FIELD GUIDEBOOK
APRIL 23 - 24 1966

SEDIMENTARY STRUCTURES AND MORPHOLOGY OF LATE PALEOZOIC SAND BODIES IN SOUTHERN ILLINOIS

SEMI-CENTENNIAL CONVENTION
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
St. Louis, Missouri

Guidebook Series 7
ILLINOIS STATE GEOLOGICAL SURVEY
Urbana, Illinois
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OF LATE PALEOZOIC SAND BODIES
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INTRODUCTION

In the late Paleozoic rocks of the Illinois Basin, sandstones are the most variable and the most disruptive units within otherwise relatively regular stratigraphic sequences. Although for many years sandstones have been examined in broader stratigraphic studies and as oil and gas reservoir rocks, considerably greater attention has been directed to their study in the Illinois Basin during the past 15 years. Systematic studies of sand bodies—including morphology, mineralogy, source areas, grain-size distribution, and sedimentary structures—have greatly increased the insight into the nature of sandstones of Illinois, particularly within Chesterian (late Mississippian) and Pennsylvanian strata.

The field excursion is directed particularly to the examination of sedimentary structures common in late Paleozoic sandstones of this Basin as an aid in interpreting the geologic history and character of sandstones in the subsurface. Although many other facets of sandstone studies will be touched on during the trip, such references can only be superficial. For this reason, a brief review of studies of late Paleozoic sandstone in the Illinois Basin is presented.

Attention is directed to three general references that are included in the bibliography at the back of this guidebook. A paper by Potter (1963), which is concerned directly with the subject of this guidebook, is referred to frequently in succeeding paragraphs. Two other general references are publications by Potter and Pettijohn (1963) on paleocurrents and basin analysis and a syllabus prepared by Pettijohn, Potter, and Siever (1965) for a short course recently offered at the University of Indiana on the geology of sand and sandstone. The latter two publications contain extensive bibliographies of world-wide literature on various aspects of sandstone studies.

Some of the methods and problems of field description of sandstones will be considered with discussion of various attributes of late Paleozoic sandstones. A number of photographs illustrating the most common sedimentary structures in these sandstones serve as a guide for recognition of these features in the field.

In the appendix, we have endeavored to provide locations and descriptions of sandstone outcrop localities in southern Illinois representative of most of the widely recognized sandstone members and formations in the Chesterian Series of the Mississippian System and in the Caseyville and Abbott Formations of the Pennsylvanian System.

Because the recent studies have had the advantage of good surface exposures and a large amount of widely distributed subsurface data, more probably is known concerning the character of Pennsylvanian and Mississippian sandstones of the Illinois Basin than in any comparable area in the world.

Acknowledgments

The authors wish to express their appreciation to colleagues on the staff of the Illinois State Geological Survey for their assistance in preparation of this guidebook. D. H. Swann has been particularly helpful in problems relating to Mississippian strata. Co-leaders on the field trip, W. H. Smith and F. N. Murray, have greatly assisted in all aspects of preparation of the material presented here. We wish also to express appreciation to many workers whose studies have provided the basis for this guidebook. It is not possible to fully acknowledge these contributions here, but we would like to mention specifically two former staff members of the Illinois Geological Survey, Raymond Siever, who pioneered and stimulated much of the work on sandstones in the Illinois Basin in recent years, and Paul Edwin Potter, whose many outstanding contributions and inspiration to other workers have greatly advanced knowledge of the sandstones.

We would like also to acknowledge the assistance of Mrs. Lois S. Halt of the Survey editorial staff whose efforts far beyond normal requirements have seen this guidebook through to its present form.
Figure 1. Generalized geologic column of Pennsylvanian System and upper part of Mississippian System of southern Illinois.
SEDIMENTARY STRUCTURES AND MORPHOLOGY OF SAND BODIES

We wish also to acknowledge Neilson Rudd, chairman, and David Stevenson, vice-chairman of the Field Trip Committee for the annual meeting of the American Association of Petroleum Geologists for their assistance in the many details involved in conducting the field trip. We are also grateful to William D. Johns, chairman of the Transportation Committee of the A.A.P.G., who handled travel arrangements.

STRATIGRAPHY

Although the stratigraphic relations of the sand bodies in the interval being studied are of fundamental importance, the objectives of the present study have not been stratigraphic. The stratigraphy of Chesterian and Pennsylvanian rocks (with emphasis on the sandstones) of the Basin are generalized in figure 1.

Because of widespread occurrence of prominent and persistent limestones in the Chesterian sequence, correlation and identification of sandstones have been accomplished more readily than in the early Pennsylvanian rocks where widespread key members do not exist. Stratigraphy of the Chesterian rocks has been considered in many reports concerned with the Illinois Basin. In addition to the Geologic Map of Illinois (Weller and others, 1945), key references on late Mississippian stratigraphy are to be found in reports by Weller (1939a, b, c, and 1940a), Weller, S. and Weller, J. M. (1939), Weller and Ekblaw (1940), Weller and Sutton (1940), Swann (1948), Atherton (1948), Swann and Atherton (1948), Perry and Smith (1958), Swann and Willman (1961), and Swann (1963). The latter reference includes an extensive bibliography on Chesterian stratigraphy.

Early Pennsylvanian stratigraphy is treated in some detail by Wanless (1938, 1955, 1962), Weller (1940b), and Kosanke and others (1960). The report by Kosanke includes an extensive bibliography of reports on Pennsylvanian stratigraphy.

Numerous published reports dealing with geologic mapping of quadrangles are not listed in this guidebook, although they have made important contributions to both Pennsylvanian and Mississippian stratigraphy. Geologic mapping of quadrangles in the area since 1960 includes a number of unpublished theses at Southern Illinois University.

TEXTURE

Considerable work has been published on the textural properties of late Mississippian and early Pennsylvanian sandstones of the Illinois Basin. A comprehensive discussion of previous work has been summarized in Potter (1963, p. 19).

Much of the work on texture in these sandstones has been directed toward distinguishing between sheet and elongate sandstone facies or between sandstones of different ages (e.g., Chesterian from Caseyville).

The salient features of Pennsylvanian-Mississippian sandstone textures are summarized below:

(a) Size range.—Pennsylvanian sandstones are slightly coarser than Mississippian sandstones and have medians running well up into the medium sand range. Mississippian sandstones have maximum medians in the fine sand class and occasional medians in the lower medium grain-size range. There are sandstones of both ages, of course, that have median sizes ranging down to silt.

(b) Vertical changes.—Most of the elongate sand bodies, independent of age, show a slight decrease in median grain size upward in a vertical section through such a body (see figs. T-5, T-15, T-19). Available data indicate that sheet sand bodies do not show any consistent pattern of variability in grain-size distribution.

(c) Relation of grain size to sand body shape.—It is to be expected that coarser sandstone would be found in the elongate sand bodies which are thicker and which possess characteristics suggesting that they were deposited by currents of higher competence than those which were responsible for sheet sandstones. Although the sandstones in the Pennsylvanian show this relation to a marked degree, the differences in grain size in Mississippian elongate and sheet sand bodies are not so apparent (Potter, 1963), but the distinction of grain size is present. The sheet sandstones usually contain a greater percentage of silt and clay.

(d) Sorting.—Most of the sandstones of the upper Mississippian and early Pennsylvanian are well sorted. The Trask sorting coefficient seldom exceeds 2.0 and generally is about 1.5. There is some indication that the Mississippian sandstones are sorted slightly better than those from the
Pennsylvanian. The elongate sand bodies contain better sorted sand than the sheet sand bodies. One cause of this difference is greater amounts of silt and clay in the sheet sand bodies. Marked changes in sorting might be expected also in conglomerates (both quartz pebble and shale pebble types), which may have secondary modes and have higher Trask coefficients indicating poorer sorting. No study of sorting of these rocks in Illinois has been made so far as we know.

(e) Roundness.—Very little data are available on roundness of quartz grains for these sandstones, principally because of the abundance of secondary overgrowths. Some special attention has been directed, however, to the use of percentage of tourmaline grains that are rounded as an indicator of relative maturity of sandstones and indirectly as an indicator of their age. A significant change in percentage of rounded tourmaline reportedly occurs at the Pennsylvanian-Mississippian boundary (Atherton and others, 1960). Some aspects of this relation are discussed in the road log of the guidebook at STOP 7.

MINERALOGY

Comprehensive studies on the mineral composition of late Paleozoic sandstones have been published. Siever (1953) reported on Chesterian sandstones, Siever and Potter (1956) on Caseyville sandstones, and Potter and Pryor (1961) on both Chesterian and Caseyville sandstones. Several other studies that have included mineralogy of the sandstones are reviewed by Potter (1963).

The mineralogic composition of late Mississippian (Chesterian) and early Pennsylvanian (Caseyville Formation) sandstones are remarkably uniform. They are orthoquartzites or protoquartzites of Pettijohn (1957) containing only small amounts of rock fragments, fine matrix, feldspar, and mica in the detrital fraction. Each of these constituents usually make up less than 2 percent except for the fine matrix, which may be up to 30 percent in some of the very fine-grained sandstones. Another constituent is the cement, which is principally quartz occurring as secondary overgrowths and carbonate (calcite or siderite). The carbonate cement content of the sandstones is highly variable. Several samples of both Chesterian and early Pennsylvanian sandstones have been reported to contain more than 25 percent carbonate cement. The majority of analyses of Pennsylvanian sandstones, however, report no carbonate cement, and the Mississippian sandstones commonly contain only a few percent. Siderite, where encountered, is found more commonly in the Pennsylvanian sandstones. Detrital microcrystalline carbonate aggregates of sand size and carbonate oolithes have been observed only in Chesterian sandstones (Atherton and others, 1960). Quantitative data on quartz cement is lacking.

Quartz granules and pebbles are abundant in sandstones of the Caseyville Formation. This is generally true of early Pennsylvanian sandstones over a very wide area from the Appalachians to northern Arkansas. The pebbles occur scattered throughout the sandstone (fig. 8C), along bedding planes, or they constitute conglomerate beds. Pebbles are generally more abundant and of larger diameter in elongate than in sheet sand bodies. Shale pebble conglomerates and scattered shale pebbles and chips are found locally in both elongate and sheet sand bodies (fig. 8D).

Above the Caseyville Formation, the younger Pennsylvania sandstones begin to show significant variations in the composition of their detrital components. The amount of fine matrix, mica, feldspar, and rock fragments increases, and the sandstones in the Spoon and Carbondale Formations, as well as those in the overlying McLeansboro Group, are mostly subgraywackes. The Abbott Formation, between the Spoon and Caseyville Formations, contains mostly protoquartzites intermediate between the relatively mature orthoquartzites (and some protoquartzites) of the Caseyville Formation and the relatively immature subgraywackes of the Spoon Formation. The younger sandstones also contain more angular sand, another expression of their less mature character.

All of the late Paleozoic sandstones of the Illinois Basin contain a rather impoverished heavy mineral suite, with zircon and tourmaline usually constituting over 90 percent of the nonopaque minerals. Garnet, apatite, rutile, and anatase may each constitute up to a few percent of the nonopaque heavy minerals, while others may be present in trace amounts. Opaque heavy minerals are magnetite, pyrite, ilmenite, and leucoxene.

Essentially all major clay minerals are present in the fine matrix in proportions about equal to those in associated shales, with the exception of kaolinite. Kaolinite is relatively more abundant than in associated shales and locally occurs in patches of "books" occupying areas as large as adjoining sand grains. These "books" are thought to be post depositional in origin. Smoot (1960b) relates regional lateral changes in the clay minerals in some late Mississippian sandstones to environmental changes.
SEDIMENTARY STRUCTURES AND MORPHOLOGY OF SAND BODIES

BEDDING AND OTHER SEDIMENTARY STRUCTURES

Active research into the study of bedding form and other sedimentary structures has been carried out along two major lines: (1) the observation and classification of structures from field studies; and (2) experimental work with sand transport and deposition in flumes or along test reaches of natural streams where flow characteristics can be measured.

Descriptions and illustrations of sedimentary structures are found in Pettijohn and Potter (1964), Dzulynski and Walton (1965), Botvinkina and others (1956), and Botvinkina (1965). A recently published symposium on sedimentary structures (ed. by Middleton, 1965) contains studies of flume experiments, observations on structures now being (or recently) formed in alluvial, deltaic, and marine environments, and studies on sedimentary structures in ancient rocks. These works provide the field geologist with a good background that should encourage more careful observations and interpretations of these features.

Bedding limits used in this guidebook differ little from many proposed classification systems and are as follows: very thin bedded—less than \( \frac{1}{8} \) inch; thin bedded—\( \frac{1}{8} \) inch to 2 inches; medium bedded—2 inches to 24 inches; thick bedded—24 inches to 48 inches; very thick bedded—greater than 48 inches (table 1).

Other aspects of the external appearance of bedding are the persistence of the beds, the smoothness of the bedding planes, and lateral and vertical changes in thickness of the beds. In our field descriptions, these characteristics are briefly described but are not considered in any formalized manner.

One of the problems we have encountered is how to describe the internal character of the bed. Pettijohn and Potter (1964) list five types of internal structure: massive, laminated (cross or horizontal), graded, imbricated, and growth structures. Hamblin (1962) demonstrated by use of x-rays that much so-called massive sandstone, i.e. without internal structure, is actually laminated. Laminations may not be visible on fresh surfaces, or in cores, but become visible upon weathering. Distinction between the external form of the bed and the internal character is not in some cases definite, making difficult the application of this classification. Where marked change in grain size, micaceous or shaly partings, or other features are present, the bedding or lamination planes stand out, and the nature of the bedding is discernible. However, in more homogeneous sequences, this distinction becomes less clear, especially in very fresh exposures or in cores.

Because of the great abundance of cross bedding and because of the numerous studies that have used this sedimentary feature in the reconstruction of paleogeographic conditions in the Illinois Basin, some special comments on cross bedding are included here. Various attempts have been made to classify cross bedding (cross stratification) and perhaps the most widely accepted in this country is that of McKee and Wier (1953). A rather elaborate scheme has been proposed also by Allen (1963).

Two principal characteristics are used to describe cross-beded sedimentation units in this guidebook. The first is the general shape of the sedimentation unit or set that contains the cross strata. Two shapes are recognized: trough, where the base of the unit is a curved, trough-shaped surface (the top may be horizontal or cut into by overlying troughs); and tabular, where the cross strata are contained in a horizontal sedimentation unit with sub-parallel top and bottom surfaces.

The second characteristic used is the shape of individual inclined strata within the cross-beded set. These strata may be planar, terminating abruptly against the horizontal top and bottom surfaces; or they may decrease in amount of inclination on approaching the base of the set, in which case they are termed tangential. Other shapes occur, some quite commonly, but the two described are the principal types found in the late Paleozoic sandstones of the Illinois Basin.

On the basis of these characteristics, four combinations of cross bedding are recognized: tabular-planar, trough-tangential, tabular-tangential, and trough-planar. All can be found within a single outcrop, but the first two are by far the most common.

The down-dip direction of the maximum dip angle of the inclined strata is measured to determine the direction of current flow. If measured over a wide area, this indicates the terminal direction of sediment transport. The amount of dip also is essential if beds have substantial tectonic dip in order that original direction of cross bedding can be calculated or determined by graphical means (see Potter and Pettijohn, 1963, p. 259-262).

