671.78 feet. Twenty-eight selected samples of the Bond Formation are on file at the Geological Survey, Urbana, Core 2409.

Reference section of the Bond Formation.

Thickness:	*(ft)*	*(in)*
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
	(depth 97 feet)	
Clay, probable core loss . . .	12	9
Bond Formation		
Millersville Limestone Member		
Limestone, nodular, white, argillaceous	5	3
Limestone, nodular, white, pure; no partings except in bottom 6 inches; vuggy . .	16	5
Shale, dark gray, hard, very fossiliferous		5
Limestone and shale interbedded, shale dark gray like above		2½
Limestone, gray, massive, nodular, fossiliferous, stylolitic .	4	7
Limestone, gray, massive, nodular		5½
Limestone, as above, in fragments, gray, hard; dense nodules		6
Limestone, gray, dense, massive, similar to above . . .	7	3
Limestone, gray, dense, with a few shaly partings that are irregular; uneven contact at base of limestone		5
Shale, dark gray, very silty, fossiliferous, calcareous; grades into		3½
Sandstone, light gray, fine, with thin, light gray, silty laminae; grades into		8½
Shale, gray, fairly soft, with several dark gray partings; calcareous		2

Thickness:	(*ft*)	(*in*)
Siltstone, gray, with finely interlaminated carbonaceous shale; carbonaceous shale about 10 percent; calcareous		7
Shale, dark gray, calcareous		¼
Siltstone or fine sandstone interlaminated with shale; more uniform in upper 2 inches, calcareous below		7½
Siltstone or fine sandstone as above, calcareous	1	10
(depth 150 feet)		
Siltstone or fine sandstone, gray, calcareous with thin, occasional micaceous and carbonaceous laminae, generally uniform, calcareous	4	8
Siltstone or sandstone, as above (broken pieces)		4
Shale, gray to dark gray, micaceous, medium-grained; carbonaceous plant fragments; fairly well laminated with light gray siltstone laminae and layers	1	7½
Sandstone, light gray, fine, with thin, dark gray shaly laminae		7½
Shale, gray, with a few thin siltstone laminae; micaceous		9
Siltstone or fine sandstone, light gray; thin laminae of carbonaceous shale similar to above; very micaceous	1	11½
(depth 160 feet)		
Shale, gray, micaceous and carbonaceous partings, with light gray siltstone laminae decreasing in amount downward; bottom two inches siltstone	1	4
Shale, gray, massive; carbonaceous plant impressions; somewhat silty, pyritic	2	10
Siltstone, light gray, somewhat carbonaceous; shale, gray, interbedded and interlaminated		9½
Shale, gray, micaceous (broken pieces)		3
Shale, gray, similar to above, interbedded with light gray siltstone; two benches of shale with siltstone between		4
Shale, gray, with thin laminae of light gray siltstone; micaceous; fairly uniform; broken pieces		3
Shale, gray to light gray, very micaceous, with carbonaceous fragments; laminae of light gray siltstone and black carbonaceous shale	4	1½
(depth 170 feet)		
Siltstone, gray, massive		4
Shale, medium dark gray with irregular lenses of light gray siltstone, fairly well bedded; tends to break into chips	1	6
Shale, gray, silty, micaceous, massive; carbonaceous plant material; grades into	1	1
Shale, slightly darker than above, pyritic nodules; better laminated than above; micaceous		5
Shale, dark gray as above; and siltstone, light gray, fairly evenly interbedded	1	
Siltstone, gray, shaly, micaceous; carbonaceous fragments; massive		9
Siltstone, as above, broken pieces		7
Siltstone, as above, unbroken, very micaceous; carbonaceous from 22 to 25 inches from top	2	6
Shale, light gray, massive, micaceous; carbonaceous fragments	2	11
(depth 180 feet)		
Shale, light gray, coarse with thin laminae and lenses of white siltstone giving shale a somewhat "birdseye" appearance	2	8½
Siltstone, light gray, finely interlaminated with micaceous and carbonaceous partings		1
Shale, gray, micaceous, medium-grained, with two bands of siltstone from 6¼ to 7½ inches and from 9½ to 10 inches from top	1	8
Siltstone, gray, becoming shaly in bottom 6 inches	2	2
Shale, medium gray, fairly well laminated; thin laminae and lenses of light gray siltstone		2½
(depth 190 feet)		
Siltstone, gray, with carbonaceous plant fragments; massive		8½
Shale, gray, micaceous, fairly well bedded; some black shale in thin regular and irregular bands; thin lenses and bands of light gray siltstone	3	4
Siltstone, gray, massive, with carbonaceous plant debris		4
Shale, gray, micaceous, with 5 percent thin light gray siltstone laminae		7½
Shale, light gray, massive, micaceous, broken fragments		6
Shale, gray, massive, coarse; similar to siltstone above but finer		8
Shale, medium gray, fairly well laminated, with thin discontinuous white siltstone laminae; some beds fairly silty	3	10
(depth 200 feet)		
Shale, steel gray, micaceous, well laminated, a few thin siltstone partings	1	
Siltstone, gray, micaceous, with some light gray irregular siltstone laminae	1	8
Shale, light gray, with a few light gray siltstone lenses		2
Siltstone, light gray, carbonized plant fragments	2	8
Shale, light gray, banded with thin white siltstone partings; tends to split along bands	2	6

	Thickness: (*ft*)	(*in*)
Siltstone, light gray	1	8
Shale, light gray, with thin light siltstone lenses		4
(depth 210 feet)		
Siltstone, light gray, massive, micaceous	1	5
Shale, light gray, fairly well laminated		5½
Siltstone, light gray	1	2¼
Shale, medium dark gray, micaceous, fairly well bedded		10
Siltstone, light gray and dark gray finely mottled; grades into		6
Shale, light steel gray, massive		1
Gap—core loss	1	10
Siltstone, light gray, hard, calcareous		4
Shale, gray, fairly well bedded, uniform, finely micaceous, becoming darker and less silty toward the bottom	3	5
Shale, gray to dark gray, well laminated, relatively soft	2	
Shale, medium dark gray, well laminated, pyritized in part with an occasional siderite concretion; fossiliferous (small gastropods)	1	9
Shale, as above, broken fragments		2
Shale, gray, similar to above, with siderite nodules, pyrite trails, and a few fossils	2	5
Coffeen Limestone Member (?)		
Space partly filled with limestone pebbles, greenish gray, dense, lithographic, somewhat like freshwater limestone		7
Shale, dark gray, soft, fossils (mainly *Aviculopecten*; one possible seed)		2
Limestone nodule, dark gray		1
Shale, dark gray to black, fossiliferous (*Aviculopecten*, productids, *Lingula*, etc.); carbonaceous	1	2
Witt Coal Member, normally banded; two thin clay bands in upper 2 inches		8½
Underclay, gray, with carbonaceous root remains (broken fragments)		2
Gap—core loss		9½
(depth 230 feet)		
Gap—about one foot of clay, gray, with many small limestone pebbles recovered; a few pieces of limestone in core box just above the clay	10	
(depth 240 feet)		
Gap—core loss	1	9
Clay, greenish gray, soft, slip-fractured; limestone nodules, greenish gray, dense, sideritic in part	2	1
Clay, mottled green and yellowish brown, with gray limestone nodules about 10 percent	2	2
Clay, mottled greenish gray and dark brown, with vertical stringers or cracks; an occasional limestone nodule	1	9
Clay, greenish gray and brown with bluish green limestone nodules that are argillaceous, nonfossiliferous and up to 4 inches across		10
Clay, mottled dark brown and greenish gray; grades into		4
(depth 250 feet)		
Clay, same as above; grades into	3	
Clay, silty, greenish gray; contains a few light gray silty streaks	2	4
Clay, dark gray; streaked and yellow mottled	2	6
Clay, dark gray, yellow mottled; relatively soft, very friable; like above but slightly darker	2	1
(depth 260 feet)		
Shale, dark gray; pyritic trails; relatively soft; fair lamination	1	
Shale, dark gray to black, with siderite bands and lenses up to 1 inch thick; very friable; pyritized trails	3	4
Shale, similar to above; broken pieces; fossiliferous (*Aviculopecten*)	1	4
Shale, dark gray, similar to above; pyritized trails and siderite bands	2	7
Shale, medium gray, fossiliferous (gastropods and pelecypods); poorly laminated; somewhat pyritic; grades into		5
Shale, gray, massive, less fossiliferous than above (gastropods, pelecypods); pyritized trails	1	4
(depth 270 feet)		
Shale, dark gray; pyritized trails; relatively soft, fairly well laminated, slightly fossiliferous	1	7
Shale, same as above, broken pieces		8
Shale, dark gray to black, rather poorly laminated, pyritic, fossiliferous (pelecypods)	2	6
Limestone, greenish gray, massive, dense, fossiliferous (including microfossils)		4
Shale, dark gray to black, calcareous, very fossiliferous, carbonaceous and argillaceous; contains megaspores	1	4
Flat Creek Coal Member, normally banded	1	¼
Underclay, with carbonaceous root remains; slip-fractured; grades into		2¾
Clay, greenish gray, slip-fractured; calcareous below first 3 inches	1	2
Gap—core loss	1	2
(depth 280 feet)		
Gap—core loss	14	