Frequently it is difficult to determine the direction of the maximum angle of dip, particularly where the cross bedding can be seen only in two dimensions on a vertical or nearly vertical face. If the vertical exposure is sufficiently irregular to permit measurement of two apparent dip directions, true dip can be determined graphically (Potter and Pettijohn, 1963, p. 78).
### TABLE 1 – COMMON PRIMARY SEDIMENTARY STRUCTURES IN LATE PALEOZOIC SANDSTONES OF ILLINOIS.
(Modified from Pettijohn and Potter, 1964)

#### I. External form of bedding

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very thick, greater than 48 inches</td>
<td>persistent, thickness variations, shape, etc.</td>
</tr>
<tr>
<td>Thick, 24 to 48 inches</td>
<td>non persistent, thickness variations, shape, etc.</td>
</tr>
<tr>
<td>Medium, 2 to 24 inches</td>
<td></td>
</tr>
<tr>
<td>Thin, ½ to 2 inches</td>
<td></td>
</tr>
<tr>
<td>Very thin, less than ¼ inch</td>
<td></td>
</tr>
</tbody>
</table>

#### II. Internal characteristics of bedding

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive</td>
<td></td>
</tr>
<tr>
<td>Laminated</td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
</tr>
<tr>
<td>Inclined (cross-bedded)</td>
<td>planar or tangential</td>
</tr>
<tr>
<td>Tabular</td>
<td></td>
</tr>
<tr>
<td>Trough</td>
<td></td>
</tr>
<tr>
<td>Ripple cross lamination</td>
<td></td>
</tr>
<tr>
<td>Graded</td>
<td></td>
</tr>
<tr>
<td>Imbricated and other oriented fabrics, e.g. oriented plant casts</td>
<td></td>
</tr>
</tbody>
</table>

#### III. Bedding plane markings and irregularities

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>On base of beds (sole marks)</td>
<td></td>
</tr>
<tr>
<td>1. Load structures (load casts, flame structures and frondescent casts)</td>
<td></td>
</tr>
<tr>
<td>2. Current structures</td>
<td></td>
</tr>
<tr>
<td>a. Scour marks</td>
<td></td>
</tr>
<tr>
<td>(1) flute casts</td>
<td></td>
</tr>
<tr>
<td>(2) channels, cut-and-fill structures</td>
<td></td>
</tr>
<tr>
<td>b. Tool marks</td>
<td></td>
</tr>
<tr>
<td>(1) groove casts (drag and slide marks)</td>
<td></td>
</tr>
<tr>
<td>(2) bounce, brush, and prod casts</td>
<td></td>
</tr>
<tr>
<td>3. Organic markings (ichnofossils) tracks, trails, and burrows</td>
<td></td>
</tr>
<tr>
<td>On partings within the beds</td>
<td></td>
</tr>
<tr>
<td>1. Parting lineation</td>
<td></td>
</tr>
<tr>
<td>2. Rib and furrow structure (related to ripple bedding)</td>
<td></td>
</tr>
<tr>
<td>On top of bed</td>
<td></td>
</tr>
<tr>
<td>1. Ripple marks</td>
<td></td>
</tr>
<tr>
<td>a. Symmetrical</td>
<td></td>
</tr>
<tr>
<td>b. Asymmetrical</td>
<td></td>
</tr>
<tr>
<td>(1) Transverse</td>
<td></td>
</tr>
<tr>
<td>(2) Cuspate</td>
<td></td>
</tr>
<tr>
<td>c. Irregular</td>
<td></td>
</tr>
<tr>
<td>d. Interference</td>
<td></td>
</tr>
<tr>
<td>2. Erosional features</td>
<td></td>
</tr>
<tr>
<td>a. Ripple scour</td>
<td></td>
</tr>
<tr>
<td>b. Current crescents</td>
<td></td>
</tr>
<tr>
<td>c. Rill marks</td>
<td></td>
</tr>
<tr>
<td>3. Pits and small impressions</td>
<td></td>
</tr>
<tr>
<td>4. Shrinkage cracks and casts (syneresis and mud) and crystal casts</td>
<td></td>
</tr>
<tr>
<td>5. Organic markings (ichnofossils)</td>
<td></td>
</tr>
<tr>
<td>a. Tracks and trails</td>
<td></td>
</tr>
<tr>
<td>b. Plant casts</td>
<td></td>
</tr>
</tbody>
</table>

#### IV. Penecontemporaneous deformation structures

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Founder and load structures</td>
<td></td>
</tr>
<tr>
<td>1. Load casts and flame structures</td>
<td></td>
</tr>
<tr>
<td>2. Ball and pillow structures (&quot;flow&quot; rolls)</td>
<td></td>
</tr>
<tr>
<td>Convolute bedding</td>
<td></td>
</tr>
<tr>
<td>Slump structures (folds, faults, and breccias)</td>
<td></td>
</tr>
<tr>
<td>Injection structures</td>
<td></td>
</tr>
<tr>
<td>Organic structures (burrows, mixed bedding)</td>
<td></td>
</tr>
</tbody>
</table>
In measuring cross bedding dip direction, or tectonic dip, we have found the simple level apparatus developed by Pryor (1958) to be most helpful in the field. Used in conjunction with a compass, measurements are much easier than using a Brunton type compass alone.

Bedding plane markings and irregularities have received much treatment in recent literature. Good reviews of these features are found in Potter and Pettijohn (1963), Pettijohn and Potter (1964) and Dzulynski and Walton (1965). Many studies of these structures have been in connection with study of turbidites. A more general occurrence of many of these structures now is recognized as in the late Paleozoic sandstones of Illinois, which are not turbidites but contain numerous sole marks, many with preferred orientation.

Pettijohn and Potter (1964) have divided bedding plane markings and irregularities into three categories: those on the base of the bed, those within the bed, and those on top of the bed. This general scheme is used in the accompanying check list of common sedimentary structures observed in late Paleozoic sandstones of the Illinois Basin listed in table 1 and illustrated on figures 4 to 9. All features illustrated in these figures will be seen on the field excursion, and table 3 provides stratigraphic and location data.

<table>
<thead>
<tr>
<th>Property</th>
<th>Elongate</th>
<th>Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal contact</td>
<td>Erosional and disconformable</td>
<td>Conformable and transitional</td>
</tr>
<tr>
<td>Thickness</td>
<td>Sand bodies commonly 20 to 125 feet. Beds thicker than 1 foot common.</td>
<td>Sand bodies rarely exceed 20 feet. Beds generally less than 1 foot.</td>
</tr>
<tr>
<td>Texture</td>
<td>Fine to occasionally fine-to-medium size in late Mississippian. Fine-to-medium and occasionally coarse sand in Pennsylvanian.</td>
<td>Fine to very fine</td>
</tr>
<tr>
<td>Conglomerates</td>
<td>Shale pebbles plus occasional fragments of limestone and chert in Chesterian sandstones. Pebbles and cobbles of shale, coal, limestone, and clay ironstone in Pennsylvanian sandstones. Quartz pebbles in Caseyville sandstones.</td>
<td>Small pebbles and pellets of shale</td>
</tr>
<tr>
<td>Mineralogy</td>
<td>High tourmaline-zircon ratio</td>
<td>Low tourmaline-zircon ratio</td>
</tr>
<tr>
<td>Sedimentary</td>
<td>Cross bedding and cut-and-fill structures predominate.</td>
<td>Ripple marks predominate.</td>
</tr>
<tr>
<td>structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithology</td>
<td>Principally sandstone with some interbedded conglomerates, shaly siltstone, and minor siltstone and shale. Usually good self potential on electric logs.</td>
<td>Sandstone plus siltstone and some shale. Poor self potential on electric logs.</td>
</tr>
<tr>
<td>Fossils</td>
<td>Marine invertebrate fossils, generally reworked, may be present but are not common. Some plant material in late Mississippian sandstones; usually appreciable plant material in Pennsylvanian sandstones.</td>
<td>Marine fossils may be present but are only rarely abundant. More plant material in Pennsylvanian than late Mississippian sandstones.</td>
</tr>
</tbody>
</table>
DENDRITIC TRIBUTARIES
Characteristic of many sandstones. Pattern develops upslope toward "basin margins."

BRAIDED BELTS
Major sand input and low gradient produces anastomosing and meandering sand belts 6 to 30 miles wide. Belts tectonically localized.

DELTAS
Develops downslope near "marine edge."

MARINE RIBBONS AND PODS
Characteristic of downslope marine sand deposition on shallow marine shelf.

Figure 2. Dispersal system for Pennsylvanian and late Mississippian sandstones of the Illinois Basin (Potter, 1963, fig. 52).
SAND BODY CLASSIFICATION

Difficulty in developing a fully satisfactory classification of sand bodies is largely related to gradations between types. Type of sand body is even more difficult to distinguish when only subsurface data are available.

Potter (1963, p. 15) has reviewed the problem of sand body classification in late Mississippian and early Pennsylvanian sandstones of the Illinois Basin. There is a problem with terms like "channel," "delta distributary," "beach sands," "offshore bars," etc., which indicate not only the shape of the sand body but also its origin. Although origin is an ultimate objective of study of sand bodies, there are advantages to a terminology which indicates only the form.

Potter (1963) presented a classification of sand bodies recognizing two basic types: sheet sand bodies and elongate sand bodies, as followed generally in this guidebook. Table 2 (from Potter, 1963, p. 19) summarizes the principal distinguishing characteristics of elongate and sheet sand bodies as considered for the late Paleozoic sandstones of the Illinois Basin.

No significant mineralogic differences have been found between channel sandstones and sheet sandstones of similar age and area. Potter, however, has reported (Table 2) that zircon-tourmaline ratios are generally higher in elongate sand bodies.

The various kinds of elongate sand bodies relative to their origin are indicated in figure 2 which represents an interpretation of the dispersal system for the late Paleozoic sandstones of the Illinois Basin. We feel that all types are represented among the various stratigraphic sandstone units. The nongenetic terms proposed by Potter (1963) for the various types of elongate sand bodies (dendroid, belt, ribbons, and pods) are not used in this guidebook. The usefulness of these terms is recognized, but the data available in outcrops commonly will not permit such differentiation.

SANDSTONE DISTRIBUTION MAPS

During the past 15 years, a substantial number of reports have included detailed maps of sandstone distribution of several Pennsylvanian and Mississippian sandstones. Prior to that time, most reports concerned with sandstone distribution in local areas referred to elongate sand bodies cutting out a minable coal or to sand bodies in oil fields. One of the earliest attempts to map a thick sand body over a relatively large area was that by Ekblaw (1931), who mapped in outcrop a channel in the Pleasantview Sandstone (Carbondale Formation) in western Illinois.

In a series of reports mapping the extent of the Herrin (No. 6) Coal in the southern half of the state, areas from which the coal is cut out by the Anvil Rock Sandstone Member (Carbondale Formation) were mapped by Payne (1941), Payne and Cady (1944), and Siever (1950). The report by Payne and Cady included photographs of minor channels cutting out No. 6 Coal in a mine.

Siever (1949) in a report on the Pennsylvanian-Mississippian contact did not map sand bodies directly, but by isopach maps of early Pennsylvanian and late Mississippian and paleogeology of the pre-Pennsylvania surface, he demonstrated the areas of occurrence of pre-Pennsylvania valleys that were subsequently filled in large measure by sand. More recent studies have included mapping of several middle Pennsylvanian channels in Indiana (Friedman, 1955, 1960; Wier, 1953, 1962). Wanless (1957) showed distribution of two sandstone channels in the middle part of the Pennsylvanian in western Illinois. Maps of middle Pennsylvanian sandstone distribution in southern Illinois have been compiled by Mueller and Wanless (1957), Hopkins (1958), Potter and Simon (1961), Andresen (1961), and Potter (1962b). The mapping was extended by Potter (1963) to include adjacent parts of the Illinois Basin in Indiana and Kentucky.

For a period of about 10 years, students at the University of Illinois working under H. R. Wanless produced basinwide maps of Pennsylvanian sandstones through the middle and part of the upper Pennsylvanian System (Wanless et al., 1963, 1966). The sand bodies are interpreted as delta distributaries more definitely on maps by Wanless and associates than on detailed maps by others.

Many distribution maps of Mississippian sandstones have been made in oil field studies, but maps of larger areas are still less numerous than for Pennsylvanian sandstones. Swann (1951), Potter and others (1958), Potter (1962c, 1963), and Swann (1964) presented maps of Chesterian sandstone distribution in the southern part of the Illinois Basin. Whiting (1959) mapped a sandstone in the Ste. Genevieve Formation in central Illinois.

Generalized location and trends of Mississippian sandstones in the Illinois Basin are shown in figure 3. The principal trends in the Mississippian sandstones approximate those in the overlying Pennsylvanian strata.
Figure 3. Diagrammatic location and trends of late Mississippian sandstones in Illinois Basin. Names in capitals represent principal sandstones in each region. Inferred location and trend of ancestral river system also indicated. Size of arrows is indicative of relative sand input into basin. Late Mississippian sediments extended well to the north of present subcrop (Potter, 1962c, fig. 14).
SUMMARY

The substantial amount of both subsurface and outcrop work on these late Paleozoic sandstones, particularly in the past 15 years, probably has provided a better understanding of the geologic history of these sandstones than for any comparable group of sandstones in the world.

Chesterian and Pennsylvanian sandstones of the Illinois Basin are generally fine grained. Medium-grained sandstones are more common in the Caseyville Formation of early Pennsylvanian age but are locally encountered throughout the sequence. Coarse-grained sandstones are relatively uncommon. Elongate sand bodies are generally slightly coarser grained than sheet sand bodies and normally have a slight decrease in grain size from the base toward the top. In a single formation, there is relatively little mineralogical difference laterally within the basin, but vertically, through the full stratigraphic interval, mineralogic differences between sandstones are more marked. Chesterian and Caseyville sandstones are orthoquartzites. Sandstones of the overlying Abbott Formation are transitional to subgraywackes in the younger Pennsylvanian. Mineralogically little difference has been recognized between Chesterian and earliest Pennsylvanian sandstones. Generally higher percentages of rounded tourmaline grains occur in Chesterian sandstones, but there is substantial overlap in sandstones immediately above and below the Pennsylvanian-Mississippian contact. Sandstones in the Abbott Formation, and particularly those in the still higher formations, are more micaceous than the older sandstones.

Basinwide patterns of sandstone distribution indicate sources primarily from the east, northeast and north (figure 3), showing the regional slopes during Pennsylvanian and Mississippian time. Sources generally east of the Appalachian Basin and in the Canadian Shield are supported by mineralogical evidence.

Detailed maps of sandstone distribution in the Basin strongly suggest that some elongate sands were deposited as dendritic tributary systems, some as complex tributary and distributary systems, some as delta distributary systems, and some as offshore deposits. The occurrence of all of these types suggests a shifting shore line of the order of 600+ miles (Swann, 1964). Very few elongate sand bodies oriented parallel to depositional strike have been recognized in the basin.

Despite extensive studies, much remains to be learned about sand bodies in general and those of this area in particular. Among the problems are: development of a sound basis for determining origin (delta, subaerial channels, pro-delta, etc.); significance of complex patterns of elongate sand bodies; significance of the internal complexity of sand bodies; lateral relation between sheet and elongate sand bodies; source of sand in minor channels; variation in thickness of sandstone along a single channel; identification of sand bodies with correlative modern environments; and the relation of sandstones to cyclical sedimentation.

As suggested by Potter (1963), the studies related to sandstones of the Illinois Basin are applicable to similar basins anywhere in the world. Such broader applications are treated at length in the recent work by Potter and Pettijohn (1963).
A. Tabular-planar cross bedding

B. Tabular-planar cross bedding

C. Trough cross bedding

D. Oblique view of two troughs

E. Tangential cross bedding with deformed upper part

F. Tangential cross bedding with overturned upper part

Figure 4.
A. Ripple marks, bed in lower left has parting lineation at right angles to ripple-strike

B. Asymmetrical current ripples (current with pencil). Base of this bed shown in figure 7D

C. Cuspate ripple marks (current from left to right)

D. Rib and furrow (current from right to left)

E. Ripple scours (current from bottom to top)

F. Ripple scours on entire surface exposed

Figure 5.
A. Parting lineation (current parallel to hammer)

B. Parting lineation (parallel to line on level) on cross-bedding surface parallel to dip

C. Small overlapping flute casts on bottom of bed (current from right to left)

D. Widely spaced flute casts on bottom of bed (current from left to right)

E. Flame structures and load casts in interbedded shale and sandstone (core is 2 1/4" across)

F. Groove and brush casts at acute angles

Figure 6.
A. Groove casts and other sole marks

B. Slightly elongate load casts oriented with long pencil, faint ripple casts with short pencil

C. Random scattered load casts, other sole marks with north-south orientation

D. Irregular load casts on the base of the same specimen shown in figure 5B

E. Irregular load casts with low relief

F. Load casts confined to circular depression in underlying yielding bed

Figure 7.
A. Ball and pillow structures

B. Large sandstone ball with some compactional folding of overlying strata

C. Quartz pebbles scattered throughout sandstone

D. Hollow casts from shale pebble conglomerate; specimen about 3 feet wide

E. Animal trails on top of sandstone bed

F. Ripple marks and animal trails on thin-bedded sandstone; trails tend to lie in ripple troughs

Figure 8.
SEDIMENTARY STRUCTURES AND MORPHOLOGY OF SAND BODIES

A. Medium bedding, beds horizontal, persistent and bounded by smooth planes

B. Flaser bedding, thin sandstone beds show ripple cross-lamination; core is 2½" across

C. Thin ripple bedding

D. Thin ripple bedding, interior of beds show ripple cross-lamination

E. Well oriented plant casts

F. Asymmetrical ripple marks (current from left to right) and syneresis cracks

Figure 9.
TABLE 3 - LOCATION LIST FOR SEDIMENTARY STRUCTURES

Cover photograph – Planar-tabular cross bedding, Tar Springs Formation, W½ SE SW sec. 15, 11S-2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. STOP 8

Figure 4
A. Planar-tabular cross bedding, Tar Springs Formation, W½ SE SW sec. 15, 11S-2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. STOP 8
B. Planar-tabular cross bedding, Caseyville Formation, NE NE NW sec. 21, 7S-5W, Randolph County, Campbell Hill Quadrangle. APPENDIX 48
C. Trough (festoon) cross bedding, Tar Springs Formation, W½ SE SW sec. 15, 11S-2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. STOP 8
D. Oblique view of two troughs, Pounds Sandstone Member, SE NW sec. 33, 6S-5W, Randolph County, Campbell Hill Quadrangle. STOP 4
E. Tangential cross bedding with deformed upper part, sandstone in Lusk Shale Member, milepost 37-52, Interstate 57, NW NW NW sec. 25, 11S-1E, Union County, Carbondale Quadrangle. STOP 11
F. Tangential cross bedding with overturned upper part, Pounds Sandstone Member, center S½ SW NW sec. 36, 10S-8E, Gallatin County, Equality 15', Karbers Ridge 7½' Quadrangles. APPENDIX 3

Figure 5
A. Asymmetrical transverse ripple marks. Underlying bed (in lower left) has parting lineation at right angles to ripple-strike, Caseyville Formation, SW SE NE sec. 28, 10S-2W, Union County, Alto Pass 15', Gorham 7½' Quadrangles (Potter, 1963, plate 5B).
B. Asymmetrical transverse ripple marks on top of the same specimen shown in Figure 7D, Tar Springs Formation, SE SW sec. 30, 7S-6W, Randolph County, Chester Quadrangle (used in Pettijohn and Potter, 1964, plate 85A). STOP 3
C. Cuspate ripple marks, Abbott Formation, northwestern Johnson County (after Potter and Glass, 1958, plate 2B).
D. Rib and furrow, Hardinsburg Formation, SW NE NE sec. 32, 13S-4E, Johnson County, Vienna Quadrangle.
E. Ripple scour, Degonia Formation, center S line SW SE sec. 2, 11S-2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. APPENDIX 61
F. Ripple scour on entire surface exposed, Degonia Formation, center S line SW SE sec. 2, 11S-2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. APPENDIX 61

Figure 6
A. Parting lineation, Granger (?) Sandstone Member, NW NE sec. 30, 9S-1E, Williamson County, Carbondale Quadrangle. STOP 6
B. Parting lineation on cross bedding surface parallel to dip, Palestine Formation, NE SE SW sec. 32, 10S-7E, Saline County, Equality 15', Herod 7½' Quadrangles. APPENDIX 55
C. Overlapping flute casts, Caseyville Formation, NE NW sec. 31, 11S-2E, Johnson County, Carbondale Quadrangle (after Potter and Glass, 1958, plate 4B).
D. Flute casts on bottom of bed, Caseyville Formation, SW SE NE sec. 28, 10S-2W, Union County, Alto Pass 15', Pomona 7½' Quadrangles (Potter, 1963, plate 5B).
E. Flame structures, load casts, and graded beds, upper part of Carbondale Formation, from core in SE SE SW sec. 3, 4S-1E, Jefferson County.
F. Groove and brush casts at acute angles, Tar Springs Formation, Carter grid sec. 17, G-25, near Crofton, Christian County, Kentucky, Crofton 7½' Quadrangle (used in Pettijohn and Potter, 1964, plate 60A).