Thickness:	(ft)	(in)
Bunje Limestone Member		
Limestone, gray, and shale, green; upper part with calcareous, fine, light gray sandstone; lower part all fragmental, making exact position questionable	1	4
Shale, gray and green, interlaminated with light gray siltstone; faint ripple mark structure	1	1½
Limestone, brownish gray; impure, hard, fossiliferous		2½
Shale, dark gray, ripple-marked, with fine, white siltstone; contains siderite concretions; calcareous in upper part		3
Siltstone, light gray or fine sandstone interbedded and interlaminated with shale, dark gray, somewhat cross-bedded and ripple-marked; 75 percent siltstone	3	1
(depth 300 feet)		
Siltstone, light gray, with thin carbonaceous shale laminae; somewhat cross-bedded		10
Siltstone, gray, with some light gray siltstone giving marbeloid structure	2	5
Siltstone, as above in two broken pieces		3
Siltstone, as above, massive, uniform	3	6
Siltstone, as above, broken pieces	1	
Siltstone, as above, massive	1	11
(depth 310 feet)		
Siltstone, as above, with occasional layers of light gray to white siltstone interbedded with gray siltstone in beds 3 to 4 inches thick	10	
(depth 320 feet)		
Siltstone, as above	3	
Gap—core loss	1	6
Siltstone, as above, broken pieces		5
Siltstone, as above	1	7
Shale, gray to dark gray with thin white siltstone laminae about 10 percent; regular interlaminations		8
Siltstone, gray, with dark gray streaks, fine-grained, breaks easily across bedding at streaks	2	10
(depth 330 feet)		
Siltstone, gray, fine-grained, well laminated, micaceous, carbonaceous, fairly hard	1	7
Shale, medium gray, irregularly interlaminated with light gray siltstone; 1-inch fossiliferous siderite layer or lens at top		11
Siltstone, gray, fine-grained, somewhat coarser and more carbonaceous in upper 5 inches	1	
Shale, medium light gray, finely micaceous, with thin white siltstone streaks playing out toward base; grading into		9
Shale, medium gray, well laminated, relatively hard, tends to break in chips; pyritized trails in bottom 3 inches		11
Shale, dark gray, calcareous and fossiliferous; fossils poorly preserved		1
Shale, gray, poorly laminated, slightly silty		2
Shale, dark gray, irregularly interlaminated with light gray siltstone		7
Shale, medium light gray, massive, irregularly interlaminated with small amount of light gray siltstone	1	4
Shale, gray to dark gray, fairly well laminated, with thin laminae of white siltstone; more regular than above, giving shale more banded appearance	2	6
(depth 340 feet)		
Shale, as above, slightly ripple-marked	3	3
Gap—core loss (probably same as shale above)	1	
Shale, gray, fairly hard, brittle, with a few thin, light gray siltstone layers; sideritic and calcareous in some bands	4	
Shale, similar to above, with more frequent sideritic and calcareous bands in upper 9 inches	1	8
(depth 350 feet)		
Shale, steel gray, well bedded, becoming more friable toward base		4
Sorento Limestone Member		
Shale, medium gray, fairly soft, very fossiliferous (layer 2 to 3 inches from top especially fossiliferous)		6
Shale, gray to dark gray, very fossiliferous, almost limestone, relatively hard		3
Shale, gray, calcareous, fossiliferous	1	11
Shale, gray, very calcareous, very fossiliferous, almost a limestone		5
Shale, gray, very well and finely laminated; breaks into small chips	2	2
Shale, black, poorly laminated, brittle and fossiliferous		4
Coal, normally banded		2½
Underclay, with carbonaceous root remains; friable, slip-fractured		2
Clay, greenish gray; occasional limestone pebble; much core missing	5	9
(depth 360 feet)		

Thickness:	(*ft*)	(*in*)
Clay, greenish gray, grading into poorly bedded shale with frequent irregular limestone nodules that become less frequent toward base	3	2
Shale, green and grayish green, somewhat mottled, smooth; occasional limestone nodule	3	10
Siderite band		1
Shale, green with some greenish gray mottling, smooth, fairly well laminated		9½
(depth 370 feet)		
Shale, as above		2½
Shale, greenish gray mottled with gray, fossiliferous (ostracodes)		2½
Shale, greenish gray, very calcareous, fossiliferous, almost a limestone, sideritic		3
Shale, greenish gray to gray, fossiliferous, becoming less fossiliferous toward base; grading into		3
Shale, gray to dark gray, fairly well laminated, uniform	4	
Shale, dark gray, calcareous, very fossiliferous (small forms); an infrequent limestone nodule	1	7
Shale, gray, calcareous, less fossiliferous than above		3
Shale, dark gray, very calcareous and fossiliferous, almost a limestone		5
Gap—fragments of gray fossiliferous shale and limestone nodules recovered	3	2
Shoal Creek Limestone Member		
Limestone, upper six inches dark gray, remainder light gray, dense, compact, fossiliferous; very shaly in part	2	8
Limestone, gray, fossiliferous, argillaceous, hard, with a few shaly streaks	1	1
Limestone, gray, fossiliferous, with thin irregular black shale layers ⅛-inch thick; grades into		10
Limestone, in beds 1 to 4 inches thick, light gray and gray; irregular beds of dark gray argillaceous limestone ½ to 4 inches thick; all fossiliferous	1	5
Limestone, gray, somewhat nodular with a few black, thin shaly partings; in general fairly massive	3	5
Limestone, gray, fossiliferous, similar to above, with shaly calcareous partings every 3 to 6 inches; partings are irregular; partly nodular; grades into	6	10
Limestone, dark gray, very argillaceous, fossiliferous; grading into		1½
Total	286	11½

Thickness:	(*ft*)	(*in*)
Modesto Formation		
Shale, dark gray in upper 3 inches, calcareous, fossiliferous, poorly bedded; breaks into small angular fragments; grades into		10½
Shale, black, well bedded, becoming fissile in the bottom 10 inches; some pyritic trails one foot above the bottom	2	1
(depth 400 feet)		
Total	2	11½

Geologic section 10.—The following outcrop sections contain most of the named members of the Mattoon Formation. Intervals between sections are uncertain.