Figure 7
A. Groove casts and other sole marks, Tar Springs Formation, Carter grid, sec. 17, G-25, near Crofton, Christian County, Kentucky, Crofton 7½' Quadrangle (after Potter, 1963, fig. 25).
TABLE 3 — continued

Figure 7 — continued

B. Slightly elongate, oriented load casts and faint ripple casts at right angles, base of bed in Tar Springs Formation, NE SW SW sec. 25, 3S–1W, Crawford County, Indiana, Beechwood Quadrangle (Potter, 1963, plate 8B).

C. Scattered load casts, short oriented groove casts, and other sole marks, Tar Springs Formation, SE SW NW sec. 30, 7S–6W, Randolph County, Chester Quadrangle. STOP 3

D. Irregular load casts on base of the same specimen shown in figure 5B, Tar Springs Formation, SE SW NW sec. 30, 7S–6W, Randolph County, Chester Quadrangle (used in Pettijohn and Potter, 1964, plate 52A). STOP 3

E. Irregular load casts with low relief, Pounds Sandstone Member, west side Interstate 57, near center W.line sec. 19, 11S–2E, Johnson County, Carbondale Quadrangle. STOP 11A

F. Load casts confined to circular depression in the underlying yielding bed, Aux Vases Formation, NW SW NW sec. 3, 5S–9W, Monroe County, Renault Quadrangle. APPENDIX 33

Figure 8

A. Ball and pillow structures in basal part of Tar Springs Formation, in creek bank, W² SE SW sec. 15, 11S–2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. STOP 8

B. Large sandstone ball in Lusk Shale Member, NW NW NW sec. 25, 11S–1E, Union County, Carbondale Quadrangle (after Potter, 1963, fig. 18). STOP 11

C. Quartz pebbles in the Caseyville Formation, SE SW NW sec. 22, 7S–5W, Randolph County, Campbell Hill Quadrangle. APPENDIX 49

D. Hollow casts from shale pebble conglomerate, Hardinsburg Formation, SW NE NE sec. 32, 13S–4E, Johnson County, Vienna Quadrangle (after Potter, 1963, fig. 16).

E. Animal trails on top of bed in Battery Rock Sandstone Member, SW NW NE sec. 10, 11S–9E, Hardin County, Shawneetown 15', Saline Mines 7½' Quadrangles. APPENDIX 9

F. Asymmetrical ripple marks and animal trails in Clore Formation, NW SE SE sec. 2, 8S–6W, Randolph County, Campbell Hill Quadrangle (used in Pettijohn and Potter, 1964, plate 88).

Figure 9

A. Medium bedding, beds horizontal and persistent and are bounded by smooth planes, interior of beds laminated, Hardinsburg Formation, near cen.NW² sec. 7, 11S–8E, Hardin County, Equality 15', Karbers Ridge 7½' Quadrangles. APPENDIX 7

B. Flaser bedding, interbedded sandstone and shale, thin sandstone beds show micro-cross lamination, upper Pennsylvanian, southern Illinois (after Potter and Glass, 1958, plate 7C).

C. Thin ripple bedding, near top of Battery Rock Sandstone Member, NW NW NE sec. 6, 11S–8E, Hardin County, Equality 15', Karbers Ridge 7½' Quadrangles. APPENDIX 6

D. Thin ripple bedding, interior of beds show ripple cross lamination, sandstone in Drury Shale Member, SW NW sec. 10, 10S–2W, Jackson County, Alto Pass 15', Pomona 7½' Quadrangles. APPENDIX 19

E. Well oriented plant casts, in flagstone floor of shelter house, Cliff View Park, Alto Pass, locality of quarrying unknown, NW NW NE sec. 15, 11S–2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. STOP 7

F. Asymmetrical ripple marks and syneresis cracks, sandstone in upper part of Ste. Genevieve Formation, SE NW SE sec. 22, 11S–2W, Union County, Alto Pass 15', Cobden 7½' Quadrangles. STOP 9
TERTIARY
CRETACEOUS

PENNOSYLANIAN
Pmo    Mattoon Fm.
      Bond Fm.
Pb     Modesto Fm.
Pmo    Carbondale Fm.
Pc     Spoon Fm.
P   Abbott Fm.
Ps    Caseyville Fm.

MISSISSIPPIAN
Mc2   Upper Chesterian (Kinkaid to Tar Springs Fms.)
Mc1   Lower Chesterian (Glen Dean to base of Chesterian)
M     Valmeyeran

DEVONIAN
SILURIAN
ORDOVICIAN

Field Trip stop
Limit of Illinoian Glaciation
Fault
Field Trip route

Modified from Geologic Map of Illinois, 1945
Figure T-1. Geology and route map.
FIELD TRIP ROAD LOG - FIRST DAY

FIELD TRIP ROAD LOG


FIRST DAY - SATURDAY, APRIL 23, 1966

ST. LOUIS, MISSOURI TO CARBONDALE, ILLINOIS

Buses will load at and depart from the south side of the Sheraton-Jefferson Hotel promptly at 7:30 AM. Log starts at the toll gate on the Illinois side of the Eads Bridge over the Mississippi River.

As may be seen from the route map (fig. T-1), the maximum limit of Illinoian glaciation in this part of the state will be crossed a number of times. The route also crosses the limit of the earlier Kansan glaciation that was overridden by the Illinoian. The upland surface over most of the area of the trip is covered by relatively thick loess, which has a maximum thickness of about 100 feet in the bluffs. The loess thins rapidly eastward from the bluffs. The route on the first day will be principally across the alluvial deposits of the Mississippi River Valley and the Illinoian till plain. All of the exposures visited on the second day of the trip lie beyond the limit of glaciation and the surficial material consists of a thin loess cover on residual soil on bedrock.

MILEAGE

0.0 Toll gate on the Eads Bridge, proceed west, road off of bridge leads into Broadway Avenue in East St. Louis.
1.6 Turn left (north) on 10th street.
1.8 Turn right (east) on Missouri Avenue (U.S. Highway 460).
3.7 ALCOA Research Laboratory on right.
5.1 Intersection Highway 163, proceed ahead. A good view of the American Bottoms and the east wall of the Mississippi River Valley.

Shortly after the Revolutionary War, on the recommendation of George Rogers Clark's soldiers, many easterners sought farm land in southern Illinois. As early as 1790, several communities had been established in Randolph, Monroe, and St. Clair Counties. Because these settlements were on the fertile plain bordering the Mississippi, the vicinity came to be known as the "American Bottoms." This stretch of land extends some 70 miles from the mouth of the Missouri River to the mouth of the Kaskaskia River, an expanse unbroken by any large tributaries and along which the Mississippi is impinged against the bedrock bluffs on the west. The land west of the river was owned at this time by Spain.

In the American Bottoms, the alluvial valley-fill may reach a thickness of more than 160 feet, but generally the maximum is around 120 feet. This fill material is recent alluvium and glacial valleytrain material. Some 80 Indian mounds are found a few miles to the north, in and near Cahokia Mounds State Park. These were constructed during the Middle Mississippian Culture (1000 to 1500 A.D.). The largest is Monks Mound, a rectangular flat-topped structure about 100 feet high, 300 feet long, and 750 feet wide, covering almost 16 acres. Wood from the mound had a carbon-14 date of 1156 A.D. ± 200 years.

6.3 Cahokia Downs racetrack on left.
6.7 Intersection Highway 157, proceed ahead on Highway 460, leaving American Bottoms. Note loess cuts on north (left) side of road.
7.9 Loess cuts on south (right) side of road.
8.7 Junction U.S. Highway 50, continue east on Highway 460.
10.0 Loess-covered rolling hill topography, this is typical of much of the route traversed during this trip.
13.2 Turn right off of Highway 460 on to State Highway 158. At stop sign turn left on Highway 158 east, proceed under overpass, turn right at stop sign on Highway 13 and Highway 158, proceed east.
13.9 Stop light, proceed east on State Highways 13 and 158.
14.3 Stop light, turn right (south) on State Highway 159, proceed south towards Redbud.
15.8 To southwest are strip mine spoil piles. Herrin (No. 6) Coal, which occurs in the upper part of the Carbondale Formation, is being strip mined in this area.
17.3 Crossing of Peabody Coal Company strip mine road. Coal is mined east of road and hauled to loading point to the west.
20.7 Entering Smithton.
26.3 Quality Stone Company Quarry about ¼ mile west of highway. Limestone is quarried from the Okaw Group (Mississippian). Several small inliers of Mississippian rocks are found in this area.
27.1 Intersection with State Highway 156, continue south on Highways 159 and 156.
27.9 Entering Hecker, continue south through town on Highway 159.
34.5 Entering Redbud, continue south on Highway 159.
34.9 Stop sign, intersection Highways 3 and 154, continue south on Highway 3.
39.9 Entering Ruma.
40.3 Intersection Highway 155, turn right on Highway 155, proceed west.
41.0 Ruma Convent on hill to south (left) of road.
46.2 Beginning of descent into Mississippi River flood plain.
46.6 Outcrop of Ste. Genevieve Limestone (Mississippian) on left (south) side of road.
46.7 St. Louis Limestone on north (right) side of road.
47.0 Entering Prairie du Rocher, continue on Highway 155.
47.1 Intersection with Modoc Road, turn left on Modoc Road.
47.2 St. Louis Limestone in bluffs to left. A relatively pure bench of Ste. Genevieve Limestone has been quarried near the top of the hill. The strata dip to the southeast so that the Ste. Genevieve lowers to level of the road about one mile southeast of Prairie du Rocher.
47.5 Bear left on Modoc Road, excellent view of bedrock bluff and loess covered hilltops.
48.3 Note cross bedding in Ste. Genevieve Limestone to left of road near top of bluff, cross bedding dips in a northerly direction.
48.7 Intersection T-road left from blacktop road, continue south.
49.0 At top of bluff is yellowish brown Aux Vases Sandstone which overlies the Ste. Genevieve Limestone.
49.3 Aux Vases Sandstone makes up about one-half of the bluff and the base appears about 25 feet above the road level on the left.
49.6 STOP 1. Mouth of Barbeau Hollow. Intersection T-road left, turn left and park. At this stop the Aux Vases Sandstone rests with erosional contact on the Ste. Genevieve Limestone (figs. T-2 and T-3).

In this general vicinity, the Aux Vases Sandstone attains a maximum thickness of almost 100 feet. Essentially all sedimentation units are cross-bedded, and only a few ripple marks occur. Cross-bedding dip directions are remarkably uniform in a small area (fig. T-4B), suggesting deposition by a unidirectional current system flowing southeast. On a larger scale (fig. T-4A) the cross bedding indicates regional flow to the south-southeast essentially parallel to the western margin of the cross-bedded elongate sand body. At this margin (northwest part of fig. T-4A), the character changes markedly, cross bedding gives way to ripple marks as the dominant sedimentary structure. The bedding becomes horizontal and thinner, the sandstone is only a few feet thick, and locally the section is entirely shale. Load casts, well-oriented groove casts, and other sole marks are abundant.
Figure T-2.
Aux Vases Sandstone on Ste. Genevieve Limestone at STOP 1. Contact is break seen about 10 feet above base of the bluff.

STOP 1. BARBEAU HOLLOW SECTION

MISSISSIPPIAN SYSTEM
AUX VASES FORMATION
Sandstone, fine grained; medium to thick cross-bedded units; truncates some upper thin beds of the Ste. Genevieve Limestone

STE. GENEVIEVE FORMATION
Limestone

Figure T-3. Columnar section, bluff at intersection blacktop road and road northeast. NW\(\frac{1}{4}\) SE\(\frac{1}{4}\) SW\(\frac{1}{4}\) projected sec. 26, T. 5 S., R. 9 W., Randolph County.
Figure T-4.  A. Cross bedding and thickness of Aux Vases Sandstone Formation.
B. Detailed map in vicinity of STOP 1 (figure adapted from Potter, 1963, fig. 48).
These features, along with the lack of disconformity with the underlying strata, are characteristic of sheet sand bodies and are well displayed by the Aux Vases Sandstone in this area. A good outcrop with these features well developed is found in the NW$_{1/4}$SW$_{1/4}$NW$_{1/4}$ sec. 3, T. 5 S., R. 9 W., Monroe County, Renault Quadrangle (see Appendix 33).

The texture of the Aux Vases is fine grained and well sorted. It is characteristic of elongate Chesterian and Pennsylvanian sand bodies to have a slight upward decrease in grain size in vertical profile. Figure T-5 shows this character as determined from sieve analyses of samples collected from an Aux Vases section 40 feet thick, located about 4 miles north of here near the western boundary of the belt sand body (Appendix 45).

After discussion and examination of the Aux Vases Sandstone proceed southeasterly on the Modoc Road.

The following is a supplementary road log that leads back to an excellent exposure of the Aux Vases elongate sand body in a small tributary to Barbeau Hollow.

0.0 From Stop 1, proceed northeasterly on gravel road up Barbeau Hollow.

0.9 Cross small bridge over tributary to Barbeau Creek.

1.0 Turn left into driveway of farm house, park along driveway, walk along secondary road to the northwest up the tributary valley approximately 1/3 mile.

STOP 1 A. Near the mouth of a southeast flowing tributary to Barbeau Creek is a prominent sandstone outcrop that terminates above a stock pond. This creek lies in a small "box-canyon" with excellent, fresh, continuous exposures. The nature of this exposure permits easy access for field examination through a sandstone section 50 feet thick. Cross bedding is unusually well developed and exposed. (See Appendix 46 NE$_{1/4}$ SE$_{1/4}$ SW$_{1/4}$ projected sec. 23, T. 5 S., R. 9 W., Randolph County, Renault Quadrangle). Return to Modoc road and continue on road log.

49.7 Passing farm of Willis Hillier. The site of the Modoc Indian Shelter lies at the base of the bluff just southeast of the house. At this point, the Ste. Genevieve-Aux Vases contact occurs about six to ten feet above road level; note slightly wavy character at the base of the Aux Vases Sandstone.

The Modoc Rock Shelter, first excavated in 1952, has been found to be the earliest site of Indian habitation yet recognized in Illinois. Carbon-14 dates from material collected from diggings under the rock shelter ranged from 2665 B.C. ± 300 years, at a depth of 8 feet, to 7922 B.C. ± 392 years, at a maximum depth of 26 feet. Projectile points and other artifacts indicate that this site was occupied during the Archaic period (8000 to 2500 B.C.) and that the Archaic Culture in this area is much older than previous datings and estimates have indicated for Illinois. A few burials dating around 3000 B.C. (Medial Archaic) have been found in the shelter. (Data from "Modoc Rock Shelter," by M. L. Fowler and H. Winters, Illinois State Museum Rept. Inv. No. 4, 1954.)

49.8 Aux Vases Sandstone forms the entire bluff.

51.2 Entering town of Modoc, Aux Vases is here in a sheet phase that continues eastward.

51.4 Sharp right turn.

51.5 Turn sharply left, do not take Ferry road.

52.0 To left in Mississippi River Bluff is thin-bedded sheet phase of Aux Vases Sandstone. Note lack of abundant large-scale
52.0 (continued)  
cross bedding and the thin-bedded nature of the strata. Ripple marks are abundant.

53.0 Boulders and residuum of Yankeetown chert to left of road.

55.6 Stop sign, intersection of road from left, continue ahead.

56.0 Continue left on main road past limestone quarries of the Randolph Quarries, Inc. to left. Quarry is in oolitic limestone of the Haney Formation (Okaw Group).

56.7 Kaskaskia River bridge.

57.3 Leaving valley of Mississippi and Kaskaskia Rivers.

59.5 Stop sign, intersection Roots Road and Highway 3, turn right on Highway 3 to town of Ellis Grove, continue south through town.

62.7 Intersection, turn right on blacktop road to Port Kaskaskia. White fences in this area enclose part of the Illinois State Penitentiary farms.

64.1 Descending hill, prepare to turn right.

64.3 T-road intersection, turn right on blacktop road to Port Kaskaskia State Park.

64.5 Sharp hairpin turn to left.

64.6 On left is breastworks of old Port Kaskaskia.

64.8 Garrison Hill Cemetery overlooking Mississippi River. At south end is the grave of Pierre Menard, who was presiding officer of the first Territorial Legislature and first Lieutenant Governor in 1818, when Illinois became a state.

65.0 STOP 2. Shelter house. During stop, sandstone slabs collected from various areas in Illinois displaying many of the common sedimentary structures will be examined.

From the shelter house overlook, nothing can be seen of Kaskaskia, the once thriving frontier town and first state capital. The city was established in 1703 near a Kaskaskia Indian Mission that had been founded 3 years before by the Catholic priest, Father Marest. Soon after its founding, Kaskaskia became an important center of French culture and commerce. It was called the "commercial queen of the west."

For protection against Indians a wooden palisade stockade was constructed at the village, but in 1734, a strong log fort with earthworks was begun at the top of the bluff. This fort, completed in 1736, was garrisoned at intervals by French troops. During the French and Indian War (1754-1760) the inhabitants, fearing a British attack, petitioned for a stronger fort, which was completed in 1760. The fort was destroyed in 1766 by the townspeople to prevent its occupation by British troops.

The seat of the French government for the Illinois Country had been at Kaskaskia but was moved about 15 miles up the river to Fort de Chartres on its completion in 1755. The British in 1772 returned the government seat to Kaskaskia, by then a thriving metropolis of 600 persons. During the Revolutionary War, in 1778, Kaskaskia was captured from the British by George Rogers Clark and his rangers. This served as his base of operations against Vincennes and other British posts, thereby attaining for the United States, firm possession of the Northwest Territory.

Shortly after the Revolutionary War, the local government broke down and Kaskaskia was plunged into anarchy. There was considerable friction between the French and American inhabitants and in 1784, John Dodge and a group of adventurers seized and fortified Port Kaskaskia, and terrorized the villagers for several years.

In 1809, the Illinois Territory was created and Kaskaskia, the most important town, became the territorial capital and also the first state capital when the State of Illinois was created in 1818. However, in 1820, the capital and the newspaper were moved to a more central location at Vandalia.

The choice of the site for the town was a poor one and subsequently the floods of the Mississippi began to take their toll. In 1844, the town was nearly destroyed, resulting in the Randolph County seat being moved to Chester, located on top of the bluff. The most disastrous flood occurred in 1881 when the Mississippi abandoned its channel to the west of Kaskaskia and occupied the shorter, straighter channel of the Kaskaskia River (fig. T-6). During the flood, the town was destroyed.
completely. A flood in 1910 finally removed all remnants of the town, ending the history of a city that in the early 1800's was the "commercial queen of the west."

After discussion and coffee break, proceed northward and turn around at refreshment stand road.

65.7 Stop sign, leaving park, turn right on blacktop road going downhill into Mississippi River flood plain.

65.9 Turn left (southeast) toward Chester, Pierre Menard home visible to right, about 600 feet west.

This home built in 1802, now preserved as a museum, is a fine example of French colonial architecture. It is the only building associated with old Kaskaskia that remains. The slave house stands in the rear. The kitchen, separated from the main building by an open porch, contains the original fireplace, a restored Dutch oven, and the original water basin carved from solid stone.

66.3 On bluff to left are limestones of the Okaw Group and the higher Menard Formation.

68.7 To left is limestone mine operated by the Chester Quarry Company. The Glen Dean Limestone (upper part of the Okaw Group) has been quarried.

70.4 Good section exposed in bluff wall to left in prison ground at the pistol range. This is location of a former quarry. The section is as follows (from A.A.P.G. Guidebook, 1949, p. 23-24):

<table>
<thead>
<tr>
<th>Thickness (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna Limestone</td>
</tr>
<tr>
<td>13. Limestone, bluish-gray, more or less cross-bedded, conglomeratic... 6</td>
</tr>
<tr>
<td>12. Shale, gray, calcareous ........................................ 2 1/2</td>
</tr>
<tr>
<td>11. Limestone, hard, bluish, thin-bedded .......................... 12</td>
</tr>
<tr>
<td>10. Shale, bluish-gray, with thin limestone bands ............. 5</td>
</tr>
<tr>
<td>9. Limestone, thin-bedded, and shale ................................. 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tar Springs Sandstone:</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Sandstone, fine-grained, cross-bedded .......................... 0-14</td>
</tr>
<tr>
<td>7. Sandstone, shaly, and sandy shale ............................... 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Glen Dean Limestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Shale, bluish .................. 4 1/2</td>
</tr>
<tr>
<td>5. Limestone, gray, crystalline ... 1 1/2</td>
</tr>
<tr>
<td>4. Shale, bluish to gray .......... 3</td>
</tr>
<tr>
<td>3. Limestone, gray, crystalline ... 1 1/2</td>
</tr>
</tbody>
</table>

Figure T-6. Change in course of Mississippi River, resulting from flood of 1881, in the vicinity of Kaskaskia.
2. Shale, bluish to gray. .................................  30
1. Limestone, gray, crystalline, massive, with shale break in upper part .  1 1/2

This quarry shows excellently the contact between the Glen Dean and Tar Springs Formations, but because of the sheer face, it cannot be easily studied. Bed 1 is the main quarry ledge of the Glen Dean that outcrops at many places along the bluff.

70.7 Main entrance to Illinois State Penitentiary (Menard).
70.8 Parking lot area in front of large prison cell block building. The stone used in construction of the buildings and wall is the Palestine Sandstone, which was quarried nearby.
71.0 White building on upper part of bluff is the Illinois Security Hospital.
71.5 Pass under Chester bridge, continue straight ahead.
71.7 Pass under railroad tracks.
72.4 Intersection T-road from left to Chester business district, continue ahead.
72.6 Outcrop in bluff to left behind large elevator is the Vienna Limestone.

72.9 STOP 3. Coles Mill Section in roadcut along northwest-southeast blacktop road.

At the Coles Mill Section, the Tar Springs Formation is completely exposed (fig. T-7). This outcrop shows the best development of sandstone in the Tar Springs Formation of this area. At many places, the entire formation contains no sandstone beds and consists entirely of siltstone and shale. Many of the features characteristic of the Chesterian and Pennsylvanian sheet sand bodies can be observed here. Such structures as load casts, ripple marks, animal burrows and tracks, parting lineation, and shale interbeds are common.

Special features to be examined are shown by numbers 1 to 4 on the diagrammatic stretch of the outcrops (fig. T-8).

After discussion and examination retrace route past grain elevator to first T-road right (northeast).

73.2 Turn right on Jones Street, begin ascent up steep valley wall.
73.7 Turn left into Chester City Park.
73.9 Turn right at intersection in the park, continue on road next to ball field.

74.0 STOP - Lunch at pavilion, Chester City Park. After lunch continue straight on northward through park.
74.2 Turn right up hill to stop sign. Be careful! Turn left onto Highway 3.
74.9 Intersection Highway 3 and Highway 150 in downtown Chester, turn right on Highway 3 and 150.
75.0 Four-way stop, intersection Highway 3 and Highway 150, proceed straight ahead on Highway 150.
79.3 Cross bridge over Mary's River. An old covered bridge has been restored and can be seen on the right.
81.0 Entering village of Bremen, turn right on Welge Road.
81.2 Turn sharp left at store building.
83.8 Entering village of Welge.
86.1 Passing by Wine Hill Church.
86.2 Intersection, T-road right, proceed ahead eastward.
MISSISSIPPIAN SYSTEM  
VIENNA FORMATION  
Limestone

TAR SPRINGS FORMATION  
Sandstone, very fine grained, thin bedded, ripple marked (transverse and cuspat); bedding generally horizontal and even; parting lineation well developed; numerous small load casts; top surface of sandstone shows mixed bedding with organic trails and burrows; this unit occurs only at southeast end of outcrop

Shale, medium dark gray, fissile, smooth, uniform

Sandstone, very fine grained; bedding irregular and discontinuous; cuspat ripple marks; shrinkage cracks; load casts; short oriented groove casts; forms persistent ledge

Shale, medium gray, moderately well laminated, silty, interbedded with numerous horizontal to slightly wavy, very fine-grained sandstone layers up to ¼-inch thick; small scale load casts

Sandstone, very fine-grained, calcareous, irregularly bedded, argillaceous with numerous thin shale partings; bottom of some beds covered with elongate burrow-like markings; ball and pillow structures

Claystone, medium gray with greenish cast, homogeneous, slightly silty

Sandstone, fine grained, calcareous, thin bedded; grades locally into very shaly sandstone in upper part; shallow cut and fill structures noted; some shale pebble conglomerates, subspherical sandstone "balls" that are highly calcareous and up to 18" thick

Shale, medium light gray, well laminated, silty, with numerous light gray siltstone interlaminations; some contorted bedding; micro-cross-laminated; grades to shaly siltstone in part; flaser bedding

GLEN DEAN FORMATION  
Shale, medium dark gray, fissile, smooth, weak, very fossiliferous and calcareous in bottom 3"

Limestone

Figure T-7. Columnar section, cut along river road south of Chester, Illinois. Chester Quadrangle, SE1/4 SW1/4 NW1/4 sec. 30, T. 7 S., R. 6 W., Randolph County.
Figure T-8.
Photo and sketch looking southeast at Coles Mill Section (STOP 3).
(1) Vienna-Tar Springs contact, animal burrows and mixed bedding in sandstone; immediately below is well developed parting lineation.
(2) Load casts and shrinkage cracks in ledge - forming sandstone.
(3) Ball and pillow structures that disrupt otherwise continuous sandstone zone.
(4) Flaser structures and intricately deformed thin bedded siltstone and shale.
86.8 Turn left on blacktop road at Sparta Feed Company Building, proceed northward toward Steeleville.

87.8 Begin descent into valley of Rock Castle Creek.

88.0 **STOP 4 on south side of bridge. Rock Castle Creek Section.**

At this outcrop (fig. T-9), a good section of sandstone of the Caseyville Formation can be examined. The section extends from a short distance east and the exposures lie principally to the west. Features characteristic of Pennsylvanian and Chesterian elongate sand bodies in general as well as those characteristic of Caseyville sandstones in particular are present.

In this area, the stratigraphic relations of the two principal sandstone members (the Battery Rock and Pounds Members) of the Caseyville Formation are not clear. Here there is no shale member (Drury) which, throughout most of southern Illinois, forms slopes separating the Battery Rock from the overlying Pounds Sandstone. The possible conditions that may exist here are: (1) the Drury Shale is absent and the two sandstones cannot be separated or differentiated from one another; (2) only the Pounds Sandstone is present—the Lusk Shale, Battery Rock Sandstone, and the Drury Shale Members having been overlapped by the Pounds Sandstone progressing northward or northwestward; or (3) only the Battery Rock Sandstone is present. This area is near the northern outcrop limit of the typical quartz-pebble bearing sandstones of the Caseyville Formation on the west side of the Illinois Basin. Northward, in western Illinois, younger Pennsylvanian strata generally rest on pre-Pennsylvanian rocks. This pattern (northward overlap) is repeated along the eastern margin of the Illinois Basin. Although a bed-by-bed progressive overlap to the north cannot be demonstrated, in general, this seems likely, and for this reason, the sandstone at Rock Castle Creek (STOP 4) is assigned to the Pounds.

One feature at this outcrop is a channel-fill that differs from the normal quartz sand channel-fill. At several localities west of the bridge, a shale-pebble conglomerate can be seen, and at one locality in a tributary ravine draining from the north, its rather steep lateral margin can be seen (fig. T-10). The strike of the lateral margin of this channel is a directional indicator, generally parallel to the flow of the current responsible for the erosion. However, the actual direction of flow is not apparent here and would have to be interpreted from other data. The shale pebbles represent locally derived material and constitute an intraformational conglomerate.

Quartz-pebble conglomerates and scattered quartz pebbles are numerous in some zones at this outcrop. The quartz-pebble conglomerates seldom exceed two feet in thickness, but isolated pebbles generally can be found in almost every bed. These quartz pebbles are not locally derived. They are not known from any older rocks in the Illinois Basin or any contiguous areas that might have been undergoing erosion at this time. Quartz pebbles are abundant in lower Pennsylvanian rocks in Indiana, Kentucky, Ohio, and other places in the Appalachians. The distribution suggests that they must have been derived from a distant source area.

Directional features are present in abundance, particularly cross bedding and oriented plant casts. The latter are seen principally to the east of the bridge and the cross bedding essentially throughout the outcrop. As can be seen from figure T-11, there is a fair correlation between the two. The mean of 9 cross-bed dip directions is S23°W and the mean of 13 plant-cast long axes is S64°W. In comparing the mean direction between the orientation of the two types of sedimentary structures, it should be recognized that the plant casts were measured principally in one part of the outcrop, through, at most, a few feet of section, whereas cross bedding was measured throughout the exposure.

In the bed of the creek, the base of troughs shows the curving plan view of the structure. The plunge of the trough axis would be parallel to the flow of the current responsible for the erosion of the trough. This measurement should be more nearly true to the direction of current than the simple measurement of cross-bedding dip direction, particularly if the latter is taken from the side of the trough-fill as often it is very difficult to determine that the cross bedding may dip at some acute angle not parallel to the trough axis. Theoretically, the only cross-bedding direction that is truly parallel to the general flow of the current is that which lies in the axial plane of the trough.

After examination and discussion, vehicles will turn around and retrace route back to turn off at Sparta Feed Company Building.

89.2 Intersection, T-road north, turn left (east), proceed towards Campbell Hill.
STOP 4. ROCK CASTLE CREEK SECTION

PENNSYLVANIAN SYSTEM
CASEYVILLE FORMATION
POUNDS SANDSTONE MEMBER

Sandstone, medium to very coarse grained; several conglomeratic beds with quartz pebbles up to 1” in diameter and scattered quartz pebbles; medium to thick bedded with much cross bedding throughout; ferruginous shale pebble conglomerate occupying erosional channels in sandstone; several poorly developed ripple scours noted in upper portion of outcrop and oriented plant casts; average cross bedding S 23° W (9); average plant cast orientation S 64° W-N 64° E (13) (see fig. T-11)

Covered

Figure T-9. Columnar section, beginning about ¼ mile upstream (east) of bridge and extending ½ mile downstream (west) of bridge. Campbell Hill Quadrangle, NW¼ sec. 33, T. 6 S., R. 5 W., Randolph County.

Figure T-10. Photo of one side of channel in sandstone filled with shale conglomerate (STOP 4).
91.6 Intersection, T-road south to Shiloh Hill, continue ahead (eastward).
95.3 Entering Campbell Hill, brick kilns on left.
95.4 Cross G. M. & O. Railroad tracks.
95.5 Stop sign, intersection State Highway 4, turn right, enter Campbell Hill.
99.5 Approaching town of Ava, prepare to turn right at junction with State Highway 151.
99.8 Turn right on Highway 151, proceed south under tracks of G. M. & O. Railroad.
103.0 Crossing bridge over Kinkaid Creek.
104.5 Karst topography from solution cavities in the Kinkaid Limestone along both sides of highway.
106.6 Outcrops of Degonia Sandstone on both sides of road.
107.5 Stop sign, intersection Highway 3, turn left on Highway 3, proceed southeast along east bluff of Mississippi River Valley.
107.9 Sandstones of the Caseyville Formation (Pennsylvanian) cap the hills. Below the Pennsylvanian, the Kinkaid Limestone and Degonia Sandstone Formations can be seen.
108.3 Abandoned quarry in limestone of Clore Formation in lower part of bluff.
109.6 Well developed cross-bedded sandstone in bluff to left is a sandstone of the Caseyville Formation. Degonia Sandstone crops out near base of bluff.
110.8 Degonia Sandstone in roadcut, note abundant cross bedding. This is typical of the elongate phase of the Degonia Sandstone.
112.0 Intersection, T-road west, Highway 149, proceed south toward Fountain Bluff on Highway 3.
113.3 Crossing Missouri-Pacific Railroad tracks.
114.3 Crossing Illinois Central Railroad tracks.
114.4 Straight ahead is Fountain Bluff, an outlier of Pennsylvanian and Mississippian rocks surrounded on all sides by alluvial deposits of the Mississippi River.
115.3 Prepare for right turn after crossing railroad overpass.
115.7 Sharp turn right on Gorham road.