Geologic section 10A.—North-facing cut bank of West Crooked Creek ⅛-mile west of bridge in NE¼ NE¼ sec. 16, T. 7 N., R. 10 E., Greenup quadrangle, Jasper County.

Type outcrop of the Reisner Limestone Member.

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Shale, light gray to medium gray, weathered, soft, much iron-stained	1	8
Shale, medium dark gray, thinly laminated, smooth; some iron staining	1	2
Shale, dark gray, well laminated, with iron staining on bedding planes; becomes darker at base; grades into	1	6
Shale, black, fissile, sheety	1	5
Reisner Limestone Member		
Limestone, shaly, brown, soft, weathered to clay in part; contains gypsum		1½
Limestone, gray, very argillaceous, fossiliferous; contains an abundance of fossil fragments and small brachiopods including *Crurithyris*		2½
Shale, brown, much weathered, very calcareous, fossiliferous		1½
Limestone, gray, very argillaceous, fossiliferous, including many brachiopods; varies from 2 to 3½ inches thick		3
Clay, medium gray, occasional carbonaceous streaks, blocky, friable, noncalcareous; may be an underclay		9
Clay, medium dark gray, slightly calcareous, carbonaceous, grades into		8
Clay, light gray, greenish cast; some black manganese (?) staining, silty, soft, friable, noncalcareous; abrupt change at base	1	6

Thickness:	(*ft*)	(*in*)
Clay, gray, soft, friable, silty, very calcareous		6
Clay, light tan, very calcareous; may be weathered limestone .		½
Limestone, light gray, weathers with slight yellowish cast in part; weathers knobby to rubbly; fossils not noted; this and underlying unit appear to be very variable in thickness in the area, although not so in this exposure	1	2
Limestone, similar to above, but more massive; tends to spall into slabs; argillaceous; no fossils observed; base concealed at creek level	1	10
Total	12	11

Geologic section 10B (modified from field notes of S. E. Ekblaw).—Traverse down Webster Creek about the middle of the S½ SE¼ sec. 32, T. 9 N., R. 8 E., Teutopolis quadrangle, Cumberland County.

Type outcrop of the Woodbury Limestone Member.

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Shale, drab to grayish drab, silty	6	
Shale, grayish drab, fossiliferous, ostracodes and brachiopods .	1	
Shale, dark gray to black, fossiliferous, ostracodes, brachiopods, and some gastropods . .		6
Woodbury Limestone Member		
Ironstone layer, medium gray; weathers reddish and rusty brown; hard, fossiliferous, containing *Straparolus catilloides*, *Pharkidonotus percarinatus*, *Meekospira peracuta*, *Glabrocingulum grayvillense*, *Lophophyllidium proliferum*, *Crurithyris planoconvexa*, *Marginifera*, crinoid stems, and a species of nautiloid		3–4
Shale, dark gray to bluish gray; contains a few small calcareous nodules; fossiliferous (*Crurithyris*); grades into .		3
Shale, black, coaly, with many gypsum crystals		3
Coal, good, hard		5
Shale, black, very carbonaceous, soft		1
Underclay, grayish blue, sandy; some carbonaceous plant remains; coaly in part; becomes shaly toward base	3	
Sandstone, thin-bedded, locally massive, calcareous; sandy shale with hard, dense, calcareous siderite nodule bands exposed down creek for nearly ½ mile .	7+	
Total	18	10+

Geologic section 10C.—Section exposed near mouth of small tributary valley, along Mint Creek, NE¼ SW¼ sec. 31, T. 8 N., R. 9 E., Teutopolis quadrangle, Jasper County.

Type outcrop of the Gila Limestone Member.

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Shale, light gray, some yellow staining; thinly laminated, smooth, well bedded, noncalcareous	1	6
Shale, gray mottled with dark gray, smooth, well laminated; contains calcareous sideritic lenses up to 2 inches thick and 10 inches across; shale is calcareous and becomes gray to light gray in lower part; contains well preserved gastropods and some small pelecypods; siderite nodules in float with similar fauna probably weathered out of this shale . . .	3	3
Shale, black, smooth, well laminated, fissile in part, noncalcareous	2	10
Coal, bright-banded, somewhat weathered; no prominent partings noted; up to 5 inches thick		3
Clay, gray, mottled with brown where weathered, slightly carbonaceous, noncalcareous . .		2
Siltstone, gray, very argillaceous, calcareous, friable; occasional carbonaceous root remains; becomes more sandy downward; contains dense, round limestone concretion 6 inches across near the base	2	4
Siltstone, gray, dense, hard, calcareous; grades laterally to argillaceous sandstone that is believed to represent the "pockmarked" sandstone in the section described below		10
Shale, gray, poorly laminated, silty, calcareous, relatively hard, almost a siltstone . . .	1	4
Siltstone, gray, sandy, numerous calcareous and sideritic nodules up to 2 inches across; base concealed near creek level . . .	1+	

(Note: Section described below in small tributary ravine believed to overlap above section bv about 3 feet.)