**Figure T-11.** Comparison of orientation of cross bedding dip directions and oriented elongate plant casts (STOP 4).

115.8 Battery Rock Sandstone exposed at base of cliff on left.
116.2 Crossing over Illinois Central Railroad tracks.
116.3 Enter Gorham, proceed straight through town, following blacktop road that swings to left on northwest outskirts of town.
118.0 Turn left on blacktop road, continue south—road passes through farmyard.
118.7 Follow road left after passing by farmhouse.
119.0 Follow road left, now going parallel to northwest face of Foutain Bluff.
119.8 STOP 5. Fountain Bluff. Note abundant liesegang and honeycomb weathering on surface; sedimentary structures for the most part are concealed by weathering, at least from this vantage point.
Fountain Bluff is principally an outlier in the Mississippi River Valley lying between a former broad channel and the present narrow course of the river (fig. T-12). Most of the exposed strata in Fountain Bluff are sandstones of the Caseyville Formation. The generally greater thickness, better cementation, and lack of shale than are found in equivalent strata in the bluff about 5 miles to the east are perhaps major contributors to the preservation of this outlier. The Mississippian-Pennsylvanian contact is well exposed on the south and southwest sides of Fountain Bluff, where Mississippian strata rise well above the floor of the valley.

The geology of Fountain Bluff is considered in some detail by Pickard (unpublished M.S. thesis, Southern Illinois University, 1961). No shale sequence has been recognized below the Battery Rock Sandstone, which we consider to rest directly on Palestine Sandstone over most of the area of Fountain Bluff. A maximum thickness of 135 feet is reported by Pickard for the lower sandstone unit. Although not exposed in the bluff viewed in Stop 5, in addition to abundant quartz pebbles, fossiliferous chert pebbles have been reported in the basal conglomerates of the Battery Rock. Poor (1925) has identified the fossils as Mississippian, suggesting locally derived cherts.

Although the Drury Shale Member is about 50 feet thick five miles to the east, no shaly strata are present between the sandstones, and this formation probably is absent here. The Pounds Sandstone Member thus rests directly on the Battery Rock Sandstone and has been reported by Pickard to have a maximum thickness of 70 feet in Fountain Bluff. The following section has been described by Pickard near the site of this stop. (Note: Pickard indicated lower sandstone as Wayside-Battery Rock, the Wayside Member being equivalent to the Lusk Shale Member.)

Figure T-12. Topographic map showing relation of Fountain Bluff to old and present course of the Mississippi River; parts of Alto Pass and Altenburg Quadrangles. Location of STOP 5 shown.

Pounds Sandstone Member (65')
Sandstone, massive, fine grained, brown, iron stained ........................................ 35
Sandstone, massive, coarse grained, buff to brown, slightly limy ............................ 30

Battery Rock Sandstone Member (105')
Sandstone, massive to medium bedded, medium grained, brown, cross bedded .............................. 17
Sandstone, massive, coarse grained, brown, few rounded quartz pebbles .................. 15
Sandstone, massive, coarse grained, brown to dark brown, many irregular iron cemented bands ......................................................... 73

After brief discussion continue to follow road northeastward.

120.0 Follow road left.
120.4 Follow road right.
120.8 Turn right onto pavement, proceed back to Highway 3.
121.6 Cross Illinois Central Railroad tracks.
122.2 Stop sign, turn left onto Highway 3, retracing route back toward intersection with Highway 149.
123.2 Rest stop—Gorham Information Center.
125.1 Intersection Highways 3 and 149, turn right on Highway 149, proceed eastward towards Murphysboro.
126.0 Bridge over Big Kinkaid Creek.
126.4 Roadcut in a sandstone of the Caseyville Formation.
127.8 Roadcut in a sandstone of the Abbott Formation.
132.0 Crossing under Missouri-Pacific Railroad overpass, entering Murphysboro, proceed eastward through town.
133.3 Intersection State Highway 127 south. Continue east on Highway 149.
133.5 Intersection Highways 149 and 13, leave Highway 149 and continue straight ahead (east) on Highway 13 towards Carbondale.
133.7 Bridge over Big Muddy River. South of here was the first major coal mining in Illinois. Coal was mined prior to 1810 and shipped down the Big Muddy River and on the Mississippi River to points as far as New Orleans.
139.1 Entering Carbondale.
140.6 Intersection Highway 51 south, main intersection downtown Carbondale, proceed eastward crossing over Illinois Central Railroad tracks on Highway 13.
144.7 Turn right (south) on Crab Orchard Lake road. Entering Crab Orchard Wildlife Refuge.
145.3 Crab Orchard Lake on left.
146.4 Now driving at base of Crab Orchard Dam, an earth-fill structure.
146.9 Crossing bridge over Crab Orchard Creek.
147.2 STOP 6. Crab Orchard Dam, NW½ NW¼ sec. 30, T. 9 S., R. 1 E., Williamson County, Carbondale Quadrangle. Turn sharp left into parking area for view of spillway and exposure.
At this locality, an elongate sand body tentatively correlated with the Granger Sandstone Member of the Spoon Formation can be examined closely. This sandstone is considerably higher stratigraphically than the Caseyville sandstones seen previously and exhibits some of the differences that characterize sandstones of this and higher formations in the Pennsylvanian. Quartz granules and pebbles that are generally found in sandstones of the Caseyville Formation are observed only locally in the overlying Abbott Formation and have not been reported in higher formations. Mica usually is not recognizable megascopically in Caseyville Formation sandstones, becoming increasingly common in higher formations. A substantial amount of interstitial clay matrix also typifies the sandstones in formations above the Caseyville; sandstones of the Abbott Formation are somewhat transitional between the older and younger types. Abundant mica, particularly on parting surfaces and argillaceous matrix in the Granger Sandstone are well displayed here. Sandstones of the Caseyville Formation are orthoquartzites to protoquartzites and those of higher formations generally are protoquartzites to subgraywackes of Pettijohn (1957).

To the west, in the cut bank by the pool below the spillway, the sandstone can be seen cutting down into underlying strata (fig. T-13).

To the west of this locality, this sandstone probably would be in the sheet phase. The angular relations in this cut bank are thought to be the result of penecontemporaneous slumping into the channel. A steep valley or channel margin may have created unstable conditions and the shales and siltstones slumped down into the channel. Differential compaction and slumping also may have occurred within argillaceous silts and clays within the channel. The angular unconformity seen here has only local importance and is not related to any regional tectonic event.

Sedimentary structures having directional significance are abundant at this outcrop. Those particularly well shown are shallow troughs each filled with a cross-bedded sedimentation unit. Most cross bedding dips in a southeasterly direction. Here, in most cases, both the axis of the trough and the dip of the cross beds can be determined. One can readily see that the variation in measured directions is greater from the cross beds than from the trough axes. Parting lineation, found in some areas, generally strikes parallel to the other directional structures. This exposure provides an unusually good "birds eye" view of relations of a complex system of cross-bedded units (fig. T-14).

After examination and discussion, vehicles will retrace route back to Carbondale.

149.7 Intersection of Lake and Highway 13, turn left on Highway 13, proceed westward to Carbondale.

153.2 Carbondale, night stop, Holiday Inn.
Abrupt change in dip - apparently the lateral margin of a channel

Figure T-13. Diagrammatic sketch of Granger (?) Sandstone lying unconformably on lower strata near the spillway of Crab Orchard Lake (STOP 6).

Figure T-14. Plane table map of cross bedding and parting lineation in Granger (?) Sandstone exposed on the surface of the spillway of Crab Orchard Lake (STOP 6). Edges of cross beds are concave in down-current direction. Dip and strike symbols show inclination of cross bedding. Heavy lines represent natural boundaries of cross beds; light lines represent eroded or overlapped units (Potter, 1963, fig. 28).
Buses will load at and depart from front entrance of the Holiday Inn promptly at 7:30 A.M.

0.0 Leaving motel, turn right on Highway 13 and proceed west through Carbondale.

0.9 Intersection, Illinois Central Railroad tracks, proceed ahead on Highway 13, crossing the main intersection in downtown Carbondale.

2.6 Turn left on State Highway Office road. This is old Highway 13, proceed west.

7.3 Intersection with Highway 127, turn left (south) on Highway 127 toward Alto Pass.

12.0 Intersection, Etherton road to west, continue south on Highway 127.

13.2 Roadcut on west side is Pounds Sandstone. Immediately under the thick sandstone is a thin coal.

16.1 Intersection, Pomona Road, continue south on Highway 127.

18.1 Johnson-Union County line, immediately south is outcrop of Battery Rock Sandstone in pasture on west (right) side below road level.

19.8 Turn left at intersection, Y-road into Alto Pass by brick school.

20.2 Main intersection in downtown Alto Pass, continue straight ahead on blacktop road parallel to G. M. & O. Railroad tracks.

20.3 Begin ascent up road to Cliff View Park, prepare for stop.

20.5 STOP 7. Turn right into Cliff View Park, stop by shelter house.

The bluff below Cliff View Park is formed principally by one or more relatively narrow channel sandstones. As seen from the railroad track level, the main sandstone exposure thins both to the northwest and southeast with a lower contact rising in the bluff in both directions. This convex downward lower surface is typical of channel sandstones bodies.

At the top of the bluff, about 10 feet of sandstone with abundant quartz pebbles occurs. This is best seen just southeast of the shelter building. This abundance of quartz pebbles is typical of the Pennsylvanian Caseyville Formation sandstones. This part of the exposure has been recognized as Battery Rock Sandstone Member for a number of years. Quartz pebbles have not been found in the channel sandstone forming most of the remainder of the bluff although quartz granules, 2 to 4 mm in diameter, are relatively numerous in some beds. Several workers have correlated this sandstone with the Degania Formation (Mississippian).

On the basis of several detailed examinations, some controversy has developed regarding the correlation of the sandstones at this locality. There is a general agreement that the quartz-pebble sandstone at the top of the bluff is in the Caseyville Formation; however, there is some question as to whether the remainder of the channel sandstone is Mississippian or Pennsylvanian.

The bases for differentiation of Pennsylvanian and Mississippian sandstones have been the subject of considerable study, particularly in the last ten years. This is reviewed in the introductory material of this guidebook. Most of the various criteria that have been found useful are not applicable at this site. No significant difference in the gross lithology of the sandstone benches is apparent except for the prominence of the quartz pebbles. It also has been reported (Emrich, personal communication, October 5, 1957) that although mica is not conspicuous, substantial quantities of mica were found in heavy mineral separations from the upper bench of sandstone.

Typically, Chesterian sandstones have been found to be finer grained than Caseyville sandstones, although there is some overlap in the grain-size data that have been published. As may be seen in the median grain-size profile shown in figure T-15, the channel sandstone here shows a general decrease upward in grain size and within a range commonly encountered for Caseyville sandstones. However, analyses have been reported for Degania sandstone within this same range. It is quite probable that the particular facies, in this case a channel, is likely to be of greater influence on grain size of the sandstone than whether it is uppermost Chesterian or lowermost Pennsylvanian in age.
Tourmaline roundness has been used as a basis for differentiating Pennsylvanian sandstones from Mississippian sandstones. It was reported by Atherton et al. (1960) that the percentage of rounded tourmaline in the total tourmaline of the heavy minerals from five Caseyville samples, taken in the top 5'5" of the bluff, ranged from 19% to 34% with an average of 25.4%. Emrich (personal communication, October 5, 1957) reported that at 8 feet from the top of the bluff, the amount of rounded tourmaline increased to 51% and below that it stayed about 45% to 50%. These figures agree with data supplied by Atherton et al. (1960, p. 9), which showed averages of 27.6% for 59 Caseyville samples and 44.2% for 79 Chesterian samples. There is much overlap in the data from which these averages were made, and the analyses they reported for 8 samples of Battery Rock and Lusk Members averaged 44.6% in comparison with an average of 36% which they reported for 6 Degonia Sandstone samples from other areas. It is concluded here that these data are not definitive and that tourmaline roundness cannot be used with much assurance to distinguish Caseyville sandstones from those of the upper part of the Chesterian. However, higher sandstones of the Abbott and Spoon Formations also rest on Mississippian rocks to the north, both in subsurface and along their outcrops. These higher Pennsylvanian sandstones have considerably lower percentages of rounded tourmaline (reported to be generally less than 10 percent) and this criterion would be useful for differentiation of Pennsylvanian from Mississippian sandstones where sandstones of the Caseyville Formation are absent.

We feel that no weight of evidence on data yet developed favors one correlation over the other at the Cliff View Park exposure.

The view to the southwest from Cliff View Park toward Bald Knob, on top of which the large cross is located, overlooks a stratigraphic interval including nearly all the Chesterian sequence. These strata dip steeply to the northeast with Devonian strata thrust against Ste. Genevieve Limestone near the base of Bald Knob along the Rattlesnake Ferry Fault. Displacement along the fault is reported locally to exceed 2000 feet. Bald Knob and the area southwest of the fault are formed by Clear Creek Chert (Devonian).

The large cross on top of Bald Knob is the scene of annual Easter Sunrise Services. The structure is 110 feet tall, weighs over 1000 tons, and is covered by porcelain coated steel panels. The total cost of this shrine to date has been about $250,000.

Note: Special attention at Cliff View Park is directed to sandstone slabs, used in construction of the shelter house, which display some good examples of sedimentary structures. Notable among these are well oriented plant casts, cuspate and irregular ripple marks, parting lineation, and load casts. The stone probably is locally derived, but it is not known from which formation this stone was quarried.

Turn around and retrace route to Alto Pass.

20.8 Intersection, Bald Knob Road, turn left following the Ozark Shawnee Trail signs, after crossing over railroad tracks, make turn to left followed by an abrupt turn near an old store building.

21.0 Turn right before crossing bridge over Highway 127. This turn off leads down to highway.

21.1 Stop sign, turn left (south) on Highway 127, continue south under overpass.

21.2 Palestine Sandstone in roadcut.

21.5 Menard Limestone with shale interbeds can be seen on left side of road.

22.0 Turn right on gravel road, immediately crossing small concrete bridge, take left fork just after crossing bridge.

22.5 STOP 8. Tar Springs Sandstone crosses road, and there is an outcrop in creek on left side of road and in bluff on right (north) side of road.

This outcrop (fig. T-16) exhibits characteristics of both elongate and sheet sand bodies. To the north of the road, the typical elongate cross-bedded sandstone forms a steep bluff. In the creek bank south of the road, there is ripple-marked horizontal-bedded sandstone that is characteristic of the sheet phase. Ball and pillow structures (fig. 8a) are particularly well exposed at the base of the unit, which is conformable with the underlying dark gray, fissile shale.
STOP 7. CLIFF VIEW PARK SECTION, ALTO PASS

BATTERY ROCK SANDSTONE MEMBER
Sandstone, medium grained, cross-bedded, with quartz pebbles up to 3/4" across; unit forms a channel in underlying sandstone, average cross bedding S 50° W (2)

DEGONIA (?) OR BATTERY ROCK SANDSTONE
Sandstone, medium grained; thins to the SE and NW; cross bedding 6"-30" thick of the festoon and planar types; some zones with quartz granules; average cross bedding S 17° E (6)

Sandstone, fine grained, thin to medium bedded; bedding horizontal and persistent

Covered

Figure T-15. Columnar section, in southwest-facing bluff below park. Alto Pass 15', Cobden 7¼ Quadrangles, NW¼ NW¼ NE¼ sec. 15, T. 11 S., R. 2 W., Union County.

STOP 8. ONE MILE SOUTH OF ALTO PASS

MISSISSIPPIAN SYSTEM
TAR SPRINGS FORMATION
Sandstone, fine grained, thin bedded; abundant trough and planar cross bedding; plant casts, average cross bedding S 39° E (5); upper 20 feet of the Tar Springs crops out on the north side of the road and the lower part crops out in the creek on the south side

Sandstone with shale partings; rare plant casts; longitudinal ripples; some shale pebbles

Shale and sandstone interbedded, some ripple marks

Sandstone, fine grained, ripple marked and ripple laminated; some trough cross bedding; bearing numerous ball and pillow structures up to 1' thick and 2' across at base

Shale, dark gray, smooth, fissile, partially covered

GLEN DEAN FORMATION
Limestone

Figure T-16. Columnar section, exposed north and south of road. Alto Pass 15', Cobden 7¼ Quadrangles, W¼ SE¼ SW¼ sec. 15, T. 11 S., R. 2 W., Union County.
The upper part of the Tar Springs on the north side of the road contains both festoon (trough) (fig. T-17) and tabular-planar cross bedding (cover photo) in the same general portion of the outcrop. The individual inclined beds are unusually thick.

Also seen in the upper part of the Tar Springs Sandstone at this stop are unbedded (massive) small channels or cut-and-fill structures that range up to about 8 feet thick and about 30 feet across.

After discussion and examination, retrace route back to Highway 127.