Thickness:	*(ft)*	*(in)*
Sandstone, light gray, medium- to fine-grained, dense, hard, finely micaceous, very calcareous; recrystallized calcite glistens on freshly broken surfaces; forms prominent resistant ledge that presents weathering aspect of a limestone	2	
Shale, greenish gray, silty, soft, friable		4
Sandstone, gray, medium-grained, dense, hard, micaceous, more argillaceous than sandstone above; an occasional carbonaceous plant fragment; weathered surfaces show conspicuous small holes or "pockmarks"		5
Shale, gray, slightly silty, with occasional carbonaceous partings		10
Shale, light gray with greenish cast, smooth; occasional small sideritic nodules; poorly laminated in upper part, becoming better laminated downward; contains nodules and thin, irregular bands of very calcareous sandstone up to 1-inch thick	3	
Shale, gray, smooth, well laminated, rather uniform, with occasional irregular calcareous sideritic nodular masses from 1 to 6 inches across	6	
Gila Limestone Member		
Limestone, gray, dense, fine-grained; weathers orange-brown; hard; no fossils observed except fish scales, teeth, etc., which are black and not numerous. . . .		1
Shale, greenish gray, thinly laminated, soft, with occasional carbonaceous streak .		½
Limestone, gray, dense, fine-grained, lithographic; no fossils observed except occasional fish remains; ranges up to 3 inches thick in nearby exposures		1
Shale, dark gray, carbonaceous, thinly laminated, soft and plastic when wet; coal horizon?		1
Shale, greenish gray and olive-gray, smooth, fairly well laminated, soft and plastic when wet		3
Limestone, gray and light greenish gray; cone-in-cone structure well developed		2
Limestone, gray and greenish gray, dense, fine-grained, hard; no fossils observed. (In the area, this limestone is normally only 2 to 3 inches thick and the overlying cone-in-cone limestone is generally absent.) Limestone is in bed of creek .		8
Clay, brownish gray, silty, soft, carbonaceous, weathered (exposed below limestone a short distance down stream; base concealed)	1	6+
Total	29	

Geologic section 10D (modified from field notes of S. E. Ekblaw).—Section near foot of hill on State Highway 131, near center W½ NE¼ sec. 3, T. 9 N., R. 9 E., Toledo quadrangle, Cumberland County.

Type outcrop of the Greenup Limestone Member.

Thickness:	*(ft)*	*(in)*
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Clay, yellowish brown, deeply weathered	1+	
Greenup Limestone Member, medium gray to grayish white, dense to subcrystalline, argillaceous, very fossiliferous, containing fusulinids in top 10 inches and gastropods, corals, brachiopods and numerous crinoid fragments in the lower part; irregularly bedded; appears to be nodular in places .	3+	
Shale, buff to greenish gray, sandy, thin-bedded, slightly micaceous	5	
Sandstone, buff, fine-grained, calcareous in upper part . . .	4	
Shale, dark gray, thinly laminated, silty, micaceous, sandy in places, with a 2-inch sandstone layer 3 inches from the top; base concealed	12+	
Total	25+	

Geologic section 10E (modified from Newton and Weller, 1937, and field notes).—Cutbank east side of Big Muddy Creek and roadcut east of bridge, NE¼ NE¼ sec. 17, T. 5 N., R. 8 E., Sailor Springs quadrangle, Jasper County.

Type outcrop of the Bogota Limestone Member.

Thickness:	*(ft)*	*(in)*
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Bogota Limestone Member		
Clay, greenish gray, probably weathered shale; soft plastic when wet; abundant crinoids, corals, etc., on weathered surface	2+	

Thickness:	(*ft*)	(*in*)
Limestone, gray, fossiliferous, weathered, nodular in a fossiliferous yellowish brown clay matrix; nodules observed up to 4 inches across	1	6
Shale, black, fissile, not well exposed, thickness uncertain	1±	
Interval poorly exposed appears to consist of weathered gray shale or clay	3	
Shale, medium gray, well bedded, flaky, nonsilty	7	
Limestone, very dark gray, weathers down into a spongy material with fossil casts; very impure, ferruginous		2
Shale, medium dark gray, finely sandy, fossiliferous		7
Sandstone, weathers brownish gray, fine-grained; fossiliferous in the upper part.		8
Shale, greenish gray becoming medium gray downward, finely sandy, rather poorly bedded		9
Carbonaceous streak, poorly developed; coal horizon	—	—
Shale, greenish gray, poorly bedded, somewhat slickensided.		6
Clay, medium gray with greenish cast, tough, silty, with abundant small limestone nodules up to 1 inch in diameter. The lower 1 foot contains irregular limestone layers that weather into nodules similar to the limestone below	3	6
Limestone, medium light gray, hard and tough, sublithographic texture, conchoidal fracture, *Spirorbis*		10
Shale, medium greenish gray, poorly bedded, silty, some limestone nodules in the upper part similar to the limestone above	4	
Sandstone, weathers brownish gray, calcareous, thin-bedded, micaceous	—	—
Total	25	6

Geologic section 10F (modified from field notes of S. E. Ekblaw).—Ravine, east side of U. S. Route 45, tributary to Salt Creek, from center of west line eastward to SW¼ NE¼ sec. 33, T. 8 N., R. 6 E., Effingham quadrangle, Effingham County.

Type outcrop of the Effingham Limestone Member.

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Shale, olive to gray, noncalcareous, nonsilty		8+
Ironstone, dark gray, very fine-grained, compact, hard, nonfossiliferous		4
Shale, olive to gray, noncalcareous, nonsilty		2
Shale, dark olive to black, thin and evenly bedded, soft, noncalcareous, nonsilty	1	4
Shale, black, hard, fissile, noncalcareous; conodonts; contains dark gray, noncalcareous, ironstone concretions up to 8 inches thick and 3 to 4 feet in diameter	1	4
Shale, dark gray, thin-bedded, silty, noncalcareous		7
Shale, gray, noncalcareous, silty, evenly bedded, slightly fossiliferous, with finely disseminated pyrite		8
Shale, dull dark gray, slightly silty, evenly bedded, noncalcareous, with finely disseminated pyrite; fossiliferous with an abundance of *Aviculopecten*	1	11
Effingham Limestone Member		
Shale, olive to gray, crumbly, calcareous, very fossiliferous		2
Limestone, dull gray tinged blue, massive in one bed, breaking slabby; finely granular; seems to be in part composed of small limestone pebbles up to ¼ inch in diameter, giving the unit a conglomeratic appearance; fossiliferous with a predominance of fossils near the base (*Myalina*, *Composita*, *Chonetes*, *Productus*, *Euphemus*, *Pharkidonotus*, *Murchisonia*, *Astartella* (?), *Lophophyllidium*, small gastropods, bryozoans, crinoids, bellerophontid gastropods)		11
Shale, light greenish gray, much iron-stained in part, thinly laminated, soft, clayey, with carbonaceous (almost coaly) layers ¼-inch thick at the top, 2 inches from top, and at base; coal horizon (?)		6
Clay, greenish gray, very silty, carbonaceous, calcareous; grades into		5
Clay, greenish gray, very silty, with numerous granules of limestone; friable, not plastic; grades into		8
Clay, greenish gray, very silty, friable; limestone granules not noted		9
Clay, greenish gray, stained yellowish brown, very calcareous, friable, with occasional small, irregular limy nodules		8
Limestone, light gray with greenish cast, silty, argillaceous, very knobby, irregular surface	1	
Sandstone, gray, micaceous, calcareous in part, shaly	4±	

Thickness:	(ft)	(in)
(Note: Sandstone exposed about ¼ mile downstream probably immediately underlies above described section.)		
Sandstone, gray, micaceous, unevenly bedded, thin-bedded to massive, beds 1 to 2 feet thick, ripple marks common . . .	12±	
Total	28±	1

Geologic section 10G (modified from field notes of S. E. Ekblaw).—Roadcut and north-facing bank of Shoal Creek, SE¼ SE¼ SW¼ sec. 26, T. 9 N., R. 5 E., Effingham quadrangle, Effingham County.

Type outcrop of the Shumway Limestone Member.

Thickness:	(ft)	(in)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Sandstone, olive to brownish gray, micaceous, very calcareous, unevenly bedded, weathering nodular	2+	
Shale, light olive, sandy, noncalcareous, fairly evenly bedded	2+	
Covered interval	5	
Shale, dark olive, evenly bedded, nonsandy, noncalcareous; becomes soft in upper part . .	4+	
Shale, olive, evenly and thinly bedded, noncalcareous, nonsandy, with some scattered ironstone concretions up to 1 inch thick and 3 inches in diameter that weather yellowish brown; becomes fossiliferous in lower 1 to 2 feet	12	
Shale, olive, weathering reddish brown, calcareous, crumbly, fossiliferous with an abundance of *Phricodothyris*, crinoids, and *Aviculopecten*		4
Shumway Limestone Member		
Limestone, shaly, olive-gray, weathering reddish brown, calcareous, somewhat bedded; very fossiliferous, containing *Phricodothyris*, *Crurithyris*, productids, *Derbyia*, *Lophophyllidium* . .	1	4
Limestone, dull gray, weathering yellowish brown, fine-grained, compact, hard, massive; thickens upstream into a massive bed 1 foot thick; fossiliferous with *Phricodothyris*, *Crurithyris*, productids, *Derbyia*, *Composita*, *Hustedia*, *Lophophyllidium* .		7
Shale, olive to dark olive, evenly bedded, slightly fossiliferous, noncalcareous, nonsandy . .		11
Shale, dark gray to black, tinged brown, noncalcareous, thin and evenly bedded, soft		7
Shale, black, fissile, hard . . .	3	2
Limestone, shaly, dull gray to bluish gray, massive, slabby; nodules in green clay matrix; base concealed; very fossiliferous, with *Myalina*, *Derbyia*, *Phricodothyris*, *Composita*, *Fusulina*, *Lophophyllidium*, *Punctospirifer*, *Chonetes granulifer*, *Orthoceras*, crinoids, bryozoans		2–16
Shale, gray, calcareous, interbedded with black, noncalcareous shale		1
Coal, contains lenses of gray, calcareous shale in top 1 inch . .		2–4
Clay, gray, with purplish cast, noncalcareous		1
Clay, dark gray, noncalcareous, blocky	1	10
Clay, light gray tinged blue, with a few scattered gray calcareous concretions; nonsandy, noncalcareous	1	11
Clay, dark gray with purplish cast		1
Clay, olive, blocky, noncalcareous		5
Clay, olive mottled with light olive, stained brown in upper portion, blocky, calcareous . .	2+	
Limestone, greenish gray, freshwater type, somewhat sandy, massive, uneven upper surface; nodules in green clay matrix; in bed of creek; base concealed	1	
Total	40	4±

Geologic section 10H.—Northwest corner of pit and highwall of abandoned limestone quarry and in small ravine just west of this point; NW¼ NW¼ NE¼ sec. 30, T. 3 N., R. 4 W., Salem quadrangle, Marion County.