22.8 Stop sign, intersection of gravel road with highway, turn right on Highway 127, proceed south.

23.3 Outcrop of Waltersburg Sandstone on right side of road.

24.2 STOP 9. Pull off on shoulder of highway. This outcrop of sandstone is in the upper part of the Ste. Genevieve Formation (SE^1 NW^1 SE^2 sec. 22, T. 11 S., R. 2 W., Union County, Alto Pass 15', Cobden 7^1_2' Quadrangles).

The stratigraphic column in this area is not known with certainty, but these thin- to medium-bedded sandstone units lie a short distance above the main limestone units of the Ste. Genevieve and are included within this formation. Because the dip is essentially parallel to the slope, there is good exposure of the bedding surfaces, but little opportunity to examine much thickness of section.

Structures particularly abundant here are ripple marks, rib and furrow, load casts, frondescent casts, slide marks, and shale pebble conglomerates. Secondary sedimentary structures particularly well developed are shrinkage cracks (fig. T-18) that have been reported on by W. A. White (1961). He used these as examples of syneresis cracks, which are defined as fissures that develop in a suspension where waters are expelled from the clay-water system by internal forces; they may

Figure T-17.
Festoon (trough) cross bedding in Tar Springs Sandstone at STOP 8.
resemble mud cracks. In this case, the cracks formed in thin clay layers under water, and sand filled the cracks during deposition of the overlying sand layer. After lithification, the sand in the cracks became part of the sandstone layer.

After discussion and examination vehicles will proceed on highway southeastward.

24.5 Turn left (east) on gravel road to Cobden.
25.6 Escarpment to left is held up by Degonia Sandstone.
25.8 Waltersburg Sandstone outcrops in ditch to the right and left of road, excellent exposure in small creek on right (south) side of road (Appendix 62).
25.8 Crossing Illinois Central Railroad tracks, escarpment face on the left (north) is made up of various formations of the Chesterian and marks the line of folding, which runs in a northwest-southwest direction. It also includes the prominent Rattlesnake Ferry Fault to the northwest. The ridge itself is a cuesta with northeasterly dip.

27.1 Road changes to black top, entering outskirts of Cobden.
27.4 Stop sign, turn left on Centennial Avenue.
27.6 Stop sign at intersection, turn left on Highway 51, proceed north.
30.1 Outcrop of Battery Rock Sandstone on both sides of road.
32.9 Jackson-Union County line.
33.2 Outcrop of Pounds Sandstone on both sides of road.
34.2 Turn right on road to Giant City State Park, leave Highway 51.
34.6 Outcrop of Pounds Sandstone is on right side of road on descending into valley.
35.7 Entering town of Makanda.

Figure T-18.
Syneresis cracks exposed on surface of sandstone bed in Ste. Genevieve Formation at STOP 9 (W. A. White, 1961, plate 4).
35.9 Crossing Drury Creek Bridge.

36.0 Crossing Illinois Central Railroad tracks, turn left in town of Makanda.

36.5 Turn right into Giant City State Park.

36.6 Bluff on right side of road is Pounds Sandstone, showing abundant cross bedding.

36.8 STOP 10. Near cen. N\(\frac{3}{4}\) sec. 27, T. 10 S., R. 1 W., Jackson County, Carbondale Quadrangle. Lunch at shelter to left of main road.

Throughout the park excellent exposures of the Pounds Sandstone can be seen. Large joint blocks, separated from the bluffs by vertical fractures, create the illusion of narrow streets bordered by tall buildings and account for the name Giant City. The sandstone is cross bedded throughout and contains numerous quartz pebbles.

After lunch proceed on road through park.

38.6 Proceed under overpass near Giant City Park office.

38.7 Turn left on Lodge Road and Little Grassy Lake boat dock road.

39.0 Intersection, turn left on road leading to Route 13.

39.2 Intersection, turn left on road which leads to Little Grassy Lake and Route 13.

39.3 Turn right, continue on road to Little Grassy Lake and Route 13.

42.9 Right turn on blacktop road.

43.4 Intersection with boat dock road, continue ahead, veering to left on blacktop road.

44.5 Crossing over spillway of Little Grassy Lake.

45.9 Intersection with T-road south to Devils Kitchen Lake and Baker Crossroads, continue ahead on blacktop road.

46.2 Devils Kitchen Lake visible to right.

47.4 Intersection with T-road east, turn right on road marked to Routes 148 and 37, proceed east on blacktop road.

49.8 Intersection with Wolf Creek and Devils Kitchen Lake road, continue ahead on main blacktop road, going easterly.

51.7 Stop sign at intersection, turn right on Highway 148, proceed south.

54.4 Turn right on Interstate 57 approach road.

54.6 Finnie Sandstone Member of the Abbott Formation in roadcut on right, sandstone occurs on both sides of approach and both sides of highway. This is a horizontal-bedded sheet phase of the Finnie. Proceed south on Interstate 57.

56.0 Outcrop of Grindstaff Sandstone Member of Abbott Formation on left (east) side of highway, at reflector milepost 43-43.

56.3 Johnson-Williamson County line, entering Johnson County. This is the southernmost extent of the Illinoian glacier. Till exposed on left (east) side of road.

57.0 Outcrop of Grindstaff Sandstone on right (west) side of road, reflector milepost 42-41.

59.8 Goreville road overpass.

60.0 Sandstone outcrop on both sides of road, this is upper part of the Pounds Sandstone Member of the Caseyville Formation.

60.2 Descending through Pounds Sandstone, milepost 39-31.

60.3 Going into Drury Shale Member, Caseyville Formation.

60.5 Relatively thick sandstone in the Drury Shale Member.
61.3 Beginning descent through Battery Rock Sandstone Member of the Caseyville Formation at milepost 38-27; bottom of Battery Rock at mile post 38-19; passing through relatively thick section of interbedded sandstone and shale of the Lusk Shale Member, the lowest member of the Caseyville, base at milepost 37-49; immediately south of here, highway is on fill.

62.0 Bridge.

62.7 Kinkaid Limestone Formation (Mississippian) exposed on both sides of road at milepost 37.

63.1 Turn right on Lick Creek exit for turn around to go north (east lanes) on Interstate 57.

63.4 Stop sign on Lick Creek Road, turn left, cross over Interstate 57. At this point there is a good view of the escarpment formed by Caseyville sandstones to the left (north).

63.5 Turn left on Interstate 57 approach.

64.8 Bridge, Kinkaid Limestone visible to right in hillside.

65.0 STOP 11. Lusk Shale and Battery Rock Sandstone Members.

A continuous vertical exposure (fig. T-19) of essentially all the Lusk Shale and Battery Rock Sandstone Members can be examined here (fig. T-20). With reference to the reflector mileposts that are situated 200 feet apart, the following summary section, listed in ascending order, should aid in the identification of the various units on the columnar section (fig. T-19):

- Base of Section – milepost 37-50.
- Prominent 15 foot sandstone in Lusk Shale – 37-52 to 38-2.
- Interbedded sandstone and shale – 38-2 to 38-12.
- Sandstone with some interbedded shale – 38-12 to 38-18.
- Dark gray, fissile shale – 38-18 to 38-20.

The Lusk Shale Member contains, in addition to silty shales and siltstones, several sandstone zones. About 2 miles east of here, in the Sec 10 Sec 19, T. 11 S., R. 2 E., Johnson County, a three-foot sandstone bed near the base of the Lusk Shale Member contains some marine fossils, notably crinoid columnals along with numerous plant casts (Wanless, field notes). The Lusk is not continuous across the southern outcrop area, and at places the Battery Rock Sandstone rests on Mississippian rocks. The sandstones in the Lusk Shale Member may be the horizontal-bedded, ripple-marked type that is more characteristic of the sheet sand bodies, or they may be the cross-bedded type characteristic of the elongate sandstones. In this section, the lower 15-foot sandstone appears to be of the elongate type and the remainder of the sandstones in the Lusk Shale Member are of the sheet type. The lower sandstone has been traced a short distance east and west, and where not present, it probably was removed by erosion prior to the deposition of Battery Rock Sandstone, which attains thicknesses of up to 100 feet. In the areas of thick development of the Battery Rock Sandstone, it forms the prominent bluffs that lie immediately to the east.

In this general area, important variations, which illustrate many of the characteristics of the Battery Rock Sandstone, can be observed (fig. T-21). Here in the highway cut, 54 feet of medium- to thick-bedded, cross-bedded Battery Rock Sandstone is exposed. A few quartz pebbles are scattered throughout. Although the contact with the underlying Lusk Shale Member is sharp, the basal bed of the Battery Rock intertongues with the shale, suggesting a conformable base. To the southeast along the outcrop the base of this sandstone apparently comes down through much, if not all, of the Lusk Shale Member and can be found within 30 feet of the uppermost exposure of Mississippian Kinkaid Limestone. Here the sandstone is much thicker and contains numerous quartz pebbles. The cross-bedding dip directions seem to be much more consistent from outcrop to outcrop and to show less variation at a single outcrop than is the case for the thinner sandstone such as the one observed in the highway cut.

It is thought that the thicker sandstone represents a single elongate sandstone, probably a river channel, which trends nearly parallel to the outcrop. The thinner sandstone may be alluvial or deltaic, or may represent the lateral margin of the same deep channel. In any case, however, the nature of the outcrop does not permit more detailed mapping. This thinner sandstone is probably more widespread than the thicker sandstone.
STOP 11. BATTERY ROCK-LUSK SECTION ON INTERSTATE 57

PENNYSYLVANIAN SYSTEM
CASEYVILLE FORMATION
BATTERY ROCK SANDSTONE MEMBER
Sandstone, medium to thick bedded, medium grained; scattered quartz pebbles; most units finely cross-bedded; bedding partially concealed by iron oxide; prominent bed at base intertongues with the underlying shale; becomes thin bedded, ripple marked and contains some shale in upper part

LUSK SHALE MEMBER
Shale, dark gray, hard, fissile.
Siltstone, gray to dark gray, carbonaceous
Sandstone, medium bedded
Sandstone, thinly bedded; shale partings; finely cross-bedded; asymmetrical ripples
Sandstone, medium to thick bedded; abundant shale pebbles; some cross bedding; several ball and pillow structures
Shale, gray to medium dark gray, silty, thinly laminated, interbedded with fine-grained sandstone beds up to 1' thick; several small ball and pillow structures up to 1'; few stems of Calamites; sandstone float blocks show fine flute casting, load casts, and ripple marks
Sandstone and shale, regularly interbedded
Sandstone, fine to medium grained; numerous cross-bedded units; quartz pebbles up to ¼" across
Shale, dark gray, micaceous, thinly laminated
Sandstone and shale, poorly exposed

MISSISSIPPIAN SYSTEM
KINKAID FORMATION
Limestone

Figure T-19. Columnar section, on east side of Interstate 57 near milepost 38 (description modified from Harris, 1961). Carbondale Quadrangle, NW¼ NW¼ NW¼ sec. 25, T. 11 S., R. 1 E., Union County.
After discussion and examination, continue northward on Interstate 57.

66.2 STOP 11A. Beginning traverse up section through Drury Shale and Pounds Sandstone Members of the Caseyville Formation (fig. T-22). Vehicles will drive slowly through this section.

The Drury Shale Member is similar in general aspects to the Lusk Shale Member, varying considerably in thickness and containing several sandstone units. Above the Drury Shale is the Pounds Sandstone which resembles the Battery Rock Sandstone. Throughout this area the Pounds Sandstone attains thicknesses as great or greater than the Battery Rock. Cross-bedding dip directions indicate similar patterns of sand movement. Quartz pebbles are characteristic, particularly of the thicker sandstone development. This exposure combined with the sequence examined in STOP 11 represent nearly the full thickness of the Caseyville Formation.

70.6 Entering Williamson County, milepost 43-28. Harris (1961) reports glacial till in north-bound lane, near the southernmost limit of glaciation in Illinois.

70.8 Grindstaff Sandstone in north-bound lane on east side of road, milepost 43-42.

72.0 Finnie Sandstone in roadcuts from here to Pulley’s Mill interchange.

72.4 Underpass at Pulley’s Mill interchange, intersection with Route 148, proceed on Interstate 57.

78.1 Crab Orchard Creek bridge.

78.9 Palzo Sandstone Member of Spoon Formation on both sides of highway, note abundant festoon cross-bedding, milepost 51-46.

80.1 Marion interchange, proceed on Interstate 57.

Route from this point continues on Interstate 57. Return to St. Louis following route marked on Figure T-1.

END OF ROAD LOG
Figure T-21. Sketch map of Battery Rock Sandstone and sandstone in the Lusk Shale Member near STOP 11. Cross bedding dip directions are shown for Battery Rock Sandstone.
STOP 11 A. POUNDS-DRURY SECTION ON INTERSTATE 57

**Pennsylvania System**
**Caseyville Formation**
**Pounds Sandstone Member**

- Sandstone, medium grained, thin bedded; load casts abundant; some groove casts noted; quartz pebbles concentrated in a 6" layer near top
- Shale, light gray, interbedded with siltstone; much iron oxide concentration; some fine and well developed liesegang banding

**Drury Shale Member**

- Sandstone, fine to medium grained, thin to medium bedded; shale pebbles; grades southward to shale, at least locally
- Sandstone, medium grained, cross-bedded; thins to about 2' to south; few quartz pebbles in basal bed; average cross bedding S 11° W (6)
- Sandstone, thick cross-bedded units

- Sandstone, fine grained, thin bedded; beds lenticular; ripple marked; shale pebbles, locally with quartz pebbles; intertongues with unit below

- Siltstone and shale interlaminated, wavy bedding, ripple marked, intertongues with units above and below
- Shale, gray, well laminated; several sandstone beds; one unit near base contains several sandstone lenses that are flat topped and convex downward at base (just N. of mile-post 39.16); few cuspatite ripples, base is gradational by intertonguing into underlying unit; asymmetrical transverse ripples with steep face dipping S 10° W
- Sandstone, fine grained, thin to thick bedded, ripple marked, micaceous; several cross-bedded units, most of which are relatively low angle; some small ball and pillow structures; intertongues into lower unit, cross bedding S 40° W, N 57° W, N 16° E
- Sandstone and shale interbedded; few small ball and pillow structures

Covered

Figure T-22. Columnar section, on east side of Interstate 57 between mile posts 39-10 (base) and 39-30 (top) (description modified from Harris, 1961). Carbondale Quadrangle, center west section line, sec. 19, T. 11 S., R. 2 E., Johnson County.
APPENDIX

The following brief descriptions of outcrops, supplementing sections described in the field trip log represent eight early Pennsylvanian and eleven late Mississippian sandstones. Several exposures are described for most formations and members listed. These are not necessarily the very best or most representative outcrops in all cases, but the list represents a selection from about 150 potential sections that were originally considered among the better exposures of these sandstones in the southern part of the state.

Many additional sections are described in published and unpublished reports and are to be found in the extensive field notebooks on file at the Illinois Geological Survey. A large percentage of these sections, however, have been compiled relative to stratigraphic studies and do not include much information on sedimentary structures. Additional details of the sand bodies are presented in this guidebook.

Quadrangle mapping studies provide a key to additional exposures, a number of which have been published in the past 25 years for southern Illinois. Within the past 10 years, a number of unpublished theses based on quadrangle mapping in southern Illinois by students at Southern Illinois University contain good stratigraphic sections that include sandstones.

A recent report by Potter (1962b) provides a list of sheet and elongate sand body outcrops throughout the state for Pennsylvanian sandstones, and Potter (1962c) has published a similar list for late Mississippian sandstones in the southern part of the state. Neither report, however, provides described outcrop sections. Special attention also is directed to published type sections of formational units of the Pennsylvanian by Kosanke, et al. (1960). Geologic sections 2 and 3 (p. 61-62) in this latter report include essentially the complete sequence of the Caseyville and Abbott Formations along the Illinois Central Railroad cut, extending from NE 1/4 SE 1/4 NE 1/4 sec. 18, T. 12 S., R. 5 E., Pope County, Brownfield Quadrangle (Pennsylvanian-Mississippian contact) northward to NW 1/4 sec. 5, T. 11 S., R. 5 E., Pope County, Harrisburg Quadrangle.

The appendix map shows, by appropriate symbols and numbers, the outcrops examined on the field trip and those described in this appendix.

The following Survey staff members have compiled the field notes and are identified on the sections with initials: M. E. Hopkins, J. A. Simon, W. H. Smith, F. N. Murray, T. K. Searight, J. E. Boudreaux, and D. A. Olmstead. The style of indicating average of cross-bedding dip direction appears on a number of the sections in abbreviated form. The average direction is shown and the figure in parenthesis following the direction indicates the number of measurements on which the average is based. (Example: "S14W(3)" indicates average dip direction of cross-bedding is "south 14" west and this represents the average of three measurements). Sections are arranged by county, but a stratigraphic unit finding list appears on the appendix map.
1. Roadcut at beach parking area in Pounds Hollow Recreation Area (SE SE SW 25, 105-8E, Equality 15' Quad., Karbers Ridge 75' Quad.) MEH, 1965

Pennsylvanian System
Abbott Formation (11'+)
Grindstaff Sandstone Member (4'+)
Covered .......................... 2
Sandstone, fine grained, thin bedded; beds 2" to 3" thick; irregular ripple marks; some rib and furrow structures; base of sandstone probably base of the Grindstaff Member .......................... 4
Shale, dark gray with numerous thin light gray siltstone interlaminations; siltstone lenses up to 1/4" thick .......................... 10
Siltstone and sandstone, interbedded; thin horizontal bedding; some ripple marks; interior of sandstone beds has a mixed appearance .......................... 6

2. Section on hillside, north side of tributary to Pounds Hollow. Outcrop is just southeast of the Pounds Lake Dam (NE NW SE 25, 105-8E, Equality 15' Quad., Karbers Ridge 75' Quad.) MEH, FNM, 1965

Pennsylvanian System
Abbott Formation
Finnis Sandstone Member (65')
Sandstone, thin bedded; some festoon cross bedding; cross bedding S4W (1) .......................... 7
Sandstone, fine grained; channel phase in lower 28', average cross bedding N89W (5); sheet plane in upper 30', average cross bedding S3S (2) .......................... 58

3. Section at steps going down cliff at "Fat Man's Misery" at Pounds Escarpment (CSW SW NW 36, 105-8E, Equality 15' Quad., Karbers Ridge 75' Quad.) MEH, FNM, 1965

Pennsylvanian System
Caseyville Formation
Pounds Sandstone Member (90'+)
Sandstone, fine to medium grained, cross bedded with medium scale cross beds; beds 1' in thickness; some beds up to 3' thick; average cross bedding S38E (5) .......................... 50
Sandstone, fine to medium grained, cross bedded with medium scale cross beds; some cross beds overturned; average cross bedding SSE (4) .......................... 40
Covered

HARDIN COUNTY

4. Roadcut, east side of blacktop road about 800' south of house (SW SW NE 6, 115-8E, Equality 15' Quad., Karbers Ridge 75' Quad.) MEH, FNM, 1965

Mississippian System
Palestine Formation (22')
Sandstone, fine grained, thin bedded, wavy bedded, beds average 1.5'; irregular ripple marks; beds slightly thicker and cross bedded in bottom 2'; average cross bedding NE (3) .......................... 5
Covered .......................... 3

Sandstone, very fine grained; horizontal bedding has been disturbed internally by burrowing, burrows up to 4' in depth; beds from 1" to 5" thick, averaging 2' thick; becomes thinner bedded and shaly downward ........................ 14

5. Section in roadcut on east side of blacktop road about 500' south of concrete bridge over

GALLATIN COUNTY

6. Section on blacktop roadcut. Base of section is at first sharp turn to west, top is about 500' northeast of intersection with road west to Garden of the Gods (NW NW NE 6, 115-8E and extending into SW SE 31, 105-8E, Gallatin County, Equality 15' Quad., Karbers Ridge 75' Quad.) MEH, 1965

Mississippian System
Waltersburg Formation (30+)
Sandstone, medium bedded; some unit cross bedded, sedimentary units up to 2' thick; average cross bedding S4W (4) .......................... 5
Sandstone, fine grained, medium bedded; beds average 2" in thickness and range up to 6"; bedding persistent but wavy; few poorly defined irregular ripple marks .......................... 10
Siltstone or very fine grained sandstone and silty shale interbedded; siltstone beds with load casts; various small tracks and trails; bedding very even and persistent; shale predominant in lower part; bedding thin; siltstone beds average 1' .......................... 15

7. Section measured in two roadcuts along blacktop road and extending to top of hill (near center NW 7, 115-8E, Equality 15' Quad., Karbers Ridge 75' Quad.) MEH, 1965

Mississippian System
Hardsinsburg Formation (65')
Sandstone, fine grained; an occasional zone with shale chips; medium bedded; bedding horizontal, even and persistent; occasional micro-cross laminations; some low angle fine cross bedding .......................... 18
Covered interval; some shale and thin bedded sandstone seen in lower 5' .......................... 35
Sandstone, fine grained, medium bedded; beds average 8' thick; all beds internally laminated; beds very flat, parallel and persistent .......................... 32
8. Section on north side of road near drive-way to house. (SW SW NE 20, 11S-8E, Equality 15' quad., Kaverns Ridge 73' quad.) MEH, FNM, 1965
Mississippian System
  Cypress Formation (27')
  Sandstone, poorly exposed ........................................ 2
  Covered ........................................................................ 2
  Sandstone, fine grained, thin to medium bedded; bedding surfaces flat; variable bedding thickness; maximum about 8" .......... 10
  Covered ........................................................................ 5
  Sandstone, fine grained, thin to medium bedded; bedding planes wavy but horizontal; beds average 2" and range up to 8" ....... 8
  Covered ........................................................................ 9

9. Section at and above waterfall in ravine (SW NW NE 10, 11S-9E, Shawmeetown 15' quad., Saline Mines 73' quad.) MEH, FNM, 1965
Pennsylvanian System
  Caseyville Formation
  Battery Rock Sandstone Member (116')
  Sandstone, medium grained, thin bedded, ripple marked; occasional shallow ripple scour; one surface noted with numerous animal trails; average strike of ripple marks N35E (3) ........................................ 23
  Sandstone, medium grained; much cut and fill channeling, mostly cross bedded; occasional quartz granules noted near base; average cross bedding N53W (3); top of unit forms top of waterfall ........................................ 3
  Siltstone, grey, argillaceous; shaly bedding .................................. 3
  Sandstone, medium grained, mixed bedding; bearing some plant fragments and shale pebbles ........................................ 1
  Sandstone, fine to medium grained, bedding thickness variable; several thin cross bedded units 3" to 4" thick; average cross bedding N60W (6) ........................................ 46

10. Small bluff on south facing escarpment (SW SE NW 33, 11S-10E, Shawmeetown 15' quad., Deer-Koven 73' quad.) MEH, FNM, 1965
Mississippian System
  Tar Springs Formation (30')
  Surface ........................................................................ 7
  Sandstone, fine grained, thin bedded; beds wavy and lenticular and average 1" to 2" thick; few tangential cross bedded units up to 6" thick; some liesegang banding; some thin zones up to 4" thick appear to be mixed by boring organisms; average cross bedding S65E (4) ........................................ 21
  Covered ........................................................................ 6
  Sandstone, thin bedded; beds 1" to 2"; ripple bedding, thin shale intercalations near base ........................................ 3

11. Southwest facing bluff and roadcut (SE NW SW 8, 12S-10E, Cave in Rock 15' quad., Cave in Rock 73' quad.) MEH, FNM, 1965
Mississippian System
  Bethel Formation (39')
  Sandstone, fine grained, sparkling, medium bedded; beds average 3" thick, tangential cross bedding; beds are persistent but variable in thickness; some appear to be shallow festoon cross beds, partly covered in upper 7' .......... 22
  Covered ........................................................................ 2

Sandstone, medium grained, sparkling, medium bedded, beds average 4" to 6", tangential cross bedding; average cross bedding due west (4) ........................................ 15

JACKSON COUNTY

12. Southwest facing bluff section (SE SE NE 7, 8S-4W, Campbell Hill quad.) MEH, JER, 1965
Pennsylvanian System
  Caseyville Formation (85')
  Sandstone, medium to course grained; some scattered quartz granules, cross bedded; some quartz pebble conglomerate in float; transverse ripple marks, partly covered ........................................ 25
  Sandstone, medium grained, mostly cross bedded; much liesegang and honeycomb weathering; lower part forms overhang; bedding largely obscured in some zones ........................................ 60
  Covered ........................................................................ 10
  Mississippian System
    Kinkaid Formation (5')
    Limestone, gray, numerous small crinoid columnals, only upper 5' was measured ........................................ 5

13. Ravine section paralleling road (NW SE SE and NE SW SE 20, 8S-4W, Campbell Hill quad.) MEH, JER, 1965
Pennsylvanian System
  Caseyville Formation
    Battery Rock Sandstone Member (10')
    Quartz pebble conglomerate; pebbles mostly 1' in diameter ........................................ 10
  Mississippian System
    Kinkaid Formation (10')
    Limestone, gray, fine grained, fossiliferous; mostly covered ........................................ 10
  Degonia Formation (5')
  Sandstone, fine grained, medium bedded; with lenticular bedding ........................................ 8
  Covered ........................................................................ 3
  Sandstone, fine grained, thin bedded; with cuspathe ripples ........................................ 4
  Covered ........................................................................ 10
  Sandstone, fine grained, cross bedded with medium bedding ........................................ 28
  Covered ........................................................................ 14

14. Up hill above abandoned limestone quarry (C-SE NW 3S, 8S-4W, Campbell Hill quad.) MEH, JER, 1965
Mississippian System
  Degonia Formation (6')
  Sandstone, fine grained, thin bedded; micro-cross laminated; top not exposed ........................................ 2
  Sandstone, fine grained; thin bedded; some planar and low angle cross bedding ........................................ 4

15. On hillside above highway east of Cora, (SW SE NE 26, 8S-6N, Campbell Hill quad.) MEH, JER, 1965
Mississippian System
  Palestine Formation (53' 10")
  Shale, light gray, thinly laminated, soft, weathers red and yellow ........................................ 1
  Coal ........................................................................ 4
  Underclay, light medium gray, silty, numerous carbonized plant rootlets ........................................ 2
  Covered ........................................................................ 6

<table>
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<th>Thickness</th>
<th>Sandstone, fine grained, medium and irregularly bedded, iron stained; bedding has mixed appearance in top several inches; casts of <em>Stigmia</em> up to 4&quot; diameter.</th>
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<td>Thickness</td>
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<tr>
<td>Thickness</td>
<td>Sandstone, fine grained; thin wavy beds; cuspatte ripple marks.</td>
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<tr>
<td>Thickness</td>
<td>Sandstone, fine grained, massive; may be out of place.</td>
<td>4</td>
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</table>

16. Outcrop in ravine and on both sides of road (SE SW 26, 98-2N, Alto Pass 15'E Quad., Pomona 73' Quad.) MEH, JAS, 1965

Pennsylvanian System
Abbott Formation
Grindstaff (?) Sandstone Member (20'E)

Sandstone, fine to medium grained, iron stained, quite micaceous in part; contains numerous shale chips in some zones, with occasional brachiopods and crinoids, no quartz or chert pebbles seen; bedding in sandstone thin and fairly regular, abundant festooned cross bedding; average cross bedding N37E (4). 20'

17. Section in Creek, base is 1/4 mi. S of highway, top is 1/4 mi. N of Highway 149 (SE NE and NE NE 3, 98-3W Murphyboro Quad.) MEH, JER, 1965

Pennsylvanian System
Abbott Formation (37'E)

Sandstone, fine grained, medium bedded; bedding forms irregular large relatively flat wedges, some tangential cross bedding. 10

Sandstone, fine grained, thin bedded; beds 3/4" to 2"; some cross bedding; poorly developed rib and furrow structures; average cross bedding S45E (3). 25

Sandstone, medium grained, massive, some cross bedding; occasional shale and quartz pebbles; pebbles up to 1/2" diameter; some chert pebbles in upper few feet. Cliff face displays exfoliation, cross bedding S35E (1). 25

Covered. 20

Sandstone, medium grained, massive. 7

18. Section at dam spillway near Midland Hills Country Club (SW NW SE 18, 105-1W, Alto Pass 15'E Quad., Pomona 73' Quad.) JAS, MEH, 1965

Pennsylvanian System
Caseyville Formation
Pounds Sandstone Member (35'

Sandstone, medium grained, coarse grained in some beds which have quartz granules; bedding generally thick, becoming thin bedded and ripple marked in upper 8'; some quartz pebbles up to 1" in occasional zones; bottom contact with Drury Shale Member disconformable with relief up to 10 feet; average cross bedding 8'E (2). 45

19. Roadcut on west side of Highway 127 (E1/2 SW NW 10, 105-2W, Alto Pass Quad.) MEH, JER, 1965

Pennsylvanian System
Caseyville Formation
Pounds Sandstone Member (35'E)

Sandstone, medium grained; bedding averages 4" in thickness, occasionally up to 1'; numerous trough cross-bedded units; average cross bedding 8'E (2). 35

Conglomerate, pebbles composed of quartz and shale up to 1"; matrix of sandstone. 8

Drury Shale Member (27'E)

Shale, medium dark gray, hard, fissile, slightly silty. 2

Siltstone and shale interlaminated; ripple bedding. 4

Sandstone, fine grained in lower part; coarse to very coarse in upper part. 10

Coal, normally bright banded. 4

Underclay, light gray, silty, numerous carbonized rootlets. 4

Covered

20. Outcrop at southeast part of Goreville interchange on Interstate Highway 57 at milepost 39-44 on east side of highway (NW SE 18, 115-2E, Carbondale Quad.) MEH, JAS, 1965

Pennsylvanian System
Caseyville Formation
Pounds Sandstone Member (35'E)

Sandstone, fine grained, micaceous, medium bedded, bedding averages 3" thick, beds up to 1" thick at top; tangential cross bedding; few ball and pillow structures in basal part; numerous quartz pebbles near top; average cross bedding S54W (4). 12

Shale and sandstone interbedded, partly covered; shale is dark gray and well laminated; sandstone in medium beds. 5

Sandstone, medium grained, medium bedded, beds average about 8"; quite ferruginous; cross bedded. 6

Shale, silty, largely covered. 2

21. Fern Grove State Park, section up steep southeast draining ravine that crosses park road at hairpin curve (E1/2 NW SW 22, 115-2E, Marion 15'E Quad.) MEH, 1965

Pennsylvanian System
Caseyville Formation
Pounds Sandstone Member (35'E)

Sandstone, medium grained; some clay chip conglomerate in float; beds average about 5" thick, ripple marked; some poorly defined ripple scours; a few shaly beds up to 1" thick. 15

Sandstone, medium grained, medium bedded, beds average 6" thick; festoon cross bedding; no quartz pebbles or granules seen in the ravine section but 200' to the southeast quartz pebbles up to 3/4" diameter are fairly abundant along base of the cliff; cross bedding common; average cross bedding 835W (3), one measurement N45E. 70

22. Railroad cut near south portal of New York Central Railroad tunnel. Top of exposure is above portal, main exposure is south of portal and in small ravine 1000' south and 100' east of portal, base of section seen at south end of cut (E1/2 NE SE 35, 115-3E, Marion 15'E Quad.) MEH, 1965

Pennsylvanian System
Abbott Formation (35'E)

Unnamed Member (25'E)
22. Section in creek bed east of road (SE SE 14, 13S-3E, Vienna Quad.) MEN, JAS, 1965
Mississippian System
Hardsburg Formation (6'+)
Sandstone, thin to medium bedded; bedding slightly undulatory; good rib and furrow indicating current flowing N20E; bedding surfaces well exposed

27. Exposure on south facing bluff (NW SW NW 19, 13S-3E, Vienna Quad.) MEN, FMN, 1965
Mississippian System
Hardsburg Formation (51'+)
Sandstone, fine grained, sparkling; most units cross bedded; medium bedded, beds average 8" but are up to 2' thick; festoon cross bedding common; 4' of relief on disconformable base; average cross bedding S74W (5) ...

28. Section in creek (SW NE SE 35, 13S-3E, Vienna Quad.) MEN, JAS, 1965
Mississippian System
Cypress Formation (30')
Sandstone, channel phase, cross bedded; a few ripple marks

29. Section in road ditch on south side of blacktop road (C 5½ SW 9, 13S-4E, Vienna Quad.) MEN, FMN, 1965
Mississippian System
Waltersburg Formation (22' 6'+)
Sandstone, thin to medium bedded, beds 1" to 3", top bed is 1' 6"; bedding horizontal ...

30. Section near top of southeast facing bluff ½ mile northeast of Kelknap (SE SW NE 1, 14S-2E, Vienna Quad.) MEN, FMN, 1965
Mississippian System
Bethel Formation (19' 6'+)
Sandstone, ripple bedded; some rib and furrow structures; a few thin shaly streaks; several layers with numerous pebble casts in upper 2' of unit ...

31. Outcrop in road cut and ditch on east side of road (SE NW SW 15, 14S-4E, Vienna Quad.) MEN, JAS, 1965
Mississippian System
Tar Springs Formation (144')

---

24. Outcrop in bed of west flowing stream just under and east of bridge (SW NE NE 34, 12S-3E, Vienna Quad.) MEN, FMN, 1965
Mississippian System
Palestine Formation (6'+)
Sandstone, fine grained, thin bedded, beds horizontal, wavy; abundant irregular ripple marks; some poorly developed rib and furrow structure; a few float blocks display small load casts.

25. Section on Highway 45, just south of Vienna (NE NE SE 8, 13S-3E, Vienna Quad.) MEN, JAS, 1965
Mississippian System
Tar Springs Formation (15'+)
Sandstone, thin bedded, slightly undulatory bedding; rib and furrow poorly developed; occasional ripple marks and cross bedding, a few shale chips in some beds.