Type outcrop of the Omega Limestone.

Thickness:	(ft)	(in)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Iron-oxide enriched clay nodules, irregular in shape; in clay matrix		1+
Clay, olive, with some black manganese staining, relatively firm, friable; some faint laminae near the base; occasional slip fractures	1	6
Shale, olive, fairly well laminated, with manganese staining prominent on partings		10
Sideritic band, brown, much weathered		2
Shale, olive, fairly well laminated; some manganese staining; weathers soft; becomes very thinly laminated with numerous silt laminae in lower part .	2	5

Thickness:	(*ft*)	(*in*)
Siltstone, light greenish gray to light gray, thinly and irregularly interlaminated with thin clay, coarsely micaceous on some partings; contains occasional weathered sideritic and silty nodules; sharp contact to top of limestone below	5	5
Omega Limestone Member		
Limestone, light gray, mottled with brown, massive; very fossiliferous with very numerous fusulinids, occasional large brachiopods and other invertebrates; fusulinids most abundant fossils in most of the rock; weathers to light reddish brown matrix (70 percent) with light gray irregular masses (30 percent)	3	6
Limestone, light gray, dense, massive, much less fossiliferous than above; brachiopods predominate; only occasional fusulinids; base concealed at point measured	5	6+
Shale, light greenish gray, some pink and tan staining, very fossiliferous; well preserved fossils weather out of shale; occasional lenses of very fossiliferous limestone that increase in number toward the top	1	10
Coal smut band, clayey, irregular in thickness from a parting up to 1 inch thick; appears to be persistent		1
Clay, light greenish gray, plastic when wet, with carbonized plant roots; several coaly smut bands up to ¼-inch thick but irregular and discontinuous		2
Clay, light greenish gray, faint suggestion of lamination; carbonized plant roots; soft and plastic when wet; irregular limestone nodules about 1 inch in diameter weather out of clay		4
Shale, light olive-gray, slightly silty, fairly well laminated iron stain on joints and some bedding surfaces; weathers soft and clayey; base concealed below creek level	3	3
Total	25	1+

Geologic section 10 I.—Exposure in roadcut of north-south road south of east-flowing tributary to Bonpas Creek, NE¼ NE¼ NE¼ sec. 6, T. 2 N., R. 14 W., Olney quadrangle, Richland County.

Type outcrops of the Bonpas Limestone Member and the Calhoun Coal Member.

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Shale, brownish gray, sandy, poorly exposed in roadcut	7±	
Bonpas Limestone Member, medium gray, weathers with a reddish cast; dense to finely crystalline, thick-bedded, weathering slabby; tends to be shaly in lower part; abundant poorly preserved fossils	3	
Calhoun Coal Member	1	4
Underclay, medium gray, soft, plastic when wet, not well exposed	1+	
Total	12±	

Geologic section 10J (modified from the field notes of J. M. Schopf).—McCleary's Bluff outcrop exposure NW¼ SW¼ SE¼ sec. 29, T. 2 S., R. 13 W., Wabash County, Illinois.

Type outcrop of McCleary's Bluff Coal Member.

Thickness:	(*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Covered hill slope		
Shale, medium gray to buff, becoming silty and flaky at bottom of the interval	20+	
Coal, banded	1	½
Underclay, white mottled		1
Shale, black, fissile		½
Siltstone, medium gray, clayey, iron-stained; grading into siltstone, clayey, light medium gray, iron oxide joint filling, iron-stained, irregularly thin-bedded	6	
Shale, dark to black, flaky with vitrain streaks		9
McCleary's Bluff Coal with a ¾-inch clay parting; top of the coal is canneloid		3
Underclay, white to light gray, hard		3
Underclay, medium gray, crumbly, with small limestone pisolites	2	
Underclay, shaly, light gray with ironstone joint bands	5	
Sandstone, shaly; siltstone and silty sandstone, thin-bedded	5	6
Siltstone, medium gray, platy; with sandstone, thin-bedded, ripple-marked in part, light gray to light buff, iron-stained. (To river level to the south)	20	
(Estimated position of Friendsville Coal about 15 feet below.)		
Total	60	11

Geologic section 10K (modified from field notes of M. W. Fuller).—Exposure in quarry NE¼ sec. 1, T. 11 N., R. 12 W., Marshall quadrangle, Clark County.

Type outcrop of the Cohn Coal Member.

	Thickness: (*ft*)	(*in*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
Sandstone, yellowish brown, very ferruginous, soft, massive to thin-bedded, cross-bedded, very dirty, somewhat conglomeratic, micaceous; contains considerable carbonaceous material	10+	
Shale, light to medium gray, clayey, very soft, thin-bedded; contains sideritic concretion fragments	4	
Shale with mudcrack network; cracks filled with iron carbonate; *Estheria* found in the small depression between the cracks		1–2
Shale, medium bluish gray, poorly bedded		5
Shale, black, possibly a coal horizon	—	—
Shale, medium olive-gray; contains minute structures resembling fossils	1	6
Covered interval	1+	
Shale, olive-gray, soft, clayey, well bedded, with a ferruginous band at base		6
Shale, medium gray, poorly bedded, slightly silty, slightly micaceous; contains very small pebbles; fossiliferous, with ostracodes	1±	
Shale, light gray with greenish cast, poorly bedded, soft; contains calcareous concretions		8
Limestone, freshwater type (?), medium gray, argillaceous, hard, massive to nodular, fossiliferous, with numerous *Spirorbis*	1	4
Clay or shale, light to medium olive-gray, very poorly bedded; contains rounded, weathered, ferruginous concretions	1	3
Cohn Coal Member, shaly		2
Underclay, medium gray, with small rounded concretions in the lower part	4	8
Underclay, greenish gray, like above	1	
Shale, olive-green, clayey, thin-bedded; becomes sandy toward base; contains many ironstone layers	15±	
Sandstone, light bluish gray, very calcareous, fine-grained, slightly micaceous, rather nodular and thin-bedded	2	
Total	44±	8
Bond Formation		
Livingston Limestone Member		
Limestone, grayish white, mottled gray and white, hard, dense, subcrystalline, fossiliferous, with numerous *Composita*	6	6
Shale, dark gray, poorly bedded, slickensided; contains a few plant fossils	2	8
Coal, good		0–3
Shale or underclay, dark gray, slickensided, poorly bedded	1	9
Limestone, grayish white, hard, massive; breaks with a conchoidal fracture; macrofossils seem to be absent; "wheat-grain" structure probably due to microfossils	14	
Total	25±	

Geologic section 11.—W. H. Krohn-Claud Smith No. 1 well, SE¼ SE¼ SE¼ sec. 10, T. 4 N., R. 5 E., Edgewood quadrangle, Clay County, elevation 529 feet. Coal Section control well 191. Sample set 11257 studied by M. B. Rolley.

Reference section of the Mattoon Formation.

	Thickness (*ft*)	*Depth* (*ft*)
Pennsylvanian System		
McLeansboro Group		
Mattoon Formation		
No record	60	60
Omega Limestone Member (reported by driller)	5	65
No record	38	103
Clay, light gray, greenish gray, limestone concretions	7	110
Shale, light gray, clay-like; numerous sideritic concretion fragments	10	120
Siltstone, light gray, very micaceous, calcareous; sideritic concretion fragments	4	124
Shale, dark gray to black, very micaceous, carbonaceous, pyritic	16	140
Shale, light gray, micaceous, carbonaceous	4	144
Shale, dark gray to black, micaceous, carbonaceous, pyritic	1	145
Coal	1	146
Sandstone, white, coherent, fine, micaceous, very carbonaceous; thin coal laminae	15	161
Shale, black; and coal	1	162
Clay, light gray, greenish gray, calcareous	6	168
Limestone, light gray to buff, slightly granular to sublithographic	7	175

Thickness:	*(ft)*	*(in)*
Clay, light gray, micaceous, calcareous	5	180
Siltstone, light gray, fine to coarse, very micaceous; sideritic concretion fragments	36	216
Sandstone, light gray, coherent, fine, micaceous, carbonaceous; many sideritic concretion fragments	14	230
Shale, light gray, finely micaceous, carbonaceous, with sideritic concretion fragments	13	243
Shale, black	2	245
Coal	1	246
Underclay	4	250
Siltstone, light gray to white, micaceous, with siderite spherules	10	260
Shale, light gray to brownish gray, finely micaceous, carbonaceous; shale, dark gray to black, micaceous, carbonaceous, fossiliferous	6	266
Shale, black	3	269
Coal, with calcite	1	270
Siltstone, light gray, micaceous, very carbonaceous	6	276
Sandstone, light gray, coherent, fine, micaceous, carbonaceous, shaly; sideritic concretion fragments	9	285
Shale, light gray to brownish gray, finely micaceous and carbonaceous; sideritic concretion fragments	25	310
Shale, black	2	312
Coal	2	314
Shale, light gray, very micaceous and carbonaceous, sideritic	11	325
Siltstone, light gray to white, fine to coarse, micaceous, carbonaceous	11	336
Shale, black; coal streak	1	337
Underclay	1	338
Siltstone, light gray to white, fine to coarse; grading into sandstone, light gray to white, coherent, very fine, finely micaceous, carbonaceous, slightly calcareous; siderite concretion fragments	12	350
Clay, light gray, very micaceous, with light gray to white limestone concretions	10	360
Total	300	
Bond Formation		
Millersville Limestone Member		
Limestone, light gray to white to buff, finely crystalline	8	368

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