---

23. In road cut on east side of Highway 45 about half way up hill, and south of intersection with route 166 (W1/2 NE SE 9, 115-4E, Marion 15' Quad., MEN, 1965
Pennsylvanian System
Abbott Formation
Murray Bluff Sandstone Member (60'+)
Sandstone, fine grained, micaceous, thin to medium bedded, beds average 2" thick and range up to 2' thick; a few shale pebbles; low angle, tangential cross-bedded units up to 1' thick; some irregular ripple marks, a few shaly partings; average cross bedding N25W, tectonic dip N42W at 29°, average cross bedding corrected for tectonic dip N29W (2) ...

---

26. Section in creek bed east of road (C SE 14, 13S-3E, Vienna Quad.) MEN, JAS, 1965
Mississippian System
Hardsburg Formation (6'+)
Sandstone, thin to medium bedded; bedding slightly undulatory; good rib and furrow indicating current flowing N20E; bedding surfaces well exposed

---

29. Section in road ditch on south side of blacktop road (C 5½ SW 9, 13S-4E, Vienna Quad.) MEN, FMN, 1965
Mississippian System
Waltersburg Formation (22' 6'+)
Sandstone, thin to medium bedded, beds 1" to 3", top bed is 1' 6"; bedding horizontal ...

---

30. Section near top of southeast facing bluff ½ mile northeast of Kelknap (SE SW NE 1, 14S-2E, Vienna Quad.) MEN, FMN, 1965
Mississippian System
Bethel Formation (19' 6'+)
Sandstone, ripple bedded; some rib and furrow structures; a few thin shaly streaks; several layers with numerous pebble casts in upper 2' of unit ...

---

31. Outcrop in road cut and ditch on east side of road (SE NW SW 15, 14S-4E, Vienna Quad.) MEN, JAS, 1965
Mississippian System
Tar Springs Formation (144')
(31 continued)

Sandstone, very fine grained, thinly interbedded with siltstone; silty shale partings; has mixed appearance.  

Siltstone, light gray; a few thin sandstone interbeds; iron stained; base disconformable, with relief of several feet.  

Sandstone, very fine grained, compact, hard; beds from 1" to 6" thick, bedding horizontal and uniform; poorly defined ripple marks; a few shale pebbles.  

Siltstone, medium gray; containing numerous thin iron-stained sandy beds; lower contact is gradational.  

Sandstone, very fine grained; beds 2" to 6" thick, alternating with silty shale with abundant ripple marks.  

Shale, slightly silty; some thin iron stained beds; contorted bedding in some silty zones.  

Shale, silty, with thin sandstone interbeds.  

Sandstone, thin to medium bedded; some undulatory bedding; some load casts.  

Sandstone, fine grained, massive; contact with underlying unit is gradational.  

Sandstone, fine grained; irregular bedding, lenticular beds 1" to 6" thick.  

Shale, medium gray; sandy and silty beds; absent.  

Sandstone, fine grained, thin bedded; several thin shaly beds; load casts and ripple marks.  

Shale, medium gray, silty, micaceous; several ball and pillow structures; some fine grained sandstone bands.  

Covered.  

Siltstone; thin wavy bedding; some soft shale pebbles; irregular ripple marks.  

Shale, medium gray, largely covered.  

Sandstone, very fine grained; horizontal bedding; beds up to 3' in thickness; load casts, possible ball and pillow structures; shale chips; some rib and furrow structures.  

MONROE COUNTY

32. Section on south bank of Dry Fork (C NW NW 27, 4S-9W, Reynolds Quad.) JAS, MEH, 1965

Mississippian System
Renaissance Formation (16')

Sandstone, medium grained, cross bedded; medium to thick bedding; planar cross bedding dominant; some transverse asymmetric ripple marks; poorly developed small cuspatte ripple marks; unit truncates the underlying sandstone.  

Sandstone, medium grained, thin bedded; some cross-bedded units up to 6" thick; numerous ripple marks; beds generally discontinuous, much low angle truncation; numerous float blocks show well developed organic burrows; average cross bedding measured throughout outcrop 326W (5').  

33. Section in west flowing ravine (NW SW NW 3, 5S-9W, Reynolds Quad.) JAS, MEH, 1965

Mississippian System
Aux Vases Formation (39')

Sandstone, fine grained, thin bedded; undulatory bedding; abundant cuspatte ripples; asymmetrical ripples in slump blocks; flat shale pebble conglomerates in some zones; load casts abundant in float.  

Shale, gray, with rust brown bands up to 2" thick in horizontal streaks and about 2' apart; occasional thin benches of sandstone similar to the sandstone above.  

Sandstone, similar to 3' sandstone above; a few poorly developed shrinkage cracks at contact with the overlying shale; sandstone has a large variety of load cast types.  

POPE COUNTY

34. Outcrop at Burden Falls (SE SW NE 15, 11S-6E, Harrisburg 15' Quad., Stonefort 7½' Quad.) TKS, DAO, 1965

Pennsylvanian System
Caseyville Formation
Pounds Sandstone Member (75')

Sandstone, medium grained; quartz pebbles common in massive bedded units; cuspatte and assymetrical ripple marks; rib and furrow structures are seen in thin bedded units south of road.  

35. Outcrop in roadcut along Highway 145 (C SW SE 5, 11S-6E, Harrisburg 15' Quad., Eddyville 7½' Quad.) MEH, TKS, 1965

Pennsylvanian System
Abbott Formation
Grindstaff Sandstone Member (25')

Sandstone, medium grained, cross bedded in units up to 2' thick; pebble conglomerates in some zones; sandstone near top of section is very coarse grained and contains some quartz granules.  

36. Outcrop along Bear Branch Creek (NE NE SW and SW SE NW 32, 11S-6E, Harrisburg 15' Quad., Eddyville 7½' Quad.) TKS, DAO, 1965

Pennsylvanian System
Caseyville Formation
Battery Rock (?) Sandstone Member (25')

Sandstone, very fine grained, thin bedded; bedding surfaces very irregular; cross bedding occasionally found; some plant remains.  

Sandstone, fine to medium grained, medium bedded; cuspatte ripple marks near top of unit; rib and furrow structures in isolated beds.  

Sandstone, fine to medium grained; some contorted structures; ripple marks; planar cross bedding.  

Sandstone, fine to medium grained, friable; bedding averages 8" thick; planar cross bedding; upper portion of this unit contains quartz pebbles up to 3/4" diameter and averaging 1/16 inch; rib and furrow structures occur in place and in float; average cross bedding 545E (2').  

37. South side of small ravine 300' E of Highway 145 (W½ NW NW 28, 12S-5E, Brownfield 15' Quad., Glendale 7½' Quad.) FNM, 1965

Mississippian System
Degonisia Formation (41')

Sandstone, fine to medium grained; festoon cross bedding; blocky; becoming thinner bedded upward in section.  

Covered.  

Sandstone, fine to medium grained; festoon cross-bed areas 50' X 50' evident in plan view; ripple marks.  

38. Outcrop on south facing slope (SW NW SE 8, 12S-6E, Brownfield 15' Quad., Waltersburg 7½' Quad.) MEH, JAS, 1965

Pennsylvanian System
Caseyville Formation (20')

Laak (?) Shale Member
<table>
<thead>
<tr>
<th>Thickness</th>
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<tbody>
<tr>
<td><strong>Rutland County</strong></td>
<td><strong>Randolph County</strong></td>
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</tbody>
</table>
| 45. Section at waterfall (SE cor. SW 3, SS-9W, Renult Quad.) MEH, FNM, 1965 | Mississippian System  
Sandstone, fine grained, cross bedded; ripple marked; average cross bedding 54SW (5)  
(See fig. T-5; median grain size vertical profile)  |
| 46. Box Canyon outcrop in tributary ravine to Barbeau Hollow (NE SE 9W, projected section 23, SS-9W, Renult Quad.) JAS, WHS, MEH, 1965 | Mississippian System  
Aux Vases Formation (50')  
Sandstone, fine grained, medium bedded; no shale beds; most beds are persistent; a few are lenticular; essentially every sedimentary unit show planar cross bedding with relatively uniform dip direction; some tangential cross bedding; occasional asymmetrical ripple marks with strike at right angles to dip of cross bedding; some symmetrical ripple marks are parallel to dip of cross beds; strike of cross beds on surface exposures are well displayed and are gently curved concave down dip; average cross bedding 57SW (5)  |
| 47. Bank on west side of bridge (SE SW NW 34, 65-7W, Chester Quad.) JAS, WHS, 1965 | Mississippian System  
Palestine Formation (6')  
Sandstone, thin bedded; load casts; asymmetrical ripple marks; parting lineation; occasional cuspatc ripple marks  |
| 48. Section along creek north of road (NE NE NW 21, 78SW, Campbell Hill Quad.) JAS, WHS, 1965 | Pennsylvania System  
Caseville Formation (20')  
Sandstone, medium grained, medium to thick bedded; numerous quartz pebbles 1/8" to 1/4" some up to 1/2" prominent planar cross bedding; zones of coarse sand and shale pebble conglomerate; average cross bedding S32W (2)  |
| 49. Section in gulley east of dirt road (SE SW NW 22, 78SW, Campbell Hill Quad.) JAS, WHS, 1965 | Pennsylvania System  
Abbott (?) Formation (20')  
Shale, thinly bedded, sandy, with thin sandstone beds  |
(49. continued)

<table>
<thead>
<tr>
<th>Thickness ft. in.</th>
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<tr>
<td>Siltytone, light gray, very argillaceous; hackly fracture; <em>Stigmella</em> prominent throughout.</td>
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</tbody>
</table>

Sandystone, medium to coarse grained; zones bearing quartz pebbles 1 handled in diameter; cross bedded; asymmetrical and cuspatc ripple marks; rib and furrow structures; thick bedded; prominent shale pebble conglomerate 2 thick in a zone 1 handled above base of sandystone; some shale conglomerate elsewhere; oriented plant fragments seen in float blocks; average cross bedding SIZE (3). | 34 |

50. Cliff overlooking Mississippi River (NW SE SE 33, 7S-6W Chester Quad.) JAS, DAO, 1965

Mississippian System

Degonia Formation (35')

Sandystone, thin bedded to very thin bedded; becomes thicker bedded in bottom 4'; many thinly laminated in thin bedded portions; symmetrical ripple marks. | 35 |

51. Outcrop above concrete retaining wall on Highway 150 in Chester, Illinois (SW SE SW 13, 7S-7W, Chester Quad.) MEH, JEB, 1965

Mississippian System

Palestine Formation (15')

Sandystone, fine grained, thin to medium bedded; numerous thin shale interbeds 1 handled thick, contains ripple marks, load casts, shale chips and plant fragments up to a few inches in length; bedding irregular and lenticular; very little cross bedding. | 15 |

52. Bluff southeast of Rockwood (NE NW NW 18, 8S-6W, Campbell Hill Quad.) MEH, JEB, 1965

Mississippian System

Palestine Formation (25')

Sandystone, fine grained, thin to medium bedded; a few units are cross bedded; cross bedding medium scale; ripple marks and ripple bedding common; cross bedding due South, due East, and NW-SE. | 25 |

53. Outcrop in ravine adjoining road (3/4 NE SE 2, 8S-6W, Campbell Hill Quad.) MEH, JEB, 1965

Mississippian System

Degonia Formation (70')

Sandystone, thin bedded. | 3 |

Covered. | 15 |

Sandystone, cuspatc ripple marks; rib and furrow structures; a few shale pebbles. | 10 |

Siltytone, cuspatc ripple marks; with thin sandystone beds. | 10 |

Covered. | 10 |

Sandystone, medium bedded, some cross bedding | 2 6 |

Sandystone, thin to medium bedded; beds horizontal and uniform; ripple marked; shows load casts, and groove casts. | 2 6 |

Siltytone, thinly interbedded with shale. | 6 |

Sandystone, thin bedded; some cross bedding; load casts; large scale cross bedding; channel cutting into flat bedding at top of unit. | 7 |

Shale, silty. | 4 |

Covered. | 4 |

Clare Formation

Limestone. | 2+ |

SALINE COUNTY

54. Type locality of Murray Bluff Sandstone Member, exposed on both sides of east-west road

<table>
<thead>
<tr>
<th>Thickness ft. in.</th>
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<tr>
<td>(N W NE 35, 10S-5E Harrisburg 15' Quad., Eddyville 7% Quad.) MEH, 1965</td>
</tr>
</tbody>
</table>

Pennsylvanian System

Abbott Formation

Murray Bluff Sandstone Member (100')

Sandystone, medium grained; much liesegang banding which generally obscures bedding; cross bedded; tectonic dip N50° at 26'; average cross bedding N70W (4), average cross bedding, each measurement corrected for tectonic dip S70W (4). | 100a |

55. Outcrop in creek bed east of highway (NE SE SW 32, 10S-7E. Equality 15' Quad., Hord 7% Quad.) MEH, 1965

Mississippian System

Palestine Formation (15')

Sandystone, fine grained; trough cross bedding and ripple scour; abundant ripple marks especially in upper part; parting lineation fairly common; large plant casts including *Lepidodendron* casts; average cross bedding S70W (4). | 15 |

UNION COUNTY

56. Outcrop in creek valley (SE NE SW 29, 11S-12, Carbondale Quad.) MEH, JAS, 1965

Mississippian System

Degonia Formation (50')

Sandystone, fine to medium grained; abundant cross bedding. | 50 |

(Some fine grained, horizontal, medium bedded sandstone crops out 20' below base of sandstone described above.)

57. Outcrop in creek bed (NW SE NO 30, 11S-15E, Carbondale Quad.) MEH, JAS, 1965

Mississippian System

Degonia Formation (25')

Sandystone, fine grained, thin to medium bedded; numerous ripple marks; good rib and furrow structures; minor amount of cross bedding near top; conformable contact with underlying grey shale. | 25 |

58. Outcrop in south flowing valley south of road (NW SW SE 33, 11S-12, Carbondale Quad.) MEH, FMN, 1965

Mississippian System

Clare Formation (16' 6'+)

Sandystone, fine grained; abundant symmetrical ripple marks; surfaces covered with numerous organic trails about 1 handled wide and several inches long; some burrows. | 2 |

Covered. | 1 |

Sandystone, fine grained, thin to medium bedded; beds average about 3 handled thick; bedding flat and parallel; few ripple scour. | 5 6 |

Shale, with thin sandstone interbedded. | 1 |

Covered. | 1 |

Sandystone, fine grained; beds at top up to 1 handled 6 thick; ripple marks; very thin beds at base. | 6 |

59. Southeast facing bluff, east of highway (SE NW NW 18, 11S-1W, Alto Pass 15' Quad., Cobden 7% Quad.) JAS, MEH, 1965

Pennsylvanian System

Casseville Formation

Battery Rock Sandstone Member (74'+)

Sandystone, medium grained, medium to thick bedded, cross bedded; occasional quartz pebbles. | 9 |
59. Outcrop in stream bed at bridge (SE SW SE 22, 115-1W, Carbolande Quad.) MEH, JAS, 1965
Mississippian System
Degonia Formation (50'+)
Sandstone, medium to thick bedded; cross bedding abundant; average cross bedding 1'6".

60. Outcrop in creek bed on both sides of section line road (SW SE 2, 115-2W, Alto Pass 15' Quad., Cobden 73' Quad.) JAS, MEH, 1965
Mississippian System
Degonia Formation (15'+)
Sandstone, thin to medium bedded; beds 1' to 6'; bedding lenticular; ripple scours on most surfaces; occasional cusptate ripples; medium- to coarse- to fine-grained sandstone; occasional load casts and rib and furrow structures; some carbonate fragments and shale pebble conglomerates.

61. Exposure in creek south of road and west of railroad (NE NW SW 25, 115-2W, Alto Pass 15' Quad., Cobden 73' Quad.) JAS, MEH, 1965
Mississippian System
Waltersburg Formation (6'+)
Sandstone, fine grained; medium bedded; beds 3' to 1' thick; numerous asymmetrical transverse ripple marks; large festoon cross beds; some parting lineation; some interference ripple marks; some rib and furrow structures; average cross bedding 1'6".
Vienna Formation (3'+)
Shale, dark gray, thinly bedded.

62. Roadcut on Interstate Highway 57 at milepost 29-3. Outcrop is on both sides of the highway and in the median (SW NW SW 31, 125-1E, Dongola Quad.) MEH, FNM, 1965
Mississippian System
Cypress Formation (22')
Sandstone, fine grained, thick bedded; beds irregular and some beds with thin interior laminations; occasional ripple marks and poorly developed rib and furrow structures near top.

63. Roadcut on Interstate Highway 57 at milepost 43-42 (SW NE SW 33, 105-2E, Marion Quad.) JAS, MEH, 1965
Pennsylvanian System
Abbott Formation
Finnie Sandstone Member (12')
Sandstone, fine grained, argillaceous, thin to medium bedded; several cross-bedded units; some thin partings of very fine grained micaceous sandstone; red and brown clay incluions; sparry, average cross bedding 1'6".

64. Roadcut on east side of Interstate Highway 57 at milepost 27-38 (SW NW SW 6, 135-1E, Dongola Quad.) FNM, MEH, 1965
Mississippian System
Aux Vases Formation (45'0")


Siever, Raymond, and Potter, P. E., 1956, (See Potter and Siever, 1956, part 2).


Illinois State Geological Survey Guidebook 7
67 p., 31 figs., 3 tables, appendix, 1966

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